



Handbook on

UNDERSTANDING SCIENCE THROUGH ACTIVITIES, GAMES, TOYS AND ART FORMS

Secondary Stage





एक कदम स्वच्छता की ओर

HANDBOOK ON
UNDERSTANDING
SCIENCE THROUGH
**ACTIVITIES, GAMES,
TOYS AND ART FORMS**

SECONDARY STAGE

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NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

ISBN 978-93-5292-208-6

First Edition

January 2020 Magha 1941

BS 2T BS

**© National Council of
Educational Research and
Training, 2020**

₹ 350.00

Printed on 80 GSM paper

Published at the Publication
Division by the Secretary,
National Council of Educational
Research and Training, Sri
Aurobindo Marg, New Delhi 110
016 and printed at???

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FOREWORD

The National Curriculum Framework (NCF), 2005, recommended that children's learning at school be linked to their life outside the school. It further advocated for adopting a constructivist approach of teaching where students and teachers are viewed as partners in the teaching-learning process. The teacher plays the role of a facilitator and helps children to express themselves, handle objects, and explore their natural and social milieu. In the context of teaching of science, the NCF-2005 suggested providing opportunities to children so as to enable them to examine and analyse their everyday experiences and integrate the same in their learning of scientific concepts. In order to realise these objectives, there is a need to reorganise classroom practices which provide opportunities to children for interaction with the environment.

The present handbook attempts to translate the ideas advocated by NCF-2005 in teaching of science to the students at the secondary stage. Various scientific concepts have been illustrated through a series of fun activities, games and toys. The young learners would love to play and participate in these activities and games, which will eventually make the learning of science interesting and enjoyable. In addition, this will also help in the learner's physical, social and emotional development.

I appreciate the efforts made by the Department of Education in Science and Mathematics of NCERT and the Development Team for bringing out this material. Several teachers contributed to the development of this material. We are grateful to their respective organisations for making this possible.

We solicit suggestions and observations of the readers to bring out further improvement in the Handbook.

HRUSHIKESH SENAPATY
Director

New Delhi
12 November 2018

National Council of Educational
Research and Training

PREFACE

Activities and demonstrations are crucial in the teaching-learning process of science. Conduct of activities on scientific concepts in a play-way method is expected to be effective for children at the secondary stage. The present publication is an attempt in this direction.

This book is an outcome of the efforts made in the direction of making science learning interactive, interesting and child-centric. This becomes more relevant considering the declining interest of children in learning science. Attempts has been made to suggest activities in the form of games, toys and fun generating concepts through a child-centric approach, so that the students at the secondary stage can learn the concepts in an interesting way.

The unique feature of this book is the suggestion of some innovative pedagogical strategies. Traditional games, which are struggling for their existence in the present era of technology, have been used as a tool to learn science concepts in an innovative manner. Indoor and outdoor games have been used as a pedagogic tool to learn science. This is expected to ultimately result in the holistic development of a child. Besides, some art forms have also been used to present the concepts of science in an interesting and interactive manner. Development of creative domain of a child through learning science is addressed through activities suggested in the handbook to make learning of science stimulating and exciting.

The activities, toys and games suggested in the handbook may be used for assessment as a tool for learning, assessment for learning or assessment of learning.

Another interesting feature of the book is the scope for involvement of children with special needs. In each and every activity this issue has been addressed and accordingly incorporated. It is expected to facilitate an inclusive setup in school in general and classroom in particular.

Sincere gratitude is due to the development team who have put their sincere efforts to bring out this handbook. Also, thanks are due to the technical staff of the NCERT for their support in the entire process.

The development team of this book believes that the book stimulates and brings the excitement and fascination for learning science by doing. Teachers and parents are requested to refer to the book in the spirit in which it has been written. Encourage and involve children to perform activities and learn by doing rather than by rote. If you find this book useful and enjoy teaching-learning science through this book we will consider ourselves well-rewarded. Suggestions, if any, for further improvement of the book are welcome.

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ACKNOWLEDGEMENTS

The National Council of Educational Research and Training (NCERT) acknowledges the valuable contribution of the individuals and organisations, involved in the development of the *Handbook on Understanding Science through Activities, Games, Toys and Art Forms* for Secondary Stage. The council acknowledges the valuable contribution of the following academicians for giving their valuable inputs in drafting the manuscripts of this book: Ambika Nag, *Resource Person* (Science), Azim Premji Foundation, Rajasthan State Institute, Jaipur; Alka Bhatia, *TGT* (Science), Gyan Devi Salwan Public School, New Delhi; Manisha Chotarani, *Assistant Professor*, Mithibai College, Mumbai; Pramila Tanwar, *Assistant Professor*, DESM, NCERT, New Delhi; Sonaleeca Das, *TGT* (Science), JNV Mokokchung, Nagaland; Vinay Kumar Singh, *Associate Professor*, DEGSN, NCERT, New Delhi.

The leadership of A.K. Wazalwar, *Professor* and *Former Head*, and Dinesh Kumar, *Professor* and *Head*, DESM for providing infrastructure facilities is highly acknowledged.

The council acknowledges the effort of R. C. Das, *Photographer* (Retd.), CIET, NCERT, New Delhi; Dinesh Kumar, *Lab Assistant* (Chemistry), DESM, NCERT, New Delhi; Malvika Shah and Rahul Kumar, *Junior Project Fellows* (Science), DESM, NCERT, New Delhi; C Thangminlal Doungel, *Editorial Assistant* (Contractual), Mohd. Wasi, *DTP Operator*, Publication Division, NCERT and other *DTP Operators*.

The contribution of APC-Office, Administration of DESM, Publication Division, and Secretariat of NCERT are also duly acknowledged.



Empowerment of Girl Child, Responsibility of All

INTRODUCTION

The child's community and local environment form the primary context in which learning takes place. The interaction of child with the environment and engagement with the kind of activities which make the child interested and self-motivated to learn and construct knowledge is the essential aspect of teaching-learning process.

This book is an attempt to suggest ways of teaching-learning in the context of the child's world. The intention is to make the boundary between the school and its natural and social environment porous.

Objectives

The handbook aims to fulfill the following objectives:

- Making teaching-learning process of science inclusive, interesting, interactive and child-friendly.
- Linking learning of science inside and outside the classroom.
- Facilitating development of various domains of a child (cognitive, psychomotor, socio-emotional, communicative, adaptive, etc.) through learning science.
- Striving towards preservation of cultural heritage by using traditional games.
- Integrating science with arts.

How to use

To meet the objectives, some exemplar activities have been suggested under three sections namely— Fun Activities, Games, and Toys, so as to integrate art with science. These activities may be used inside or outside the classroom for making learning alive, vibrant, and meaningful.

There is a scope to modify or improvise these activities as per the need and convenience of the user. Care has been taken to identify low-cost or no-cost materials to perform activities.

Games section includes outdoor as well as indoor games including Board Games. The innovative pedagogical practices have been explored by suggesting the integration of traditional game with teaching-learning of science concepts.

The handbook uses the term Facilitator, which may be either teacher or learner depending on whether the activities are facilitated by the teacher or exclusively planned by learners themselves. This

opens up the opportunity for peer group learning through trial and error method as well.

The activities in each section confirm to a format that includes: Number of Participants; Time Required; Material Required; How to Proceed/Play; Note to Teacher; Points for Discussion; Science behind the Game; Extension of the Activity/Game/Toy; CWSN (Children with Special Needs).

The activities suggested are to be performed in groups so that participation of the whole class may be ensured. Time required for performing the activity is mentioned for smooth conduct through advance planning. In some cases if time required exceeds from 40 minutes, planning may be done accordingly either by arranging for two periods at a stretch or by splitting the phases of activity in two days.

Instructions are mentioned on how to proceed for the activity or play the game. Wherever required, 'Note for the Teacher' is mentioned in a separate box. It is expected to sum up the activity with discussion on the concept involved to make the exercise meaningful. Therefore, under the head 'Points for Discussion', some exemplar questions are suggested on the concept to initiate discussion after performing the activity.

Children have to construct knowledge on the basis of their experiences while performing activities, the Science behind the Activity/game/toy is mentioned as a reference for the teacher.

Under the heading 'Extension of the Activity', more concepts are suggested for which the same activity may be used as a learning tool.

In an inclusive classroom every child should be a part of teaching-learning process. Ways and modifications for involvement of Children with Special Needs (CWSN) are mentioned at the end of every activity to make the whole process inclusive.

As assessment is the part of teaching-learning process, the suggested activities provide an opportunity to be used either in the form of 'assessment as learning', 'assessment for learning' or 'assessment of learning'. As a result there will be a shift beyond paper pencil test, and assessment will become interesting and holistic.

It is expected that the activities suggested in the book will support in developing certain skills such as— problem solving, collaboration, communication, discussion, socio-emotional, performance, creativity, etc., among learners.



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FUN ACTIVITIES

SOUND

HOW DO YOU VARY YOUR VOICE



Number of Players

Entire class



Time Required

10 minutes



Material Required

Few balloons and a pair of scissors.



How to Proceed?

- ⊙ Cut a ring of about 2cm wide from the balloon as shown in the figure below.

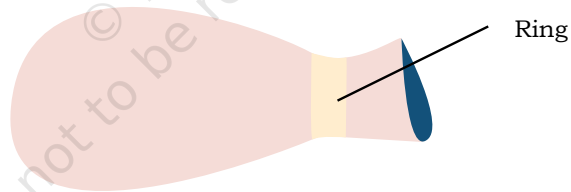


Fig.1

- ⊙ Stretch the ring by holding it from two sides across its diameter and blow through it.
- ⊙ You would hear a whistle.
- ⊙ Try to produce different whistle sounds by further stretching or relaxing the strip.



Points for Discussion

1. How does the sound change on stretching and relaxing the rubber ring?
2. Why does the sound change on stretching the ring?



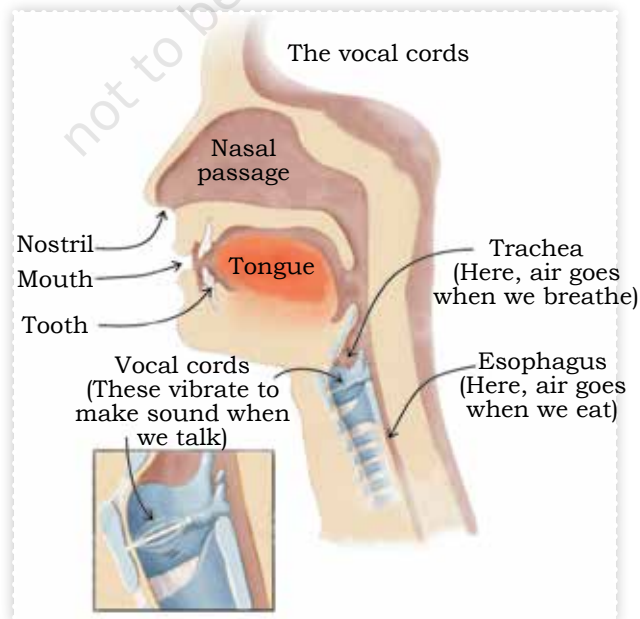
Science behind the Activity

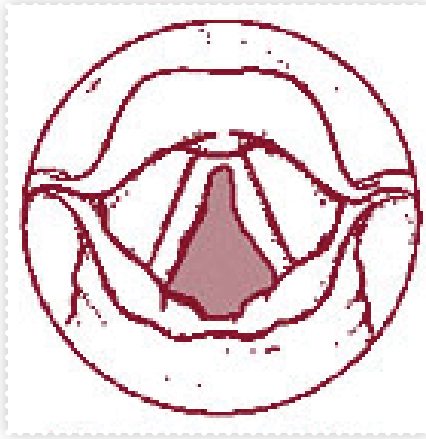
You must have learned that in our throat we have a voice box, or larynx, through which we speak. The particular part that gives us our voice are the vocal cords. The vocal cords are two stretched membranes. It is the vibration of these membranes that is responsible for the voice we produce. By varying the degree of stretching, we can produce sounds of various types.

In this activity, the stretched strip of balloon mimics our vocal cords, and by varying the degree of stretching we can produce sounds of various types, just as we do with our vocal cords. This strip therefore acts as a crude model of the vocal cords and production of sound by it.

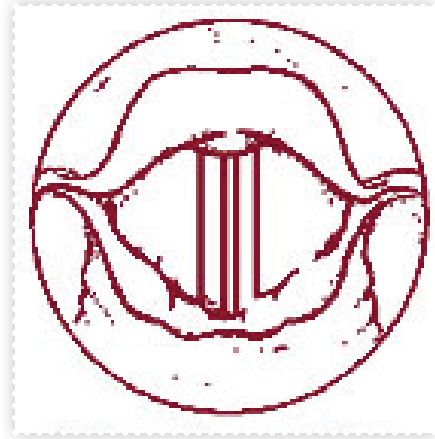
Why does the type of sound change when we stretch or relax the strip?

The reason is that the degree of stretching changes the tension in the strip which changes the frequency of the sound produced.





Vocal cords while breathing



Vocal cords while speaking

https://en.wikipedia.org/wiki/Vocal_folds



CWSN (Children With Special Needs)

- ⊙ This activity can easily be performed by CWVI since it is based on auditory clues. Verbal prompts or physical prompts may be required for the step involving the stretching of the ring (and extent).
- ⊙ For students with locomotor disability: No modification is required.
- ⊙ For students with hearing impairment: Variation in the sound produced may be explained through sign language or gestures.



STRANGE SOUND



Number of Participants

Entire class, in groups of 5 students each.



Time Required

About 2–3 minutes per player



Material Required

One medium sized empty plastic or metal can, 1m thick strong thread, and a small piece of thick cloth (For each group).



How to Proceed?

- ⊙ Make a small hole at the bottom of the plastic or metal can. Pass one end of the cord through it. Tie a matchstick (or toothpick) to this end of the thread so that the thread does not come out of the can.



Fig.1

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ Hold the can in one hand and place the piece of cloth around the thread (near its end).
- ⊙ Now quickly slide the cloth over the thread away from the can while still pressing it over the thread.
- ⊙ Listen carefully if a sound is produced.
- ⊙ Repeat the above steps by sliding the cloth at different speeds.



Points for Discussion

1. Why is a screeching sound produced?
2. Is a loud sound produced if the cloth is rubbed over the thread without the can?
3. Does the can have a role in magnifying the sound produced?



Science behind the Activity

The vibrations created by rubbing or plucking of the thread are transferred to the empty can causing the amplification of the sound produced.

EXTENSION ACTIVITY

- ⊙ Hold the can in one hand and press the other end of the thread with your foot to make the thread taut. Now pluck the thread and listen to the sound produced.
- ⊙ Ask one of your friends to cover the mouth of the can and repeat the whole process.
- ⊙ Encourage students to repeat using cans of different materials and sizes and also with threads of different thicknesses. They may also use a spring instead of thread and shake the can with spring hanging down. Or the spring may be tapped against a hard surface to produce sound. This way, encourage students to produce different sounds. For all these variations students may compare the sounds produced.





Fig. 2



CWSN (Children With Special Needs)

- ⊙ The activity can easily be performed by CWVI because it is based on auditory clues. The teacher or a peer may be asked to provide physical cues while performing the activity for the first time.
- ⊙ For students with locomotor disability: No modification is required.
- ⊙ For students with HI: The variations in the sound produced may be explained using sign language.

CENTRIPETAL FORCE

DEFYING GRAVITY



Number of Participants

Entire class, in groups of 5–6 students each.



Time Required

20 minutes



Material Required

A small tube (empty ink tube of a discarded ball point pen), a piece of thick thread or string about a metre long, and two objects weighing approximately 25g and 200g.



How to Proceed?

- ⊙ Take the tube and pass the thread through it.
- ⊙ At one end of the thread tie the light weight (could be an eraser, pebble or a metal nut).
- ⊙ At the other end suspend the heavy weight (a piece of brick, a block of iron or wood would be fine).

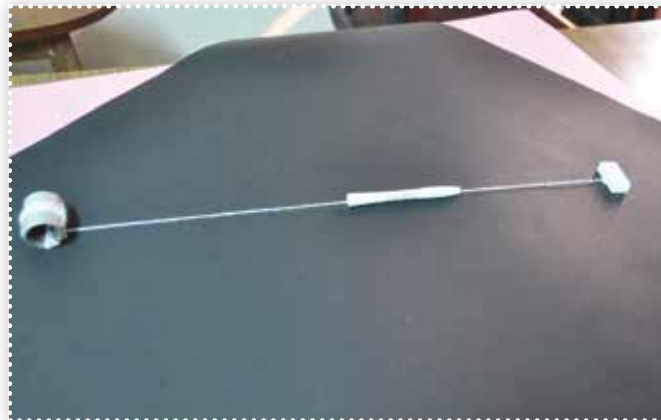


Fig.1

Fun Activity

- ⊙ Now holding the tube firmly, whirl it around so that the light weight starts moving in a circular orbit (Fig. 2). Always keep the string taut.

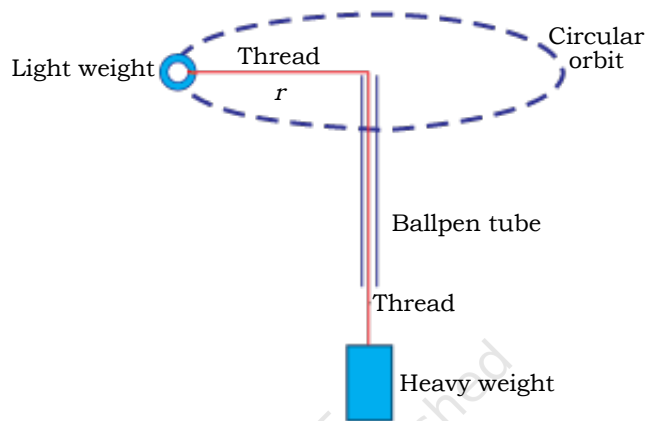


Fig. 2

- ⊙ Increase the speed of rotation slowly.
- ⊙ Observe that as the light weight starts rotating the heavy weight gets pulled up against gravity.



Science behind the Activity

To maintain an object rotating in a circular orbit a force is required to act on the object. This force is called the **centripetal force**. If you rotate an object holding the string in hand, you will feel a pull on the hand. This pull is due to the tension in the string. In this case, there is no hand therefore the pull is on the heavy weight. If the light weight is rotating fast, the centripetal force is stronger than the force of gravity on heavy weight. As a result it gets pulled up, apparently defying gravity.

EXTENSION ACTIVITY

When the heavy weight has been pulled up so that it is near the lower end of the ballpen tube, gently pull it down. You will find that the frequency of rotation of the light weight increases. As you keep pulling down the heavy weight, the frequency keeps increasing. You will learn in higher classes the complete explanation of this phenomenon. Here we can just give a hint. A rotating body acquires a property called angular momentum, which it tends to conserve, in accordance with a law called conservation of angular momentum. The magnitude of the angular momentum $L=mr^2\omega$, where m is the mass of the body, r is the radius of the circular orbit and ω is the frequency of rotation. By pulling the heavy weight downwards, we decrease the radius of the orbit. To keep the angular momentum constant the frequency of its rotation must increase as a consequence.



CWSN (Children With Special Needs)

- ⊙ For CWVI: No modification is required because the movement can be felt by them. Only the procedure may be demonstrated with physical cues for the first time.
- ⊙ For CWHI: No modification is required.
- ⊙ For CWLI: No modification is required.



SCATTERING OF LIGHT

COLOUR OF SUN AT SUNRISE AND SUNSET



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Rectangular container of clear glass or transparent plastic (approximately 30cm × 20cm × 15cm), a large torch (three large cells) or LED torch, water, milk (50ml) and a plane mirror (6cm × 10cm) with a suitable stand.



How to Proceed?

- ⊙ Fill the container with water.
- ⊙ Add a few drops of milk at a time till water appears just milky.
- ⊙ With the help of the plane mirror, direct a beam of sunlight on a face of the container so that the light passes through its length (Fig. 1).
- ⊙ Alternatively, use a torch instead of sunlight (Fig. 2).

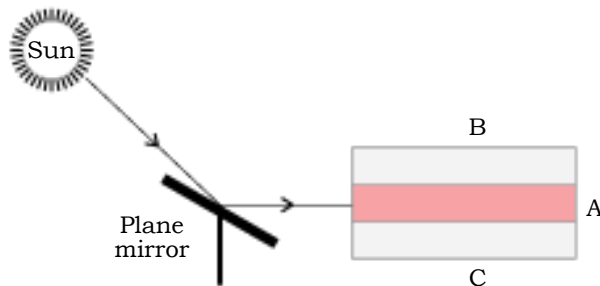


Fig. 1

- Look at the light through the container from Point A (Fig. 1 and Fig. 2). You will see light coming out with a reddish hue. If the incident light is more powerful, the colour of the transmitted light will be redder.
- If you look from Point B or C, you will see light with a bluish hue.

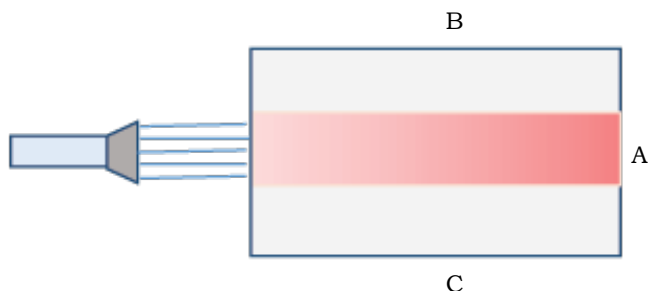


Fig. 2



Science behind the Activity

The particles of milk are suspended throughout the water in the container. These particles scatter light. The white light of the torch consists of seven prominent colours: violet, indigo, blue, green, yellow, orange and red. The wavelength of light increases from violet to red colour. You might have seen the white light split in its component colours in experiments with prisms.

The scattering of light by milk particles is more effective for shorter wavelengths than for longer wavelengths (proportional to $\frac{1}{\lambda^4}$). Therefore, blue light is scattered more than the red light. The scattered light is sent in all directions (Fig. 3).

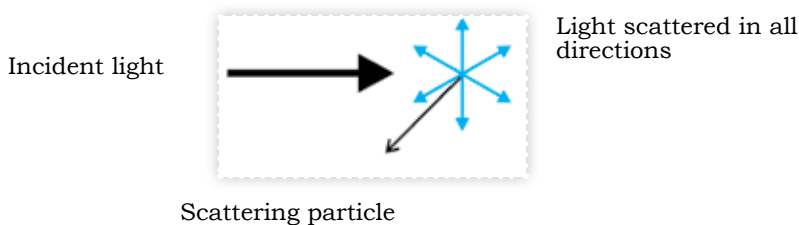


Fig. 3



When we look at the light coming out through the side of the container opposite to the side on which light is incident (from Point A), we see the light from which blue colour has been filtered. The colour of light, therefore, appears reddish. On seeing from Points B and C, we see the scattered light which is richer in blue colour.

When you see the sun at sunrise and sunset, you see it red because much of the blue colour has been removed by scattering due to air and dust particles in the atmosphere of the earth. As the sun keeps rising in the sky after sunrise, reddishness decreases because the path of sunlight becomes progressively shorter through the atmosphere (Fig. 4). If you look in any direction other than the sun, you see the scattered blue colour. That is the reason for sky appearing blue.

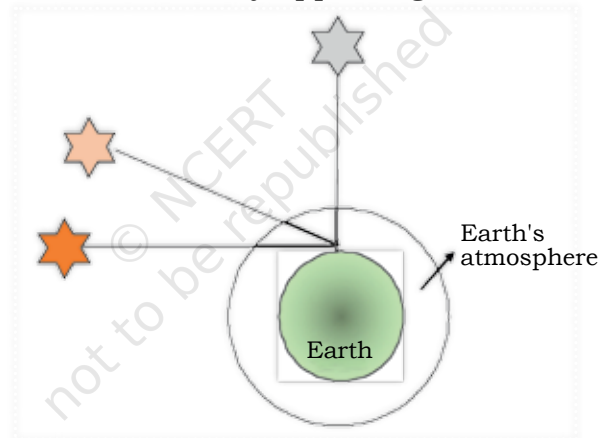


Fig. 4



CWSN (Children With Special Needs)

- ⊙ For CWVI: Since, this experiment is based on purely visual concept, the student with visual impairment may be paired with a sighted buddy.
- ⊙ Availability of colour probes (to detect and tell about the colour change) will enable the student to know about the colour change. In absence of colour probes the change may be conveyed verbally to the student.

MAGNETIC EFFECTS OF ELECTRIC CURRENT

ELECTROMAGNETIC INDUCTION



Number of Participants

Entire class in groups of 5–6 students each.



Time Required

30 minutes




Material Required

Coil of enamelled copper wire (about 100 turns), enamelled copper wire (about 10 m), strong bar magnet, a galvanometer, two cells, two LED 1.5 V (preferably of different colours), and a sand paper.



How to Proceed?

- ⊙ Clean the ends of the copper wire by rubbing them with sandpaper. If the readymade coil is being used, clean the ends of the coil.
- ⊙ Wind the wire in the form of a coil of radius about 1.5cm. You should be able to get about 100 turns. Make sure that you leave sufficient length of wire at both the ends to make connections. 
- ⊙ Connect the coil to a galvanometer as shown in (Fig. 1).
- ⊙ Hold the magnet in such a way that one of its poles points towards the coil.
- ⊙ Move the magnet rapidly towards the coil (Fig. 1).
- ⊙ The needle of the galvanometer gets deflected to one side, showing that the moving magnet has induced a current in the coil.

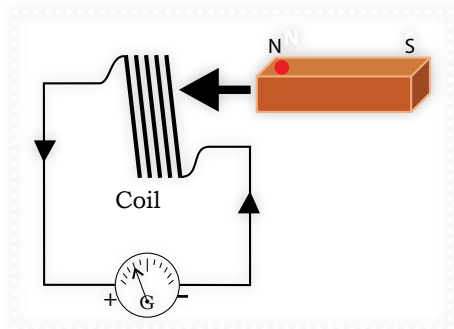


Fig. 1

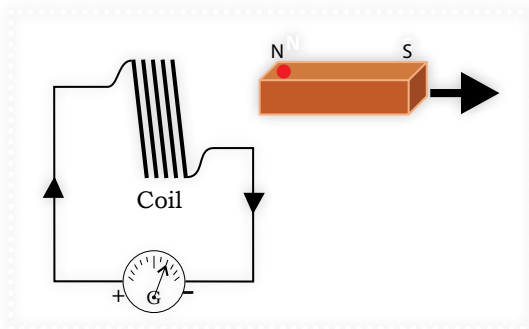


Fig. 2

- ⊙ Now move the magnet away from the coil (Fig. 2). This time the galvanometer needle gets deflected in the direction opposite to the previous direction, showing that the induced current in the coil is now in the reverse direction.
- ⊙ Move the magnet faster and notice the increase in the deflection.
- ⊙ Now repeat the above activity with the other pole of the magnet towards the coil. All deflections are now reversed compared with earlier case.



Science behind the Activity

When a magnet moves towards the coil, the magnetic field linked to the coil changes. The changing magnetic field induces current in the coil. This phenomenon is called magnetic induction. Instead of the magnet, the coil can be moved, or both can be moved towards or away from each other. As long as there is **relative motion** between the coil and the magnet, the current is induced in the coil. The direction of the induced current depends on the direction of motion of the magnet. When the magnet moves away, the direction of the current induced is opposite to that produced when the magnet moves towards the coil. For a given coil, the deflection of the galvanometer depends on the strength of the magnet, and the relative speed between the coil and the magnet.

EXTENSION ACTIVITY

- ⊙ Change the number of turns in the coil and note the changes in the magnitude of the deflection in the galvanometer needle.
- ⊙ The bar magnet can be replaced by a similar coil with a core of soft iron and connected to a cell in which a current is flowing (Fig. 3). This coil is equivalent to a bar magnet. Then the relative motion between the two coils can induce current in the coil connected to the galvanometer.
- ⊙ Insert a core of soft iron in the coil connected to the galvanometer and notice the change in the extent of deflection.

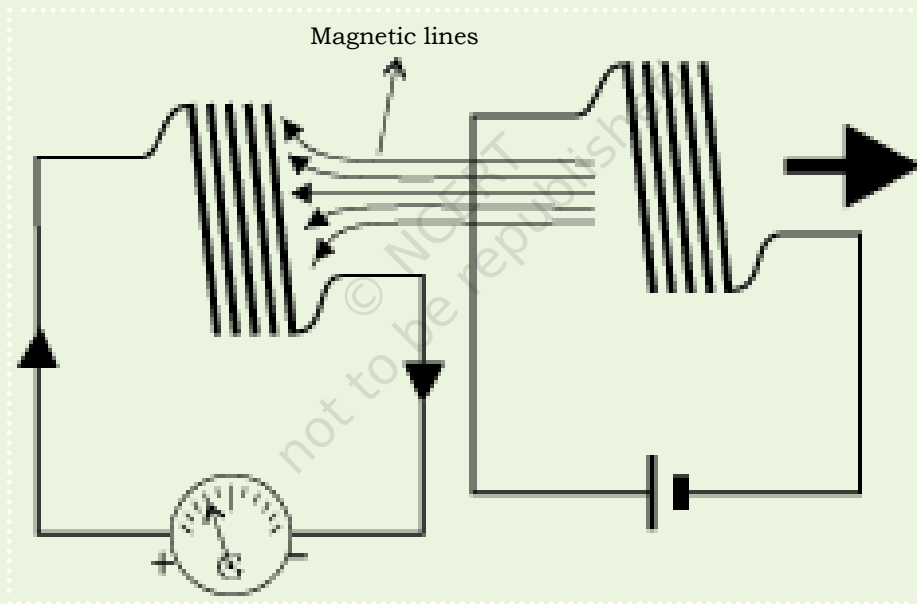


Fig. 3

- ⊙ Connect the coil with LEDs as shown in Fig. 4 and Fig. 5. If the magnet is strong and moved fast, the LEDs should glow; one while the magnet is moved towards the coil, and the other when it is moved away from the coil.



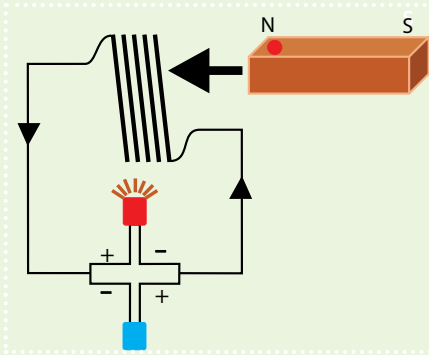


Fig. 4

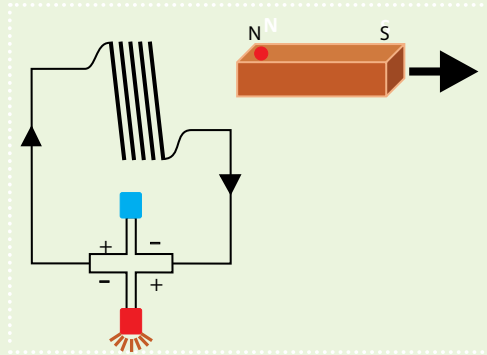


Fig. 5



CWSN (Children With Special Needs)

- ⊙ For this activity CWVI must be paired with another student who can tell him about the deflection in the needle and the change in the direction of the deflection. The peer can also help him with the set up, and for carrying out the activity light probes may be used.
- ⊙ For CWHI and CWLI: No change is needed.

REDOX REACTION

CHANGING COLOUR LIKE A CHAMELEON



Number of Participants

Entire class



Time Required

30 minutes



Materials Required

Funnel, filter paper or cotton, two glass tumblers or beakers, glass rod, potassium permanganate and sodium hydroxide.



How to Proceed?

- ⊙ Facilitator will divide the class into groups to perform the activity.



- ⊙ Prepare a dilute solution of potassium permanganate by dissolving 0.5g in 250ml solution.
- ⊙ Prepare 0.01N solution of sodium hydroxide by dissolving 0.1g in 50ml solution. Take 20ml of the potassium permanganate solution in a glass beaker.
- ⊙ Add about 1ml 0.01N sodium hydroxide solution to it. Note the colour of the solution.
- ⊙ Take a filter paper and fold it. Place it in the funnel and keep it on a flask.

- ⊙ Pour the coloured solution slowly through the funnel and note down the change in the colour of the filtrate.
- ⊙ Repeat the above four steps by using a cotton ball in place of filter paper. Observe and note down the change in the colour of the filtrate.
- ⊙ In another beaker, take 20ml of potassium permanganate solution and 1ml of sodium hydroxide solution. Transfer this solution into another beaker through a plastic strainer.



Points for Discussion

- ⊙ What was the colour observed on adding 0.01N sodium hydroxide solution to potassium permanganate solution?
- ⊙ Did the colour of the solution change after passing through filter paper?
- ⊙ Did the colour of the solution change after it was filtered through cotton ball?
- ⊙ Did the colour of the solution change after passing through plastic strainer?
- ⊙ Which of the material present in filter paper or cotton helped in the colour change of the solution and why?



Science behind the Activity

This is an example of redox reaction. Cellulose present in filter paper or cotton act as a reducing agent that reduces alkaline solution of potassium permanganate into potassium manganate. The green colour of the filtrate slowly changes to brown and finally becomes colourless, as potassium manganate formed during redox reaction is colourless. There is no change in colour when the coloured solution is passed through plastic strainer as no redox reaction occurs.

EXTENSION ACTIVITY

A variety of material or devices such as cotton wool, plastic, cotton cloth, nylon cloth, stainless steel strainer could be used to find out if there is any change in colour.



CWSN (Children With Special Needs)

- ⊙ CWVI may either be provided colour probes or they should be paired with a sighted buddy who can tell the child about the colour change.

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THE DANCING MUG



Number of Participants

To be done individually preferably at home.



Time Required

5 Minutes



Material Required

A bucket and a mug.



How to Proceed?

- ⊙ For this activity you will need a running tap of water.
- ⊙ Keep the bucket under the running tap and fill it.
- ⊙ Place the mug in water in the bucket.
- ⊙ Note the manner in which the mug floats on water. Is it floating in vertical position or is it tilted?
- ⊙ Place the mug on water in different ways and note the manner in which it finally rests (Fig. 1).
- ⊙ Open the tap a little so that a thin stream of water flows out of it. Let the water fall into the mug floating in water. If required, adjust the mouth of mug for the tap water to fall inside it (Fig. 2 and Fig. 3).
- ⊙ Observe what happens to the tilting of the mug as it gets filled with water. Make a note of the surface of water inside the mug. Is it also tilted like the mug or is it horizontal? Also try to note the difference



in level of water between the bucket and the mug when it comes to vertical position (Fig. 4).

- ⊙ Slightly tilt the water-filled mug and release it. Note the position in which the mug finally settles. Repeat it a few times. Does the mug always come back to the vertical position?
- ⊙ Open the tap again and let the mug get filled up to the brim. Make a note of the levels of water inside and outside the mug during this time. Does the mug sink more and more as it gets filled with water?



Science behind the Activity



A body floats in a liquid if the weight of the liquid displaced by it is higher than its own weight, that is, the upthrust is more than the weight of the body. Initially, when the mug is empty it floats in an inclined position. This is because in equilibrium position,

the centre of gravity of the mug should be at the lowest point. However, as the mug gets filled with water, the position of its centre of gravity keeps falling with respect to the outside water surface. At the same time the centre of gravity also keeps shifting



towards the axis of the mug making it tilt more and more towards a vertical position. Finally, the mug begins to float in a vertical position.



CWSN (Children With Special Needs)

- ⊙ By pairing the visually impaired child with a sighted buddy he may be made to feel the different positions of the mug and he may be guided by the buddy to feel the surface of the coater inside the mug and the difference in the level of water between the bucket and the mug and other such changes by means of tactile sense.
- ⊙ For CWHI: No modification is required.

AMPLITUDE OF PENDULUM

DO YOU TRUST SCIENCE?



Number of Participants

Entire class



Time Required

30 minutes




Materials Required

Two litre can (tin/plastic), thick nylon cord (about 5 m long), sand (about 2 kg).



How to Proceed?

- ⊙ Fill the can with sand so that it weighs about 2kg. If available you could use 2kg weight.
- ⊙ Suspend the can like a pendulum in the middle of a room from the ceiling. If this is not possible, you could go out and suspend the can from a tree, or make some other suitable arrangement for its suspension. The can acts as the bob of a pendulum. 
- ⊙ Take the can to one side and adjust the height of the pendulum from the ground so that in its extreme position it is roughly at the level of the nose of the student. Make a line on the ground to mark her/his position.

Before letting the students perform this activity:

- The teacher must ensure that the student taking the assigned position does not move at all from that position.
- Also ensure that the bob is not given any push while releasing it.

- Ensure that the lid of the tin can is secured so that it does not open during the activity.
- Make sure that the support is strong and the bob does not get separated from the string.
- ⊙ Ask a student to stand firm on that line and not move away.
- ⊙ Let her hold the can only a few centimetres from her nose. Ask her to let the can go, without giving it any push.
- ⊙ Observe the reaction of the student as the can approaches her after completing an oscillation.
- ⊙ Does she move from her position as she sees the can approach her?
- ⊙ Let each student in turn stand in the position taken by the first student.
- ⊙ Repeat the process.
- ⊙ See the reaction of the students as the can approaches them.



Science behind the Activity

The distance of the extreme position of the pendulum from the mean position is called its amplitude (L in Fig.1). From the experiments on the simple pendulums we know that for a given pendulum the amplitude never increases while the time for one oscillation remains constant. Even knowing this, the student has a natural tendency to move away to protect himself/herself from being hit by the 2 kg weight. Not only these students, it is a universal tendency. This means that when it comes to being hurt, we have very little faith in science.

In this case, every time the pendulum is set oscillating, its time period is constant and its amplitude does not change much if the friction at the point of suspension is small. The amplitude does not increase in any case.

So, armed with this fact, there was little to be afraid of when the heavy can was approaching us. We should have had faith in science.

Remember that the first astronaut had enormous faith in science when he agreed to go into space; consequences of any wrong calculation or assumption could have been extremely disastrous. Every new venture is fraught with dangers; but faith in scientific process gives us the courage to undertake it.

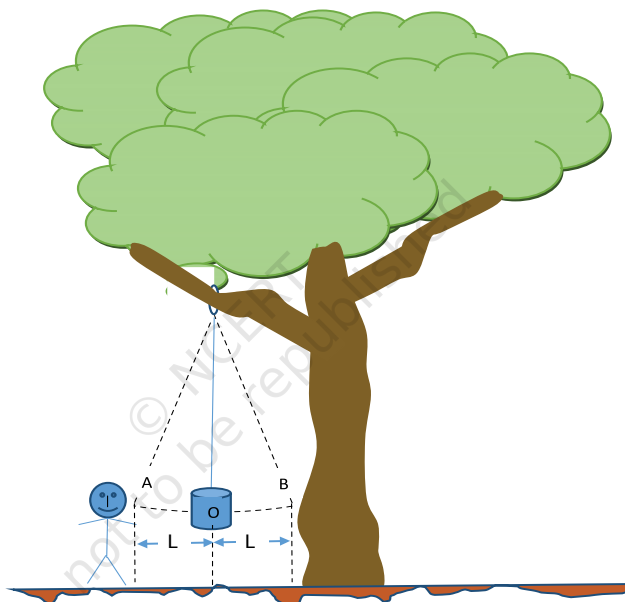


Fig.1



CWSN (Children With Special Needs)

- ⊙ For CWVI: It's a purely visual activity so observation of the approaching pendulum is not possible. A sighted buddy or teacher may tell the student about it.
- ⊙ For CWHI: No modification is required.
- ⊙ For CWLI: No modification is required.



LIVING ORGANISM

FIND MY 'MISSING PART'



Number of Participants

Entire class



Time Required

30 minutes



Materials Required

Chart paper, cardboard, marker pens, double sided tape, pair of scissors and cloth piece for blindfolding the players.



How to Proceed?

- ⊙ This game is about finding the 'missing part' of the body of an organism.
- ⊙ Students may prepare cut-outs of diagrams of some organisms, such as Hydra, Spirogyra, Bacterial cell, Euglena, etc.
- ⊙ The cut-outs may be prepared in such a way that all its parts are detachable.



For example, make a cut-out of *Hydra* with one or more of its detachable tentacles, stinging cells, etc., or a filament of *Spirogyra* with detachable chloroplast, pyrenoid, nucleus, etc.

- ⊙ Divide the class into two teams, A and B, and make them sit teamwise.
- ⊙ Fix the cut-out on a soft board or a cardboard with the help of double sided tape.
- ⊙ Players of both teams will observe the cut-out carefully and find out which part is missing from it.

- ⊙ Facilitator will call one student from team A and hand over the missing part. The student will observe using various senses the position of the missing part.
- ⊙ The facilitator will tie a cloth strip on the student's eye to blindfold.
- ⊙ After that the facilitator will turn around the blindfolded player and ask to affix the missing part with a double sided tape. The other members of the team can guide this player by giving directions such as 'Go left', 'Move a bit on the right', so on and so forth!
- ⊙ Affixing of 'missing part' at the correct location will give 10 points to the team and placing it in wrong location will not fetch any points.
- ⊙ Likewise, after the turn of team A is over, a player of Team B shall be blindfolded and asked to affix another missing part.
- ⊙ The facilitator will begin next round of game with another example.
- ⊙ Team that scores more points will be declared as winner.



Points for Discussion

- ⊙ The facilitator can initiate the discussion about the position, characteristics and function of the 'missing part' of each example.
- ⊙ Based on these parts, there can also be a discussion about the characteristic features of various phyla.



Science behind the Activity

- ⊙ The uniqueness (or characteristic features of all organisms) is the basis of diversity in living forms.

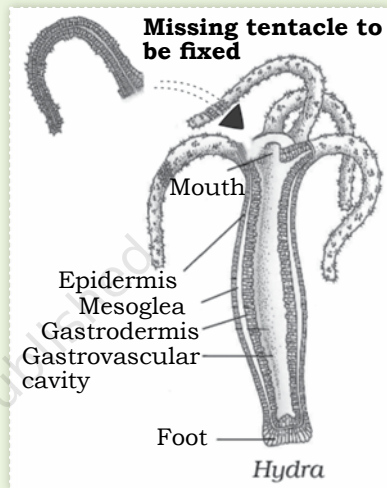
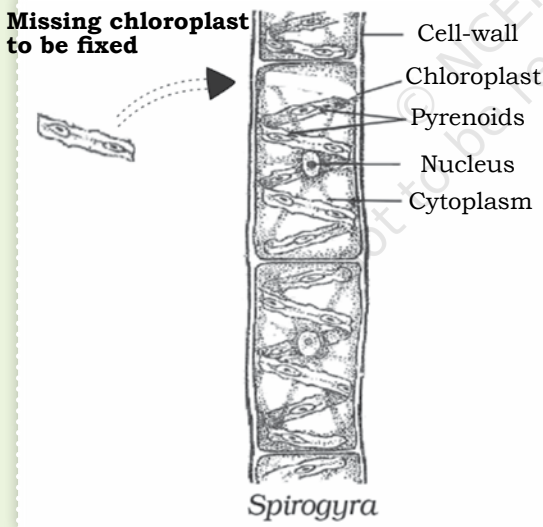


Fun Activity

- Organisms have been classified into different groups and sub-groups on the basis of their similarities, differences and relationships.
- Through this game, examples of various phyla and their characteristic features can be reinforced in a play-way manner.

EXTENSION ACTIVITY

- The plot of this game can be used to reinforce location and structures of various Plant tissues and Animal tissues; for example, those of meristematic tissues in plant body, of guard cells in epidermal layer, of dendrite in neuron unit of nervous tissue, etc.



- Debate can be held about the importance of biodiversity and about causes of decline in biodiversity.
- 3-D models of organism belonging to different groups may be used to play this game.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The diagrams have to be made tactile using different textures which can be easily discriminated, and the activity may be done using that.
- ⊙ For low vision student diagrams may be drawn using bold lines.
- ⊙ For CWHI: No modification is required.

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NEUTRALISATION REACTION

DISAPPEARING BEADS



Number of Participants

Entire class



Time Required

10 minutes



Materials Required

100ml measuring cylinder, 5ml dilute (10%) HCl, 90ml kerosene, 10ml 1% NaOH solution, phenolphthalein solution and a dropper.



How to Proceed?

- ⊙ Take a 100ml measuring cylinder and add 5ml HCl into it. Now add carefully 90ml kerosene slowly to form a layer over the acid.
- ⊙ Add a drop of phenolphthalein solution to 10ml 1% NaOH solution, taken in a test tube (this gives a reddish-pink coloured solution).
- ⊙ From the top of the cylinder add a drop of coloured NaOH solution. Observe the movement of the drop through the kerosene to the acid below it.
- ⊙ The drop retains its colour through kerosene but disappears in the layer of acid at the bottom.
- ⊙ Likewise add more drops of coloured NaOH solution and observe. It creates wonderful visual as if tiny beads are coming down from the kerosene layer and are disappearing at the bottom.



Points for Discussion

- ⊙ Where has the bead gone? Why did it retain its colour in kerosene?



Science behind the Activity

This is a neutralisation reaction. There is an acid at the base of the cylinder. The coloured beads are made of dilute base and phenolphthalein. The cylinder contains kerosene on the top of the layer of acid. The two chemicals are immiscible so they form two different layers. When pink drop of base passes through the layer of kerosene, it looks like a bead falling down as base is also immiscible with kerosene. When pink bead enters the layer of acid it gets neutralised by the acid layer and disappears. This forms an illusion of disappearing beads.

EXTENSION ACTIVITY

- ⊙ The fun activity can be played with different combination of acids, and bases and a neutral liquid (kerosene).
- ⊙ In place of kerosene, turpentine oil or any refined oil can be used.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The student may be paired with a sighted buddy to explain the changes which are purely visual. The markings on the cylinder may be made tactile.
- ⊙ For CWHI: No modification is required.



PH OF SOLUTION

CHEMICAL RAINBOW IN A BOTTLE



Number of Participants

Entire class



Time Required

20 minutes



Materials Required

Dilute hydrochloric acid (HCl), sodium hydroxide (NaOH), universal indicator, 10ml test tube, conical flask and droppers, two standard flasks (250ml) (Fig. 1).



How to Proceed?

- ⊙ Prepare 0.1 M solution of NaOH by dissolving 1g solid NaOH in water in 250ml standard flask.
- ⊙ Take 5ml water in a test tube or conical flask and add two drops of universal indicator to it.
- ⊙ Add 0.1 M HCl drop by drop to it till the solution becomes red in colour (Fig. 2).
- ⊙ Now start adding 0.1 M NaOH solution. With every drop there will be change in the colour of the solution. The colour will change from red to



Fig.1: Material required

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

orange Fig (3) to yellow Fig (4) to green Fig (5) to blue Fig (6) to indigo Fig (7) to violet Fig (8) by adding drops of the base.

- ⊙ On getting violet colour, Fig (8) put aside the bottle of NaOH solution and start adding HCl solution drop by drop.
- ⊙ On adding acid, the colour of the solution in the bottle will change to blue to indigo to green to yellow to orange to red.



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8





Points for Discussion

What is it that makes the solution change colour? What would happen to the red colour if you continue adding acid? Similarly, what would happen to the violet colour if you continue adding base?



Science behind the Activity

This is a reaction showing the change in the pH value of the solution. Universal indicator responds to the number of H^+ or OH^- ions present in a solution and shows a particular colour. That is why when concentration of these ions is changed by adding drops of either acid or base, solution keeps changing its colour. On continuous addition of acid, the red colour intensifies. Similarly, violet colour intensifies on further addition of base.

EXTENSION ACTIVITY

Students can do the same experiment with red cabbage juice. To extract red cabbage juice, make a paste of red cabbage in warm water, strain and cool the solution. Use it in place of universal indicator.



CWSN (Children With Special Needs)

- ⊙ CWVI may either be paired with a buddy to tell him about the colour change or colour probes should be provided to him.

Precaution: Desired volume of acid and corrosive solutions may be provided to the CWVI if he is conducting the activity independently.

- ⊙ For CWHI: No modification is required.

DEFECTS OF VISION

MODEL OF THE EYE



Number of Participants

Entire class divided into groups each of 5–6 students.



Time Required

35 minutes



Materials Required

Each group of students is to be provided with a cylindrical jar (diameter about 10cm and height about 15cm) made from clear plastic or glass (a 250ml round bottom flask preferably with a flat bottom can also be used), convex lens L_1 (focal length 10cm), convex lens L_2 (focal length 20cm), concave lens L_3 (focal length 20cm), two lens holders, a 15cm x 15cm piece of thick cardboard/styrofoam, a pair of scissors/sharp paper cutter, two laser pencil lights, sticking tape, milk (50ml) and water.



How to Proceed?

- ⊙ Fix the lens L_1 on a lens stand and place it in front of the cylindrical jar. Make sure that the optic centre of the lens lies nearly in the line through the middle of the jar. If required, adjust the height of the jar and/or that of the lens by placing a pile of books under them or by any other suitable arrangement.
- ⊙ Fill the jar with water up to a height such that its level is above the upper edge of the lens kept in front of it. Add a few drops of milk to the water in the jar.



The amount of milk added should be just enough to give it a milky appearance.

- ⊙ Now fix the two laser pencils horizontally on a piece of cardboard using sticking tape such that the rays from them are parallel to each other and are close together. Fix this arrangement on a laboratory stand or place it on a pile of books such that the laser lights are at the same height as the optic centre of the lens (Fig. 1).
- ⊙ Direct two parallel beams of laser light on the jar containing milky water. Look at the laser beams through water in the jar from the other side or from the open top of the jar. Do you observe that the two beams of light get converged in the milky water in the jar? If the beams of laser light in milky water are not visible clearly, add a few more drops of milk or water depending on whether the colour of milky water is too light or too dark.
- ⊙ Where do the two beams of light appear to meet in the milky water? Do they meet within the jar or outside it? In this model of the eye, the jar of water and the lens in front of it may be considered to represent the eye (Fig. 1). In the above arrangement the inner surface of the jar on the opposite side, would represent the position of the retina of the human eye.
- ⊙ When parallel rays meet in front of the retina (Fig. 2), the eye cannot see distant objects clearly. This defect of the eye is called myopia or near-sightedness.
- ⊙ Now place a diverging or concave lens L_3 in front of lens L_1 . Observe what happens to the image point. Does it move forward or backward? The shifting of the image towards the retina mean that a diverging lens can be used to correct myopia (Fig. 3). To bring the image exactly at the retina, you need a

concave lens of suitable focal length. This is what an ophthalmologist does to prescribe for you a lens of correct focal length (or power).

- ⊙ Next, adjust orientation of the two laser pencils fixed on the cardboard such that the beams of light from them are slightly diverging instead of being parallel. Switch on the two laser lights and observe the path of the two diverging beams in the milky water. Where do the two beams meet? Is the image point still at the retina or slight behind it? Which type of eye defect does this represent? Rays from nearby objects reaching the eye are divergent. If these divergent rays meet behind the retina, nearby objects cannot be seen clearly. This defect of the eye is called hypermetropia or far-sightedness.
- ⊙ Now, place lens L_2 in front of the eye lens (L_1). Observe what happens to the image point. Does it move forward or backward? The shifting of the image towards the retina from behind it means that a converging lens can be used to correct hypermetropia (Fig 4). To bring the image exactly at the retina, you need a convex lens of suitable focal length. This is what an ophthalmologist does to prescribe a lens at correct focal length (or power).



Science behind the Activity

The following ray diagrams would help you to understand how the divergent and convergent lenses help in correcting two types of eye defects namely—myopia and hypermetropia [Fig. 5 and Fig. 6].

Note to the Teacher: In a normal eye, the light reaching the eye from far and near object always gets focussed at the retina. This is possible as the focal length of normal eye lens gets suitably adjusted due to its power of accommodation.



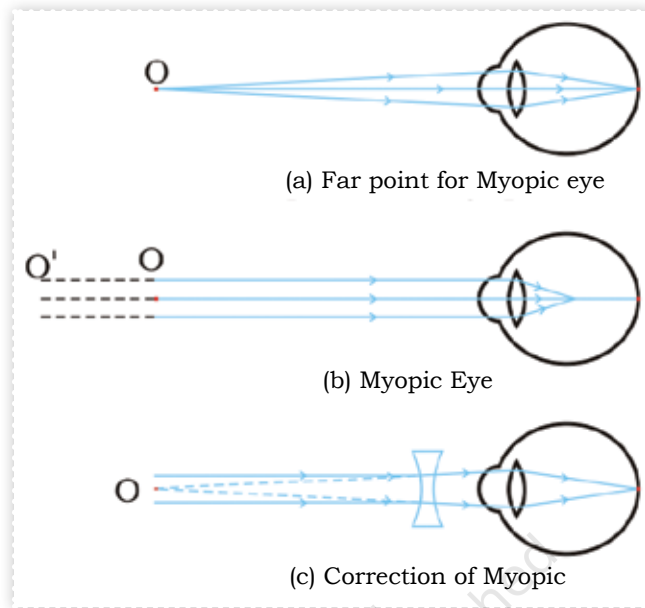


Fig.1

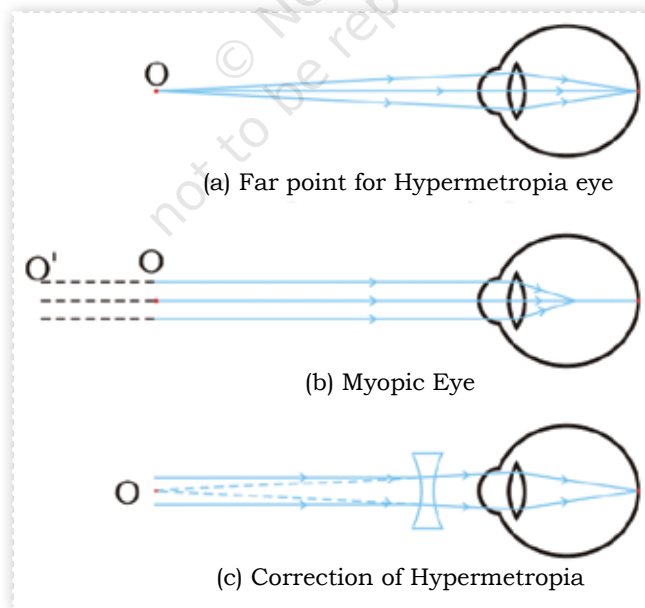


Fig.2



Fig.3



Fig.4



Fig.5



Fig.6



CWSN (Children With Special Needs)

- ⊙ For CWVI: Purely visual activity but the concept of myopia and hypermetropia and their correction can easily be given by giving tactile ray diagrams.
- ⊙ For CWHI: No modification is required.



DISPLACEMENT REACTION

A FANCY BOOK MARKER



Number of Participants

Entire class



Time Required

1 hour



Materials Required

Iron strip (3cm × 10cm), glass tumbler, water, copper sulphate (5g), wax, oil paint, brush, metal bowl, candle and match box.



How to Proceed?

- ⊙ This activity can be performed individually.
- ⊙ The facilitator may ask the students to dip iron strip in a bowl of molten wax. Allow layer of wax on both side of the strip to deposit.
- ⊙ Ask students to scratch the wax from the strip to make a design of their own choice. They can also scratch some name.
- ⊙ Prepare solution of copper sulphate by dissolving about 5g of CuSO_4 in 250ml of water in a glass tumbler.
- ⊙ Ask students to dip the designed iron strip in the solution of CuSO_4 as shown in Fig.1. Leave it aside for one hour.
- ⊙ Now take out the strip from the solution, and remove the wax by putting the strip in boiling water. Your designed book marker is ready for use.
- ⊙ The book marker can also be decorated with designs made with oil paints of various colours.



Points for Discussion

- ⊙ In which colour does the design appear and why?
- ⊙ Is the colour uniformly spread over the design?
What happens to the blue colour of CuSO_4 solution taken in the beaker?



Science behind the Activity

This activity is an example of a displacement reaction. Iron being more reactive than copper, displaces copper from the solution of copper sulphate. The copper gets deposited on the surface, wherever iron is exposed to the copper sulphate solution. As a result of this displacement reaction, the blue colour of copper sulphate solution changes to green due to the formation of ferrous sulphate.

The copper colour does not appear on the unexposed part of the strip.

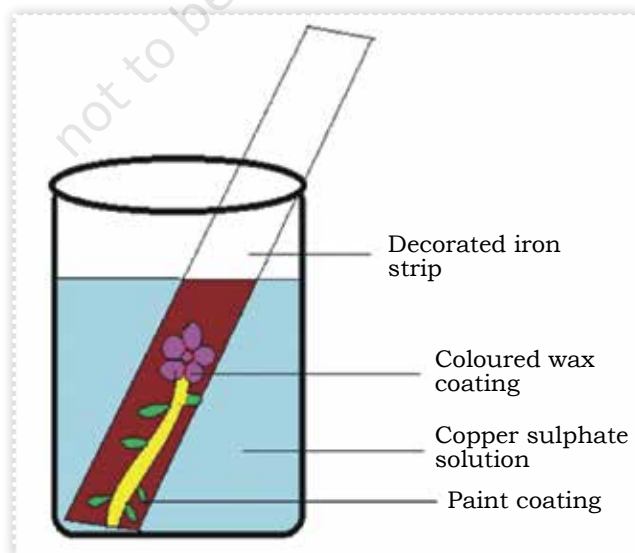


Fig. 1



EXTENSION ACTIVITY

- ⦿ By changing the metal and metal ion solution, metallic cards of different colours can be prepared. Thus (e.g., by using a strip of aluminium and solution of iron sulphate) various metals and the reactivity series can be visualised.



CWSN (Children With Special Needs)

- ⦿ The CWVI may perform the activity easily if they are paired with a sighted buddy. The CWVI student may be given the freedom to perform the activity only with verbal cues or prompts and the change in colour (wherever it occurs) must also be told.
- ⦿ For CWHI: No modification is required.

BOTH EYES JUDGE THE DEPTH OF AN OBJECT

THE EYE CAN DECEIVE YOU



Number of Participants

Each student will do this activity.



Time Required

5 minutes



Materials Required

Two sharpened pencils.



How to Proceed?

- ⊙ Hold two sharpened pencils one in each hand, with sharpened edges facing each other (Fig.1).
- ⊙ Stretch both of your hands in front of your eyes.
- ⊙ Shut one of your eyes.



Fig.1

- ⦿ Now move the two pencils gradually towards each other and see if you can touch the tips of the pencils together (Fig. 2).
- ⦿ The result may surprise you. Try again.



Fig.2: A child trying to touch tips of the pencils with one eye closed.



Science behind the Activity

To judge the depth of any object we have to use both eyes which view the object from slightly different angles. Therefore, this simple exercise becomes difficult as we shut one eye, and see with the other.



CWSN (Children With Special Needs)

- ⦿ For CWVI: Purely visual activity can't be performed by CWVI.
- ⦿ For CWHI: No modification is required.

FLOATING FINGER



Number of Participants

Each student will do this activity.



Time Required

5 minutes



Materials Required

Nil



How to Proceed?

- ⊙ Stand about 2–3 metres in front of a white screen or a wall. Stretch your both hands in front of your eyes with the forefingers of two hands touching each other horizontally (Fig. 1).
- ⊙ Now look beyond the fingers at the screen or the wall.
- ⊙ While keeping your eyes fixed at the wall, move apart the forefingers gradually. You will be able to see a ghost finger hanging in the air (Fig. 2).
- ⊙ If you focus your eyes on the ghost finger, it disappears, but appears again when you look far.
- ⊙ If you continue to pull the two fingers apart you will find that the size of the ghost finger shortens, becoming circular (Fig. 3) and finally disappearing when the separation between the two fingers is about 3–4cm.



Fig. 1

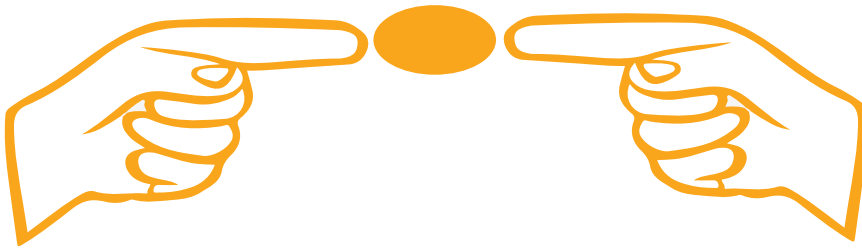


Fig. 2

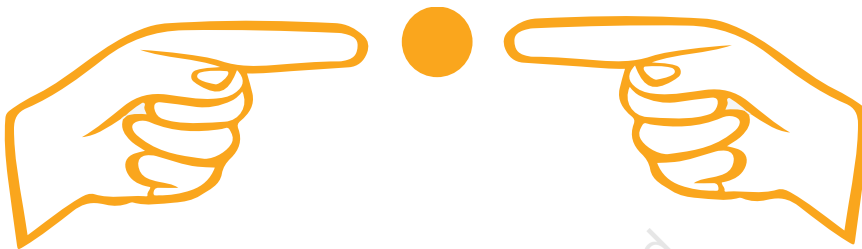


Fig. 3



Science behind the Activity

Our two eyes form two different images. Each eye has its own field of vision differing slightly in angle from the other. When the brain receives the messages from both the eyes, it combines the two messages and enables you to see the object.

When you are looking far, the images of the ends of the two fingers are not coincident and you get two separate images. When the brain receives the messages from both the eyes, it combines the two messages and you see a floating finger.



CWSN (Children With Special Needs)

- ⦿ For CWVI: Purely visual activity can't be performed as it requires visual input. Description may be provided in Braille.

DISPERSION OF LIGHT

MAKE YOUR OWN RAINBOW



Number of Participants

Entire class in 4–5 groups.



Time Required

10 minutes



Material Required

Water sprayer



How to Proceed?

- ⊙ Take a spray bottle and fill it with water.
- ⊙ When the Sun is fairly low and behind you (such as early morning or late in the afternoon), use the sprayer to produce a fine spray. Keep spraying for some time to produce a dense fog of water droplets.



Fig. 1

- ⊙ Observe carefully. What do you see? A Rainbow! You can even see the component colours of a rainbow.
- ⊙ The direction of sunlight is important at the time it strikes the spray. It determines whether or not you will see a rainbow.



Science behind the Activity

1. White light is made up of a spectrum of colours, each with its own wavelength.
2. When light from the sun strikes a water droplet, some of the lights are reflected. The rest of the light is refracted and gets split into its component colours.
3. At the rear of the droplet, the light strikes the water-to-air interface, where it gets internally reflected.
4. As the rays are refracted once again, the various wavelengths get dispersed further. The overall result of this is the increased separation of the component colours of white light and the appearance of rainbow (Fig. 2).

Fig. 2 shows what happens when the sunlight strikes an individual droplet.

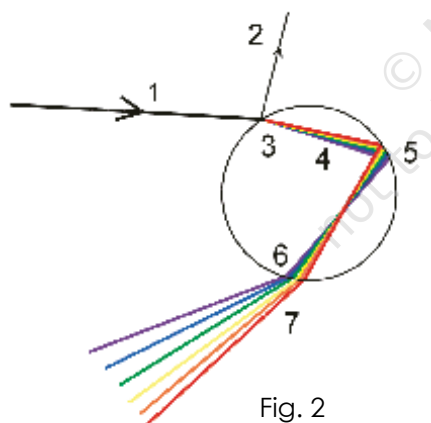


Fig. 2

1. Light from Sun strikes droplet.
2. Some of the light is reflected.
3. The rest of the light is refracted into the droplet.
4. Light splits into its component colours (Dispersion).
5. Internally reflected ray at rear of droplet.
6. Refraction again as light leaves the droplet.
7. Colours are further dispersed.



CWSN (Children With Special Needs)

- ⊙ The activity is purely visual but the Science behind the Activity may be explained using the tactile diagram.
- ⊙ For CWHI: No modification is required.

PROPAGATION OF WAVE

THE WAVE MODEL



Number of Participants

Entire class



Time Required

30 minutes



Materials Required

100 thin straight drinking straws and 3m long sticky tape about 2cm in width.



Fig. 1



How to Proceed?

- ⊙ Carefully unwind about 1.5 metres of tape on the floor or on a table with its sticky side up. Take care that the tape is straight (Fig. 2).
- ⊙ Mark the mid-points of the straws and then place them uniformly one by one on the tape, such that their mid points are on the



tape and the separation between two straws is about 3 – 4cm (Fig. 3(a) and (b)).

- ⊙ Leave 10cm of the tape from both the ends to hold it.
- ⊙ Stick 50–60 straws in this manner.
- ⊙ Now stick another piece of tape on top of this arrangement of straws. This way all the straws will be sandwiched between two layers of sticky tape.



Fig.2

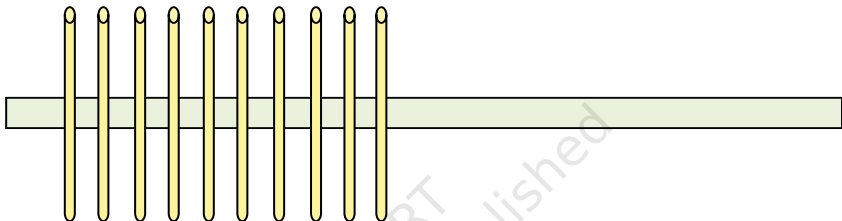


Fig.3(a)



Fig.3(b)

- ⊙ Your wave model is now ready.
- ⊙ Ask a student to hold one end of this wave model and another student to hold the other end. Ask them to keep the wave model stretched.

- ⊙ Gently tap at one end of a straw near either end, of the wave model.
- ⊙ Observe carefully. Do you see a disturbance travelling along the length of the wave model? Observe the time taken for the disturbance to move.
- ⊙ Now hold the model a little loose and again produce a disturbance by striking the straw at one end. Observe again the speed with which the disturbance moves along its length. Do you feel that the speed of the disturbance is now slower? If the wave model is held tight, then the speed of the wave becomes faster.
- ⊙ Tap continuously the straw fixed at one end. The energy will be transmitted and a wave can be seen to propagate from that end. One can even see a reflected wave from the other end.
- ⊙ Next, twist the straw fixed at one end by about 40° and release it. Do you observe a transverse wave propagating along the wave model?



CWSN (Children With Special Needs)

- ⊙ CWVI may be paired with a sighted buddy and straws with tactile marking at their midpoint may be given to him. He may be asked to note the time difference in different setups by telling him about the start and end of the movement.
- ⊙ For CWHI: No modification is required.



ELECTRIC CIRCUIT

LEMON POWER HOUSE



Number of Participants

Entire class divided in 4–5 groups.



Time Required

20 minutes



Materials Required

Thin strips of copper and zinc (6cm × 0.5cm × 0.2cm) three each, two LED s (light emitting diode), a divider from the geometry box, three beakers (100ml) (or glass tumblers of similar size, or containers cut from ½ litre water bottles), 1m long connecting wire, water, a lemon (one can also use vinegar), sand paper.



Fig. 1



How to Proceed?

- ⊙ Clean the surfaces of all the copper and zinc strips with sand paper. Pierce a small hole at one end of each strip with the sharp point of the divider.
- ⊙ Cut 4 pieces of the connecting wire each 10cm long. Remove 1cm insulating coating from both the ends of each piece of the wire.
- ⊙ Take three beakers and fill with water up to half of their capacity.
- ⊙ Place one strip of copper and one strip of zinc in each beaker as shown in Fig.2. These strips should not touch each other in water.
- ⊙ Now connect the strip of copper from 1st beaker to the strip of zinc from 2nd beaker with a piece of connecting wire. Then connect the copper strip from 2nd beaker to the strip of zinc from 3rd beaker with a piece of connecting wire. This arrangement gives us three cells connected in series.



Fig. 2

- ⊙ Identify the polarities of LED. Out of the two legs of LED the longer one is the positive terminal. Connect this positive terminal of the LED to the copper strip in the 3rd beaker with a connecting wire. Now connect the zinc strip in the 1st beaker to the negative terminal of the LED with a connecting wire.

- ⊙ Observe the LED. It may glow faintly. You might not be able to see the glow.
- ⊙ Now add a few drops of lemon juice or vinegar in each beaker and observe the LED. Does LED glow brighter this time? Can you see it easily?





Science behind the Activity

1. Here copper strip acts as the positive terminal and zinc strip as the negative terminal of each cell. Tap water is usually a poor conductor of electricity, therefore, although the circuit is completed the LED may not glow or give a faint glow.
2. When we add some acidic solution such as lemon juice or vinegar to water, it becomes a better conductor and the current produced is stronger. So LED glows brighter.

EXTENSION ACTIVITY

1. Reduce the number of batteries one by one and observe the glow of the LED (Fig. 3).

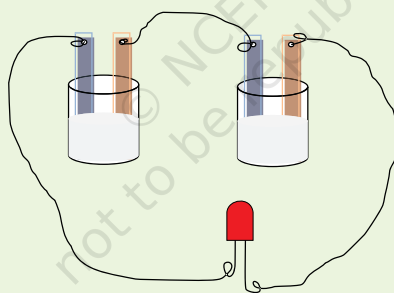


Fig. 3

2. Connect one more LED in parallel to the LED in the circuit and observe whether or not both the LEDs glow (Fig. 4).

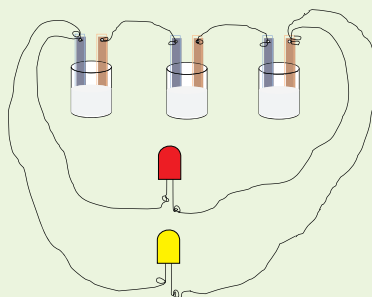
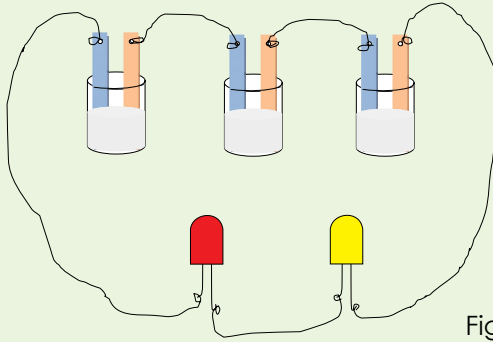


Fig. 4

3. Connect two LEDs in series in the circuit and observe the glow of both the LEDs (Fig. 5).



4. Repeat the activity by using a pinch of salt instead of lemon drops.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The students with VI may be paired with a sighted peer for doing the set up. The intensity of the glow or absence of it may be told verbally by the peer or by use of light probe.
- ⊙ A tactile circuit diagram may be provided to facilitate the understanding of the arrangement.



PRESSURE IN LIQUIDS

STRAW WATER PUMP



Number of Participants

Entire class in the groups of two students each.



Time Required

20 minutes



Materials Required

A drinking straw with a bend, a straight straw into which the bent straw fits, a plastic bead with a hole which would fit in the straight straw, a thin plastic bead with a hole which would fit in the bent drinking straw, bicycle ball bearings, sticky tape, glass tumbler, water.



How to Proceed?

- ⊙ Take the straight straw. At one end of the straw fit the plastic bead with its hole towards its opening with a sticky tape. Drop a ball bearing inside this straw from the other end (Fig. 1).
- ⊙ Now take the bent drinking straw. Fit the thin plastic bead at the open end of the longer arm of



Fig. 1

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

the straw with a sticky tape. Drop a ball bearing in this straw from the bent arm.

- ⊙ Make a small cut along the bent arm of the straw and twist this portion to make a nozzle. This will act as the outlet for water (Fig. 2(a)).
- ⊙ The bent straw will act like a piston (Fig. 2(b)).



Fig. 2 (a)



Fig. 2 (b)

- ⊙ Insert the longer arm of the bent straw in the straight straw such that it fits tightly (Fig. 3). Your straw water pump is ready for use.
- ⊙ Take a glass tumbler. Fill it with water. Dip the end



Fig. 3

of straight straw fitted with bead in the water. Hold it vertically with one hand and move the inner straw up and down. Do this continuously for a few times. In a few strokes the pump will start functioning and water will rush out from the nozzle.





Fig. 4



Science behind the Activity

- ⊙ This is a model of hand-pump which works on the principle that water flows from higher pressure to lower pressure.
- ⊙ When you move the inner straw outward, the pressure of air inside the outer straw is reduced. The water rises in it due to the higher pressure (that is atmospheric pressure) on the surface of water in the tumbler when you move the piston down, the water cannot move back in the beaker because the opening of the outer straw is blocked by the ball bearing in it. As a result a small amount of water makes its way to the inner straw. Moving the inner straw up and down continuously the water comes out from the narrow opening of the bent straw (Fig. 4).

CWSN (Children With Special Needs)

- ⊙ CWVI may easily perform the activity with verbal cues and physical prompts. He may also feel the rush of water from the nozzle by placing his hand in the front.
- ⊙ For CWHI: No modification is required.

ELECTROMAGNETISM

D. C. MOTOR



Number of Participants

Entire class in the groups of 4–5 students each.



Time Required

20 minutes



Materials Required

A dry cell 1.5 V, a small disc magnet, 1 m long insulated copper wire used for motor winding, two large safety pins (about 6cm long), a piece of old cycle tube.



Fig. 1



How to Proceed?

- ⊙ Wind 8–10 turns of the insulated copper wire around the neck of a water bottle to make a coil. Leave about 10cm of wire free on both sides of the coil.
- ⊙ Loop the free ends of the wire through the coil to make a knot in such a way that 5cm of the wire comes out of the coil in opposite direction. These free ends of wire will act like arms of the coil. Both these arms should lie along the diameter of the coil. This will ensure a well balanced coil.
- ⊙ Scrape the insulation completely from both the arms of the coil, till you see shining copper underneath.

Fun Activity

- ⊙ Cut 0.5cm broad rubber bands from an old cycle tube. Stretch them on the dry cell, one across and one along its length.
- ⊙ Fix two long safety pins at the two terminals of the cell through the rubber band stretched along its length. Make sure that circular rings of the safety pins are upwards and are at the same level. Now insert free ends of the coil through the circular rings of these safety pins such that the coil rests on them in a horizontal plane.
- ⊙ Fix the magnet on the cell using the rubber band fixed earlier across it.
- ⊙ Rotate the coil by giving it a small push. Does it keep spinning?
- ⊙ If not, check the contact of pins with the terminals of the cell.



Fig. 2



Science behind the Activity

An electric motor is based on the principle of electromagnetism. When circuit is closed a current flows through the coil. This current interacts with the magnetic field produced by the magnet due to which the coil starts rotating.

EXTENSION ACTIVITY

1. Bring another magnet above the coil. If the coil spins faster, this would mean the pole facing the coil is opposite to that of the first magnet. If, on the other hand, the motor slows down, this would mean that the pole facing the coil is similar to that of the first magnet.
2. Take out the coil and shape it into an egg shaped dumbbell. This coil will also rotate very well.
3. You can try various shapes and sizes of coils.



CWSN (Children With Special Needs)

- ⦿ For CWVI: The child with visual impairment can easily participate in the activity by verbal cues about the steps or physical prompts whenever needed. The child may also feel the spinning easily, or the movement can also be felt by placing a paper.
- ⦿ For CWHI: No modification is required.



ARCHIMEDES PRINCIPLE

A DIVER AT YOUR COMMAND (CARTESIAN DIVER)



Number of Participants

Entire class divided into groups of four each.



Time Required

20 minutes (for making the toy and playing)



Materials Required

One transparent cylindrical plastic jar about 20cm high, 7–8cm diameter or a cylindrical glass tumbler, small glass bottle like that used for homeopathic medicines (3cm long and 1cm diameter), a few strong rubber balloons (to cover the mouth of jar), a 100ml beaker, a few crystals of KMnO_4 , a pair of scissors and thread.



How to Proceed?

- ⊙ Fill the jar with water. Ensure that the jar is filled up to the brim.
- ⊙ Take some water in 100ml beaker. Fill some water in the small bottle in such a manner that it floats vertically just inside the surface of water.
- ⊙ Put a crystal of KMnO_4 in the small bottle to make it coloured. Close the mouth of the small bottle with your thumb and immerse it upside down in the water inside the jar (Fig. 1).



Fig. 1

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ Cut out the neck of a large balloon and stretch it on the mouth of the jar (Fig. 2). Secure it tightly with a thread. Ensure that once the mouth of the jar is covered with stretched membrane, no air leaks into the jar.

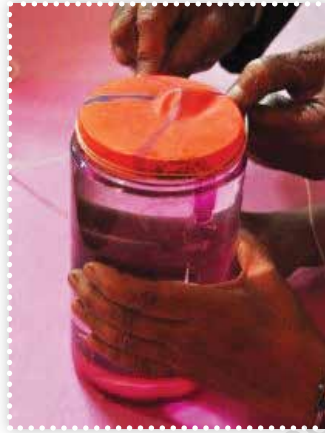


Fig. 2

- ⊙ Now press the stretched membrane with your palm and observe the motion of the small bottle. Also observe the level of water in the small bottle as it goes down. If the small bottle does not move downwards, check that:



Fig. 3: Pressing the membrane and the diver going down.

- (1) there is no air between the water and the membrane.
 - (2) there is no leakage of air into the jar.
- ⊙ If there is no air and air leakage, and small bottle is still not moving downwards, vary the pressure on the membrane.
 - ⊙ As you gradually increase the pressure on the membrane, the small bottle moves downward like a diver (Fig. 3).
 - ⊙ Now release the pressure on the membrane and observe the diver moving upward (Fig. 4). As it goes up, observe the level of water in the diver.





Fig. 4:
On releasing the pressure, the diver coming up



Science behind the Activity

When the weight of water displaced by the small bottle is smaller than the total weight of the bottle (including water in it), it sinks.

When we press the membrane, pressure on the surface of water increases. It forces some water into the diver, which sinks as a result. When the pressure is released, some water comes out from the diver and it rises up again.



CWSN (Children With Special Needs)

- ⦿ The CWVI may need some verbal and physical cues to perform the activity and to gauge about the position of the diver in addition to the tactile sense. The VIC may be asked to press and release the membrane and buddy must be asked to explain the effect.
- ⦿ For CWHI: No modification is required.

FORCE AND INERTIA

WHERE WILL THE THREAD BREAK?



Number of Participants

Entire class in the groups of 4–5 students each.



Time Required

15 minutes



Materials Required

A heavy weight about 200g (such as G.I. elbow available at hardware stores) and thread about 3m long.



How to Proceed?

- ⊙ Tie the weight in the middle of the thread. Hang the thread with a nail fixed at a height of about 2 m.
- ⊙ Hold the lower end of the thread and apply gradually increasing downward force till the thread breaks. At which point did the thread break?
- ⊙ Now repeat step 1 again and pull the thread with a jerk. Which part of the thread breaks this time?
- ⊙ Why does the thread break at different points when the force is applied in different ways?



Fig. 1



Science behind the Activity

1. When gradually increasing downward force is applied, the upper part of the thread breaks due to the combined effect of the force applied and the force applied by the weight on the upper part of the thread.
2. When we apply force with a jerk, the lower part of thread breaks due to inertia offered by the weight.



CWSN (Children With Special Needs)

- ⊙ CWVI may perform the activity with some help from his sighted peer. The Science behind the Activity may be verbally explained to the CWVI.
- ⊙ For CWHI: No modification is required.

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COMPLEMENTARY COLOURS

MAGIC BIRD

(PUZZLING COLOURS)



Number of Participants

Entire class



Time Required

20 minutes (for preparation and performing the activity)



Materials Required

Four white drawing sheets (30cm x 30cm), marble paper (red, green and blue), sketch pen (black), a pair of scissors, glue and sticking tape.



How to Proceed?

- ⊙ Cut the shape of a bird, from each of the three coloured marble papers.
- ⊙ Paste each shape on a white drawing sheet with the help of glue.
- ⊙ Draw a small black eye for each bird with the black sketch pen.
- ⊙ Paste the drawing sheets with different coloured birds on a wall at your eye level.
- ⊙ Paste the white drawing sheet on the wall near the drawing sheets with birds as shown in the figure. You can draw a bird cage or a tree or a window on this sheet.
- ⊙ Stare at the eye of the red bird for about 30 seconds. Then quickly shift your eyes to the white sheet (bird cage or tree). What do you observe? You may see a cyan (bluish green) bird on the white sheet.

- ⊙ Now repeat the above process staring at the green bird. This time you may see a magenta (reddish-blue) bird on the white sheet.
- ⊙ Finally, stare at the blue bird. What do you observe this time? You may see yellow bird on the white sheet.



Science behind the Activity

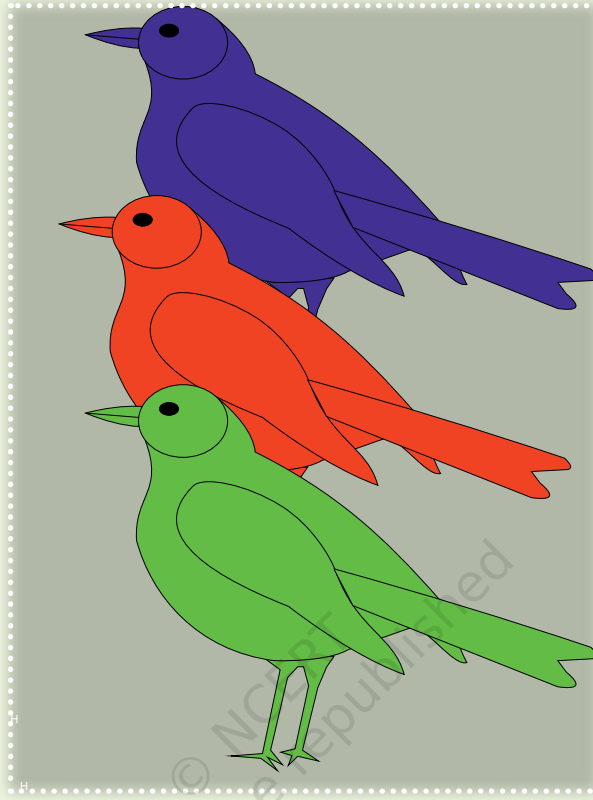
The bird that you see on the white sheet is called the after-image. An afterimage is an image that stays with you even after you have stopped looking at the object. Your retina is lined with light-sensitive cells called rods and cones. Cones are sensitive to coloured light. Each of the three types of cones is sensitive to a particular range of colour.

When you stare at the red bird, the image falls on your retina. The red sensitive cells start to grow tired and stop responding to red light. The white drawing sheet reflects red, blue and green light to your eyes as white colour consists of these three primary colours. When you suddenly shift your eyes to white board, the fatigued red-sensitive cells do not respond to the reflected red light. However, the blue-sensitive and green-sensitive cones respond strongly to the reflected blue and green light. As a result you see a bluish-green (cyan) bird.

When you stare at the green bird, your green sensitive cells become fatigued and this time you see a reddish-blue (magenta) bird on the white drawing sheet. Similarly, when you stare at the blue bird you see red and green light which you see as yellow colour.

EXTENSION ACTIVITY

You can use bright coloured stickers or different coloured papers from stationary shop and observe the colour of afterimage.



CWSN (Children With Special Needs)

- ⦿ For CWVI: (Purely visual activity) The Science behind the Activity written in Braille script may be provided to the child to facilitate the understanding to the concept.
- ⦿ For CWHI: No modification is required.





GAMES

COLLOIDS

COLLOIDAL PARTNERS



Number of Participants

Entire class is divided in teams of six students each.



Time Required

30 minutes



Material Required

Chart paper, marker, pens, placards displaying names of colloids.



How to Play?

- Facilitator will prepare chart and placards of examples, as shown below, with the help of students. This chart will be displayed during the game.

Dispersed Phase	Dispersing Medium	Examples
Liquid	Gas	Fog, cloud, mist
Solid	Gas	Smoke, automobile exhaust
Gas	Liquid	Shaving foam
Liquid	Liquid	Milk, moisturiser
Solid	Liquid	Mud, milk of magnesia
Gas	Solid	Foam, sponge, pumice stone
Liquid	Solid	Jelly, cheese, butter
Solid	Solid	Coloured gemstone, milky glass

- Each team will prepare six chestees (cards to be worn or pasted on chest) with a sheet of paper (preferably thick one) and write one of the following phrases on each. These names can also be written in Braille, and matching pictures may also be pasted.

Dispersed phase	–	solid
Dispersed phase	–	liquid
Dispersed phase	–	gas
Dispersing medium	–	solid
Dispersing medium	–	liquid
Dispersing medium	–	gas

- Two students will note the time taken by each team and score awarded.
- At the start of the game, two teams wearing their chestees comes forward and stands facing each other as shown in the figure.
- Now, the facilitator will show a placard on which the name of a colloid is written, say fog.

As soon as the two teams see the placard, the students wearing the specific chestees of the states of dispersed phase and dispersing medium from each team will move towards the facilitator. In this case, liquid as dispersed phase and gas as dispersing medium are supposed to move.

The facilitator will check the answer.

Ten marks will be awarded to the team reaching first with correct answer. Five marks will be awarded to the team coming later with correct answer.

The winner among the two teams will now play with the next team in the same manner.

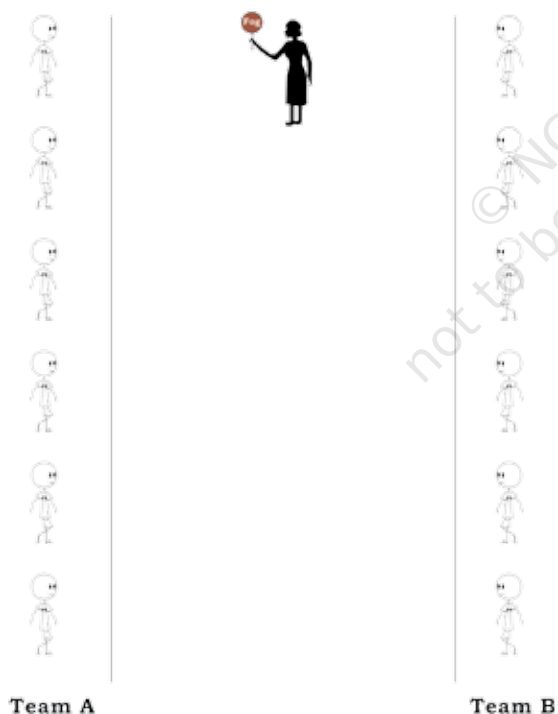


Fig. 1: Layout of the play area



Points for Discussion

The Facilitator will discuss that the components of a colloided solution are the dispersed phase in the dispersion medium. The solute-like component or the dispersed particles in a colloid form the dispersed phase, and the component in which the dispersed phase is suspended is known as the dispersing medium.



Science behind the Game

When a substance (dispersed phase) is dispersed in another substance (dispersion medium) a colloid is formed. The type of colloid will depend on the states (solid, liquid or gas) of the dispersed phase and dispersion medium.

EXTENSION OF THE GAME

More examples can be included in next rounds.



CWSN (Children With Special Needs)

- ⊙ CWVI may need a peer to move towards the facilitator. The child may be provided with the chart in the Braille script.
- ⊙ For CWHI: No modification is required.



Ions

TIC, TAC, TOE



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Chalk, marker pen and black board.



How to Play?

- ⊙ The facilitator will draw fig.1 on the board.

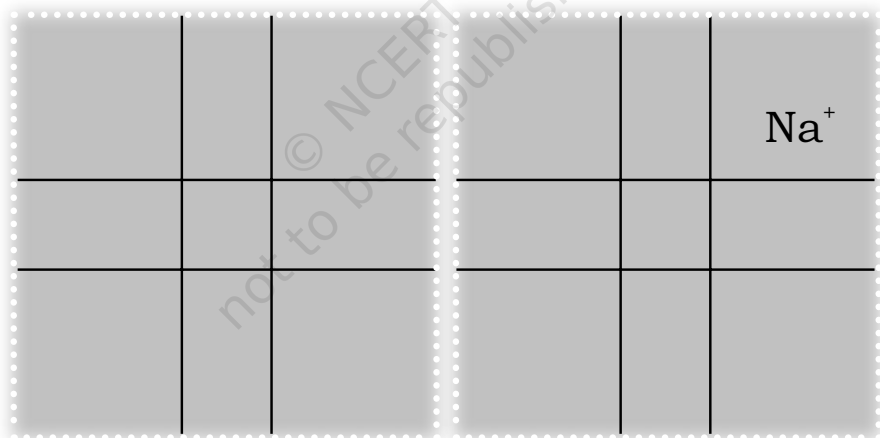


Fig. 1

Fig. 2

- ⊙ The facilitator will divide the class in two teams.
- ⊙ The team getting the first chance by a toss will send one of its member to the board who will write symbol of an ion in any one of the boxes (Fig. 2).
- ⊙ Now a member of the other team will go to the board and write symbol of another ion in one of the boxes (Fig.3).

- ⊙ The aim of each team is to make a vertical, horizontal or diagonal sequence of three cations or three anions.
- ⊙ Each team will try to prevent the opposite team from doing so.
- ⊙ The team which succeeds in writing a correct sequence (horizontal, vertical or diagonal) will be declared winner (Fig. 4). A correct sequence implies that the symbols and their charges are correct.

		Na^+
Cl^-		

Fig. 3

Al^{3+}	O^{2-}	Na^+
	K^+	S^{2-}
Cl^-		Mg^{2+}

Fig.4



Science behind the Game

For the convenience of writing the formulae of compounds and representing chemical equations, universally accepted symbols of elements are used. The game helps students to learn and remember the names and symbols of elements along with their valency.



This game can also be played by using the following combinations:

- I. Elements in the various groups of the periodic table
- II. Singly charged cations and anions
- III. Doubly charged cations and anions
- IV. Alkali metals and alkaline earth metals
- V. Halogens and noble gases



CWSN (Children With Special Needs)

- ⊙ CWVI should either be given a peer to tell the symbols of cations and anions that have been written on the board, or the symbols should alternatively be written in Braille too so that the child can place them in the desired column. Board should be made tactile with columns where pre-prepared chits can be affixed.
- ⊙ For CWHI: No modification is required.

THE MOLE CONCEPT

MOLE LUDO



Number of Participants

Eight students



Time Required

30 minutes



Material Required

Paper/Chart paper, dice, tokens and cardboard sheets.



How to Play?

- ⊙ Game is to be played in the classroom.
- ⊙ Facilitator is required to paste Sheet 1 (reference board) and Ludo Game Sheet 2 (Figure 1&2) on cardboard to prepare Game Board. Sheets may also be made either tactile or in Braille for CWVI.
- ⊙ Facilitator can make two to four teams with two members in each team.
- ⊙ Each team will select one section of the game board to place their tokens.
- ⊙ A player of a team rolls the dice and the number the person gets, corresponds to the number of particles. The second player of the team will roll the dice and the number will determine the food item assigned to the team. Likewise, all teams will roll the dice and proceed to game board.

Rules of the game

1. A player of the team must roll six or one on the dice to move the token to start the Ludo board game.
2. The team has to take a compulsory halt at block seven and block 12; it cannot jump over it.

3. On answering correctly at block seven (see example) the team will get a chance to throw the dice to move forward. Similar condition applies at block 12
4. In case of incorrect answer to either of the block seven or block 12, team will go back and start afresh.
5. If the number on dice exceeds the exact number required to reach block seven or block 12, the player loses that turn.
6. To move from block 12 to 'house', the team must get 1 on the dice.
7. The team whose token reaches the house first is the winner. Other teams will continue till their token reaches the house.

For Example

Suppose on rolling dice, number two comes on the dice, then number of particles will be 3.011×10^{23} (block (2), sheet 1).

In the next step, suppose dice turns out number three, the choice of food will be citric acid in lemon juice (block three, sheet two).

On reaching block seven, the team will calculate the number of moles of citric acid using formula mentioned in Step 3 on sheet 1.

$$\text{Number of mole (n)} = \frac{\text{given number of particles}}{\text{Avagadro's number}}$$

$$\text{Number of mole (n)} = \frac{3.011 \times 10^{23}}{6.022 \times 10^{23}} = \frac{1}{2}$$

$$\text{Number of mole (n)} = \frac{1}{2}$$

On reaching Block 12, the team has to calculate the mass (g) of citric acid according to formula in Step 4 (sheet 1) to score House.

Molar mass of citric acid ($\text{C}_6\text{H}_8\text{O}_7$) = 192 g

$$\begin{aligned}\text{Mass of citric acid} &= \frac{1}{2} \times 192 \\ &= 96 \text{ g}\end{aligned}$$

Data

Molar mass of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)= 180 g

Molar mass of (lactic acid ($\text{C}_3\text{H}_6\text{O}_3$))= 90 g

Molar mass of sucrose/lactose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)= 342 g

Molar mass of water (H_2O)= 18 g

Molar mass of citric acid $\text{C}_6\text{H}_8\text{O}_7$ =192 g

Avogadro's Number= 6.022×10^{23}

**Points for Discussion**

- ⊙ Difference between atomic mass and molar mass.
- ⊙ Avogadro's number, relation between number of moles and number of particles.

**Science behind the Game**

Children will be able to understand concepts of mole, molecular mass and atomic mass.

**CWSN (Children With Special Needs)**

- ⊙ For CWVI: Both the board & dice must be made tactile with proper Braille labeling. CWVI should be asked to bring his Taylor Frame for mathematical calculations.
- ⊙ For CWHI: No modification is required.



Sheet 1

6.022×10^{23} (6)	18.066×10^{23} (5)	12.044×10^{23} (4)
48.176×10^{23} (3)	3.011×10^{23} (2)	24.088×10^{23} (1)

Number of particles

Step 1

Choose Your Food

Glucose (6) Molar mass of Glucose 180g	Milk (5) Molar mass of Lactose 342g	Mango Juice (4) Molar mass of Sucrose 342g
Lemon Juice (3) Molar mass of Citric acid 192g	Curd (2) Molar mass of Lactic acid 90g	Water (1) Molar mass of Water 18g

Step 2

Move to Game Board

Let's play the game

Mass = Molar mass (M) × Number of moles (n)
(m)

Step 4

Number of Moles = $\frac{\text{Number of particles (step 1)}}{\text{Avogadro's Number}} = \frac{N}{N_A}$

Step 3

Move to House

At Mark 7




Fig. 1 (Sheet 1)

House

Fig. 2 (Sheet 2)

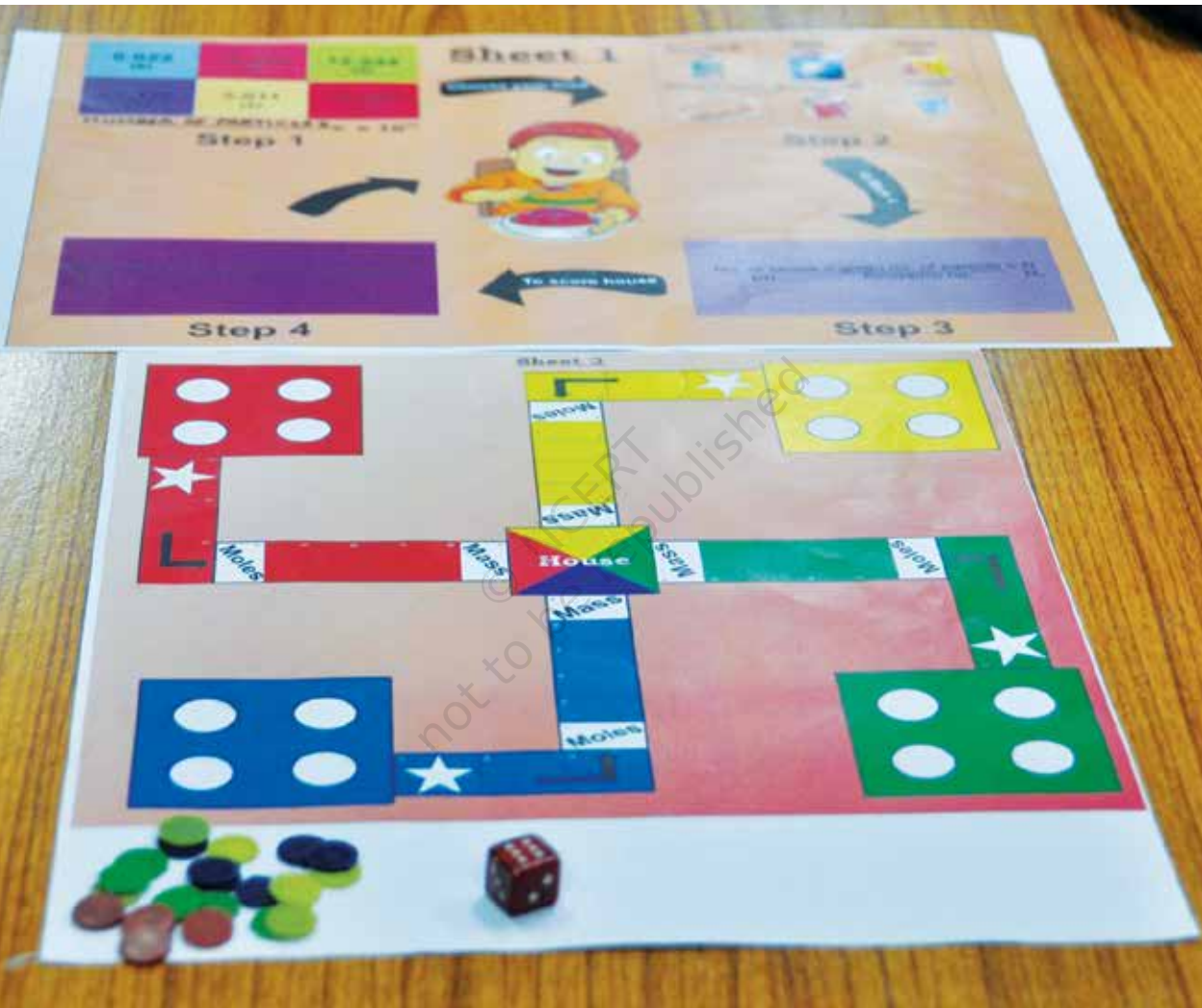


Fig. 3



LIFE CYCLE OF PLANTS

FROM SEED TO SEED



Number of Participants

2-4 players



Material Required

Game board, dice, tokens of different colours.



How to Play?

- ⦿ Players will be given tokens of different colours and dice to play the game. Every player would own token of different colour.
- ⦿ Start the game by rolling the dice. Players will move forward over the board using token as per the number displayed on the dice.
- ⦿ More than one player cannot occupy the same square at a time. In case the other player while rolling the dice reaches the same square, will put the token in the square replacing the token of the existing player and sending it back to start position.
- ⦿ Player who reaches first to the exit point will be the winner of the game.



Points for Discussion

Discussions can be based on following concepts:

- ⦿ Types of Angiosperms on the basis of number of cotyledons present in the seed.
Hint: Dicots and Monocots with suitable examples.
- ⦿ Differentiation between Monocots and Dicots.
- ⦿ What are the various parts of a typical lower?
- ⦿ What is the role of the following parts of a lower?
a) Sepals b) Petals c) Stamen d) Pistil

- ⊙ What is Pollination? Give some examples of mode of pollination.
- ⊙ How is self-pollination different from cross pollination?
- ⊙ What is fertilisation? Where does it take place?
- ⊙ What changes take place in the pistil of flower after fertilisation?



Science behind the Game

Biological life cycle is the sequence of life stages that an organism undergoes from birth to generation of offspring capable of going through the same stages.

EXTENSION OF THE GAME

Such type of board game can be prepared for lifecycle of monocot plants also.

Contents of the boxes in the board game	
Box No.	Content
0	START
1	I am a dicot seed Rough and tough seed coat I need To protect the tiny embryo within me. Come join me in my life's journey!
2	---
3	Water, temperature, air Are my friends for Germinating me bright (healthy). Food from cotyledons Happens to be my first diet. You brought me luck Jump straight to number 5.



Contents of the boxes in the board game		
4	Lack of water Has made me dry So go back to 'START' Coz you made me cry 😞	
5	I was once a seed And now I have germinated This world is so beautiful I am happy and elated 😊	
6	At Box no.12 you have to STOP whether in one turn or more Get required 'dots' on top (of the dice).	
7	I grew from a dicot seed To become a dicot plant. You now get an extra chance. That reward I grant !	
8	---	
9	Tap tap tap I have a Tap root Difficult to uproot.	
10	----	
11	You are now at The 11 th station. With net-like veins in leaves, Called Reticulate venation.	
12	Beautiful flowers on my tender branches Now go to box 15– You have great chances	To go on further you can have your say self or cross pollination choose your way!!!
13	----	
14	Cross Pollination Pollen travels from the platform of anther	Self Pollination Wind, water or insect, I may not need

Contents of the boxes in the board game		
	To reach the stigma station Via wind, water or insect The process is pollination.	Within the flower I can breed
15	Note: Figures of both self and cross pollination in box 15 only.	
16	No water, no insect, no air Oh! Go back to 12 and sit on the chair Take a second thought.	You don't have to wait for external agent You can pollinate yourself. You are brilliant Jump to 20
17	-----	
18	Cross pollination allows more diversity. Oh! it is such a reason for gaiety Jump to 21	
19	-----	Inbreeding causes less vigour. Go back to 12 and take a second thought
20	Hurrah! I am done with pollination, Now ready for fertilisation!!!	
21	----	
22	Go back to Box no. 15 Pollen tube has not reached the ovule But next time if you stop at 22 You may easily through.	
23	----	

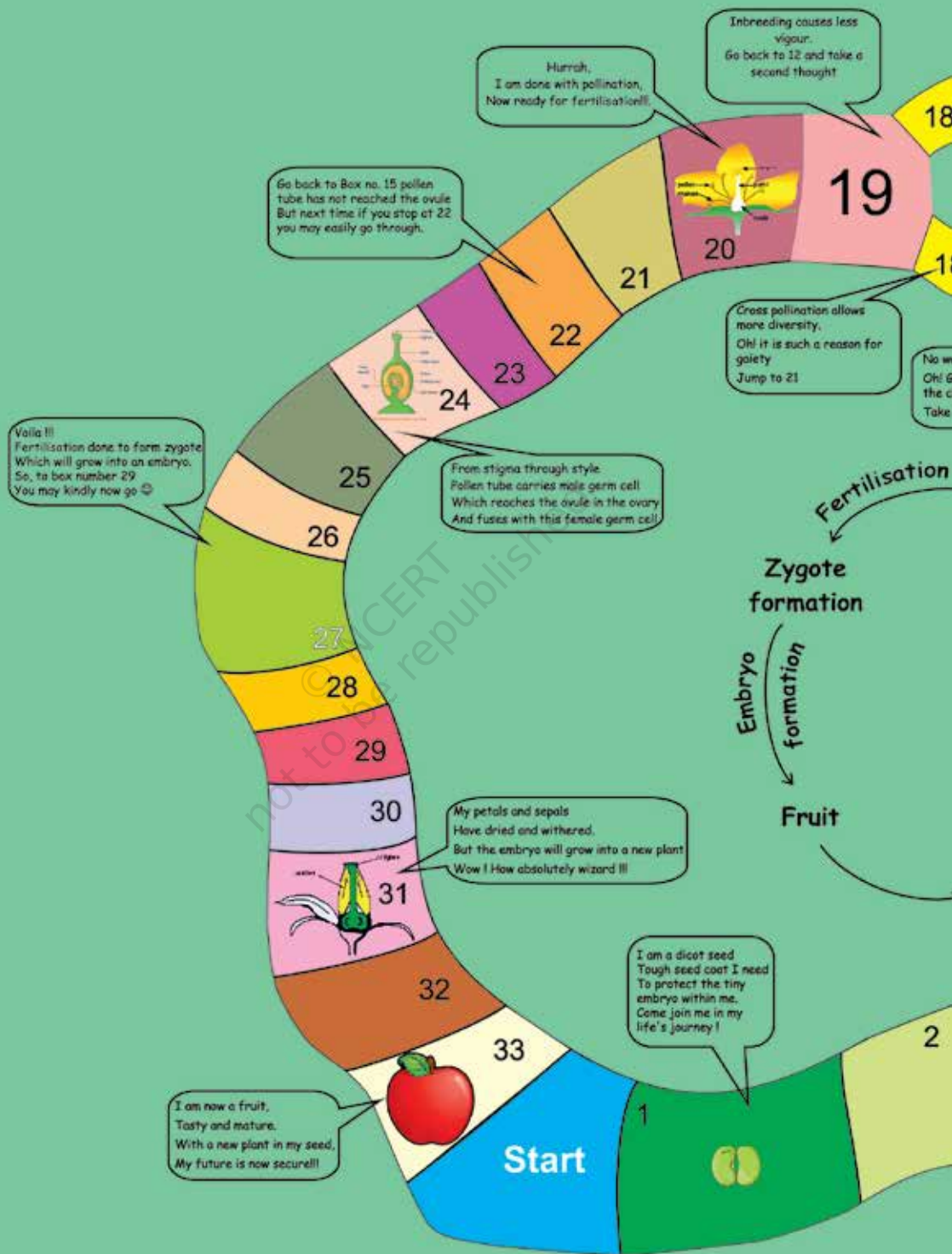


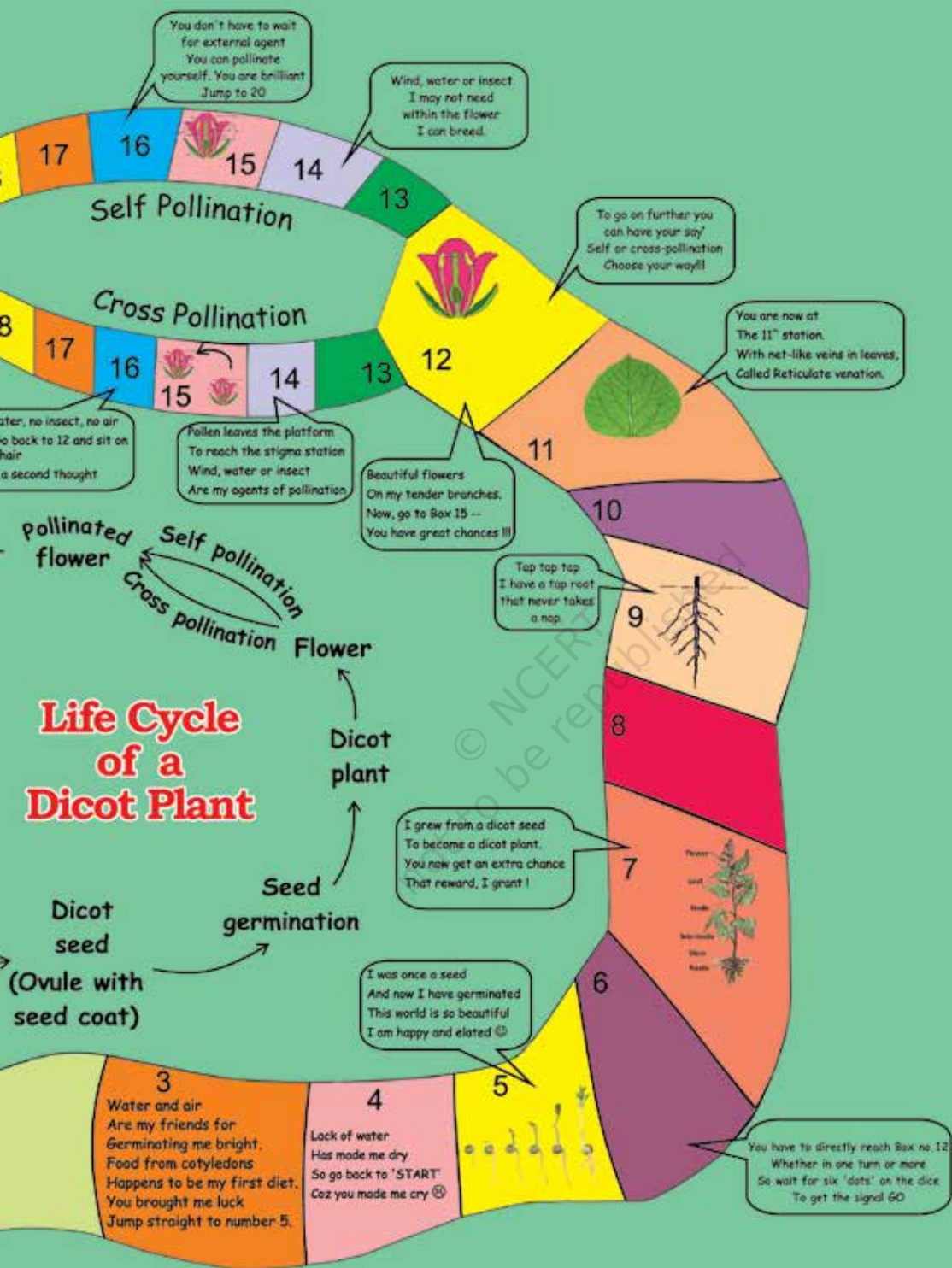
Contents of the boxes in the board game	
24	From stigma through style Pollen tube carries male germ cell Which reaches the ovule in the ovary And fuses with the female germ cell.
25	---
26	---
27	Voila !!! Fertilisation done to form a zygote Which will grow into an embryo. So, to box number 29 You may kindly now go 😊
28	----
29	-----
30	----
31	My petals and sepals Have dried and withered. But the embryo will grow into a new plant Wow ! How absolutely wizard!!!
32	----
33	I am now a fruit, Tasty and mature With a new plant in my seed, My future is now secure!!!



CWSN (Children With Special Needs)

- ⦿ For CWVI: The board has to be made tactile with Braille labeling. Numbers in the dice too should be in Braille.
- ⦿ For CWHI : No modification is required.





VALENCY

SEVEN MUSICAL CHAIRS



Number of Participants

Entire class



Time Required

30 minutes



Material Required

11 Chairs, cardboard sheets, marker/pen, thread/safety pins, a pair of scissors, musical instrument.



How to Play?

- ⊙ Cut 27 pieces of cardboard.
- ⊙ Write symbols of elements on 30 cards such as K, Na, Mg, Ca, Al, Cl, I, Br, P, H, S, O, N, He, N.
- ⊙ Write valence number on other 28 cards. Four sets of seven valencies +1, +2, +3, 0, -1, -2, -3.
- ⊙ Tie the card to the players on which the symbol of element is written. Thus each player will act as element.
- ⊙ Tie the card with the valence number to the twelve chairs arranged in a circle (Fig. 1).
- ⊙ To start the game the music will be switched on.
- ⊙ The players will move around the chairs in one direction till the music is on.
- ⊙ As soon as the music stops, the players will have to occupy the chairs with valency corresponding to the element they represent. Since chairs are fewer than the number of players, a few players will be left without chairs and will be out of the game.
- ⊙ The players who will occupy wrong chairs will also be out.

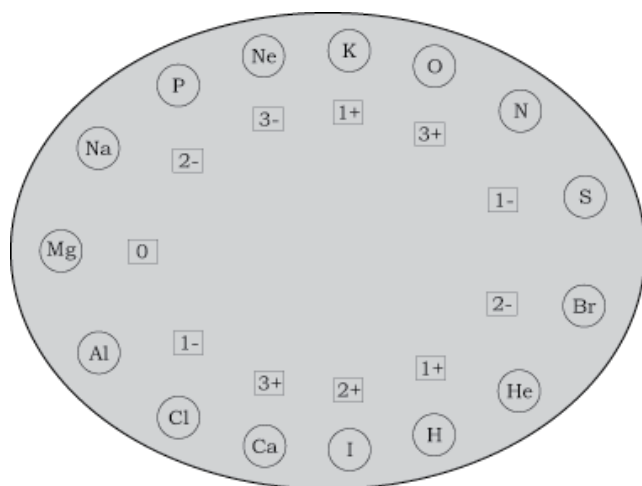


Fig. 1: Squares are representing chairs and small circle are representing students

- ⊙ In the next round, one chair less than the number of left players are arranged.
- ⊙ Facilitator, while removing chairs should ensure that at least one chair depicting valency corresponding to elements held by the players remains in the circle.
- ⊙ The game will continue till the last seven players for whom there is at least one chair to occupy.
- ⊙ The game can be repeated with a new set of children.



Points for Discussion

The facilitator may discuss the symbols of elements, their valency and formation of ions i.e., cations or anions with the players after playing this game.



Science behind the Game

An ion is a charged species and can have a positive or negative charge. A positively charged ion is called a cation, such as Na^+ , Mg^{2+} , Al^{3+} etc. Similarly, a negatively charged ion is called an anion, such as Cl^- , S^{2-} , N^{3-} etc.

EXTENSION OF THE GAME

After understanding the correct representation of ions, this game can be played to understand formation of compounds.



CWSN (Children With Special Needs)

- ⊙ For the convenience of Visually Impaired players and Hearing Impaired players, make signs with hands when the music begins and stops. Visually Impaired Children should be assisted by other children to take them to the desired chair bearing the card with correct valence number.

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REFRACTION OF LIGHT

BET YOU CAN'T LIFT THE COINS



Number of Participants

Entire class, divided in teams of 5–6 students each.



Time Required

30 minutes



Material Required

A bucket (38–45cm high), a one/five rupee coin and water.



How to Play?

- ⊙ Fill the bucket with water and place a one or five rupee coin at the centre of its bottom. Mark the level of water in the bucket.
- ⊙ In the first round one student from each team will be asked to pick up the coin in one attempt without groping for it.
- ⊙ If the student succeeds in picking the coin, the team gets two points.
- ⊙ After each attempt the water in the bucket must be brought to the same level as before. Set the coin at the centre as before.
- ⊙ Another student from each team will try to pick up the coin in subsequent rounds till each student in all the groups has tried.
- ⊙ The team that collects maximum points wins the game.



Science behind the Game

The coin under water appears to be at a slightly smaller depth than it actually is due to refraction of light from water to air. If viewed from the side, the coin may also appear displaced sideways due to refraction. Most of the students are likely to aim at the apparent position of the coin and may fail to lift it.

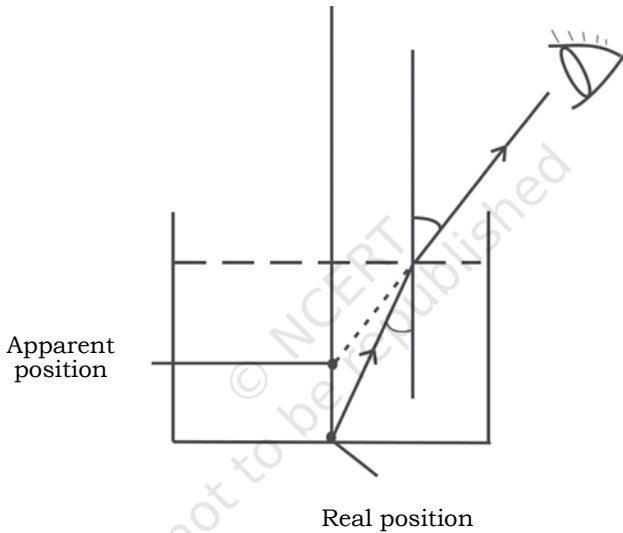


Fig. 1



CWSN (Children With Special Needs)

- ⊙ CWVI may not be able to do it because it is purely visual activity. The above figure may be made tactile to facilitate the understanding of the concept behind this activity.
- ⊙ For CWHI: No modifications are required.



BOHR'S MODEL OF ATOM

RUSH TO THE ORBIT



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Chalk or quicklime powder (*choona*), chart paper.



How to Play?

⊙ Play this game in an open space.

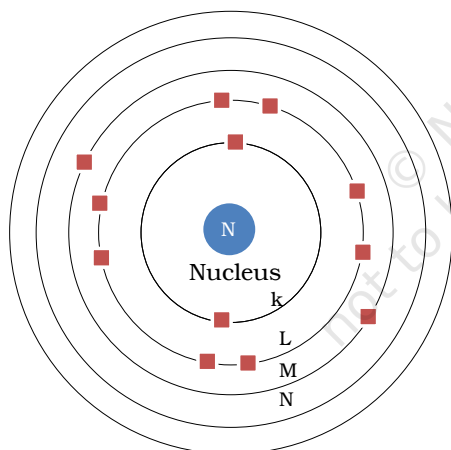


Fig. 1

⊙ Draw six circles as shown in the figure with chalk powder or with tactile circumference to facilitate participation of children with visual impairment (CWVI).

⊙ Familiarise the CWVI beforehand with the play arrangement or figure for their active participation.

⊙ Prepare 20 placards with 'electron' written on them.

⊙ Mark the innermost circle 'Nucleus' of the atom.

⊙ Mark the circles as K, L, M, N representing atomic orbits.

⊙ Divide the class into two teams A and B with equal number of players.

- i. A toss will decide which team will play first. Suppose team B has to play first, then team A will nominate one of its members to act as the nucleus. The members of team B will stand outside the circle.

- ii. All the placards will be kept in the circle representing the nucleus. The student acting as the nucleus will pick one of the placards.
- iii. Facilitator will ask team A to play music or clap. The players of team B will start running in the outermost circle (not assigned K, L, M, N shell number).
- iv. Facilitator will signal to stop music or clapping.
- v. When the music or clapping stops, the nucleus will show the placard flashing a number representing the atomic number of the atom, and will also announce the number aloud.
- vi. The required number of players running in outermost circle will arrange themselves in the circles marked as K, L, M, etc., according to the electronic configuration of the atomic number announced. The team will also be required to name the element.

Each task will consist of —

- (a) arranging themselves in correct configuration.
- (b) naming the element.

Each task will carry one mark. The facilitator will award marks accordingly. If the playing team fails at one or both of these tasks, the chance will be given to the other team. If they answer correctly, they will be awarded one bonus mark.

- vii. The placard once used will be removed from the pile.
 - viii. In the next round, the other team will play. The rules of the game will remain the same.
- ⊙ If possible write the number on placards in Braille, or make the numbers tactile.



Points for Discussion

This game gives an idea of the structure of an atom, the relationship between atomic number and number of electrons, how many orbits an atom can have and how many electrons can be there in each orbit?





Science behind the Game

The game is based on the Bohr model of an atom. According to this model –

- I. Only certain orbits known as discrete orbits of electrons are allowed inside the atom.
- II. While revolving in discrete orbits, the electrons do not radiate energy.

These orbits or shells are called ‘energy levels’. These orbits or shells are represented by the letters K, L, M, N, ... or the numbers, $n = 1, 2, 3, 4, \dots$

EXTENSION OF THE GAME

This game can be adapted to explain configuration of ions also. Care should be taken to convey to players that number of protons remains same and electrons are lost or gained in the formation of ions.

For example, to depict formation of O^{2-} ion, facilitator should announce the number of protons of oxygen atom and then 10 players will arrange themselves in two orbits with two players in K orbit, eight players in L, the outermost orbit to show electronic configuration of $O^{2-} = 2, 8$. This configuration should not be confused with electronic configuration of Neon.

The facilitator can also convey that configuration of ion can be similar to the configuration of an atom of any other element.



CWSN (Children With Special Needs)

- ⊙ Already incorporated in the "How to Play".

FOOD CHAIN

CATCH AND CONNECT



Number of Participants

Entire class in batches of 15 players.



Time Required

20–30 minutes



Material Required

Thick chart paper to make masks and flag posts, string or elastic, 16 m long cotton rope, sketch pens and paints or pictures.



How to Play?

- ⊙ Make masks: Students will make 15 face masks. Cut out eye-slits in the masks. The area of the mask covering the forehead may contain the drawing, sketch, picture or name of the organisms it represents. String or elastic will be attached at both ends to tie the masks around the head.
- ⊙ Make food chain links: Cut out 12 cotton straps or ropes, 60cm each, to make 'food chain links'. Make loops at both ends to enable the players to hold the ends securely.
- ⊙ Make fag posts: Cut out three fag posts which will represent three different ecosystems. With bold marker pen write down the name of an ecosystem on each fag post.
- ⊙ Prepare the game area: Select a playing ground and mark starting line and finishing line at a distance of 20 m. Plant flag posts at the finishing line to represent various ecosystems.
- ⊙ Instructions for players:
 - Students will assemble at the starting line.
 - Facilitator will point at the flag posts at the

finishing line of the track and read aloud the names of ecosystems written on them.

- Each player will be given a mask which they will wear on their face.
- They will also be handed over a 'food-chain link' strap each.
- When the whistle goes, the players with their masks on and link straps held in their hands, will run towards the flag post representing the ecosystem that they think they belong to.
- At the finishing line they will arrange themselves to form food chains near the flag posts of their respective ecosystems. They will hold the strap to link with each other.
- After the formation of food chains they will rush back to the starting line with their links intact.
- The team which is first to reach the starting line with correctly formed food chain will be the winner.

Layout of the game field:

Flag post Lake	FINISHING LINE		STARTING LINE	Students standing in random order with masks on their faces and 'food-chain links' in their hands
Flag post Desert				
Flag post Forest				



Points for Discussion

After the food chains have been formed, the facilitator will rectify the position of the players in their food chains (if needed). Thereafter, a discussion will follow on:

- The significance of different trophic levels.
- One consumer can occupy different trophic levels in different food chains.
- Reason behind restricted number of trophic levels in a food chain.
- The role of sun as the primary source of energy should also be deliberated upon.
- How the loss of predators in a food chain can bring about alteration in an ecosystem.



Science behind the Game

The game helps in comprehending and revising the concepts of food chain in an ecosystem. It clarifies the concept of various trophic levels, orders of consumers and stages of carnivores in food chains.

An example of food chains operating in various ecosystems is given below in a tabular form:

	1st Trophic level	2nd Trophic level	3rd Trophic level	4th Trophic level	5th Trophic level	
Ultimate source of energy	Producer	Primary consumer	Secondary consumer	Tertiary consumer	Quaternary consumer	Type of Ecosystem
	Producer	Herbivore	Primary carnivore	Secondary carnivore	Tertiary/ Top carnivore	
Sun	Green algae	Insects and their larvae	Small fish	Large fish	Fish eating bird (ex. Crane)	Pond
	Cacti	Beetles	Lizard	Snake	Fox	Desert
	Grass	Grass-hopper	Rat/Frog	Snake	Hawk	Grassland



EXTENSION OF THE GAME

The concept of 10 percent law can be introduced in the game. Players with masks of 'producers' will be provided with certain amount of energy written on a slip. After the team forms a food chain and reaches back the starting line they will also calculate the energy transferred from the first trophic level to the last trophic level.



Fig. 1: Fox Mask



CWSN (Children With Special Needs)

- ⊙ CWVI can easily participate in the activity. Finishing line, starting line and the track should be made tactile. Lanes should be numbered.
- ⊙ Children representing 3 Ecosystems should announce it aloud telling his position with respect to lane number.
- ⊙ The CWVI may also be paired with a sighted peer for running to and fro.
- ⊙ For CWHI: No modification is required.

NEWTON'S THIRD LAW OF MOTION

A BOAT WITHOUT OARS



Number of Participants

Entire class



Time Required

About 5 minutes
per player



Material Required

One small piece of thermocol (10cm × 12cm long), one medium sized balloon of thick rubber, 15cm long piece of hard drinking straw, sticking tape, tub (about 30cm diameter) filled with water.



How to Play?

- ⊙ Using a pen, draw the shape given in Fig.1 on the piece of thermocol. Using a sharp knife, cut along the shape drawn. Attach the mouth of the balloon at one end of the straw and tie it firmly with a string. Place the balloon with the straw on the thermocol piece as shown in Fig. 2 and secure the straw with tape. Your boat is now ready to sail!
- ⊙ Inflate the balloon by blowing through the straw and keep your finger on the mouth of the straw to prevent the air from escaping out of the balloon (Fig. 3).



Fig.1

- ⦿ Place the thermocol boat on the surface of water in a tub while keeping your finger on the mouth of the straw.
- ⦿ Remove your finger from the straw and observe what happens. The boat moves without oars.

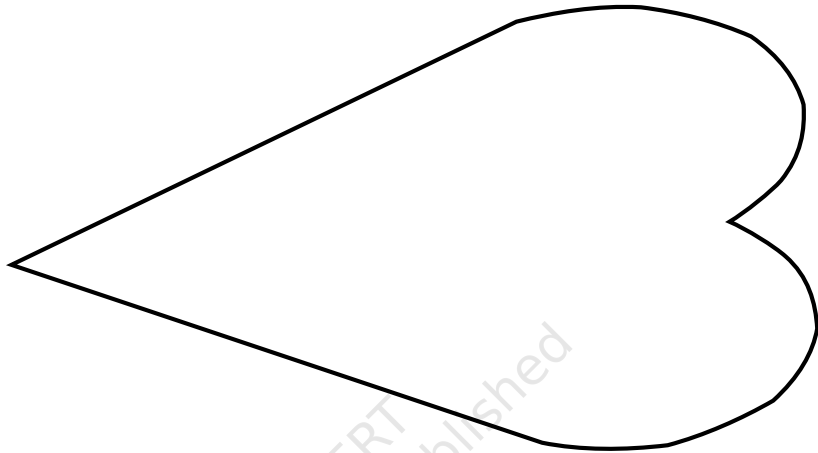


Fig.2



Fig.3



Science behind the Game

When the finger is removed from the straw, air rushes out of the straw. Due to Newton's third law of motion, a force acts on the boat in the direction opposite to that of the escaping air. This force causes the boat to move in that direction, which is opposite to that of the escaping air. When the balloon gets deflated completely, the boat stops.



CWSN (Children With Special Needs)

CWVI may be paired with a sighted peer for carrying out the activity. He may be given instruction about preparation of the boat and attaching it to the balloon with the straw. After removing the finger he may be asked to feel the movement of the boat by noting the initial and final position of the boat and the gush of air.



TYPES OF CHEMICAL REACTIONS

SPOON RACE CARRYING REACTIONS



Number of Participants

Eight players



Time Required

30 minutes.



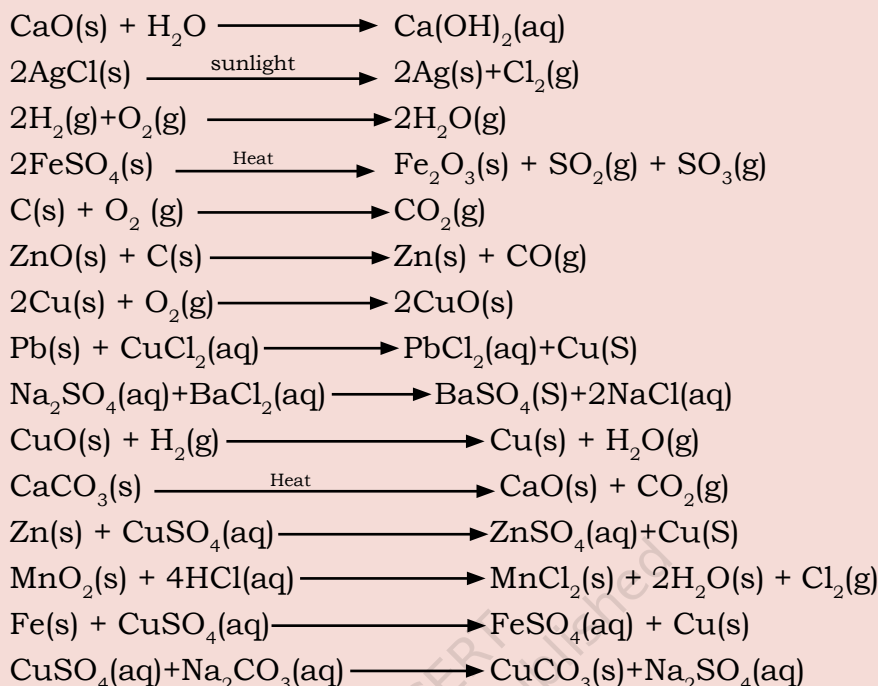
Material Required

Eight spoons, four lemons, sheets of paper, pen, a pair of scissors and five bowls or containers



How to Play?

- ⊙ Facilitator with the help of the players will prepare four sets of five chits with names of chemical reactions such as Combination Reaction, Decomposition Reaction, Displacement Reaction, Double Displacement Reaction and Redox Reaction written on it. These chits will be folded and kept in container A1 A2 A3 and A4.
- ⊙ Similarly, another 15 chits will be prepared on which different chemical reactions (as given below) will be written. On each chit only one chemical reaction has to be written. Four sets of these chits will be kept in containers (B1, B2, B3, B4) to be placed at 25m (or any available distance) from the START line.
- ⊙ Four teams of two players each will take part in the relay race at a time.
- ⊙ One spoon and one lemon will be given to four players, and one spoon each will be given to another four players.



- ⊙ To start the game, four players with spoon and lemons will stand at the 'START' line. The facilitator will ask players to pick up a folded chit from the container A. Each player will keep the chit in the spoon under the lemon and hold it in their mouth (Fig.1).
- ⊙ At 25 metres from the 'START' line, containers, B1, B2, B3 and B4 will be kept on the ground and another four players will stand with their spoons.
- ⊙ On getting signal from the facilitator, the players at the 'START' line will start moving, balancing their lemon along with the chit on the spoon.
- ⊙ On covering a distance of 25 metres, they hand over their lemon and the chit to their respective partners. In case the lemon is dropped down, the player can pick it up and continue moving ahead.



- ⊙ After reading the chit and discussing with each other, any team member will pick up any one appropriate chemical reaction chit from the container B.
- ⊙ Players standing at 25 metres will keep both the chits in the spoon with lemon on it and will move to reach 'FINISH' line.
- ⊙ Team members reaching the 'FINISH' line first with correct combination of types of chemical reactions, with lemon and chits on the spoon will be declared the winner. Facilitator will verify the correct combinations.
- ⊙ Similarly, the game will continue with other students of the class.



Points for Discussion

Facilitator will initiate discussion on various types of chemical reactions with examples.



Science behind the Game

Chemical reactions involve the breaking and making of bonds between atoms to produce new substances. Chemical reactions may be broadly classified as combination reaction, decomposition reaction, displacement reaction and double displacement reaction and redox reactions.

EXTENSION OF THE GAME

- ⊙ At the START line, each team will be given the chit with a reaction written on it. The team which picks up the maximum number of slips with example of same type of reactions will be declared winner.



Fig. 1



CWSN (Children With Special Needs)

- ⊙ CWVI may be paired with a sighted peer who can help and maneuver to read out the chits or the chits may be prepared in Braille too.
- ⊙ For CWHI: No modification is required.



COMMON SALT– A RAW MATERIAL FOR CHEMICALS

THAK THAK THAK... FREEZE!



Number of Participants

Two teams with six players each.



Time Required

15 minutes for one round



Material Required

Chart paper, sketch pens, a pair of scissors, and a stick.



How to Play?

- ⊙ Prepare two puzzle boards as shown in (Fig. 5 & 6) or you may use the cut-outs from the booklet.
- ⊙ Prepare the following placards or you may use cut-outs from the booklet.

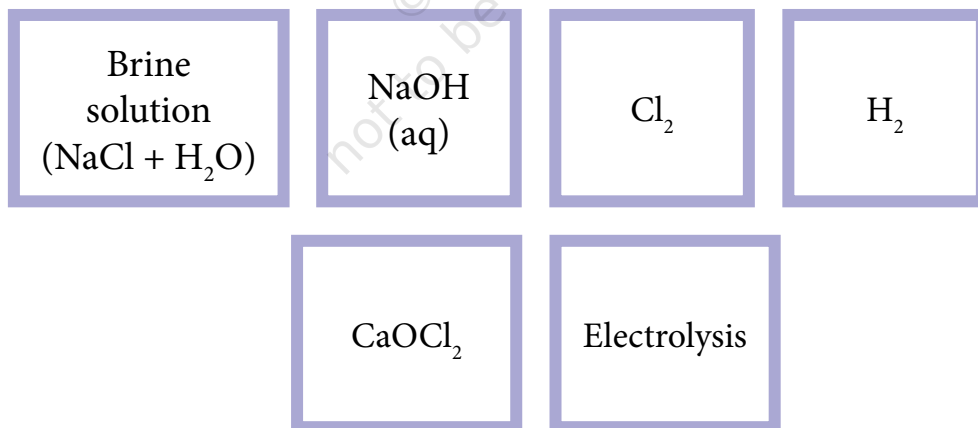


Fig. 1: Cards to be made for preparation of bleaching powder
(cards for puzzle board 1)

- ⊙ Form teams 'A' and 'B' with six players in each team to play on the puzzle board 1 for the preparation of bleaching powder.

- ⊙ The game can be played in a room or in a playground.
- ⊙ Out of six players of team A one player will be selected as 'den' who will be collecting all the cards from team B during the game.
- ⊙ To begin the game each player of team B will be given a card mentioned in Fig 1. and will take their position at about 10 metre from the 'den' at starting line (Fig. 2).
- ⊙ The 'den' of team 'A' will stand holding a stick with the back towards team B players.
- ⊙ After they have taken their positions the 'den' will start producing thak thak sound with the help of a stick.
- ⊙ On hearing the sound thak thak, team B players will start moving to make an attempt to tap the 'den' (Fig. 3).
- ⊙ The 'den' can stop the thak thak sound anytime and shout 'FREEZE' and all the players of team B will freeze as statues. At the same time the 'den' will turn back. If the 'den' catches any player not frozen, then that player will be declared out and their card will be collected by the 'den'.
- ⊙ The freeze period cannot be longer than 10 seconds. 'Den' can make an effort to incite the player to move without touching the player.
- ⊙ The 'den' will be declared out in case any player of team B succeeds in tapping the 'den'. The 'den' will then be replaced by another member of their own team.
- ⊙ When team A collects all the cards from team B, they will then place the placards starting with the key card, i.e., brine and other placards at appropriate places to complete the reactions on the Puzzle Board 1. If team A fails in either collecting all the cards or completing the reactions within 10 minutes, the task will pass on to team B.
- ⊙ At the end of 10 minutes, team A will place cards on the board. If they do not have all the cards then reaction will not be completed. Here, team B can help by selling the cards they have for two points.



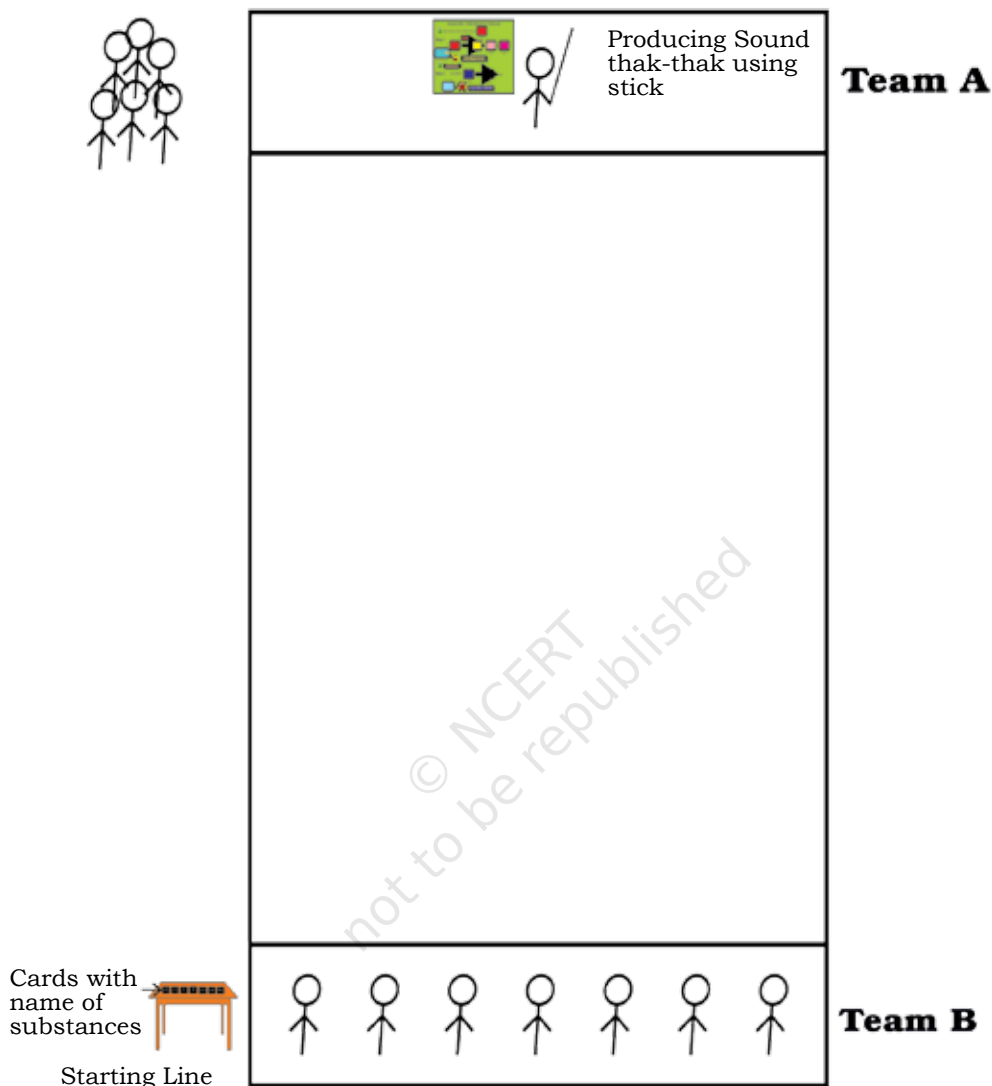


Fig. 2: Arrangement of the game

- ⊙ Facilitator may decide the scoring scheme of the game.
- ⊙ Likewise, other teams can be formed to play with the following set of placards and Puzzle Board 2 (Fig. 6) for preparation of washing soda.

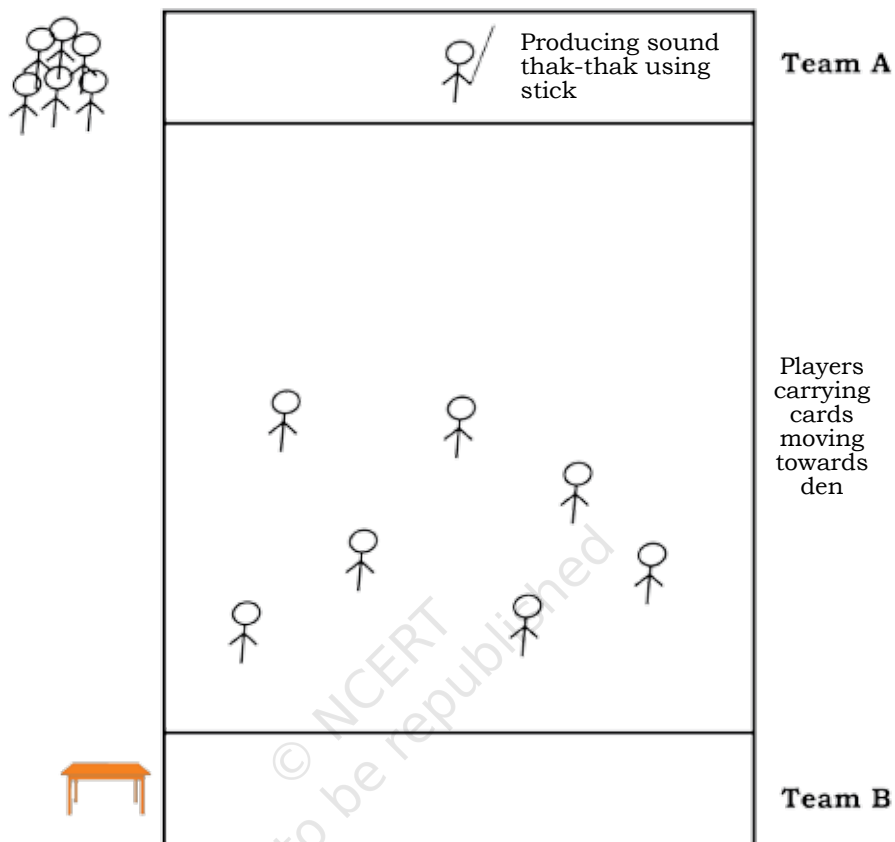


Fig. 3: Players playing the game



Science behind the Game

The common salt (NaCl) is an important raw material for various material of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder. Through this game players will learn how one substance (NaCl) is used as a raw material for making many different substances.



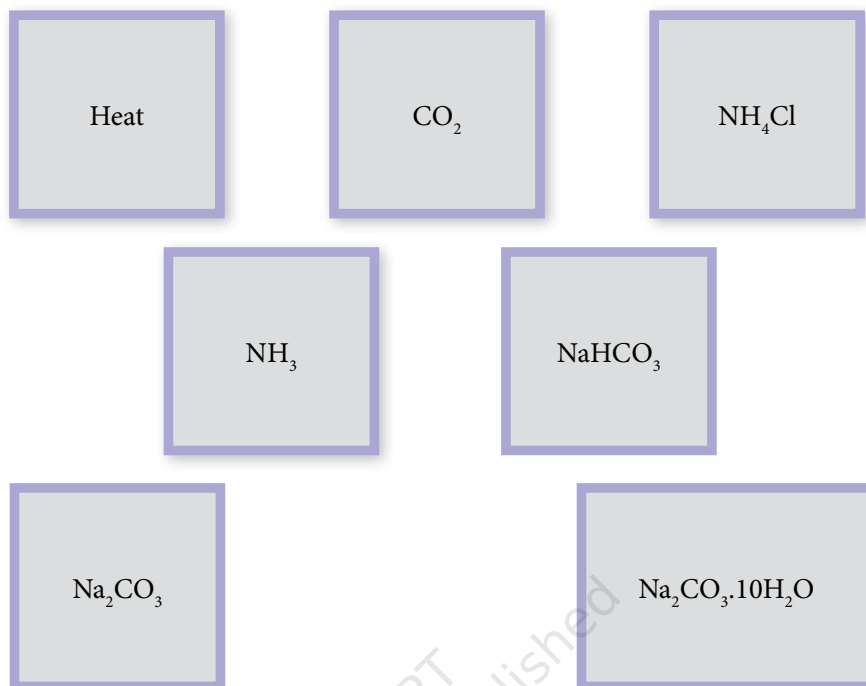


Fig. 4: Cards to be prepared for preparation of washing soda (cards for puzzle board 2)

EXTENSION OF THE GAME

- ⊙ Teams A and B exchange their roles with Team C and D, and the game is played again.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The cards may be prepared in Braille and if the player has to move in a playground he may be paired with a sighted buddy.

PUZZLE BOARD 1

Common Salt – A Raw Material for Chemicals

Step 1

1 Open the step 1 with the help of key card

2 $\xrightarrow{\text{From Player}}$ 2 + +

Brine Solution

From Player

From Player

From Player

SODIUM HYDROXIDE

1 Bring chlorine to unlock step 2

Step 2

$\text{Ca(OH)}_2 +$ \longrightarrow + H_2O

From Player

From Player

BLEACHING POWDER

I can help yourself. I can do your dirty work. I can help of the rusting on your wall. I'll even do your day without think.

I can help yourself to handle and release. I believe and now helpful in making the drinking water pure.

I am used for making bleaching powder which is very famous among all of you as it is used to make bread and cake soft and spongy.

I am very smart and active. I can be used as a cleaning agent for domestic purposes.

Fig. 5

PUZZLE BOARD 2

Common Salt – A Raw Material for Chemicals

Step 1

1 $\text{NaCl} + \text{H}_2\text{O} +$ + \longrightarrow +

Brine Solution

Carbon dioxide

Ammonia

Sodium chloride

Sodium Hydrogencarbonate

From player

From player

From player

From player

SODIUM HYDROGEN CARBONATE

Heat Sodium Hydrogen Carbonate to unlock step 2

Step 2

1 NaHCO_3 $\xrightarrow{\text{From player}}$

From player

From player

$\text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O}$ \longrightarrow

From player

(Washing Soda)

From player

WASHING SODA

I am used for making bleaching powder which is very famous among all of you as it is used to make bread and cake soft and spongy.

I am very smart and active. I can be used as a cleaning agent for domestic purposes.

Fig. 6

Answer Key:

Puzzle Board 1: Preparation of bleaching powder.

Puzzle Board 2: Preparation of washing soda.



NATURAL SELECTION

COPY CAT



Number of Participants

Entire class divided into three groups (each group with 12 students).



Time Required

40 minutes



Material Required

One brown colour coir mat/nylon mat/fur cloth, 100 green gram seeds, 100 brown gram seeds, 10–15 plastic forks, 10–15 plastic spoons, 15–20 plastic cups and Stop watch (This material is sufficient only for one group).

NOTE: It is a simulation game to explain natural selection. It is based on feeding success of beetles in their habitat.

(Refer to the table given below. It explains what the above materials represent and their function).

S.No.	Materials required	Quantity	To represent	To function as
1	Green colour mat	01	Green grass of habitat	Camouflage in habitat
2	Brown colour mat	01	Brown grass of habitat	Camouflage in habitat
3	Green gram seeds	100	Green beetles	Prey in habitat
4	Brown gram seeds	100	Brown beetles	Prey in habitat
5	Plastic forks	06	Predator population 'F'	Feeding apparatus of predator 'F'
6	Plastic spoons	06	Predator population 'S'	Feeding apparatus of predator 'S'

7	Plastic cups marked 'F'	06	Stomach of predator 'F'	Seed collection cup of predator 'F'
8	Plastic cups marked 'S'	06	Stomach of predator 'S'	Seed collection cup of predator 'S'
9	Stop watch	01	Time duration for feeding	Measuring time



How to Play?

- ⊙ Only one group of 12 students can play at a time with 1 set of game kit. More groups can play simultaneously if more game kits are available.
- ⊙ Place the green and the brown mat on two different tables.
- ⊙ Position 6 students around each table. These students will represent the predators.
- ⊙ Scatter equal number of green and brown gram seeds on both the mats. These seeds will represent green and brown beetles as the prey.
- ⊙ After this the facilitator will hand over 3 forks and 3 spoons to students on each table.
- ⊙ Students with forks will represent predator population 'F' and those with spoons will represent predator population 'S'. Forks and spoons will be used as feeding structures by predators 'F' and 'S', respectively.
- ⊙ The facilitator will also provide a cup to each predator on both the tables. These cups will represent stomachs of the predators and shall be labelled as 'F' and 'S' accordingly.
- ⊙ Facilitator will then instruct them to lift as many seeds as they can with their forks and spoons within the given time limit (preferably 15-20 seconds). Facilitator will warn them against directly picking up the seeds with their fingers.



- ⊙ When the facilitator gives the command ‘START’, all predators will start lifting up seeds with the help of their respective feeding structures, forks and spoons, and dropping them in their respective cups.
- ⊙ Predators will stop lifting the seeds when they hear the command ‘STOP’.
- ⊙ Each predator will count the number of seeds collected in their cups separately.
- ⊙ The predators will then line up according to the number of seeds collected by them. Predator with the highest number of seed collection in the cup will stand first in the line and the one with least will stand last.
- ⊙ The facilitator will count the total number of green and brown beetles (seeds) eaten by each predator and record the number of seeds in the table drawn on the black board.
- ⊙ The activity will be repeated by the remaining 2 groups.
- ⊙ A discussion will follow on the basis of data collected.

GROUP NUMBER : 1

(Tables below are given as example for data collection, calculation, analysis and interpretation).

A. Data Collection

1	Colour of grass mat	GREEN grass mat						BROWN grass mat					
2	Number of seeds scattered on each mat	50 green seeds + 50 brown seeds						50 green seeds + 50 brown seeds					
3	Types of predators	Predators 'F'			Predators 'S'			Predators 'F'			Predators 'S'		
4	Player (predator) number	1	2	3	4	5	6	1	2	3	4	5	6

5	GREEN seeds collected in cup by each player	4	5	4	2	2	3	10	12	7	4	5	7
6	BROWN seeds collected in cup by each player	9	11	7	5	4	9	5	7	3	1	2	5
7	Total no. of seeds (green+brown) collected by each player	13	16	11	7	6	12	15	19	10	5	7	12

B. Calculations based on Data Collection

1	Colour of grass mat	GREEN grass mat		BROWN grass mat	
2	Types of predators	Predators 'F'	Predators 'S'	Predators 'F'	Predators 'S'
3	Green seeds collected separately by predators 'F' and 'S' from each mat	$4+5+4=13$	$2+2+3=7$	$10+12+7=29$	$4+5+7=16$
4	Brown seeds collected separately by predators 'F' and 'S' from each mat	$9+11+7=27$	$5+4+9=18$	$5+7+3=15$	$1+2+5=8$
5	Green +brown seeds collected separately by predators 'F' and 'S' from each mat	$13+27=40$	$7+18=25$	$29+15=44$	$16+8=24$



6	Total no. of seeds (green +brown) collected together by predators from each mat	$40+25= 65$	$44+24=68$
7	Total no. of seeds (green +brown) left out by predators on each mat	$100-65=35$	$100-68=32$

C. Analysis and Interpretation

1	From which colour mat did the players pick up more green seeds?
2	Why were less number of brown seeds picked up from BROWN mat?
3	Predators with which type of feeding apparatus could pick up more seeds?
4	In this activity, what factors does the survival of beetles depend upon?
5	What is the relationship between the colour of grass of habitat and colour of surviving beetles?
6	From the data table, pick out two predators, one each from GREEN and BROWN grass mat, which have the best feeding efficiency. (That is, they could spot and eat more beetles as compared to other predators).



Points for Discussion

Some questions that can be raised to understand the Science behind the Game are given below:

- ⊙ What is the relationship between the colour of the grass of the habitat and the colour of the surviving beetles?

Hint: Camouflage

- ⊙ What is the relationship between the colour of the grass of the habitat and the ability of the predator to spot its prey?
- ⊙ What is the relationship between the feeding structure of the predator and its feeding efficiency?



Science behind the Game

Organisms Evolve by Natural Selection as follows:

1. There are variations between the individual organisms that make up any population (a population is a group of organisms of the same species living in the same place at the same time).
2. These variations occur partly because there are random mutations or errors in DNA copying in the genome of individual organisms.
3. Individuals with certain variants of the traits may survive and reproduce more than individuals with other variants i.e., certain variations are favoured by nature and are carried forward.
4. Therefore, due to natural selection coupled with other factors, the population evolves.

EXTENSION OF THE GAME

Depict the data on a graph paper. This will help you to see the trends in population of beetles more clearly in different habitats, and for different colour of the beetles. This will also allow students to understand how predator's feeding efficiency and the ability of the prey to protect itself influences survival of prey.

Note:

- ⊙ This is a simulation game in which a population of predators 'F' and Predator 'S' will use their respective



feeding structures to feed on a given background in order to survive. This simulates a situation that may exist in nature, in which the survival rate of the predator and the prey depends on conditions like habitat, camouflaging capability of the prey, efficiency of feeding structure of the predators etc.

- ⊙ The facilitator may use locally available seeds and mats matching their colours.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The game is based on visual inputs and eye hand coordination. Two beads of different texture, one resembling the coir mat texture and the other bead of strikingly different texture may be used to represent two different populations of beetle.
- ⊙ For CWHI: No modification is required.

REACTIVITY SERIES

POCKET THE SERIES



Number of Participants

2 or 4 players



Time Required

30 minutes



Material Required

Carrom board, carrom coins (16 pieces) and striker, maker pen, paper and glue.



How to Play?

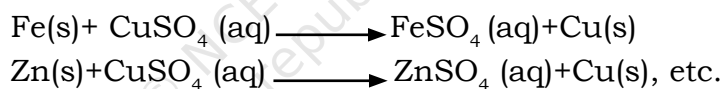
- ⊙ It is played by flicking a carrom “striker” disc with finger at the target coins. The goal is to collect points by pocketing maximum coins, plus the “red queen” coin, in the pockets. The team which pockets maximum coins will be the winner.
- ⊙ The facilitator will prepare 16 carrom coins by pasting symbols of metals (included in the reactivity series) –Al, K, Na, Li, Ca, Mg, Zn, Fe, Ni, Sn, Pb, Cu, Hg, Ag, Au, Pt. The red coloured coin can be made hydrogen by writing H on it. The symbols of metals and hydrogen should be pasted on one side only, which should always be kept upward.
- ⊙ Arrange the carrom coins with red “coin” in the centre and rest of coins around it in concentric circles (Fig. 1).
- ⊙ Each player sits on each side of the board and be allowed to strike from that side only.
- ⊙ During the play striker should be on the line for flicking’.
- ⊙ By tossing of a coin, facilitator will decide which player will play first.

- ⊙ Each player has to pocket two consecutive coins to score a point i.e., any metal coin followed by one more metal coin, one above or one below in the reactivity series. The pocketed coin will be placed back to the board if it is not covered with a valid coin. The player may be allowed to refer to reactivity series chart (Fig. 2). A player's turn will continue as long as the person keeps pocketing a valid pair of coins.
- ⊙ Pocketing the striker will cost you to lose one turn.
- ⊙ 'Boric acid' powder or any talcum powder may be used on the board to enable the pieces to slide smoothly.



Points for Discussion

Facilitator will discuss reactivities of various metals depending on their position in the reactivity series and will also discuss examples of displacement reactions. For example–



Science behind the Game

The metals at the bottom of the reactivity series are the least reactive. They are often found in a free state in nature. The metals at the top of the reactivity series (K, Na, Ca, Mg, and Al) are so reactive that they are never found in nature as free elements.

The metals in the middle of the reactivity series (Zn, Fe, Pb, etc.) are moderately reactive. These metals based on their reactivity are used for extracting/obtaining metals.



Fig.1: Carrom

Chart to be displayed for reference while playing the game**Reactivity series of metals and related metallurgy**

K	} Metals of high reactivity (Reduction of their oxides is done by Electrolysis)
Na	
Li	
Ca	
Mg	
Al	} Metals of medium Reactivity (Reduction using carbon)
Zn	
Fe	
Ni	
Sn	
Pb	} Metals of Low reactivity (Found in native state)
(H)	
Cu	
Hg	
Ag	
Au	
Pt	

Fig. 2



Fig. 3

**CWSN (Children With Special Needs)**

- ⊙ For CWVI: The carrom coins must be Braille labelled and the CWVI must be given a chance to explore the set up thoroughly before beginning the game.
- ⊙ Reactivity series must be given to the CWVI in Braille for ready reference.
- ⊙ For CWHI: No modification is required.



IUPAC NOMENCLATURE

IUPAC... SHOW YOUR PACK



Number of Participants

Three players per pack of cards.



Time Required

30 minutes



Material Required

Single coloured chart papers and marker pens.



Preparation for the Game

- Student will prepare 52 cards from the chart paper as per the tally given below:

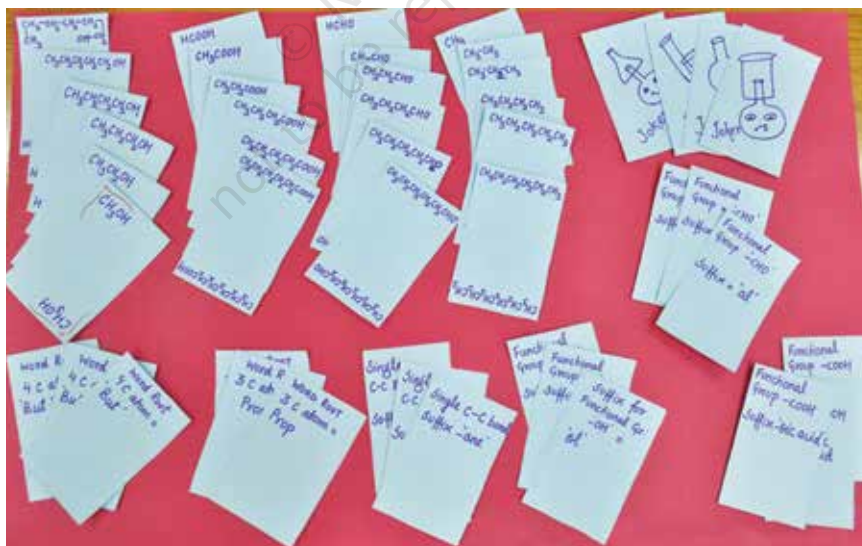


Fig. 1

Information on card					Number of cards
CH ₄	CH ₃ -CH ₃	CH ₃ CH ₂ CH ₃	CH ₃ CH ₂ CH ₂ CH ₃	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	6
CH ₃ OH	CH ₃ CH ₂ H	CH ₃ CH ₂ CH ₂ OH	CH ₃ CH ₂ CH ₂ CH ₂ OH	CH ₃ CH ₂ CH ₂ Cu 2CH ₂ OH	6
HCOOH	CH ₃ COOH	CH ₃ CH ₂ COOH	CH ₃ CH ₂ CH ₂ COOH	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ COOH	6
HCHO	CH ₃ CHO	CH ₃ CH ₂ CHO	CH ₃ CH ₂ CH ₂ CHO	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CHO	6
Word Root 'Prop' for 3 carbon chain	Word Root 'Prop' for 3 carbon chain	Word Root 'Prop' for 3 carbon chain	Word Root 'Prop' for 3 carbon chain	-	4
Word Root 'But' for 4 Carbon Chain	Word Root 'But' for 4 Carbon Chain	Word Root 'But' for 4 Carbon Chain	Word Root 'But' for 4 Carbon Chain	-	4



Suffix 'ol' for OH, alcohol	Suffix 'ol' for OH, alcohol	Suffix 'ol' for OH, alcohol	Suffix 'ol' for OH, alcohol	Suffix 'ol' for OH, alcohol	-	-	4
Suffix 'oic acid' for -COOH, Carboxylic acid	Suffix 'oic acid' for -COOH, Carboxylic acid	Suffix 'oic acid' for -COOH, Carboxylic acid	Suffix 'oic acid' for -COOH, Carboxylic acid	Suffix 'oic acid' for -COOH, Carboxylic acid	-	-	4
Suffix 'al' for -CHO aldehyde	Suffix 'al' for -CHO aldehyde	Suffix 'al' for -CHO aldehyde	Suffix 'al' for -CHO aldehyde	Suffix 'al' for -CHO aldehyde	-	-	4
Suffix 'ane' for alkane c-c single bond	Suffix 'ane' for alkane c-c single bond	Suffix 'ane' for alkane c-c single bond	Suffix 'ane' for alkane c-c single bond	Suffix 'ane' for alkane c-c single bond	-	-	4
Joker	Joker	Joker	Joker	Joker	-	-	2
'an'	'an'	'an'	'an'	'an'	-	-	2
Total number of cards =							52

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ The facilitator may get 10 such sets of 52 cards prepared so as to engage the entire class or may give the task of preparation of these cards as group activity to the students.
 - i. Six cards will have structural formulae of compounds of first six members of homologous series of alkanes.
 - ii. Six cards will have structural formulae of compounds of first six members of homologous series of alcohol.
 - iii. Six cards will have structural formulae of compounds of first six members of homologous series of carboxylic acid.
 - iv. Six cards will have structural formulae of compounds of first six members of homologous series of aldehyde.
 - v. Four cards with Word root “Prop” for three carbon chain.
 - vi. Four cards with Word root “But” for four carbon chain.
 - vii. Four cards with Suffix= ‘ol’ for functional Group = –OH.
 - viii. Four cards with Suffix= ‘oic acid’ for functional Group = –COOH.
 - ix. Four cards with Suffix= ‘al’ for functional Group = –CHO.
 - x. Four cards with Suffix= ‘ane’ for Single C–C Bond (Saturated Carbon chain) Alkane.
 - xi. Two cards with “Joker” written on it, which can be used as any card.
 - xii. Four cards with “an” written on them are kept in a separate pile face up and are available for every player at the time of declaration.





How to Play?

- ⊙ Shuffle the cards and distribute 10 cards each to the two players. Four 'an' cards will be kept face up on the table aside.
- ⊙ The remaining 30 cards of the pack will be kept face down in the middle.
- ⊙ The first player will pick the top card from the pack kept face down in the middle.
- ⊙ If this card is helpful in making any of the sequences with the cards in her/his hand, the player may retain the card. At the same time a card from his hand that the player may consider not useful in making any sequence, will be discarded. A separate heap of such discarded cards should be made with face up in the middle of the table.
- ⊙ The next player has the option of picking up either the top most card in the face up pile, or a card in the face down pile.
- ⊙ When the pile of face down cards is all used, the face up cards will be shuffled and placed face down.

Each player at the time of declaration will require:

- (a) a sequence of three cards showing structural formulae of any three consecutive members of homologous series of alkane/alcohol/aldehyde or carboxylic acid. For example, the player may make a sequence of cards having CH_3OH , $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$.
- (b) another possible sequence of 3 cards showing structural formulae of three consecutive members of another homologous series of alkane / aldehyde or carboxylic acid is CH_3CH_3 , $\text{CH}_3\text{CH}_2\text{CH}_3$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$.
- (c) to acquire two-word root cards to name third or fourth member of the homologous series. For example: word root card 'Prop' and/or word

root card 'But'. (Please note that Word root cards of only 3- C chain-'Prop' and 4- C chain 'But' will be available in the pack. It should be clarified to the players that Word root cards 'Meth', 'Eth', 'Pent', 'Hex' are not available in this pack).

- (d) to acquire two suffix cards to name the functional groups of the two sequences the player has in hand. For example: If the player declares the sequence given in step (a), she/he has sequence of alcohol, then she/he must aim to acquire suffix card 'ol'. Similarly, for sequences of step (b), the player must aim to acquire suffix card 'ane'.
- (e) four cards with 'an' written on them that have been kept in a separate pile, with face up and will be used only when the player declares his hand in the end. For example to declare the IUPAC name of an alcohol with 3- C chain, the player will pick up one 'an' card and then will show the cards in the order of Prefix card 'Prop', 'an' card and suffix card 'ol' to depict the IUPAC nomenclature of Propanol.
(Here, it is important that facilitator should emphasise to the students that if the name of the functional group is to be given as a suffix, the name of the carbon chain is modified by deleting the final 'e' and adding the appropriate suffix, i.e., Propane - 'e' = propan + 'ol' = Propanol).
- (f) a joker which can be used as any of the cards required by the player.
- (g) to make a correct sequence first and declare the hand, to be the winner.



Science behind the Game

This game is helpful in learning the homologous series and nomenclature of carbon compounds.

The names of compounds in a homologous series are based on the names of the basic carbon chain modified



by a “prefix” or “suffix” indicating the nature of the functional group.

For example, the names of the homologous series of the alcohols are methanol, ethanol, propanol, butanol, pentanol and hexanol.

EXTENSION OF THE GAME

1. This game can be extended to include the learning and naming of branched chain carbon compounds and structure having two functional groups also.
2. Variations can be introduced by having more cards in the pack and instructing that a sequence of any three homologous series and acquiring cards of nomenclature of any two or three compounds.
3. Another word root may be included in the cards such as ‘Meth’, ‘Eth’, ‘Pent’, ‘Hex’.
4. Cards of some more functional groups may be included such as ‘ene’ and ‘yne’.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The cards may be made in Braille or the child may be paired with a sighted buddy.
- ⊙ For CWHI: No modification is required.

HUMAN EXCRETORY SYSTEM

TRAIL THE TWIST (BOARD GAME)



Number of Participants

Two



Time Required

30 minutes



Material Required

Board, Dice, Tokens (coins) of different colours.



How to Play?

- ⊙ Each player will be given one token of different colour.
- ⊙ The starting point of the game will be 'glomerulus' and ending point will be 'urinary bladder'.
- ⊙ Each player will enter the game only after filtration from glomerulus to the Bowman's capsule. A player can be filtered and move in game, only if they roll a six. Otherwise, the player has to wait for the next turn.
- ⊙ Players will roll the dice turn by turn and move along the boxes according to the number on dice.
- ⊙ While moving forward, the player may land on G, A, S, W or boxes without any letter. The letter represents the following substances.
 - G = Glucose
 - A = Amino acids
 - S = Salts
 - W = Water

- ⊙ If the player lands on a box G or A, the player will leave the kidney tubule and go back to the starting point as Glucose and Amino acids are reabsorbed from the tubule.
- ⊙ If the player lands on a box S, the facilitator will ask a question. As some of the salt is reabsorbed and some stays in the kidney tubule, the player will move ahead in the tubule if their answer is correct. In case of a wrong answer, the player will go back to the starting point.
- ⊙ Similarly, the facilitator will ask another question if the player lands on box W, as the amount of water to be excreted or absorbed depends on how much excess water is there in the body and how much water is needed back. If the player answers the question correctly, they will move ahead in the kidney tubule but if the answer is wrong, the player will go back to the starting point.
- ⊙ Some suggestive questions are as follows:
 - i. name any one organ of the excretory system of human beings.
 - ii. where are the kidneys located in the body?
 - iii. name the basic filtration unit of kidney.
 - iv. state two major functions of the kidney.
 - v. what happens to glucose which enters the nephron along with the filtrate?
 - vi. name the blood vessel which brings blood to the kidneys.
 - vii. name any two nitrogenous waste products which are removed from the blood.
 - viii. what is the function of urinary bladder?
- ⊙ Once the player has reached the bladder, they need not wait for more than one turn, since the urine

cannot stay in the bladder for very long. Therefore, the player will be allowed to exit as urine in the next turn irrespective of the number rolled on the dice. The other player may win the game if the rolled number on the dice is exact.

- ⊙ The player who first exits from the bladder wins the game.



Points for Discussion

- ⊙ Various Excretory products and methods of excretion in different organisms.
- ⊙ Basic mechanism of excretion in humans.
- ⊙ Impairment of kidney function and Dialysis.

Note to the Teacher

Prepare multiple boards to ensure maximum participation.

EXTENSION OF THE GAME

The game can be adapted to teach diseases like Diabetes and proteinuria.



Science behind the Game

The human excretory system includes a pair of kidneys, a pair of ureters, a urinary bladder and a urethra. Kidneys make urine by filtering out waste products from the blood such as urea and uric acid.

Formation of urine takes place in three steps—

- ⊙ Filtration
- ⊙ Selective Reabsorption
- ⊙ Tubular Secretion



The basic unit of filtration in kidneys is a **nephron**. It filters the blood and then selectively reabsorbs some substances like glucose, amino acids, some salts and major amount of water. At the same time it also secretes some substances in the filtrate, which need to be excreted out; such as H^+ , K^+ and ammonia.

The urine from each nephron enters the collecting duct. From there it enters the ureters and reaches the urinary bladder. It is stored here until the pressure in the bladder leads to urge to pass it out. Finally, the urine is excreted out through the urethra.

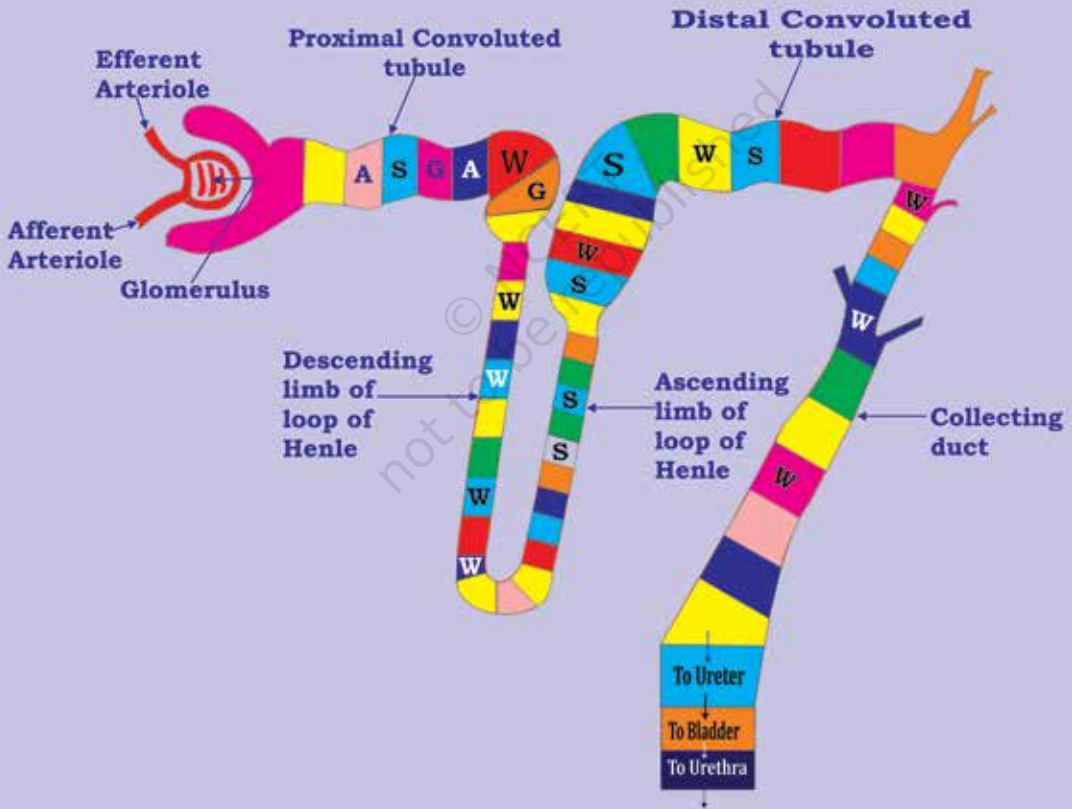


Fig. 1

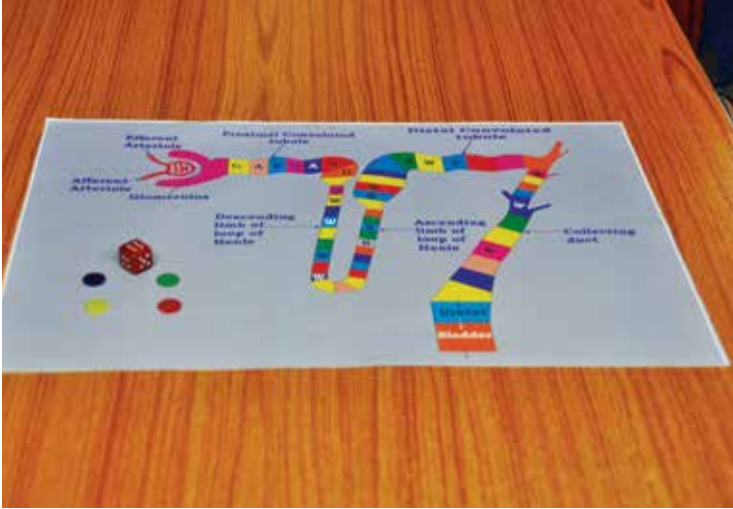


Fig. 2

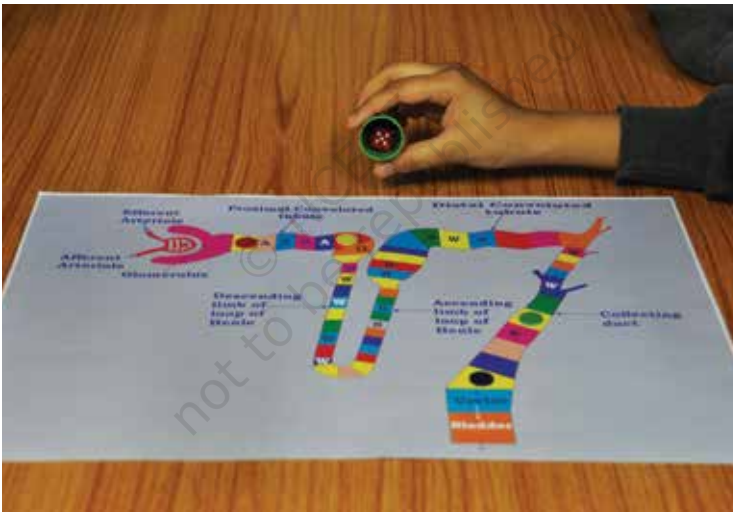


Fig. 3



CWSN (Children With Special Needs)

- ⊙ For CWVI: The Dice and the board must be made tactile with proper labeling in Braille.
- ⊙ For CWHI: No modification is required.



CHEMICAL EQUATIONS

THREE-LEGGED RELAY RACE



Number of Participants

32 (24 players and eight as referees).



Time Required

30 minutes



Material Required

Strips of cloth to tie legs, chart paper, marker pens, four pencils, pair of scissors, 12 bowls.



How to Play?

- ⊙ The facilitator will prepare four sets of three types of slips of items given in Table 1.
- ⊙ There will be four teams of six players each.
- ⊙ There will be four straight tracks for the relay race. On each track, three pairs of players of the same team will stand at meter distance from each other as shown in the figure below. The positions as marked as X, Y and Z.

Table 1

Name of element	Name of combining substance	Name of product formed
Sulphur	Oxygen	Magnesium oxide
Aluminium	Water	Copper oxide
Copper	Hydrochloric acid	Magnesium hydroxide
Zinc	Sulphuric acid	Sodium hydroxide
Magnesium		Sulphur dioxide
Sodium		Zinc chloride

Carbon		Zinc oxide Zinc sulphate Magnesium sulphate Sodium oxide Sodium chloride Sodium sulphate Copper chloride Copper sulphate No reaction : two Cards The product is ____: two Cards
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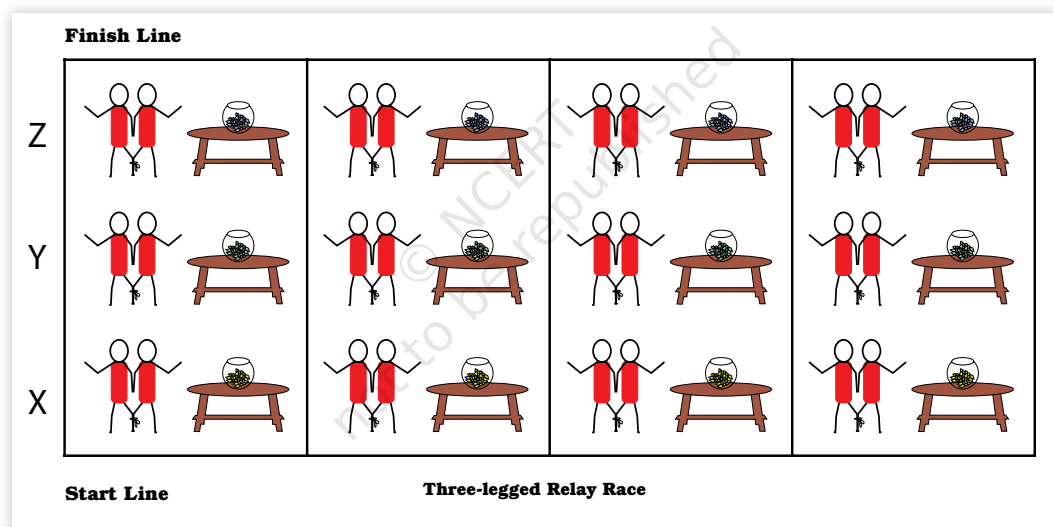


Fig. 1

- ⊙ The facilitator will place a bowl containing slip of name of elements at position X, a bowl containing names of combining substance at position Y and a bowl containing slips of name of product formed at position Z in each track.
- ⊙ The facilitator will ask each pair of player to tie their one leg with each other and get ready for three-legged race.



- ⊙ The facilitator will inform that no team is out of the race even if any of the team member falls down during the race. The pair should stand up and continue the race.
- ⊙ Before the race begins, the facilitator will ask first four pairs standing at position X to pick up a folded slip from the bowl.
- ⊙ On getting signal from the facilitator they start running and hand over the slip to the second pair of their team at position Y. Then, this pair will pick up another slip from the bowl kept there and will run towards position marked as 'Z' with both the slips and hand over the slips to the third pair of team standing there.
- ⊙ After reading the slips, they will choose an appropriate card from bowl kept at position Z on each card, name of the probable products corresponding to reaction between element and combining substance is written.
- ⊙ In case, no reaction is possible between the two reacting species, the team will select the card "No reaction". In case, reaction is possible but no corresponding card is kept in bowl, the team will write the name of the product on the blank card "The product is _____".
- ⊙ For example, if first pair of a team picks up the element magnesium, the second pair picks up oxygen, then the third pair should pick up magnesium oxide which is the product of the reaction between magnesium and oxygen.
- ⊙ The team with two slips and a card will then run towards the finish line. The team that reaches first and carries the correct combination of cards will be declared as winner.



CWSN (Children With Special Needs)

- ⊙ For CWVI: As the game is to be played in pairs, the only modification required would be the Braille transcribed slips.
- ⊙ For CWHI: No modification is required.

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MOTION

HOW FAST DO YOU REACT?



Number of Participants

Whole class divided into groups of two each.



Time Required

30 minutes



Material Required

50cm ruler



How to Play?

- ⦿ Choose a partner.
- ⦿ Let your partner hold the ruler as shown in Fig. 1. The zero of the ruler should be at the bottom.
- ⦿ You extend your hand in such a way that it is ready to catch the ruler (see Fig.1). Zero of the ruler should be in between the fingers of the extended hand.
- ⦿ Ask your partner to count up to five and then release the ruler.
- ⦿ As soon as your partner releases the ruler, try to catch it in as short a time as possible.
- ⦿ Note the reading on the ruler where you managed to catch it. It is a measure of the time you took to react.
- ⦿ Change places with your partner and let her measure her reaction time.
- ⦿ Let the whole class compete and discover the student with the fastest reaction time.



Science behind the Game

Suppose a friend throws a rubber ball at you suddenly. Your reaction to evade, or catch, the ball is not instantaneous. There is always some time lag. This time lag is called the reaction time. Your senses, in this case your eyes, send the information to your brain. Your brain processes the information and then sends you instructions to react, in this case to evade or to catch the ball.

You must have seen in TV replays how a cricketer standing in slips reacts fast enough to hold a catch. The reaction time for him is a fraction of a second. These players are trained, therefore they can react really fast. With practice you too can improve your reaction time.

Moreover, if you expect a certain event to happen and are prepared for it, your brain is on alert and processes information faster. In such situations you tend to react faster. That is why when you have practiced a few times, your reaction time is shorter.

EXTENSION OF THE GAME

1. Try the activity 5 times and note down your observations. Did your reaction time improve?
2. Find difference in your reaction time when you use your dominant hand (the hand with which you write) and the other hand.
3. Find if there is any difference in the reaction time of boys and girls.
4. Perform the activity at home with your parents and other older members of your family. Find if the reaction time is related to age.
5. Since the ruler falls under gravity, it is possible to convert the distance on the ruler to the time in seconds. You can use the given ready-made chart to get an idea of how fast you react.



Distance on the scale (cm)	5	10	15	20	25.5	30.5	43
Time (s)	0.1	0.14	0.17	0.2	0.23	0.25	0.3

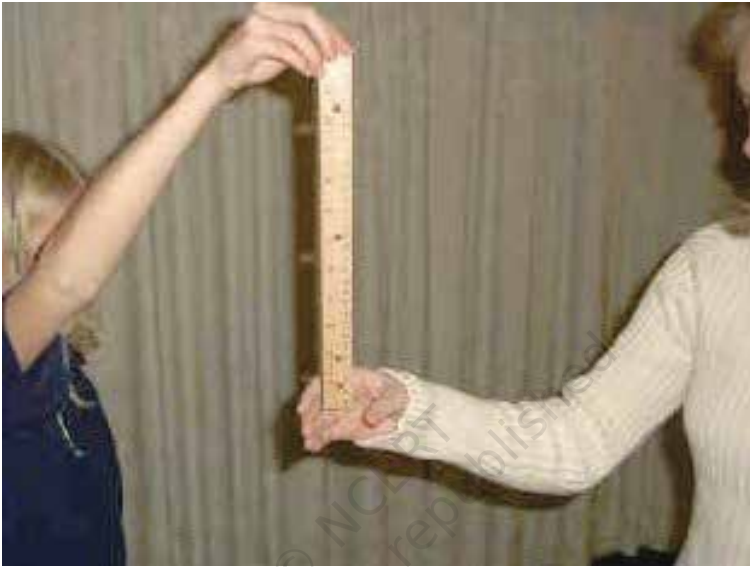


Fig. 1

(<http://www.scientificamerican.com/article/bring-science-home-reaction-time/>)



CWSN (Children With Special Needs)

- ⦿ The reaction time of CWVI may be recorded by giving the child more chances. The CWVI child must be pre familiarised with the set up. Some audio clue may be given before releasing the ruler.
- ⦿ For CWHI: No modification is required.

BONDING IN CARBON COMPOUNDS

MY BOND... MY IDENTITY



Number of Participants

Entire Class



Time Required

30 minutes



Material Required

Ribbons of various colours, yellow ribbon—18 metre, light blue ribbon (27 metre), black marker, red marker and bindi packet (Red and black bindis) (or stickers) of two different colours to represent electrons in carbon outer most orbit of an atom hydrogen).



How to Play?

- ⊙ Divide the class into two teams A and B with equal number of players (say around 18 players in each team— six players representing carbon atom and 12 players representing hydrogen atoms).
- ⊙ Six players of each team representing the carbon atoms will prepare six waist-bands each as shown in Fig. 1. Stick one black coloured bindi at centre of vertical ribbons to represent valence electrons of carbon atom as shown in Fig. 1.

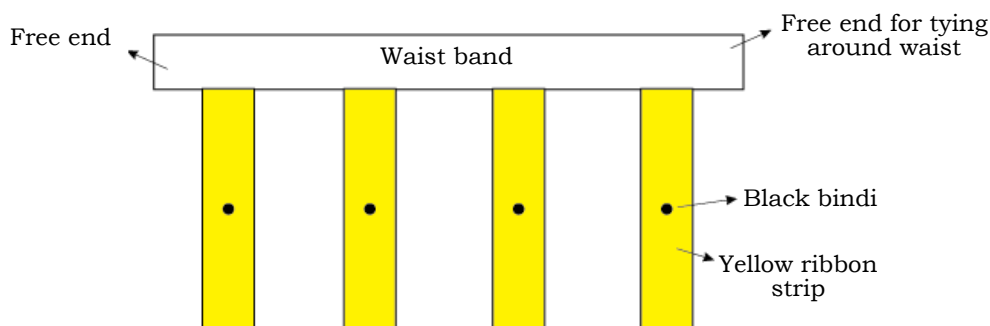


Fig. 1

- Similarly, other 12 players of a team will represent hydrogen atoms and will prepare 12 waist-bands blue coloured as shown in the figure 2. Fix a red colour bindi at centre of vertical position which will represent 1 valence electron of hydrogen atom.

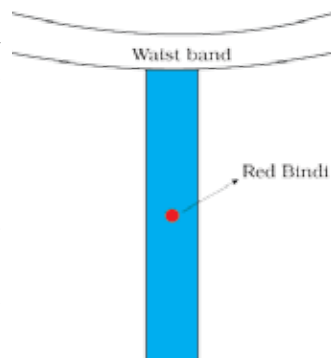


Fig. 2

- Players will be asked to tie the free ends of their respective waist-bands. The players wearing the carbon waist-band should have one strip in front, one at the back, and two on both sides (Fig 3). The players wearing the hydrogen waist-bands should have light blue strip of ribbon in front.



Fig. 3

- To start the game, the two teams will line up. When the facilitator announces the name of a carbon compound to be formed, the required number of carbon players and hydrogen players from both the teams will step out in front of their team and form the desired structure by tying one vertical ribbon of carbon with one vertical ribbon of hydrogen. The two ribbons tied together would represent formation of 1 covalent bond indicating sharing of electrons.
- Suppose the facilitator announces 'methane'— one player representing carbon atom and 4 players representing hydrogen atom will step out from each

team. The 4 players representing 4 hydrogen atoms will tie their one vertical ribbon each with 4 vertical ribbons of player representing carbon atom (Fig. 4).

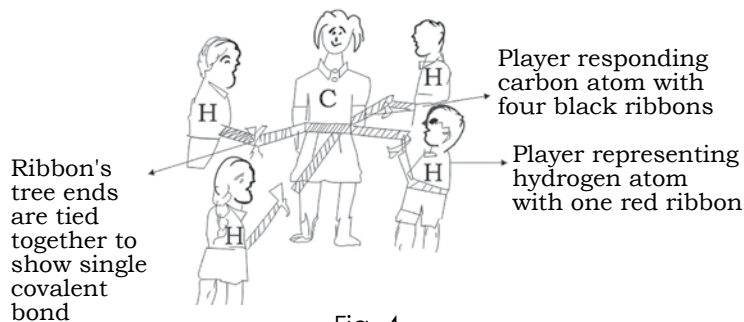


Fig. 4

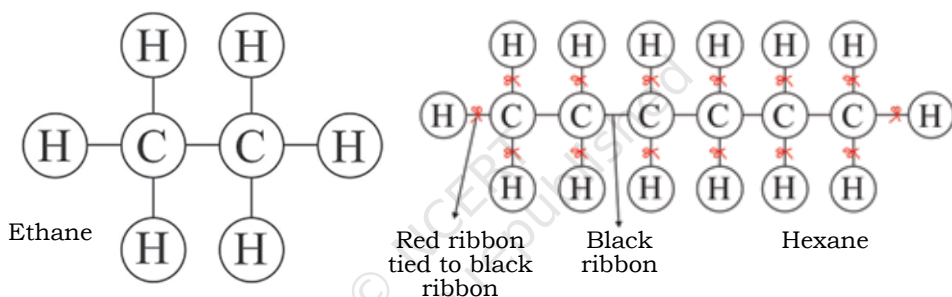


Fig. 5

- ⊙ Facilitator will check if correct structure has been formed and will discuss and summarise the concept.
- ⊙ Facilitator will then announce one by one other saturated hydrocarbon compounds (Fig. 5) and students will form respective structures.



Points for Discussion

- ⊙ Facilitator will discuss that carbon forms compounds by sharing of electrons and thus form covalent bonds, which have been depicted by tying of ribbons. Property of 'Catenation' to be discussed here.



- ⊙ The facilitator will warn students that these are only representation, nothing to do with the actual formation of bonds or structures of molecules.



Science behind the Game

- ⊙ Carbon atoms cannot form ionic compounds. If they gain 4 electrons to form C^{4-} anion, 6 protons with neutrons cannot hold 10 electrons. Similarly carbon cannot lose 4 electrons to form C^{4+} cation as large amount of energy is required. To overcome this limitation, carbon shares its valence electrons with other atoms of carbon or with atoms of other elements, through covalent bonds.

EXTENSION OF THE GAME

1. The game can also be played to show double and triple covalent bonds formed between other atoms such as $O=O$, $N=N$, $H_2C=CH_2$, $HC=CH$ and $O=C=O$.



CWSN (Children With Special Needs)

- ⊙ For CWVI: Ribbons of different textures may be used to denote carbon and hydrogen.
- ⊙ For CWHI: No modification is required.

METABOLIC PROCESSES IN LIVING ORGANISMS

THE FASTEST WINS



Number of Participants

As many participants as the slips made, four group leaders, two time keepers.



Time Required

20-30 minutes



Material Required

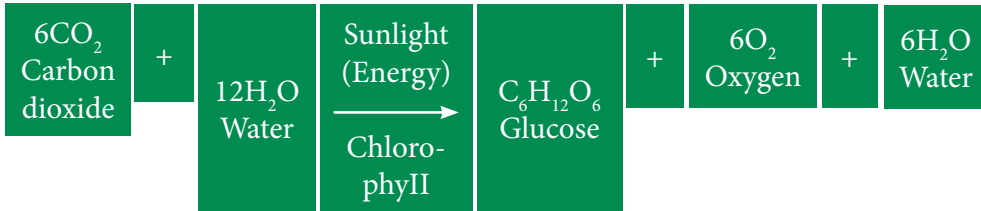
Sheets of four different colours (Red, Green, Orange and Purple), cardboard or plastic box, stop watch.



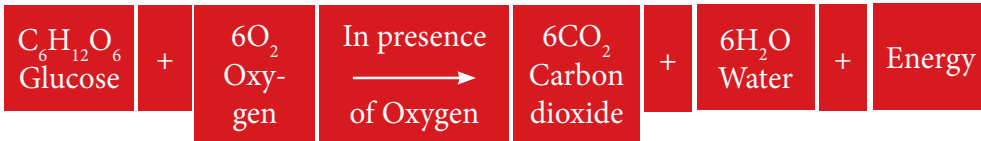
How to Play?

- ⊙ Cut out approximately 10 slips of each of the following colours to represent life processes given along with them:
 - (i) Green slips for 'Photosynthesis'.
 - (ii) Red slips for 'Aerobic respiration'.
 - (iii) Orange slips for 'Anaerobic respiration in yeast cells'.
 - (iv) Purple slips for 'Respiration in muscle cells'.
- ⊙ Write information on slips as per the colour code. Each slip would have either the name of reactant(s), or product(s) or reaction conditions. These slips arranged in correct order (as per their colour code) will represent chemical reaction of that process. Some slips have only a + (plus) sign. Such slips will be placed at appropriate places while arranging in a reaction. Sequence of slips representing various processes are given below:

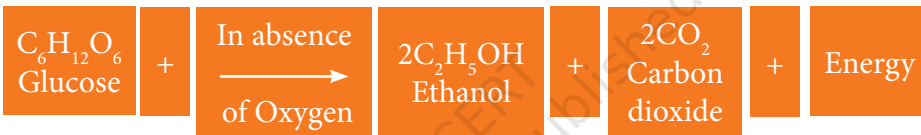
i. Green slips for photosynthesis:



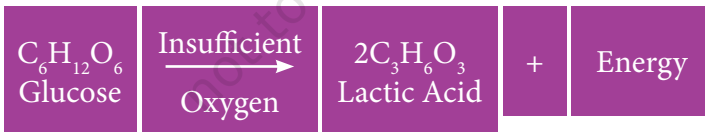
ii. Red slips for aerobic respiration:



iii. Orange slips for anaerobic respiration in yeast cells



iv. Purple slips for anaerobic respiration in muscle cells:



- ⊙ Select four group leaders and assign them different colours – Green, Red, Orange and Purple. Also mark four tables as Green, Red, Orange and Purple.
- ⊙ Facilitator will put all the prepared slips in a box. Each player will pick up one slip and go back. They will place their slips on their tables upside down.
- ⊙ When the facilitator says ‘START’ to begin the game, the time keeper will start the stop watch.
- ⊙ Simultaneously, the four group leaders will quickly move along the desks and start looking for players having slips of the same colour to form their groups.

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ Players will hand over their slip to the leader and they will start moving towards the assigned table.
- ⊙ Once at their respective tables, players will identify the reaction and try to quickly arrange the slips in correct order. As soon as they complete the reaction, they will call the facilitator.
- ⊙ Facilitator will check the correctness of the reaction. The team, that arranges their slips first in the correct order, will be declared the winner.
- ⊙ The students will keep their slips back in the box and play the game again.



Points for Discussion

- ⊙ The conditions required for each process.
- ⊙ Location in the body of organism where these processes take place.
- ⊙ Comparison between the products formed in the absence or presence of oxygen during respiration.



Science behind the Game

With the help of this game teacher will be able to explain the important metabolic processes of living organisms.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The information on the slips should be written in Braille. If the student has to be given the role of facilitator then the texture of the slips should also be different and the players may quickly verbalise the reactant, product or the reaction condition to lessen the total time taken. CWVI (when in the role of the facilitator) may be led to the student with similar coloured slips.
- ⊙ For CWHI: No modification is required.



MICELLE FORMATION

KICK OUT DIRT



Number of Participants

Entire Class



Time Required

30 minutes



Material Required

Chart papers, cardboards, marker pens, pins, glue, pair of scissors.



How to Play?

- Facilitator has to prepare the following material with the help of students.

- (a) Twelve zig-zag shaped strips of chart paper representing long hydrocarbon part of a soap (hydrophobic end) as shown in Fig. 1 (a).



Fig.1 (a)

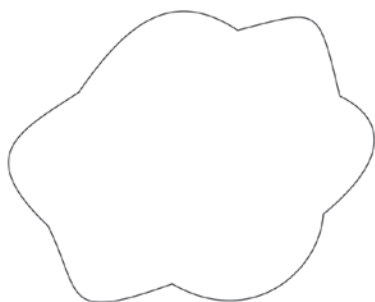
- (b) Twelve round or oval shaped cut-outs representing short ionic end of a soap molecule (hydrophilic end) as given in Fig. 1(b).



Fig.1 (b)

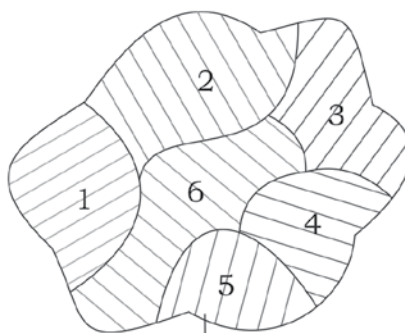
- (c) One large irregularly shaped dirt particle to be prepared with a piece of cardboard Fig. 2(a). Paste white chart paper on it (representing clean area).

- Trace the outline of this dirt particle on a piece of brown coloured chart paper. Cut it into six irregular shaped small pieces. Place the six irregular shaped



Dirt particle with uneven outline with white chart paper pasted on it

Fig.2(a)



Six Brown pieces

Fig.2(b)

small brown pieces Fig. 2(b) on the large white dirt particle Fig. 2(a). Similarly make another set of dirt particle.

- ⊙ Prepare two Placard named “Hydrophobic” and “Hydrophilic” and write 12 questions on them including value based questions.

Following are suggestive questions which may be adopted or adapted by the facilitator—

Hydrophobic Placard	Hydrophilic Placard
Q1. What does hydrophobic end of the soap molecule stand for?	Q1. State the valency of carbon.
Q2. Which end of the soap molecule represents the tail?	Q2. Which end of the soap molecule dissolves in water?
Q3. Which end of the soap molecule attaches itself to the dirt particle?	Q3. What is an emulsion?
Q4. What is the difference between ethane and ethene?	Q4. What does hydrophilic end of the soap molecule stand for?
Q5. Does the colour of soap affect its cleansing action?	Q5. In which form the micelle clusters exist in the soap solution?
Q6. Why soap does not form foam in hard water?	Q6. Does the smell of soap effect its cleansing action?



Hydrophobic Placard	Hydrophilic Placard
Q7. Which end of the soap dissolves in oil?	Q7. What is the chemical composition of soaps?
Q8. Why are the soaps more eco-friendly than detergents?	Q8. What is the general nature of dirt? (Answer: Oily)
Q9. How many hydrogen atoms are there in a hexane molecule?	Q9. Why does a soap solution appear cloudy? (Answer: As the soap molecules are large enough to scatter light.)
Q10. What change will you observe if you test soap with litmus paper (red or blue)?	Q10. Why do different sources of water produce different quantity of lather/foam by the same soap?
Q11. Why should we wear clean clothes?	Q11. How does the cleansing action of soap and detergents take place?
Q12. Why should we use soap for bathing?	Q12. Why should the use of the detergents be discouraged?

- ⊙ To begin the game, two teams will be formed and facilitator keeps two bowls, one having 12 zig-zag shaped hydrocarbon strips Fig. 1(a) and the other 12 oval shaped cut-outs Fig. 1(b). Two dirt particles are placed in front of each team.
- ⊙ Each team will be asked two questions one after the other, one from hydrophobic placard and the other from the hydrophilic placard.
- ⊙ Two members will be called from each team. If they answer both the questions correctly they will be allowed to pick out one piece of zig-zag shaped strip and one oval cut-out. They will join the two pieces together to make a soap molecule. They will use this soap to remove one piece of dirt particle cut-out with hydrophobic end facing it Fig. 3(a) and 3(b).

- © The team having earned maximum number of soap molecules will be able to form a micelles cluster Fig. 3(b) and they will remove all the brown coloured dirt particles by pulling their soap molecules (as shown in Fig. 3(a)). Their area will be declared clean as white chart paper will now be visible, and they will be declared winners.

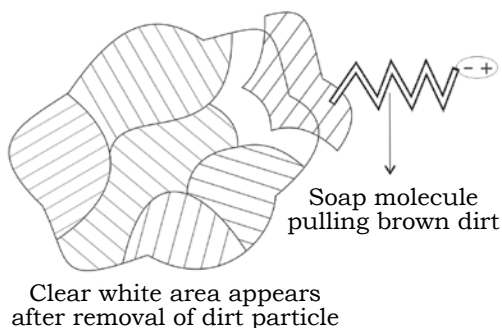


Fig. 3(a)

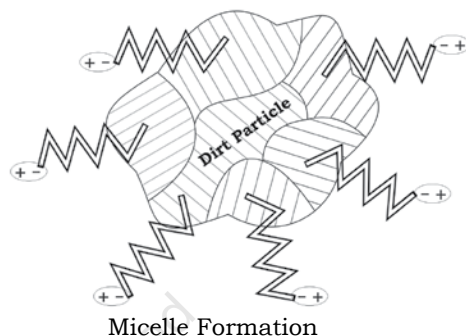


Fig. 3(b)



Science behind the Game

This game demonstrates the use of soap in cleaning. Most dirt is oily in nature and oil does not dissolve in water. The molecules of soap are sodium or potassium salts



of long chain carboxylic acids and fatty acids. The ionic-end of soap dissolves in water while the carbon chain dissolves in oil. The soap molecules thus form structures called micelles, where hydrophobic end is towards the oil or the dirt droplet. This forms an emulsion in water as shown in figures.





CWSN (Children With Special Needs)

- ⊙ For CWVI: No modification is required as the shapes can easily be recognised by them and placed accordingly.

CENTRIPETAL FORCE

DANCING MARBLE IN A BOTTLE



Number of Participants

Whole class divided in teams of 5–6 students.



Time Required

15 minutes



Material Required

An empty 2l soft drink bottle, a glass marble, a stop watch/clock.



How to Play?

- ⊙ Divide the class into 4–5 teams each with 5–6 students.
- ⊙ Place the glass marble in the bottle. Hold the bottle in a horizontal position with the marble resting somewhere near the middle (Fig. 1).



Fig.1

- ⊙ Now set the bottle in a circular movement. The marble starts executing circular motion along the inner surface of the bottle. The challenge before the players is that the marble should neither fall in the bottle nor spill out of it while continuing in circular motion. The marble will continue in this state even when the bottle is brought to a vertical position with its mouth downwards. The marble should remain in circular motion for some time.
- ⊙ Each team will be given five minutes for practice before the game.
- ⊙ Each member of the team gets one minute to move the marble. They earn two points for the team if they succeed in moving the marble continuously for at least 30 seconds along the circular path when the bottle is inverted.
- ⊙ The team which earns maximum points wins the game.



Science behind the Game

As we increase the speed of rotation of the marble, a stage comes when its speed is such that the normal reaction of the wall of the bottle on it can provide sufficient centripetal force for it to keep moving in the circular path. So it does not fall and remains in that state for some time.



CWSN (Children With Special Needs)

- ⊙ The CWVI with verbal and physical cues may perform this experiment, and will be able to know about the motion of the marble with his tactile and auditory sense.
- ⊙ For CWHI: No modification is required.

DIVERSITY IN LIVING ORGANISMS

LATCH ON TO YOUR MATCH



Number of Participants

Twenty one players, one usher, two scorekeepers and a group of students for making placards and secret-paper-slips.



Time Required

30 minutes



Material Required

Placards, strings, blank papers and paper clips.



How to Play?

1. Preparation of placards and secret-paper-slips

- Students will make 10 placards and 11 'secret-paper-slips'.
- Placards will demonstrate any 10 taxonomical groups of living organisms which are given in the textbook.
- Corresponding to these 10 placards, 10 secret-paper-slips will be prepared. Each secret-paper-slip will have a prominent characteristic feature, or an example, or meaning of a term corresponding exclusively to one taxonomical group only. Make sure that no secret-paper-slip matches with more than one group written on placards.

- The eleventh secret-paper-slip is the odd one out. It will have a feature that does not belong to any placard.
- Now, fold the paper slips and secure each with a paperclip.

2. Formation of Teams

This game is based on the popular game of musical chairs. However, when the music stops, instead of sitting on chairs, the player having a slip will latch onto the person holding the appropriate placard.

The teacher will make two teams and give them instructions as given below.

- **Team A** (Standing team) of 10 students.

Instructions for team A

- a. The students will stand in a queue and hang placards around their necks.
- b. They can rest one arm on their hip so that they can latch to their partners when required.

- **Team B** (Running team) of 11 students.

Instructions for team B

- a. When the music starts playing, team B will go around team A in clockwise direction.
- b. They will try to RECALL the characteristics of each taxonomic group written on placards worn by team A.
- c. While moving around team A, they will be given secret-paper-slips by the usher.
- d. As the music stops, the facilitator will give the command 'OPEN', only after which team B will open their secret-paper-slips.
- e. The usher will be positioned near the first member of team A.

3. How to play the game?

STEP 1: The players of team B will be allowed to take 5–6 rounds around team A so that they get sufficient

time to recall the characteristics of each group displayed on the placards. The facilitator will tell the usher to hand over the secret-paper-slips to team B students, one by one, as they pass by the first member of team A. They will continue to run around till the music stops.

STEP 2: As soon as the music stops, the team B will open their slips and read. Each secret-paper-slip will contain a piece of information related to any one of the placards with team A.

STEP 3: After reading the secret-paper-slip, team B will look for their matching partner from team A, while still moving in the same direction. On finding their matching placard, they will latch on to the arm of that player.

STEP 4: The game will end when all members of team B, except one, have found their match. This eleventh runner should have an “unmatched” slip.

STEP 5: The facilitator will note the number and types of mistakes made by team B.

STEP 6: Team A and B will exchange roles and play the game again.



Points for Discussion

- ⊙ After the game ends, the pairs formed will come forward one by one and justify their choice.
- ⊙ Runner with an 'unmatched' slip will answer to which Phyla/Group it belongs.



Science behind the Game

Most teachers face difficulty in teaching the topic on "Diversity in the Living Organisms". Even students have difficulty in recapitulating the characteristics of each group. This game will help



to reinforce content and enhance recall, reinforce content and enhance factual knowledge through informal learning.

EXTENSION OF THE GAME

The game can be adapted to topics such as cell organelles, tissues.

Sample of a set of Placards and matching Secret paper slips

	Placards with Team A	Secret-paper-slips with Team B
1	Arthropoda	They have jointed legs.
2	Gymnosperms	These plants have naked-seeds.
3	Nematoda	Worm that causes elephantiasis is an example of this group.
4	Reptilia	They have exoskeleton of scales and three-chambered heart.
5	Monera	They do not have a defined nucleus or cell organelles.
6	Pisces	They have exoskeleton of scales, fins and two-chambered heart.
7	Mammalia	Bat is an example of this group.
8	Fungi	Most of them use dead and decaying organic matter as food.
9	Aves	The forelimbs of this group of animals are modified for flight.
10	Platyhelminthes	Their bodies are dorsoventrally flattened.
		They are found both in water and on land (extra slip)

contd.



CWSN (Children With Special Needs)

- ⊙ For VIC: The placards and secret paper slips may be prepared in Braille and a buddy/peer may be assigned to the CWVI to facilitate mobility and to read out the placard (in cases where tactile exploration of the card is not possible). For low vision students both the placard and secret paper slip must be made in large font and bold print.
- ⊙ For a child with locomotor disability too, a buddy will be required to facilitate his movement.



Fig.1



NEUTRALISATION REACTION

NEUTRALISE ME / LOOK FOR MY SALT



Number of Participants

21 Students



Time Required

30 minutes



Material Required

Chart paper, sketch pens, chalk powder, safety pins, cardboard.



How to Play?

- ⊙ Prepare 10 cards (6"x6") having the names of 10 different salts, such as
NaCl (sodium chloride),
K₂SO₄ (potassium sulphate),
CH₃COONa (sodium acetate),
NaNO₃ (sodium nitrate),
HCOOK (potassium formate),
CaCl₂ (calcium chloride),
Mg(NO₃)₂ (magnesium nitrate),
CH₃COOK (potassium acetate),
NH₄Cl (ammonium chloride),
NH₄NO₃ (ammonium nitrate).
- ⊙ Prepare 10 cards (12"x8") having names of acids -
HCl (hydrochloric acid) (three cards), CH₃COOH (acetic acid) (two cards), H₂SO₄ (sulphuric acid)

(one card), HNO_3 (nitric acid) (three cards), HCOOH (formic acid) (one card).

- Similarly prepare 10 cards (12"x 8") having names of bases–

NaOH (sodium hydroxide) (three cards), KOH (potassium hydroxide) (three cards), Mg(OH)_2 (Magnesium hydroxide) (one card), Ca(OH)_2 (calcium hydroxide) (one card).

- These cards having names of acids and bases will have a sling attached so that they can be worn around neck.
- Make a circle (about 1m radius) on the ground using chalk powder.
- Place the 10 cards having the names of salts in circle.
- Divide the students in two teams as A and B.
- Tie sheets having names of 10 acids to players of team A.
- Similarly tie sheets having names of 10 bases to players of team B.
- Let the player of two teams stand in two rows across the diameter of the circle. There will be a finishing line and two circles near it to place the cards picked up by the players. The word 'Water' is written in both the circle (Fig. 1).
- Facilitator announces the name of one acid and name of one base say H_2SO_4 (acid) and KOH (base).
- As soon as the names of acid and base are announced, the respective player of the teams will reach near the circle, will shake hands and look for the salt formed by them. For example, if the name of acid announced is H_2SO_4 and base is KOH , then the player have to look for salt K_2SO_4 .
- The player who picks the card first will run to the finishing line and drop the card to circle allotted to the team. This player will score the point, if the answer is correct.
- To nullify the player's score, the opponent player can run and tap on the back.



- ⊙ In case the picked up card is not the correct answer, no score is awarded.
- ⊙ The players after completing the round will join their respective team.
- ⊙ The game will continue.



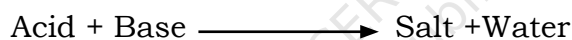
Points for Discussion

Facilitator will discuss how acids and bases react with each other forming salts and water.

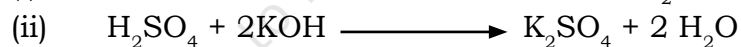
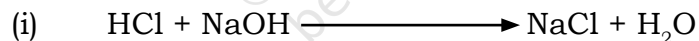


Science behind the Game

The reaction between an acid and a base to give a salt and water is known as neutralisation reaction.



Examples:



CWSN (Children With Special Needs)

- ⊙ For CWVI: The names on the cards may be written in Braille to facilitate participation of children with visual impairment.
- ⊙ The circle may be made tactile by using rope or clay.
- ⊙ Let the CWVI be pre-familiarised with the play arrangement, such as figures and team position and assign CWVI a sighted buddy for moving around.

EXTENSION OF THE GAME

This game will be played for any set of reactions.

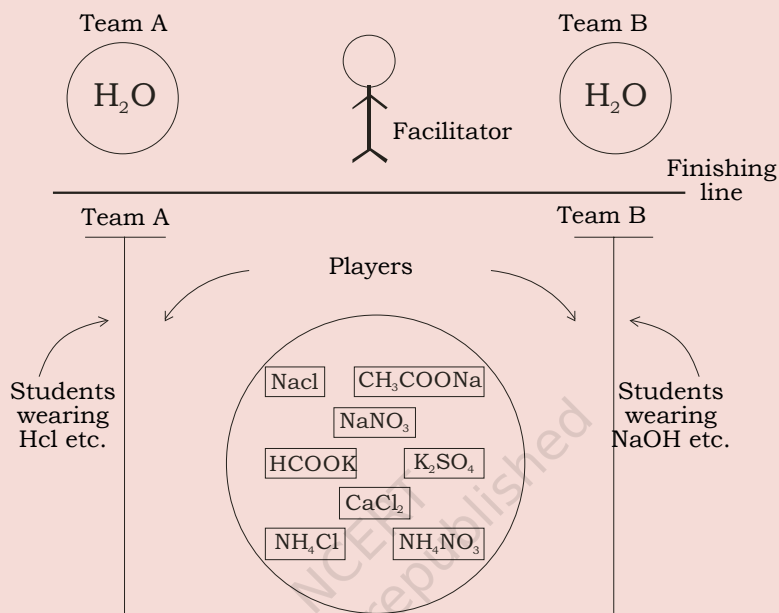


Fig. 1: Open space showing arrangement for the game



DISEASES IN HUMANS

'DEAL' WITH DISEASES



Number of Participants

Six groups of five players each (in a class of 30 students).



Time Required

30 minutes



Material Required

A pack of 30 blank cards for each group (Discarded business cards, which have one blank side, can also be used), sketch/marker pens.

Note: Braille can be used to include visually-challenged students.



How to Play?

- ⊙ Each pack of 30 cards will have five different sets, each set containing six cards related to one disease. One of the cards is called the 'disease card' which will have name of the disease. The remaining five cards of the set will have any five key facts related to that disease. The back of each card shall be kept identical for all cards.
- ⊙ The facilitator will separate five 'disease cards' from each pack of 30 cards. One player in each group will be appointed as the card dealer and will be handed over the 'disease cards' of that group. Dealer will shuffle the 'disease cards' and deal in clockwise direction. The remaining 25 cards will be kept face down in the centre.

- ⊙ Now, the first player (dealer) will draw a new card from the pack. Other players will also draw one card each from the top of the pack taking turns in clockwise direction.
- ⊙ If the players think that the card is related to their 'disease card', they will keep the card. Otherwise, they will place the card back face down at the bottom of the pack.
- ⊙ If a player realises that the card kept is a wrong card in one particular round, it can be discarded in the next round by saying DISCARD. This player will be allowed to draw a new card now only in the next round. The game will continue till one of the players collects all the 6 cards (1+5) of a disease.
- ⊙ The first player who gathers five cards correctly, as per the 'disease card', is the winner. The player will show the cards while saying 'I DECLARE'. The facilitator will check the cards to declare the first winner. In case, the player has kept wrong cards in the set, they will place these cards back in the pack, face down, and will resume the game with the correct cards.
- ⊙ The game will continue till another player says 'I DECLARE'.
- ⊙ After the declaration of the rightful first winner, the rest of the players will continue the game till all the cards in a pack are drawn. In the end, if there are no takers for a couple of cards from the pack, the facilitator will inform the group which disease it belongs to.

Rules for scoring points

1. The first player who collects five cards correctly will get 10 points.
2. The second one to 'DECLARE' will get eight points, while the third one will get five points.



Points for Discussion

- ⊙ Facts about diseases other than those covered by the cards.
- ⊙ The diseases other than those played in the game.





Science behind the Game

This game is meant to revisit the key facts related to causes, transmission, symptoms, prevention and treatment of human disease.

Sample of pack of 30 cards: for five players

Typhoid	HIV AIDS	Peptic ulcers	High blood pressure	Dengue fever
It is caused by bacterium- <i>Salmonella typhi</i>	It is a pandemic disease caused by a virus	It is caused by a bacterium - <i>Helicobacter pylori</i>	It is a non-infectious disease	The vector of this disease is <i>Aedes aegypti</i>
It spreads through contaminated water and food	It is a sexually transmitted disease	The disease can be aggravated by the overuse of pain killers	Excessive weight and lack of exercise may pose a threat.	The virus of this disease enters the body along with the saliva of the mosquito
Vaccination can prevent the disease.	It can be transmitted through infected blood transfusions and hypodermic needles	Symptoms are acidity-related pain in the stomach	This condition increases the risk of a heart attack or stroke	It is also known as break-bone fever

Typhoid	HIV AIDS	Peptic ulcers	High blood pressure	Dengue fever
Symptoms are persisting high fever for several days, weakness, abdominal pain, constipation, and headache	It cannot be acquired by hand shake or sharing food with an infected person	Stomach pain increases with secretion of acid	Less salt intake is advised in this condition	Symptoms of this disease include fever, headache, muscle and joint pain, and a fall in platelet count
It can be prevented by drinking clean water, and adopting better sanitation and hand washing practices	The virus of this disease primarily affects the immune system	Marshall and Warren received the Nobel Prize for discovering the cause of this disease	High blood pressure is also considered a lifestyle disease	The disease can be controlled by not allowing water to collect in the surroundings




CWSN (Children With Special Needs)

- ⊙ For CWVI: The cards should also be transcribed in Braille along with the regular print.
- ⊙ For CWHI: No modification is required.



Typhoid

Typhoid




It is caused by bacterium -Salmonella typhi




It spreads through contaminated water and food



Vaccination can prevent the disease



Symptoms are persisting high fever for several days, weakness abdominal pain, constipation and headache



It can be prevented by drinking clean water, and adopting better sanitation and hand washing practices




HIV AIDS


HIV AIDS



It is a pandemic disease caused by a virus



It is a sexually transmitted disease



It can be transmitted through infected blood transfusions and hypodermic needles



It cannot be acquired by hand shake or sharing food with an infected person



The virus of this disease primarily affects the immune system



Peptic ulcers

Peptic ulcers



It is caused by a bacterium - *Helicobacter pylori*



The disease can be aggravated by the overuse of pain killers



Symptoms are acidity and severe pain in the stomach



Stomach pain increases with secretion of acid




Marshall and Warren received the Nobel Prize for discovering this disease



High blood pressure

High blood pressure



It is a non-infectious disease



Excessive weight and lack of exercise may pose a threat




This condition increases the risk of a heart attack or stroke



Doctor advises less salt intake in this condition




It is also considered a lifestyle disease



Dengue Fever


Dengue Fever



The vector of this disease is *Aedes aegypti*



The virus of this disease enters the body along with the saliva of the mosquito



It is also known as break-bone fever



Symptoms of this disease include fever, headache, rash, muscle and joint pain, and a fall in platelet count



The disease can be controlled by not allowing water to collect in the surroundings



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ANIONS AND CATIONS

ION COMBOS



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Sheets of paper, pen, two containers and a pair of scissors.



How to Play?

- ⊙ Facilitator will divide the class into two teams A and B.
- ⊙ Facilitator will prepare two sets of cards having symbols of ions written on them. Each set of cards will be placed in separate containers and will be kept on a table. Some suggested examples of ions are given below:
One cards each of Na^+ , Zn^{2+} , SO_4^{2-} , NO_3^- , K^+ , Al^{3+} ,
 H^+ , S^{2-} , Ca^{2+} , Li^+ , B^{3+} , Be^{2+} , N^{3+} , O^{2-} , F^- , OH^- .
Two cards of Mg^{2+}
Four cards each of O^{2-}
Six cards of Cl^-
- ⊙ Each player of team A and B will pick up one card from their respective containers.
- ⊙ Each player speaks out loudly the name of the cation or the anion which they have and seek cooperation of the players of their team to make molecules. The players have to make possible formulas, for which they have to group together. They will then run and report to the facilitator by announcing the formula.
- ⊙ To make the game more exciting, the facilitator may allow the players to shout the names of the ions while finding and making their correct formula.

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ Facilitator will check the correctness of the formulas of each team.
- ⊙ The team reporting the maximum number of correct formulas in the given time, say 5 minutes will be declared the winner.
- ⊙ Some of the possible formulae which can be made are K_2SO_4 , $CaCl_2$, $NaOH$, KOH , $MgCl_2$, $NaCl$, $ZnSO_4$, $Mg(OH)_2$, $Zn(OH)_2$, $AlCl_3$, KNO_3 , $Ca(OH)_2$, KCl , Na_2SO_4 , $Ca(OH)_2$, $LiCl$, $LiOH$, Li_2O , CaF_2 , NaF , Na_3N .



Points for Discussion

The facilitator will discuss about the ions and the rules to write writing chemical formulae.



Science behind the Game

The students will learn that compounds are composed of metals and non-metals containing charged species called ions. A negatively charged ion is called an anion and the positively charged ion, a cation. A group of atoms carrying a charge is known as polyatomic ion.

EXTENSION OF THE GAME

The facilitator may extend the game by giving two sets of cards having names of different reactants and products. Facilitator may encourage the students to make the possible correct chemical reactions. The team which depicts maximum reactions in 10 minutes will be the winner.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The symbols on the chits should be written in Braille along with print.
- ⊙ For CWHI: No modification is required.



REACTIVITY SERIES

GO ROUND AND ROUND... DISPLACE ME ON THE GROUND...



Number of Participants

13 students



Time Required

30 minutes



Material Required

Card board sheets, Marker pens, safety pins/thread, paper sheet, cutter, a pair of scissors.



How to Play?

- Facilitator will get prepared the material as per the instruction given below.
- Cut 13 square pieces of card board sheet (5cm × 5cm).
- Write names and symbols of 13 metals from the reactivity series with marker on the pieces of card board.
- Players may decorate, draw or paste the pictures of objects made from these metals on the respective cards to make them attractive.
- Ensure involvement of differently abled children in the activity. Cards may be prepared in Braille or embossed using sparkle tubes.

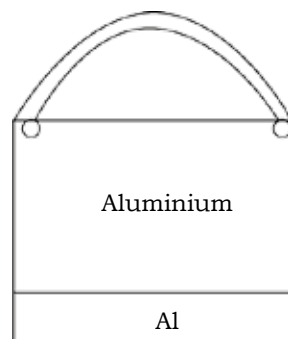


Fig.1

- ⊙ Players will hang these card boards (Fig. 1).
- ⊙ Each player with a card (of one metal) will represent that particular metal.
- ⊙ Facilitator will also prepare small chits with tasks/acts written on them which are to be performed by the players when they commit a mistake.

Some of the tasks may be—

1. Make a sound like that of hydrogen on combustion.
 2. Name elements from atomic number 1 to 5 in 10 seconds.
 3. Name elements from atomic number 1 to 5 in reverse order in 10 seconds.
 4. Act like a piece of sodium in water.
 5. Produce a sound which is heard when a burning matchstick is brought near a mouth of test tube containing Zinc metal and an acid.
 6. Produce sound heard when compressed carbon dioxide dissolved in water is being released.
- ⊙ Players will sit in a circle facing towards the centre, as shown below.

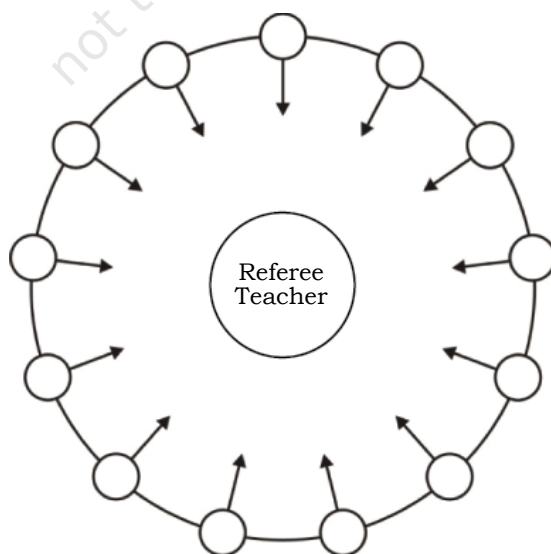


Fig. 2



- ⊙ At the start of game, the facilitator will touch any player; say magnesium metal. This player will run around the circle and will have to touch another player lower in reactivity than magnesium. On touching say zinc, magnesium metal player will say 'displaced' and magnesium will sit at the place of zinc and zinc will continue the game. (Since magnesium is more reactive than zinc).
- ⊙ But suppose magnesium metal player touches potassium metal player, then facilitator will announce that magnesium has made a mistake as potassium is more reactive than magnesium. As a corrective measure and to add fun, element magnesium metal player will be made to perform any one small task written on the slips kept in a bowl.
- ⊙ If any player taps gold metal, then gold metal player will get up and say loudly, "I do not displace any metal" and will move out of the circle and stand near the facilitator.
- ⊙ Facilitator will again touch any other player for the game to continue. Now amongst the players sitting in the circle, silver is the metal left at the bottom of the reactivity, so if any metal player happens to tap silver metal player, the player will get up and say, "I cannot displace any metal present here" and will move out of the circle and stand ahead of gold metal player ,near the facilitator.
- ⊙ So in this manner, players at the lower most end of the reactivity series will slowly form a queue near the facilitator in the order of their position in reactivity series.
- ⊙ In this way, players will be able to identify which metal can be displaced by which other metals.



Points for Discussion

Discussion will be held to understand the concept of displacement reaction and reactivity series.



Science behind the Game

Reactivity series is a list of metals arranged in the order of their decreasing activities.

K	Potassium		Most reactive
Na	Sodium		
Ca	Calcium		
Mg	Magnesium		
Al	Aluminum		Reactivity decreases
Zn	Zinc		
Fe	Iron		
Pb	Lead		
[H]	Hydrogen		
Cu	Copper		
Hg	Mercury		
Ag	Silver		
Au	Gold		Least reactive

The metals at the bottom of the reactivity series are often found in a free state and are the least reactive. The metals at the top of the activity series are so reactive that they are never found in nature as free element. The metal in the middle of the reactivity series (Zn, Fe, Pb, etc.) are moderately reactive. They are found in the earth's crust mainly as oxides, sulphides or carbonates.



EXTENSION OF THE GAME

Game can also be played by making cards of metals and their salts to understand the displacement reactions.

**CWSN (Children With Special Needs)**

- ⊙ For CWVI: Chits and cards may be prepared in Braille along with the print.
- ⊙ The students in the circle may say their names, i.e., metals which they are representing when a visually impaired student has to play. To move to the desired position he may be paired with a buddy.
- ⊙ For CWHI: No modification is required.

CHANGE IN THE STATE OF MATTERS

DON'T BE LATE FOR YOUR STATE



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Chart papers, markers, lime powder (choona), a whistle, music player.



How to Play?

- Facilitator with the help of students will get the following five placards prepared.

Fusion

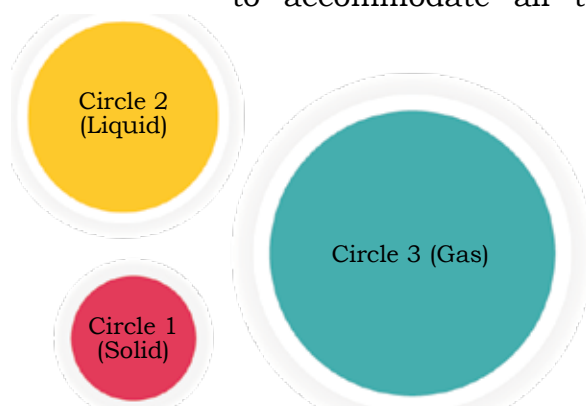
Vaporisation

Sublimation

Solidification

Condensation

- Facilitator will draw three circles in the play area. The area of each circle should be large enough to accommodate all team members during the play. Smaller circle will represent solid, medium circle will represent liquid and the biggest circle will represent the gas Fig.1.



- The class will be divided into three teams A, B and C.

Fig.1

- Duration of each round of the game will be 5 minutes.
- Facilitator will inform the players that while standing in solid state students may stand in a huddle (close to each other) with hands latched together. If standing in liquid state, they may stand little far with open arms and finger tips touching. If standing in gaseous state, they may stand far apart from each other.
- Facilitator will also instruct that in Case 1, change into states may be involved in any of the processes which will be shown on placards and the players will have to run to reach the appropriate circle to score the points.
- To start the game, announcement of any one of the states of matter will be made, say, 'Solid' by the facilitator.
- All players of team A will rush and stand in the respective area.
- When music starts, the players will look at the placard (with instruction), all the players will run in the direction of the expected state.
- When music stops, those players who have not reached the expected area will be declared out.
- On reaching the appropriate area the player will arrange themselves as per the instructions for that state.
- Again when music starts, they will look at the placard and rush for the expected area. When music stops, player found outside the expected area should be declared out.
- The number of players left at the end of the first round will be the score of Team A.
- Similarly Team B and C will play.
- At the end, the winner team will be the one that has scored the maximum points.



Points for Discussion

- ⊙ Matter exists in three forms– Solid, Liquid and Gas.
- ⊙ On increasing the temperature of solid substances they are converted into liquid state and on further

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increase of temperature they are converted into gaseous state. However, there are some solids which on heating directly get converted into gaseous state.

- ⊙ On decreasing the temperature of gaseous substances they are first converted into liquid state and then on further decrease in temperature they are converted into solid state. However, some substances in gaseous state on cooling are directly converted into solid state.



Science behind the Game

The inter conversion of matter from one state to another can be achieved by three ways.

1. By changing the temperature.
2. By changing the pressure.
3. By changing both, temperature and pressure.

EXTENSION OF THE GAME

The game may be played by making placards with specific examples of solids, liquids and gases, such as ice, camphor, iodine, compressed natural gas (CNG), wax, air, etc.



CWSN (Children With Special Needs)

- ⊙ The cards may be made in Braille as well, and the CWVI should be familiarised with the arrangement from the point of view of mobility.
- ⊙ He may be assigned a peer to facilitate his movement to the desired place.
- ⊙ For CWHI: The instructions must be given in sign language.



THE MOLE CONCEPT

PICK ONE MOLE



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Chart paper, marker pen



How to Play?

- Facilitator will prepare 30 cards containing information about atomic mass, of an element or molecular mass of a molecule along with Avogadro's numbers (as shown in Sample 1).
- A few of these cards will have incorrect information (as shown in Sample 2).

Sample 1

Correct cards for reference

C (12g)
 6.022×10^{23}
atoms of
Carbon

H₂ (2g)
 6.022×10^{23}
molecules
of Hydrogen

Na (23g)
 6.022×10^{23}
atoms of
Sodium

O₂ (32g)
 6.022×10^{23}
molecules
of Oxygen

N₂ (28g)
 6.022×10^{23}
molecules
of Nitrogen

Ca (40g)
 6.022×10^{23}
atoms of
Calcium

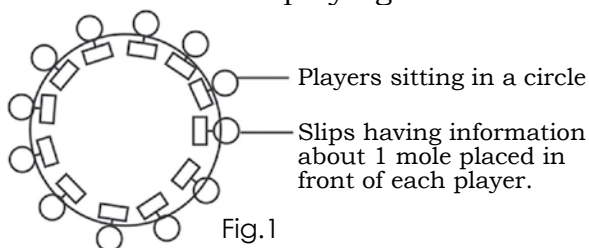
Sample 2**Incorrect cards for reference**

<p>C (6g) 6.022×10^{23} atoms of Carbon</p>	<p>H (1g) 6.022×10^{23} molecules of Hydrogen</p>	<p>O₂ (16g) 6.022×10^{23} atoms of Oxygen</p>
<p>N (14g) 6.022×10^{22} atoms of Nitrogen</p>	<p>Ca (20g) 6.022×10^{23} atoms of Calcium</p>	

More such cards can be prepared with elements/molecules such as

- I. He atom (He)
- II. Boron atom (B)
- III. Sulphur molecule (S₈)
- IV. Ammonia (NH₃)
- V. Chlorine gas (Cl₂)

- ⊙ The facilitator will make the players sit in a circle, as shown in figure:
- ⊙ In front of each player, one card containing either correct or incorrect information is kept. A student other than those playing in a circle will act as a 'den'.



- ⊙ On announcing name of any atom or molecule by the facilitator, the 'den' moves around the circle and pats the player having correct card.

For example

If facilitator announces "one mole of oxygen", the den will move around and pat the player having card with correct information representing one mole of oxygen as shown in the box.



O_2 (32g)
 6.022×10^{23}
 molecules
 of Oxygen

- ⊙ If the 'den' pats player having correct card, then den will replace the player who will now be the new 'den'. The 'den' will then read aloud the correct information so that everyone hears it. The 'den' will then be provided with new card. Facilitator will announce name of another atom or molecules. The new 'den' will start moving around the circle and look for card with correct information. In this way the game continues.
- ⊙ If the 'den' pats the player having incorrect card, then den will be declared out of the game. If a student is available, they will take over as 'den'.



Points for Discussion

1. Definition of one mole
2. Difference between atomic mass and molecular mass
3. Definition of Avogadro's number.



Science behind the Game

Students will understand the concept of mole and its relation with atomic or molecular mass and Avogadro constant.



CWSN (Children With Special Needs)

- ⊙ CWVI may be given a sighted buddy to read out to him the information written on the card (because moving around and reading the info in Braille will be more time consuming).

FERMENTATION

DECIPHER THE PHRASE



Number of Participants

Entire class (4–5 students per team).



Time Required

Two periods



Material Required

Luke warm water (27°C–32°C), 200g yeast powder (available at grocery stores), table sugar, five discarded water bottles of same volume (500ml), medium sized-balloons, bold marker pen.



Fig.1



How to Play?

- ⊙ The facilitator will select a phrase or a proverb. An example of a proverb is given below:
“TRY TRY UNTIL YOU SUCCED”
- ⊙ The above phrase has five words.
- ⊙ The facilitator will inflate five balloons and with a bold marker pen write one word each on these balloons.

- ⊙ The balloons should then be deflated back and kept aside for the fun-activity. One deflated balloon each will be given to the teams just before the beginning of the fun activity.
- ⊙ Since there are five words in the phrase, the facilitator will make five teams. Each team may have 4–5 students.
- ⊙ The facilitator, with the help of students, shall set up five tables, one for each team. Each table will have: 500ml bottle filled up with 125ml warm water, 25gm of yeast powder, deflated balloon with secret word written on it.
- ⊙ The facilitator will assign tables to the five teams and give following instructions:
 - i. Add 25g yeast in the bottle containing luke warm water and swirl it gently.
 - ii. Then add one teaspoon sugar in the bottle and swirl it gently again, in order to dissolve the sugar.
 - iii. Stretch the given balloon a couple of times to loosen it and then put it around the mouth of the bottle.
 - iv. Keep the set-up in a warm place for about 20 to 30 minutes. Stir the set-up occasionally.
 - v. Observe that the balloon starts getting inflated. Decipher the word which will appear as the balloon inflates.
 - vi. As soon as the word is deciphered on the inflating balloon, the players will call the word loudly.
- ⊙ Facilitator will write the deciphered words on the blackboard.
- ⊙ The teams will attempt to unscramble the deciphered words to create a meaningful phrase.
- ⊙ The team which will first decipher the phrase correctly will be the winner.



Points for Discussion

Examples of some questions which the teacher may ask to initiate discussion in the class:

- ⊙ Why is respiration considered as one of the basic processes for living organisms?
- ⊙ What products are formed in this reaction?
- ⊙ What is the purpose of using warm water?
- ⊙ Have you heard or seen anyone using yeast in everyday life?
- ⊙ Why does the balloon get inflated after 20-30 minutes of setting up of the activity?
- ⊙ What is the process known as?

The facilitator may enrich the discussion further by exposing students to various applications of fermentation in daily life, such as making bread, idli, naan etc. Yeast is also used in baking. During fermentation ethanol and carbon dioxide gas is produced. Carbon dioxide forms bubbles and the dough rises. Since baking is done at high temperature, the yeast cells ultimately die and nearly all the ethanol that is formed gets evaporated. Yeast fermentation is used to produce alcoholic beverages.

Yeast fermentation is also used to make ethanol for fuel.



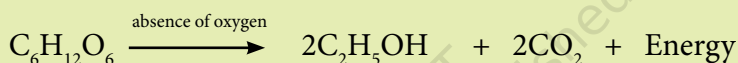
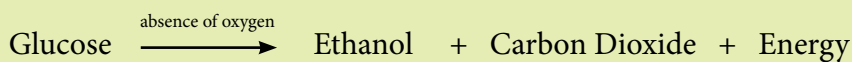
Science behind the Game

- ⊙ Yeast is a unicellular fungus. It can respire, both, in the presence or absence of oxygen.
- ⊙ In the presence of oxygen, aerobic respiration takes place, whereas in the absence of oxygen, anaerobic respiration or fermentation occurs.
- ⊙ Yeast uses its own enzymes to break down complex sugars. It breaks down granulated sugar into a form

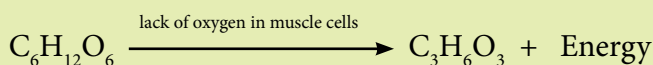
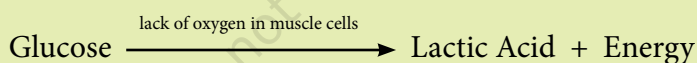


that it can consume. The yeast uses sugar and warm water as food to grow in size and reproduce.

- ⊙ Warm water accelerates the fermentation reaction by providing the optimum temperature.
- ⊙ During fermentation the yeast produces carbon dioxide and ethanol as metabolic waste products. As the volume of carbon dioxide increases, it gets filled in the empty space of the bottle and further rises up to inflate the balloon that is stretched around the neck of the bottle.
- ⊙ The reaction proceeds as follows:



- ⊙ Sometimes humans also resort to anaerobic respiration, as seen in certain skeletal muscle cells when they face oxygen deficiency, for e.g., during vigorous physical exercise.



EXTENSION OF THE GAME

1. Try doing this activity by using water at different temperatures in different bottles to find out the optimum temperature for growth of yeast.
2. You can also try adding different amounts of sugar to warm water in different bottles to find out whether fermentation process is fast in diluted or in concentrated solution.

3. Take different food materials in different bottles such as pineapple juice, orange juice, lemon juice, etc., and try to find out which food material supports inflation of balloons or which food material helps the yeast to react more and produce large amount of gas to give you a “SUPER BALLOON” as shown in Fig. 2.

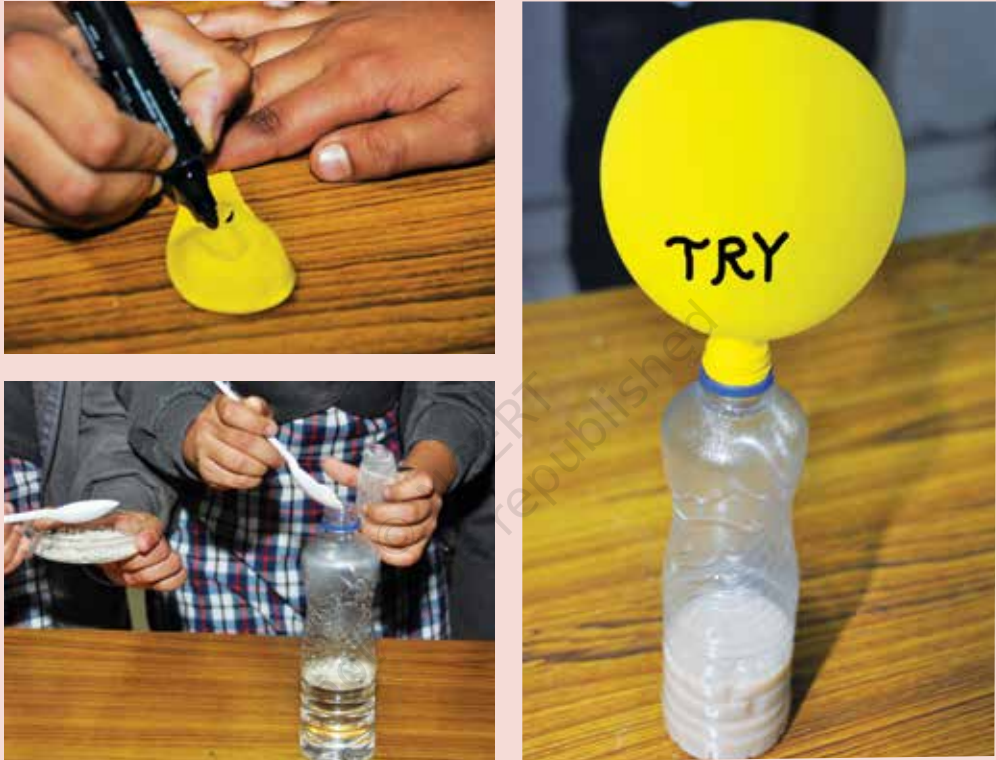


Fig. 2



CWSN (Children With Special Needs)

- ⊙ CWVI may be paired by a sighted buddy for this game.
- ⊙ For CWHI: No modification is required.



PERIODIC TABLE

FIND MY PLACE



Number of Participants

Entire class divided into teams of four players each.



Time Required

30 minutes



Material Required

Chart paper, ruler, sketch pens (to prepare the outline of the Periodic Table and its Groups and Periods), a pair of scissors.



How to Play?

- ⦿ The class will be divided into teams of four players each.
- ⦿ Two students of each team will be involved in preparing the outlines of the Periodic Table, for their team.
- ⦿ Other students of each team will prepare 18 chart paper strips with symbols of 18 Groups of Modern Periodic Table written on them vertically.
- ⦿ Outlines of Periodic Table will be spread on the tables or floor in front of each team. All the 18 vertical 'Group' strips will be placed upside down nearby in random order.
- ⦿ The facilitator will say 'Start' and each team will place all the strips on the outline after discussion among themselves. The facilitator will set a time limit for placing the strips correctly [Fig. 1(a)].
- ⦿ The team which places the strips correctly in minimum time will be declared winner.



Points for Discussion

The game will be followed by a discussion on the arrangement of first 20 elements in the Periodic Table and their properties. The game can be played at many levels of difficulty.



Science behind the Game

- ⊙ Knowing the position of the elements in the Periodic Table helps in recognising their chemical properties.
- ⊙ After the game, the facilitator can discuss trends in properties like valency, atomic size, atomic weight, metallic and non-metallic nature and electro negativity in the Modern Periodic Table [Fig. 1 (b)].

EXTENSION OF THE GAME

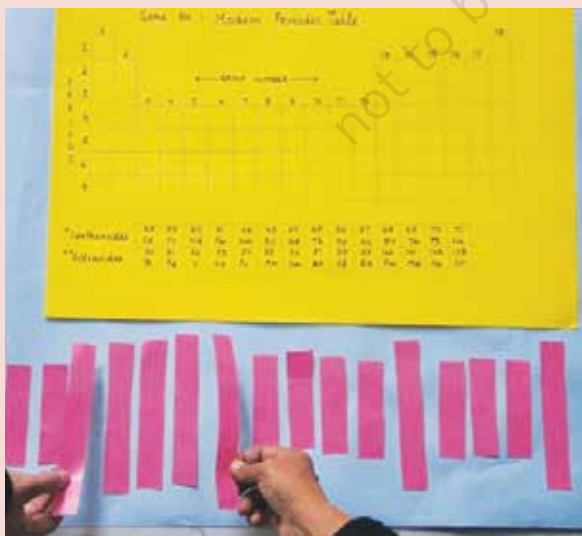


Fig. 1 (a)

- ⊙ Game for the Periods can be played in the same manner [Fig.1 (c)].
- ⊙ To make the game more challenging make sets of strips of 'Groups' or 'Periods' in which places of certain elements be left vacant, and the teams will be asked to place them in the correct position only after they write the symbols of the missing elements on the blackboard.



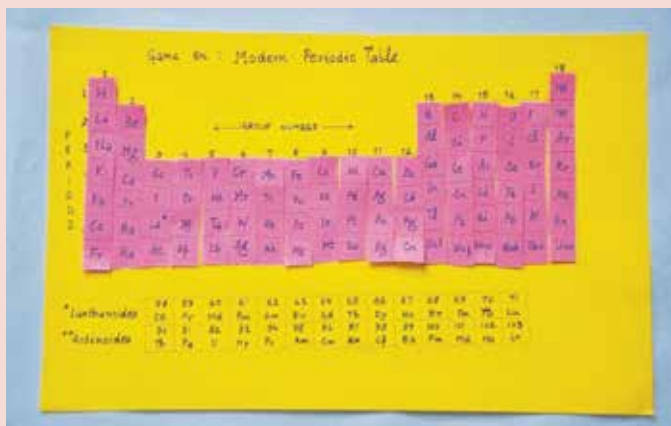


Fig. 1(b)



Fig. 1(c)



CWSN (Children With Special Needs)

- ⊙ For CWVI: Chart paper strips may be transcribed in Braille.
- ⊙ For CWHI: No modification is required.

SOUND

MUSICAL SOUND



Number of Participants

Entire class in the groups of 4–5 students each.



Time Required

10 minutes



Material Required

One metre long flexible plastic pipe (used to drain water out of a sink or a washing machine).



How to Play?

- ⊙ Hold one end of the pipe and swing it in the air as shown in Fig. 1.



Fig. 1

- ⊙ You may hear a sound.
- ⊙ Change the speed of rotation of the swinging pipe. Hear the sound carefully.

- ⊙ Repeat this swinging by holding the pipe at different positions so that the length of swinging portion of the pipe gets changed. Each time you will hear the sound of a different quality.
- ⊙ Now hold one end of the pipe close (say 3–4cm) to your mouth and blow hard into it. You will hear a sound.
- ⊙ As the air passes through the pipe it vibrates and produces a note.
- ⊙ If you put one end of the pipe in your mouth and blow hard into it, then you will hear a whistling sound.
- ⊙ Now try this. Close one end of the pipe and try to blow hard into it with the open end into your mouth. No matter how hard you try, there will be no sound. For the sound to be produced there should be some vibration. As both the ends of the pipe are closed, there are no vibrations and therefore no sound is produced.
- ⊙ If you make a hole anywhere in the pipe you will be able to blow and produce vibrations and may produce a sound.



Science behind the Game

Sound is produced when something vibrates. The vibrating body causes the medium (water, air, etc.) around it to vibrate. Vibrations in air travel as longitudinal waves, which we can hear when these reach our ears.

As you swing the pipe, the air in the pipe vibrates and produces a sound. The faster you swing it, the higher is the pitch and shriller is the sound. As you change the length of the swinging pipe, the length of the vibrating air column changes and hence you hear different sounds.



CWSN (Children With Special Needs)

- ⊙ For CWVI: No modification is required as the activity is based on auditory skills. CWVI may be made to feel the vibrations in the length of the pipe so that he can understand the relation between the length of the pipe and the sound produced.
- ⊙ For CWHI: Hearing capacity of the child will determine the way of his involvement. Student with mild hearing loss may be able to know the difference between the sounds produced but for others the relation will have to be explained through sign language.

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ELEMENTS

ELEMENTOLA



Number of Participants

Entire class



Time Required

30 minute



Material Required

Chart paper, ruler, sketch pens (to prepare the outline of the Periodic Table and its Groups and Periods), a pair of scissors.



How to Play?

- Facilitator with the help of players will prepare slips of first 20 elements in the periodic table giving their symbol and atomic number. These cards will be kept in a bowl.
- Facilitator will also write down the symbols of first twenty elements on the blackboard (Fig.1).

H	B	F	Al	Cl
He	C	Ne	Si	Ar
Li	N	Na	P	K
Be	O	Mg	S	Ca

Fig. 1: Symbols of first 20 elements

- The facilitator may use the cards/tickets already prepared or each player may be asked to make a box with nine squares on a piece of paper.

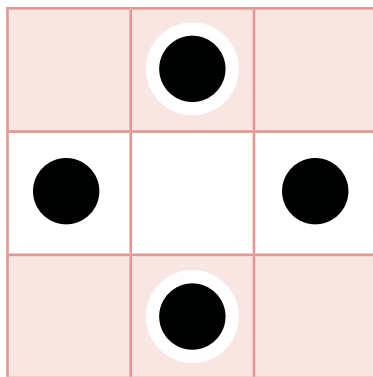


Fig. 2

- ⦿ In case, players prepare their own tickets, they are asked to copy any 5 symbols of elements randomly from the blackboard, keeping any 4 boxes blank on their ticket as shown in Fig 2.
- ⦿ To start the game the facilitator will pick up one slip from the bowl and speak aloud either name or atomic number of the element written on it.
- ⦿ Players will have to strike out symbol of that element if it is on their ticket.
- ⦿ Quick three, Four corners, First row, Third row, Diagonal lines and Full house will be declared as and when their symbols are struck out.
- ⦿ The first full house will signal the end of the game.
 - Quick three: The player who strikes out any three elements first in a ticket, will announce “Quick three” and will be declared winner of quick three.
 - Two rows: A player who is able to strike out any one of two rows specified by the facilitator will announce, “First row” or “Third row” whatever is the case. The facilitator after tallying the symbols will declare the player winner for that row. Same procedure to be followed for the other specified draw.
 - Four corners: The player who is first to strike out elements at the four corners of the ticket will be declared winner of four corner.



- Diagonal lines: The Player who is the first to strike out the elements along any diagonal will be declared the winner of diagonal line.
- Full house: The Player who is first to strike out all the elements in the given ticket will be declared the winner of full house.



Points for Discussion

The name of elements, their symbols, atomic numbers and their position in the Periodic Table can be discussed.



Science behind the Game

By playing the game students will be able to relate the names and symbols of the elements. Players can also learn the atomic numbers and their position in the Periodic Table.

EXTENSION OF THE GAME

- ⊙ Tickets can also be prepared from elements having atomic numbers more than 20 given in the periodic table.
- ⊙ Tickets with more than nine boxes can also be prepared.



CWSN (Children With Special Needs)

- ⊙ For CWVI: Slips may be made in Braille and ticket must be made tactile with Braille markings.
- ⊙ For CWHI: The chosen ticket may be showed to the CWHI.



WATER POLLUTION

LET'S SAVE THE RIVER GANGA



Number of Participants

Four



Time Required

30 minutes



Material Required

Card board, chart paper, sketch pens, a pair of scissors, one die, one token each of green, yellow, red and blue colours.



How to Play?

- ⊙ Facilitator will paste the given board game on a sheet of cardboard.
- ⊙ Facilitator will prepare 80 tree-shaped tokens from cardboard or chart paper.
- ⊙ The board game depicts course of River Ganga starting from its source Gangotri to the Bay of Bengal.
- ⊙ The course is depicted through a series of boxes which are the 'STATIONS'. Some boxes have 'activity' written on them.
- ⊙ Some boxes indicate activities that lead to pollution of River Ganga while other boxes indicate activities that prevent pollution.
- ⊙ Facilitator will explain the rules of the game to the players.
- ⊙ Each player will be given 10 'Tree Coins' and remaining 40 'Tree Coins' will be placed in a pile.
- ⊙ To begin the game each player will choose the colour of token (green, yellow, red or blue) and place it at Gomukh 'station' which is the starting point.
- ⊙ Each player will roll the dice. The player who gets the highest number will begin the game. The remaining players will take turns to play in clockwise direction.

- ⊙ To enter the game from Gomukh station, a player must roll a six on the dice.
- ⊙ If a player's token lands on a 'Station' with 'activities, which do not cause pollution in river Ganga basin (shown in green boxes), the player will be rewarded with one 'Tree Coin' which the player will pick up from the pile.
- ⊙ If a player's token lands on a 'Station' with 'unwanted activity' (which causes water pollution) shown as 'Red Alert', the player will be given two penalties to come out of the 'Red Alert'. The two penalties are :
 - a. give away three tree tokens, one each to the three opponents.
 - b. enter "Community Service Loop". The player can only move forward if number thrown is exact to land on two stations within the loop which contain remedial measures.
- ⊙ If the token lands on the station representing heritage sites or cities Devaprayag, Rishikesh, etc., (according to the list available on the web-site of NGRBA), the player gets one more turn as a reward.
- ⊙ At each station the player will read aloud the name of the city and the message in the box. If the player forgets this, one "Tree Token" will need to be returned to the pile.
- ⊙ The player who reaches Gangasagar with maximum number of "Tree Coins" will be declared the winner.



Science behind the Game

- ⊙ The Ganges, the largest river in India is now considered as one of the most polluted rivers.
- ⊙ The Ganga Action Plan or GAP was a program launched in January 1985, to reduce the pollution load in the river.

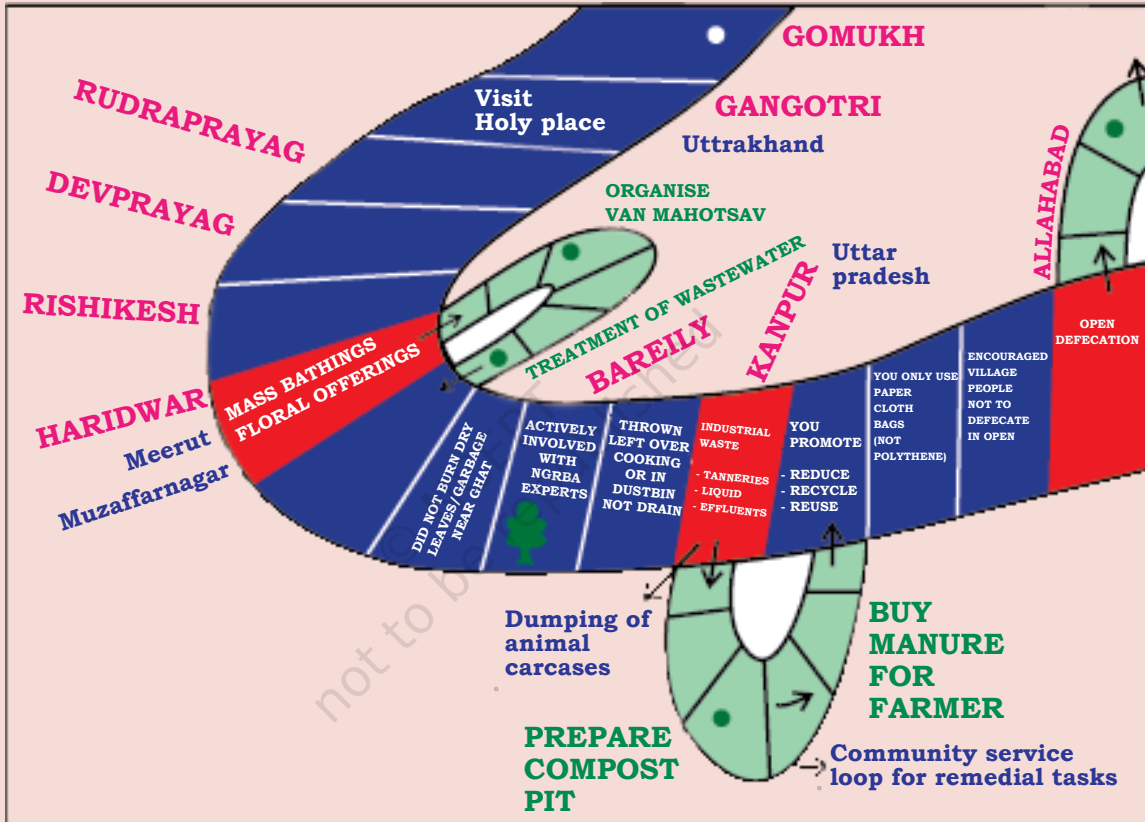



- ⊙ Coliform is a group of bacteria found in human intestines, whose presence in Ganga water indicates contamination by these disease-causing microorganisms.
- ⊙ Pollution threatens not only humans, but also more than 140 fish species, 90 amphibian species and the endangered Ganges river dolphin.
- ⊙ But the efforts to decrease pollution level in the river has not yielded desired results.
- ⊙ NRGBA (National River Ganga Basin Authority) was established by Government of India, on 20 February 2009. It declared Ganga as the “National River” of India.
- ⊙ Integrated Ganga Development Project titled ‘Namami Ganga’ (obeisance to Ganga River) was announced by Government of India on July 2014. As a part of the programme, Government of India has ordered shutdown of 48 industrial units around Ganga.



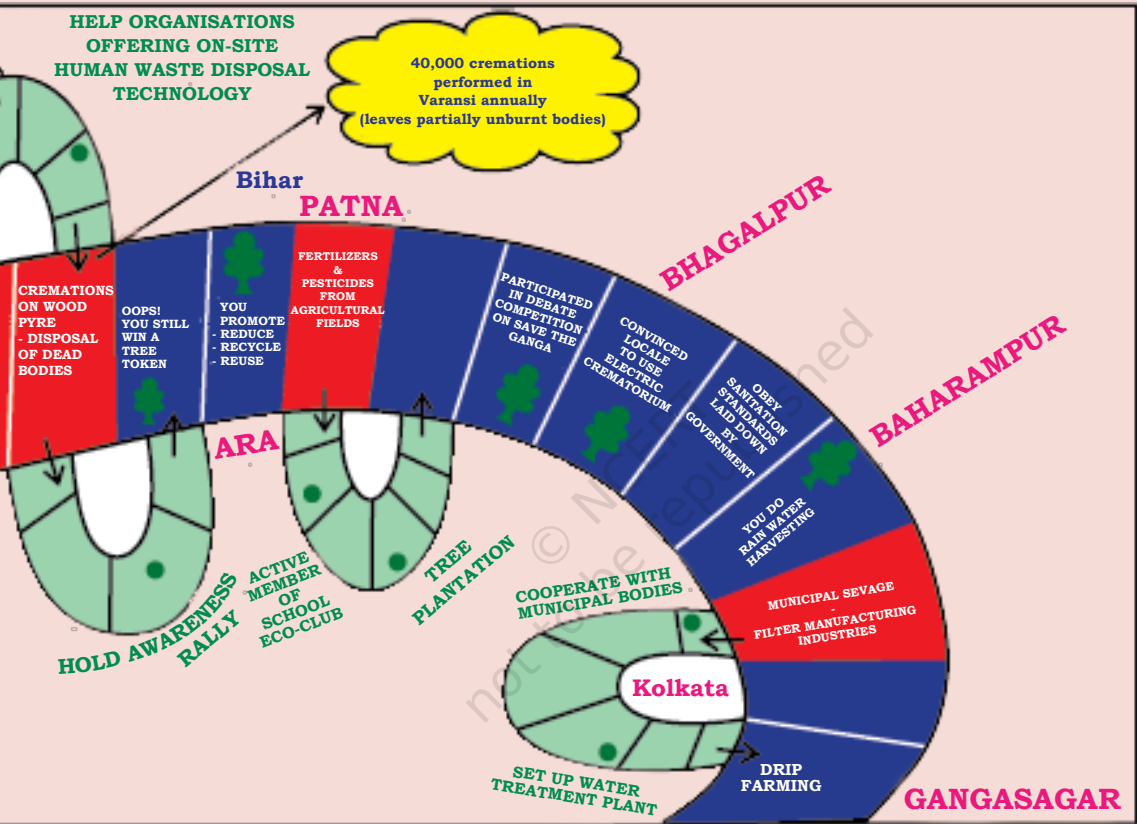
Points for Discussion

- ⊙ Factors responsible for causing water pollution in the river and steps taken to restore River Ganga to its past glory.
- ⊙ Measurable factors which can be used to quantify pollution or the quality of water that is used for various activities.
- ⊙ Long term and short term perspective in managing our resources.
- ⊙ How would the disposal of garbage, etc., affect the living organisms in the river?
- ⊙ Major industries that account for a large fraction of pollution load in rivers.
- ⊙ Case study of Kanpur tanneries.



 = Tree Token





EXTENSION OF THE GAME

Similar game for other major rivers, such as the Yamuna, Brahmaputra can be made.



CWSN (Children With Special Needs)

- ⦿ For CWVI: The board must be made tactile with Braille and tickets, and dice must be Braille transcribed.
- ⦿ For CWHI: No modification is required.

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THE STRUCTURE OF THE HEART

THE HEART ARCADE



Number of Participants

One student



Time Required

10–15 minutes



Material Required

A kit with a jigsaw puzzle of heart, well labelled diagram of heart (as a reference) and a timer.



How to Play?

The facilitator may set competition among players; the one who correctly assembles the jigsaw puzzle in least time will be the winner.

- ⊙ Select a flat and hard work area such as a table, to assemble the jigsaw puzzle.
- ⊙ Empty the contents of the puzzle from the box on the table.
- ⊙ Place the diagram of heart at one side of the work area. This will help you as a reference while assembling the puzzle for the first time.
- ⊙ Spread out all the pieces of the puzzle with their face up.
- ⊙ Separate out the edge pieces from the centre pieces.
- ⊙ Arrange the edge pieces so as to construct the "frame" or the outer boundary of the puzzle (This will make it easier for students to work inward).
- ⊙ Next, tile out the remaining pieces by interlocking the tabs with their corresponding blanks (tabs are parts that project out, and blanks are their counterpart in which the tabs get interlocked).

Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ Try to interlock tabs and blanks in small recognisable sections.
- ⊙ Assemble small sections and place them roughly in their locations while referring to the given diagram of heart.
- ⊙ Continue "filling in the gaps" of the puzzle until it is complete.

Note to the Teacher: Prepare multiple sets of jigsaw puzzle to ensure maximum participation.



Points for Discussion

1. Detailed structure of the human heart
2. Blood pressure
3. Life style and heart diseases



Science behind the Game

1. Heart is a muscular organ, which pumps blood throughout our body.
2. It is as big as the size of our fist.
3. It has two sides, right and left, which are separated by a partition so that the oxygenated and the deoxygenated blood not get mixed up.
4. It has four chambers– two upper chambers known as the atrium and two lower chambers known as the ventricles.
5. Left atrium receives oxygenated blood from the lungs through the pulmonary vein. This blood then enters the left ventricle through a valve.
6. Left ventricle pumps blood into the largest artery, the 'aorta', which carries oxygenated blood to all parts of the body.



7. Right atrium receives deoxygenated blood from the body through superior and inferior vena cava. This blood is then pumped into arteries which carry blood to the right ventricle through a valve.
8. From the right ventricle the blood is pumped into the pulmonary artery which carry blood to the lungs for oxygenation.

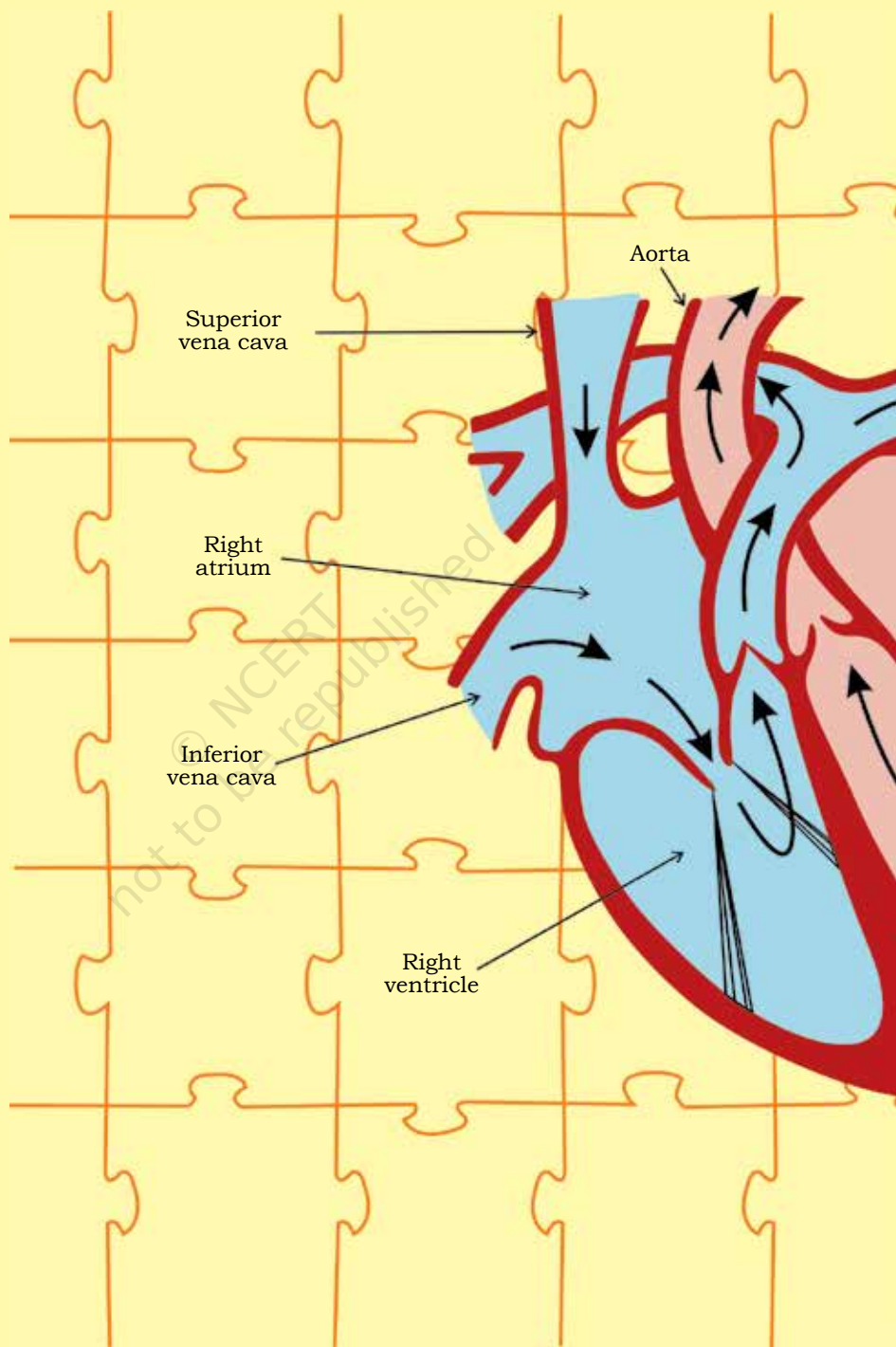
EXTENSION OF THE GAME

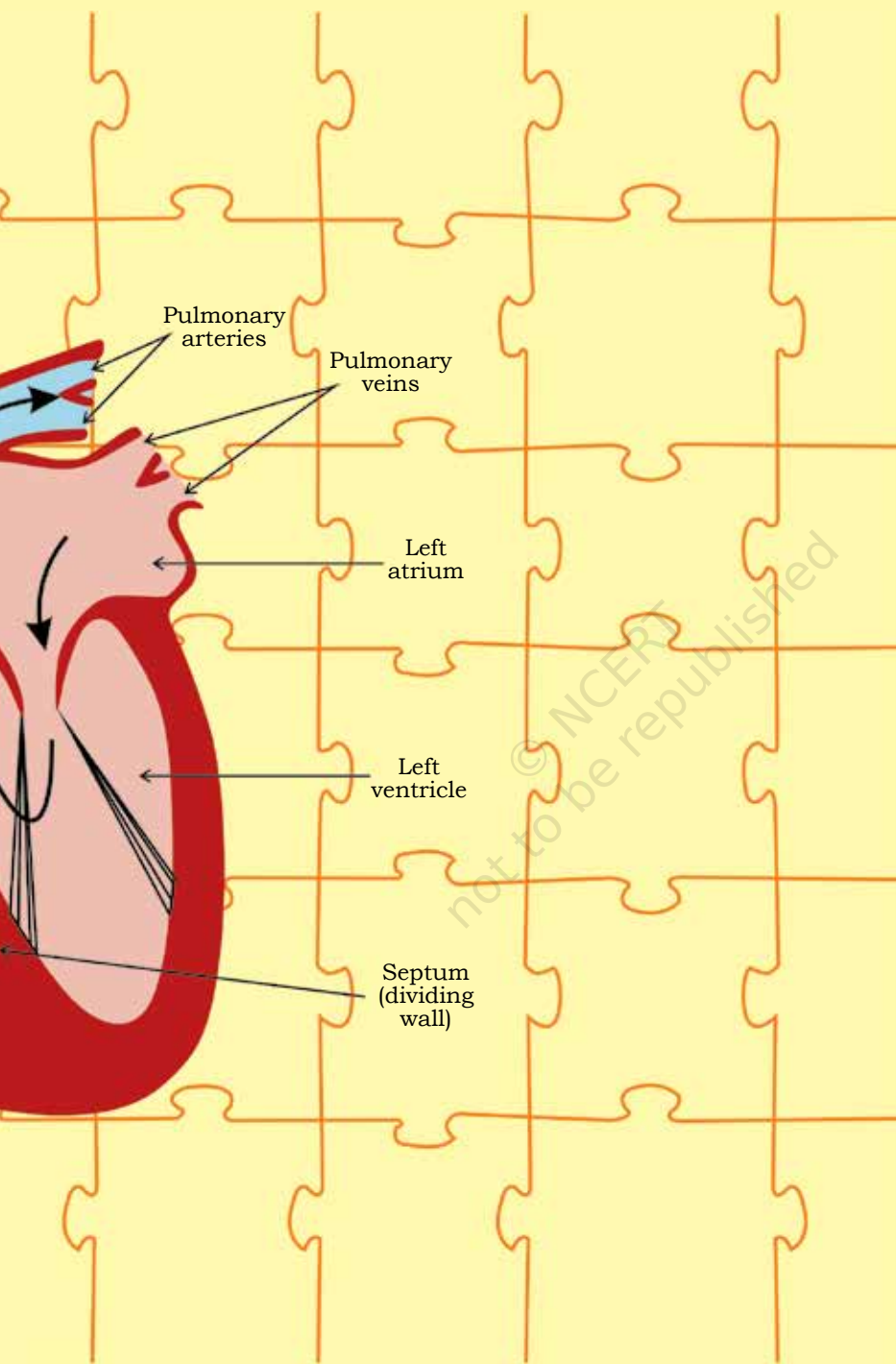
When the players are well versed with assembling the jigsaw puzzles with the help of the reference diagram, encourage them to assemble it without any reference (i.e., on their own). This will help them in visualising the diagram and improve their understanding of anatomy of heart.



CWSN (Children With Special Needs)

- ⦿ For CWVI: Tactile diagram with Braille labeling should be provided and the puzzle too should be made tactile and Braille labeled.
- ⦿ For CWHI: No modification is required.





FOOD WEB

WEAVING A FOOD WEB



Number of Participants

Four students



Time Required

20-30 minutes



Material Required

Hard board, thick chart paper, sketch pens, paints, pictures, $\frac{1}{2}$ inch nails, hammer, four reels of coloured thread (red, yellow, purple and green), a pair of scissors.



How to Play?

- ⊙ To prepare the board game, paste a chart paper on the hard board.
- ⊙ Roughly mark the positions of organisms on the chart paper.
- ⊙ Paste small pictures of organisms selected to create a food web.
- ⊙ Write names of organisms below the pictures.
- ⊙ Fix a nail on the left hand side of each name.
- ⊙ Four players will take their positions, on four sides of the board game.
- ⊙ Each player will tie the first knot on the producer with the coloured thread allotted to them.
- ⊙ After this they will take turns to move forward in a food chain by winding their thread around the nail of the organism belonging to the next trophic level. In one turn they can move only one step forward.

- ⊙ Once a player reaches the top carnivore, they will tie a knot around the nail of the organism and snip off the thread with the help of a pair of scissors, thus, accomplishing one food chain. This player will restart from the same producer to build another food chain with the same colour thread.
- ⊙ When all the players have exhausted their options of compiling food chains the game will end.
- ⊙ Each player will prepare a tally of food chains compiled by them, in the table given below.

	1st Trophic level	2nd Trophic level	3rd Trophic level	4th Trophic level	5th Trophic level
	Producer	Primary consumer (Herbivore)	Secondary consumer (Primary carnivore)	Tertiary consumer (Secondary carnivore)	Quaternary consumer (Tertiary carnivore)
Food chains made by Player 1					
1					
2					
3					
4					
Food chains made by Player 2					

	1st Trophic level	2nd Trophic level	3rd Trophic level	4th Trophic level	5th Trophic level
1					
2					
3					
4					
Food chains made by Player 3					
1					
2					
3					
4					
Food chains made by player 4					
1					
2					
3					
4					

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Layout of organisms in the board game :



Interconnect Food Chains to Create a Food Web

		Producer 1							
Producer 4				Tiger					Owl
		Eagle					Hawk		
									Snake
		Fox		Insect-eating bird			Kingfisher		
			Wild cat		Butter-fly			Nectar-sucking bird	
		Lizard							
			Rabbit		Toad				Caterpillar
			Squirrel		Seed-eating bird			Mice	
		Deer		Honey bee			Plant-eating insect		Goat
	Grass		Plant seeds			Flowers		Plant leaves	
		Producer 3							



Fig. 1: Food Web Board





Points for Discussion

On the basis of food chains compiled in the table, the players will discuss the frequency of occurrence of organisms in the various food chains. This will help them to understand the concept of cross-linkages of food chains to form a food web.



Science behind the Game

- ⊙ The sun is the ultimate source of energy for life on Earth. As a result, living organisms have evolved special ways to harness energy of the sun and use it for their life processes. They have also developed special relationships and interactions that allow energy to be transferred. Once the energy has been captured, it gets transferred through various organisms in a particular direction. This transfer of energy is called a **food web**.
- ⊙ Thus, a food web is a graphical model depicting many food chains linked together to show the feeding relationships of organisms in an ecosystem.

EXTENSION OF THE GAME

Create a food web which operates in soil (detritus food chain) and discuss its relationship with soil fertility and soil pollution.



CWSN (Children With Special Needs)

- ⊙ Pictures must be Braille labeled.
- ⊙ Threads used must be of varying thickness or texture.
- ⊙ For tying knot and for preparing a tally CWVI may be supported by a sighted peer.

PUZZLE

WHO AM I?



Number of Participants

Individual game



Time Required

30 minutes



Material Required

Crossword sheet— one for each student



How to Play?

- ⊙ The facilitator will distribute crossword sheet to every student.
- ⊙ The students are asked to read all the clues carefully and fill the blank spaces in the crossword sheet with suitable options.
- ⊙ The time allotted for completing the crossword is 25 minutes. The student who completes the sheet with maximum correct answers is the winner.
- ⊙ Provide the sheets in Braille to the child with visual impairment.



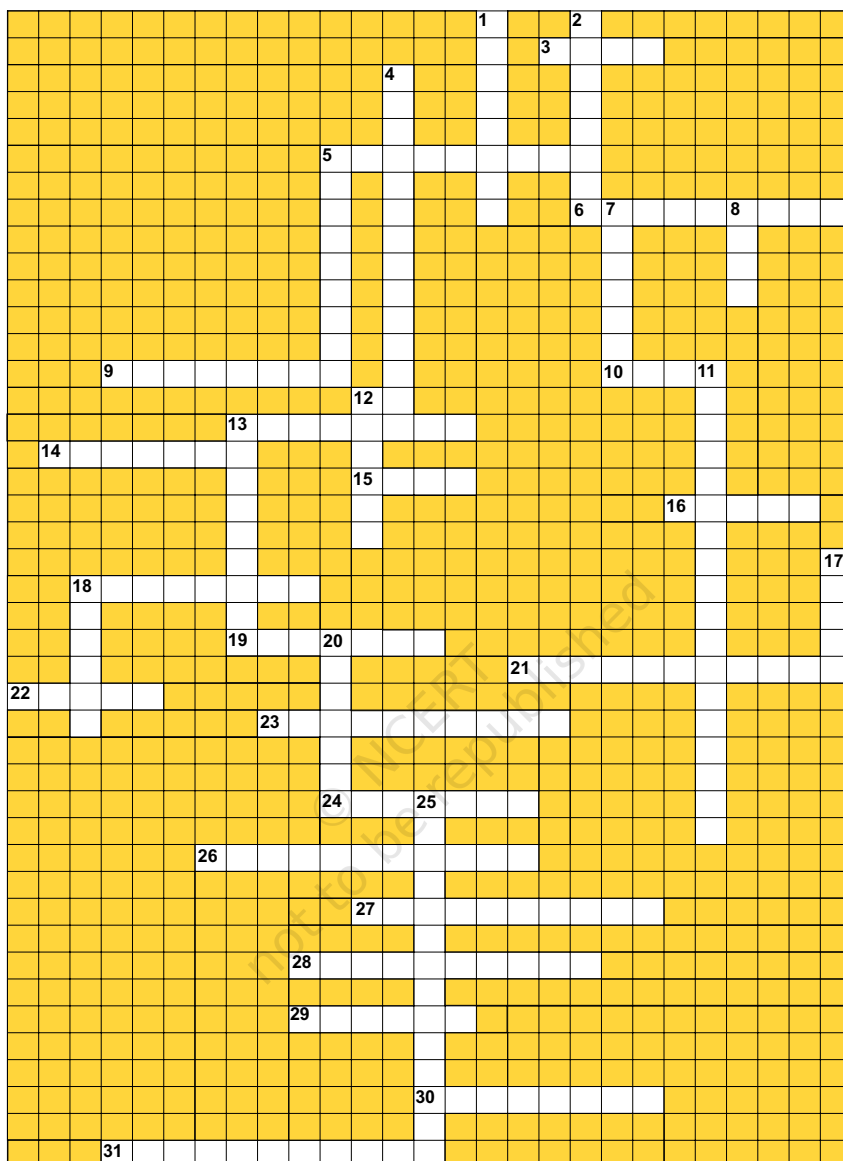
Points for Discussion

The facilitator will talk about the various clues and options that constitute the crossword grid.



Science behind the Game

This crossword is a combination of some known facts and concepts that may help in building up the basic understanding of science for secondary students.

**Down**

01. Gas evolved on adding acid to metals(8)
02. Poor conductor of electricity(9)
04. Technique used in pathology laboratory in the process of testing blood samples(14)
05. Intermixing of different types of particles on their own(9)
07. Solvent used in tincture of iodine(7)

- 08. Impurity present in a blast furnace(4)
- 11. Reaction between barium chloride and sodium sulphate is an example of (6,12)
- 12. Cheaper reducing agent(6)
- 13. Metal present in Chlorophyll(9)
- 17. A non-reactive element(5)
- 18. Element used in the treatment of cancer(6)
- 20. Isotope of hydrogen(7)
- 25. Technique used for separating drug from blood(14)

Across

- 03. Synonym of “heap” (4)
- 05. Cleaning agent that causes water pollution(8)
- 06. Known as founder of chemical sciences(9)
- 09. Main constituent of air(8)
- 10. An element that affects the nervous system(4)
- 12. Symbol of gas which is toxic in nature (2)
- 13. Its presence makes alcohol unfit for drinking(8)
- 14. A gas obtained by reaction between nitrogen and hydrogen (7)
- 15. Author of “Description of Nature”(4)
- 16. Chemical change involving simultaneous oxidation and reduction(5)
- 18. The process that gives brown colour to sugar(8)
- 19. A kind of change of state(7)
- 21. Change of state directly from gas to solid(11)
- 22. Mixture of two completely miscible solids in the solid state(5)
- 23. He is called the father of Nuclear Physics(10)
- 24. Liquid metal, also known as quicksilver(7)
- 26. Element stored in water (11)
- 27. Familiar name of NaCl (6,4)
- 28. Different forms of the same element that occur in nature(10)
- 29. Combination of slag with flux(6)
- 30. One of the elements found in free state in nature(8)
- 31. Essential for electrolysis(11)

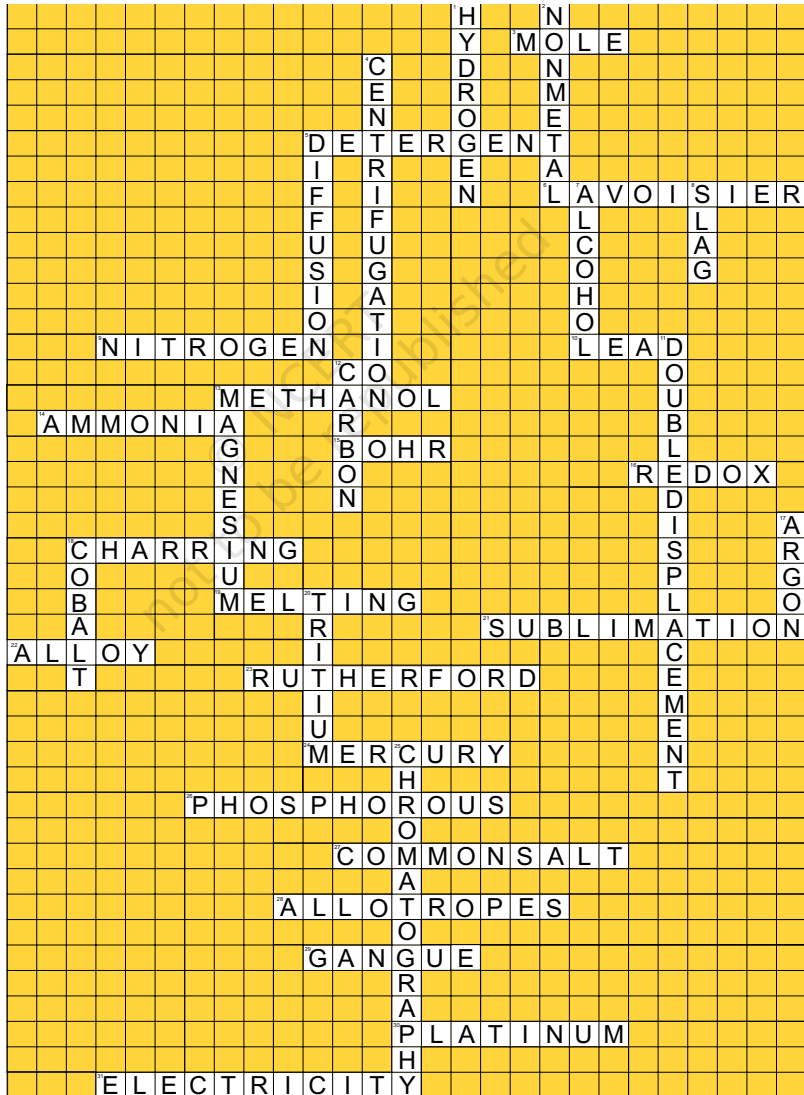




CWSN (Children With Special Needs)

- ⦿ For CWVI: The crossword may be made tactile and numbered. The clues must be transcribed in Braille, and separate alphabets may be given in Braille so that they can be arranged on the crossword sheet.
- ⦿ For CWHI and CWLI: No modification is required.

SOLUTION



IUPAC NOMENCLATURE

RING MY NAME



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Paper chits, paper cards, blackboard, chalk, ping pong ball, three empty bottles (500ml).



How to Play?

- ⊙ Divide the black board in two halves by drawing a vertical line in the middle, one for writing the scores and other half to be used by teams.
- ⊙ This game will be played in two rounds.
- ⊙ Facilitator will write molecular formula of different carbon compounds on chits of paper. These chits are folded and kept in a bowl.
- ⊙ Facilitator will write IUPAC names of carbon compounds on cards. Depending upon the difficulty level (easy, moderate, difficult) keep them in three separate bottles. These bottles may be labelled for 20 points, 50 points and 80 points, respectively.
- ⊙ Each row in the class will be designated as one team.
- ⊙ A two member group of a team will come forward.
- ⊙ One of the members will pick one chit from the bowl, write the structure of carbon compound on the board. After discussion with the assigned partner, the player will write the name of carbon compound on the board.



Fig. 1: Round 2 (Ring The Bottle)

- ⊙ Facilitator will check the correctness of answer and award 20 points for correct answer. This set of member will also qualify for the next round.
- ⊙ If they fail to answer correctly, they do not get the opportunity to go to the next round.
- ⊙ For the next round, the facilitator will place three bottles containing IUPAC names of carbon compounds at the other end of the table, making sure that the separation between bottles is larger than the size of the ball.
- ⊙ The other member of the group will now throw the ball to hit one of the bottles. The group will draw a card from the bottle which the ball hits first. The group has to write structure of the carbon compound corresponding to IUPAC name written on the card.
- ⊙ If group draws structure correctly on the board, they will score the points as marked on the bottle. On incorrect answer, group will not be given any points.
- ⊙ Scores will be displayed on blackboard simultaneously.
- ⊙ The first group of second team proceeds in the same manner.
- ⊙ Team with the highest score will be the winner.



Points for Discussion

Nomenclature of carbon compounds will be discussed.



Science behind the Game

Students will gain knowledge of various functional groups and learn to write the structure and IUPAC names of carbon compounds.

EXTENSION OF THE GAME

- ⊙ Student can learn types of chemical reactions and balanced chemical equations through the game.



CWSN (Children With Special Needs)

- ⊙ CWVI may have his Taylor Frame for drawing structural formula.
- ⊙ For visual tasks like throwing the ring, the sighted team member should take the lead and IUPAC names should also be written in Braille.





TOYS

ELECTROMAGNETIC INDUCTION

SHAKE AND MAKE LIGHT



Number of Participants

Entire class



Time Required

30 minutes



Material Required

Empty reel or spindle (of thread), insulated copper wire of 24 gauge (about 30m), a pair of strong cylindrical magnets (the width or diameter of the magnet should be such that it can freely move inside the spindle); coloured LED, sandpaper.



How to Proceed?

Facilitator may assist the students in fabricating the toy. Once a few students have made the toy, they may assist the rest of the class.

- ⊙ Take the empty reel or spindle. Make marks on it to divide it into nearly three equal segments. DO NOT CUT (Fig. 1).
- ⊙ Leaving about 20cm of wire free, start winding it over the middle segment of the reel/spindle. Wind it over and over as evenly as possible. Wind about 1000–1200 turns till about 20cm of wire remains free at the other end.
- ⊙ Scrape the insulation from the wire (about 1cm) at both ends. Connect the two ends of the wire to two leads of the LED.
- ⊙ Place one magnet inside the reel or spindle tube.
- ⊙ Hold the reel or spindle with your thumb and finger in such a manner that its ends are covered (Fig. 2).



- ⊙ Shake the spindle vigorously (Fig. 3). Ensure that the magnet moves freely inside the spindle.
- ⊙ As you shake the spindle faster you will see the LED glowing brighter.
- ⊙ Facilitator may note that if one magnet is not producing appreciable brightness in LED, then she/he should advise students to place two magnets inside the tube and try again.
- ⊙ It is advisable that the activity be performed away from bright light.



Science behind the Toy

When we shake the spindle, the magnet inside it moves. Due to the moving magnets, the magnetic field around the coil changes. Changing magnetic field will induce electric current in the coil and light up the LED. As the magnet moves from one side to the other, its direction changes and so does the direction of induced current. Therefore, the LED glows when the direction of current is favourable. So, LED blinks rather than glow continuously. The toy illustrates the principle behind the dynamo used in bicycles and power generators.



Fig. 1

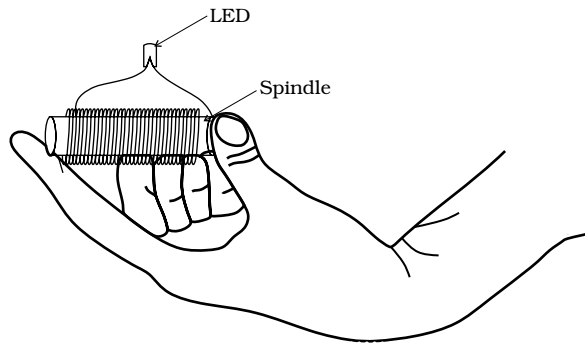


Fig. 2



Fig. 3



CWSN (Children With Special Needs)

- ⊙ The CWVI may be paired with a sighted peer for this activity helping him whenever he needs it. He may be given a light probe to detect the light.
- ⊙ For CWHI: No modification is required.



CAN YOU FLOOR ME?



Number of Participants

Entire class in a groups of 4–5 students.



Time Required

30 minutes (for preparation and playing with the toy).



Material Required

Rubber or good quality plastic ball (7–8cm diameter), about 200g lead shots/steel ball bearings/iron nails, hacksaw blade, chart paper, glue, a candle, match box, coloured felt pens.



How to Proceed?

- ⊙ Cut the rubber ball in two halves with the help of hacksaw blade.
- ⊙ Fill one half with lead shots or steel bearings. The lead shots or steel bearings should be filled up to a height just below the edge Fig. 1.
- ⊙ Fix the lead shots with molten wax, so that they may not move when the ball is tilted.
- ⊙ Now prepare a cone from the chart paper. The base of the cone should be slightly larger than the diameter of the ball. Paste it on the rubber ball as shown in the diagram. Use coloured felt pens to make the clown colourful Fig. 2.
- ⊙ Tilt the clown to one side. Why does it come back to its original position?





Science behind the Toy

The centre of gravity of the toy lies near the base of the clown. Hence, the toy is in stable equilibrium when standing erect. Therefore, when we disturb it, the clown comes back to its original position.



Fig. 1



Fig. 2



CWSN (Children With Special Needs)

- ⊙ The CWVI may be made to feel the changing position of the clown using tactile sense by placing their own hand in the opposite direction.
- ⊙ For CWHI: No modification is required.



BALANCING THE TOY HORSE ON TWO LEGS



Number of Participants

Entire class in groups of 5–6 students each.



Time Required

30 minutes (for preparation and playing with the toy)



Material Required

Cork (4.0cm upper diameter and 2.5cm lower diameter) (Note: **that the rubber stopper will not work**), chart paper, coloured sketch pens, thick copper wire about 50cm long (18–20 SWG), pins, glue, and a pair of scissors.



How to Proceed?

- ⊙ Draw the head and tail of a horse on the chart paper. Colour them with the help of sketch pens.
- ⊙ Make their cut outs by cutting them carefully with the help of a sharp pair of scissors.
- ⊙ Paste the head of the horse on the face of the cork with smaller diameter and the tail on the other face as shown in Fig. 1.
- ⊙ Insert two pins on the bottom of the cork. These pins represent two legs of the horse. Notice that the pins are not parallel. (Fig.1)
- ⊙ Try to balance the toy horse on its two legs. Can you do it?



Understanding Science through Activities, Games, Toys and Art Forms (Secondary Stage)

- ⊙ Now make a coil with copper wire such that at its one end about 10cm of wire is left free. Insert the free end of wire in the cork and bend it as shown in Fig. 1.
- ⊙ Again try to balance the toy horse on its two legs. Can you balance the horse this time? If not, adjust the shape of the wire till you can balance the horse. Think why the horse can be balanced on its two legs. Tilt the horse slightly to one side. Why does it come back to its original position? In this position the horse is in stable equilibrium.



Fig. 1



Science behind the Toy

- ⊙ In every object there is a point at which the whole weight of the body is supposed to act.
- ⊙ We saw that on tilting the horse slightly it comes back to its original position.
- ⊙ When the wire is inserted into the cork, the centre of gravity of the whole system (toy, horse and the wire) lies within the coiled wire. The vertical line through the centre of gravity passes through the line joining the two pins.



EXTENSION OF THE TOY

If cork of desired size is not available then try to make this toy with a thermocole piece. You can also cut a horse from a soft ply board. Some other light materials may also be tried. Use your power of imagination.



CWSN (Children With Special Needs)

- ⊙ The CWVI can be paired with a sighted buddy for the construction part. The part that requires balancing may be done by him independently using his kinesthetic sense.
- ⊙ For CWHI: No modification is required.

AMAZING BALANCE



Number of Participants

Entire class in the groups of 4–5 students.



Time Required

20 minutes (for preparation and playing with the toy).



Material Required

One ceramic cup of height 6–7cm, folding kitchen knife with blade about 7cm, tripod stand, match box (with wooden matches).



How to Proceed?

- ⊙ Push the pointed end of the knife into a matchstick. The knife must be bent in such a manner that the angle between its blade and the handle is 90° or slightly more.
- ⊙ Now place the matchstick on the rim of the cup as shown in Fig. 1. Adjust the position of the match stick so that it is balanced. Make sure that the tip of the match stick is inside the periphery of the cup.
- ⊙ Light the match stick (Fig. 1). What do you observe?
- ⊙ The unburnt part of the match stick rests on the rim of the cup. The knife and the match stick together remains in equilibrium (Fig. 2).





Science behind the Toy

This toy works because the centre of gravity of the whole arrangement of knife and match stick lies just below the point of support of match stick.

EXTENSION OF THE TOY

In place of a knife you can use a divider with sharp legs from your geometry box. In this case you must use a thicker match stick.



Fig. 1



Fig. 2



CWSN (Children With Special Needs)

- ⊙ CWVI: The child with V.I. may be made to feel the set up and the position of the match stick gently. CWVI may be made to feel initial and final position of the match stick before and after burning.
- ⊙ For CWLI and CWHI: No modification is required.

OPTICAL ILLUSION

IS THE 'SMILEY' MOVING?



Number of Participants

Entire class in the groups of 4–5 students each.



Time Required

10 minutes



Material Required

60cm of stiff electrical wire, a small plastic ball (nearly the size of table tennis ball), plastic bead through which the wire can be inserted and a small piece of PVC pipe about 2.5cm in diameter.



Fig. 1



How to Proceed?

- ⊙ Paint a **'Smiley'** on the ball.
- ⊙ Wind the wire on PVC pipe to make a spiral with about 10 turns [Fig. 2(a)].
- ⊙ Remove it from the pipe and pull it slightly [Fig. 2(b)].



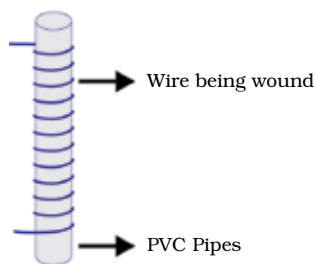


Fig. 2(a)

- ⊙ Insert the **'Smiley'** in between the two loops of the spiral so that it is somewhere in the middle of the spiral. Tie a small thread on one end of the spiral. Attach a bead on the other end (Fig. 3).



Fig. 2(b)

- ⊙ Hang the spiral vertically by the thread with one hand. With the other hand twist the thread.
- ⊙ What do you observe?

Wow! The **'Smiley'** appears to be going up or down depending on the direction of winding or unwinding of the thread. It is an amazing optical illusion, very simple to make!

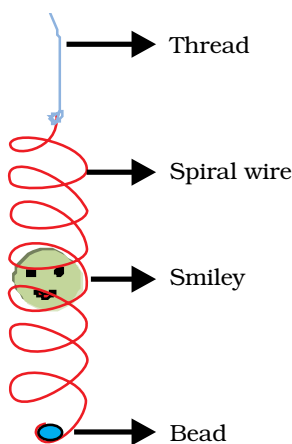


Fig. 3



Science behind the Toy

An **optical illusion** (also called a **visual illusion**) is a visually perceived image that differs from the objective reality. The information gathered by the eye is processed in the brain to give a perception that does not tally with the physical reality.

EXTENSION OF THE TOY

1. Paint a spiral on a drinking straw. Pass a thread through the straw. Fix a cap of the water bottle to one end of the thread. Hold this assembly vertically straight and twist the thread. It appears as if the stripes of the spiral on the straw are moving up or down.
2. Take a discarded CD. Draw a spiral around its centre with a marker on its upper side. Fix a marble at the centre hole of the CD with an adhesive. Now rotate the CD on the floor or a table. You will observe as if a series of circles are spreading out or moving in towards the centre of the CD.



CWSN (Children With Special Needs)

- ⊙ For CWVI: The observation would not be possible because visual inputs are needed. He may be given tactile diagrams showing how the smiley will appear going up and down (through a series of diagrams).
- ⊙ For CWHI: No modification is needed.

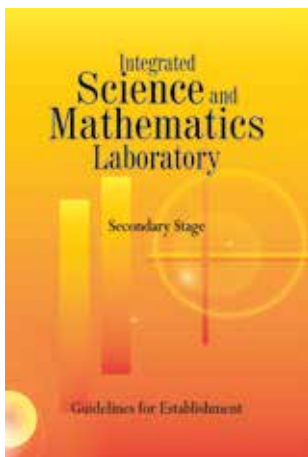


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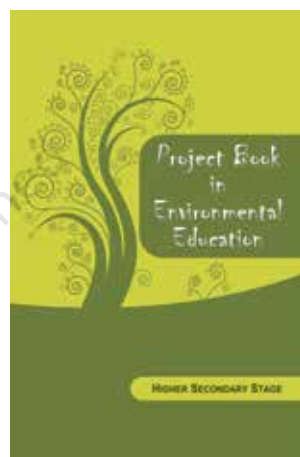
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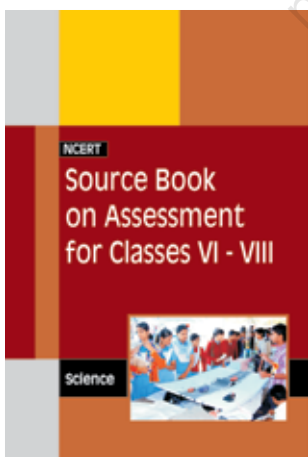


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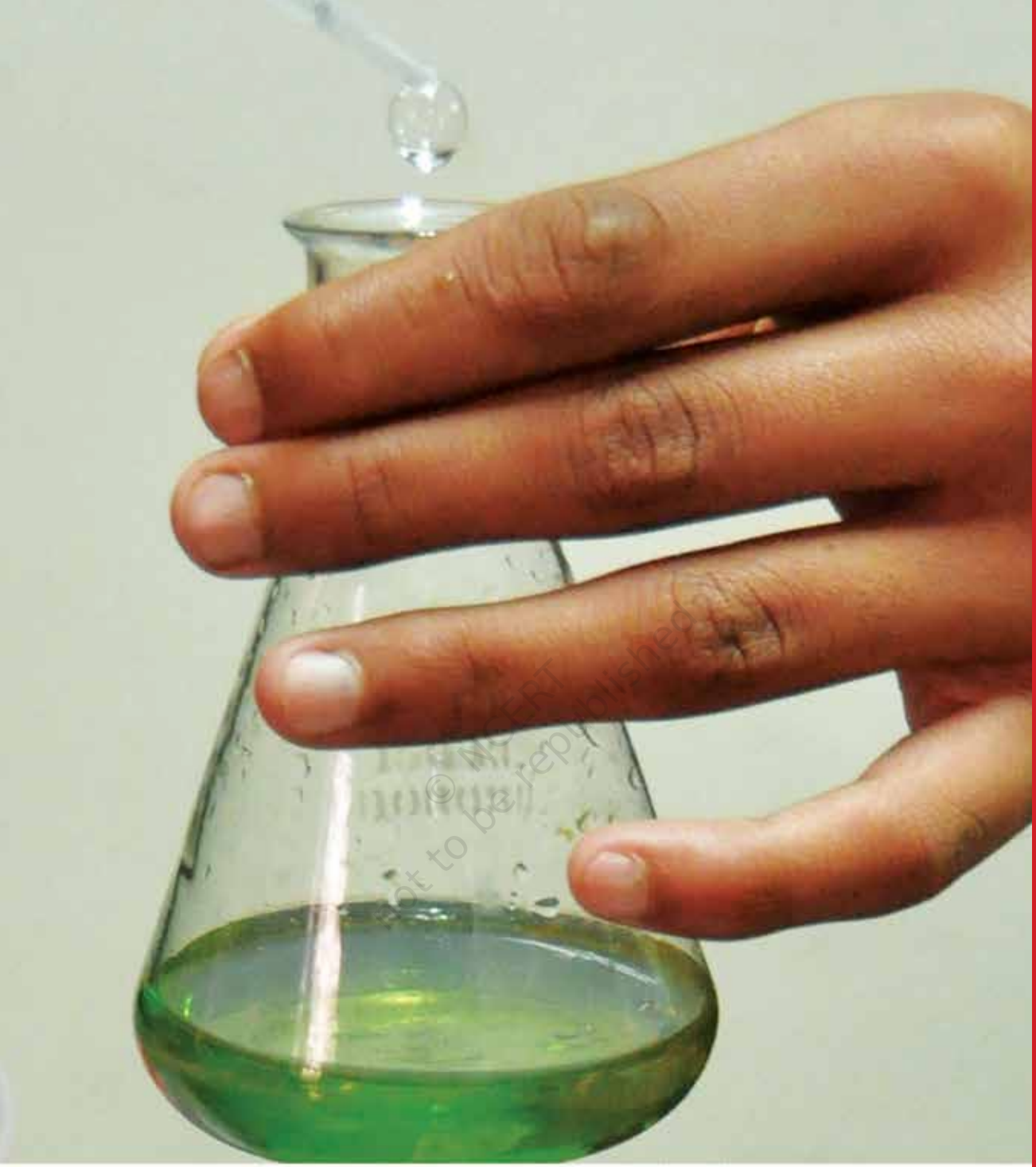
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