

Analysis of Students' Learning Performance in Science at Middle Level

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Abstract

All children by nature have curiosity, and it is this curiosity that leads them to search. Keeping this in view, National Council of Educational Research and Training, India has developed activity- based textbooks which promote skill of reasoning and self expression. In this study, learning performance of students studying at middle level (upper primary stage; Classes VI-VIII) was done by giving questions according to their cognitive level. The study reveals that unfortunately students have not shown the expected performance even though the textbooks give ample space to child to think and explore. The study shows that either the teachers are not able to use the textbooks in the expected way, may be due to lack of desired infrastructure or they are not trained in inquiry- based science teaching-learning process.

Key Words: NCF-2005, Middle Level, Activity- Based Teaching-Learning, Reasoning Questions, Language Difficulty.

Introduction

Children are curious by nature. Given the freedom, they often interact with and experience things around them. Children enter middle stage after completing primary schooling. At this stage children can and should be provided plentiful opportunities to engage with the processes of science: observing things closely, planning and designing activities, posing questions and finding answers to these questions, recording observations, discussing and presenting data, drawing figures, plotting graphs and of course drawing inferences from what they observe. Literature also shows that science process skills are effective in teaching-learning of science (Brotherton & Preece, 1995; Chang & Mao, 1999; Harlen, 1999; Key & Bryan 2001; Turpin & Cage, 2004; Walters & Soyibo, 2001; Wilke & Straits, 2005). Sufficient time and opportunities have to be provided for this. The children at this stage are to be engaged in learning the principles of science through familiar experiences, working with hands to design simple equipment units and models. Scientific concepts are to be developed mainly through activities and experiments.

In India, National Council of Educational Research and Training (NCERT) is a leading body for school education. It is an autonomous body constituted by the Government of India. The main functions of this organisation are : Curriculum Development; Teacher Training; Extension Activities; Evaluation and Consultancy. The four Curricular Frameworks for school education have been brought out by the NCERT in the years--1975, 1988, 2000 and 2005. National Curriculum Framework -- 2005 (NCERT, 2005), recommends a pedagogy that is hands-on and inquiry-based. While this is widely accepted at the ideational level, practice in India has tended to be dominated by chalk and talk method. To make any progress in the desired direction, some changes were made at the level of the syllabus (NCERT, 2005). It was decided that science content from Classes VI to X should be compulsory subject for all and not be

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framed along disciplinary lines, but rather organised around themes that are potentially cross-disciplinary in nature. Generally, the choice of themes and sub themes reflects the trust towards weakening disciplinary boundaries that was one of the central concerns of NCF-2005. On the basis of these themes, National Council of Educational Research and Training (NCERT) has developed textbooks and other resource materials for middle level (upper primary stage) in science. Since the textbooks (NCERT,2006; NCERT,2007; NCERT,2008) are in use for almost a decade in the school system, a research study has been taken to assess the performance of the children with respect to various concepts in science at middle level (upper primary stage; Classes VI-VIII).

Methodology

For Classes VI, VII and VIII, separate tools to assess the performance of students were developed. Before finalization, the tools were tried out with forty students of each class of a Government school. The modified, tools for Classes VI, VII and VIII were used for the present study (**Annexure**).

These tools were administered on 1054 student (Class VI-385 students, Class VII-336 students and Class VIII-333 students). No time limit was fixed for answering the questions. The data was collected and analysed.

Analysis of data

Analysis of data was done manually because most of the questions were open ended. Item wise analysis of data for Classes VI, VII and VIII is shown in Tables 1, 2 and 3 and the graphic representation has been shown in Figures 1, 2 and 3

Table 1	Class VI	Number of Students – 385		
Question No.	Correct %	Partially correct %	Incorrect %	Not attempted %
1.	00.00	38.91	45.19	15.90
2.	10.65	62.34	21.82	5.19
3.	4.16	75.84	8.05	11.95
4.	0.26	39.22	37.66	22.86
5.	10.13	79.22	8.05	2.60
6.	2.60	12.73	28.83	55.84

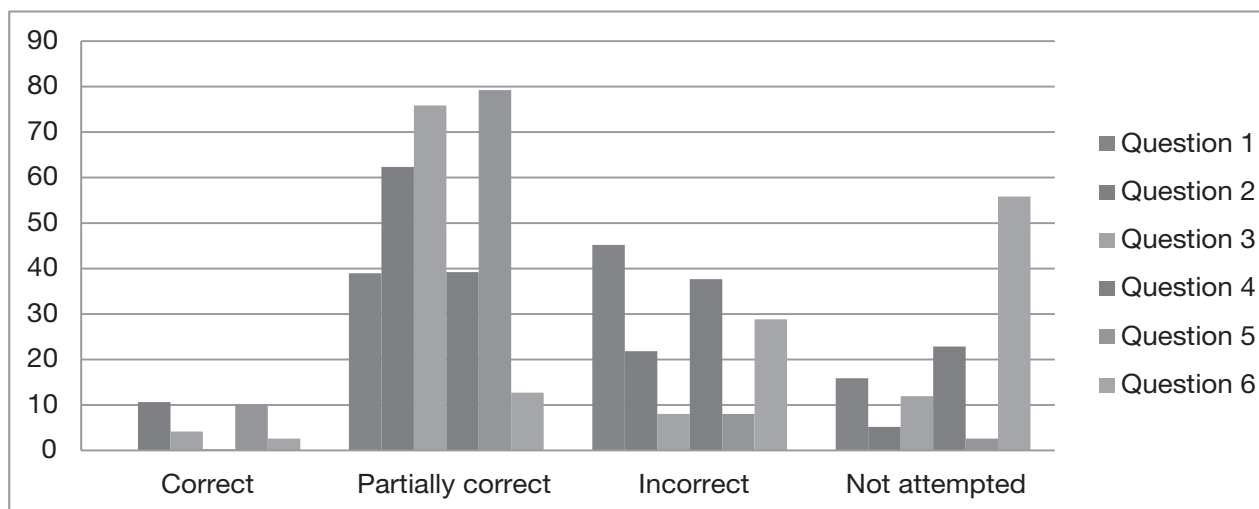


Figure 1: Graphic Presentation

Table 2	Class VII Number of Students – 336			
Question No.	Correct %	Partially correct %	Incorrect %	Not attempted %
1.	0.60	38.40	37.00	24.00
2.	13.00	25.00	42.00	20.00
3.	05.00	27.00	40.00	28.00
4.	7.00	2.00	32.00	59.00
5.	9.00	69.00	10.00	12.00
6.	0.30	27.00	22.00	50.70

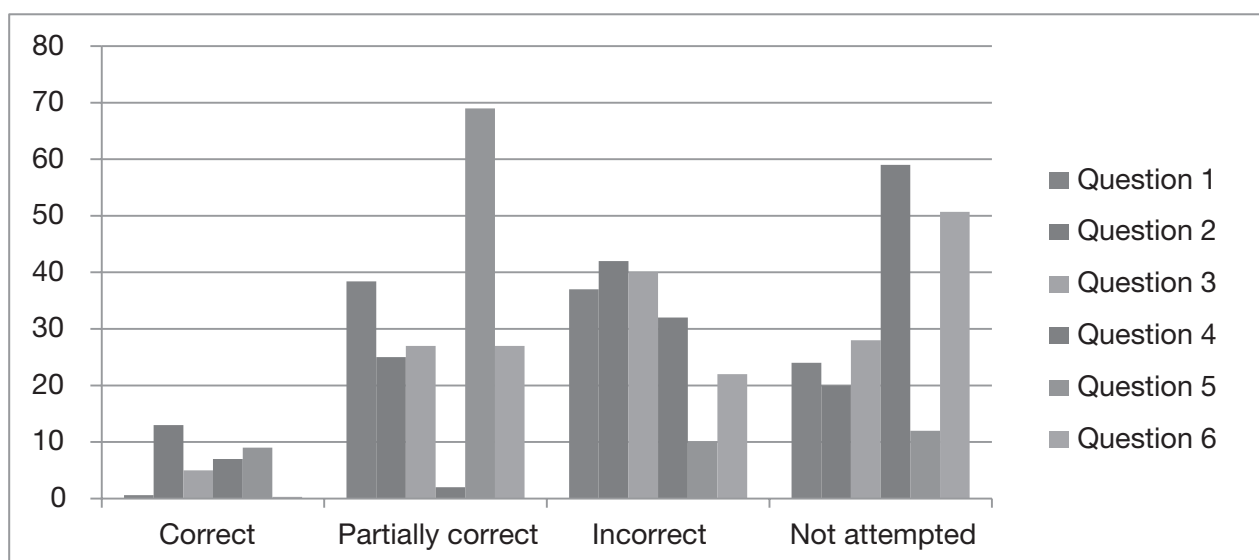


Figure 2: Graphic Presentation

Table 3	Class VIII	Number of Students – 333		
Question No.	Correct %	Partially correct %	Incorrect %	Not attempted %
1.	2.70	91.80	4.20	1.30
2.	0.00	36.04	20.42	43.54
3.	0.00	79.58	2.10	18.32
4.	1.50	74.40	9.10	15.00
5.	0.30	79.58	1.80	18.32
6.	1.50	29.43	25.83	43.24

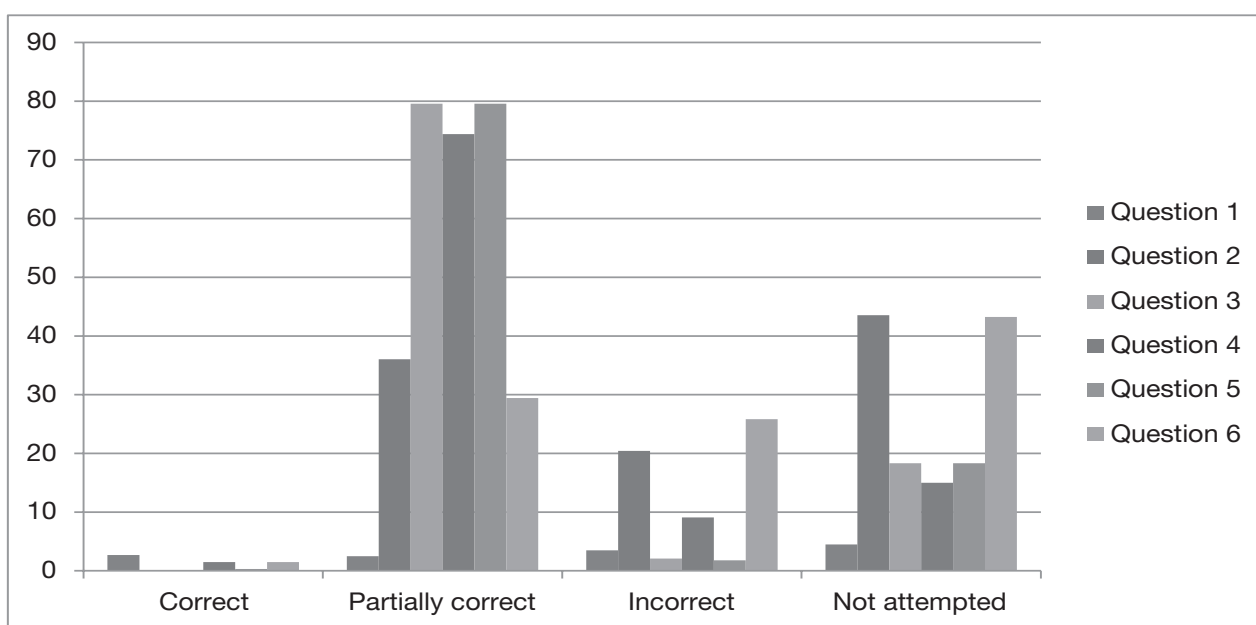


Figure 3: Graphic Presentation

Interpretation of data

CLASS VI

Question 1: The item was related to identification of the natural fibres and the processes leading to making fabrics. Most of the students (45%) could not give correct response for identifying the two processes - knitting and spinning. A number of activities have been given in NCERT science textbooks and these need to be done by students in the classroom for better understanding of these processes. Perhaps the **format of the question was unfamiliar** to the students.

Question 2: The format of this question seemed familiar to students. 22% students failed in reporting 'odd one' related to 'floating' and 'solubility' of liquid material in water because they were perhaps not familiar with the concept of solubility. It seems that the students were not **familiar with technical terms like 'solubility'**.

Question 3: The items were related to separation of substance by identifying the correct and wrong statements and re-write the correct version of the wrong statements. Around 75% students identify all correct and wrong statements but only 4% could re-write the correct version of wrong statements. It appears that students **either overlooked the second part of the question or were reluctant to write the corrected statements in their own words.**

Question 4: The question had two parts. Part (a) of the question was related to the separation of four components of a mixture. The students had to choose the methods from the list and give appropriate order to them. 37.66% students gave incorrect response to this question. It seems students could not give the correct sequence of the methods to separate the components from the mixture. It appears that students were confused by the list which contains various methods of separation. Very few students had attempted part (b) of the question which was very easy. They might have overlooked it due to too much engagement with the part (a). May be, the students were under the impression that **all seven methods of separation have to be used.**

Question 5: The question is related to identification of the changes which can be reversed or which cannot be reversed from a list of ten changes. 79% had given partially correct response to this question. It seems the students were **confused about the format of the question.** Perhaps, one example could have been given for their guidance in the tool.

Question 6: In this question two activities were given from which students had to draw some conclusion. The conclusion for the first activity (a) was that air was present in the bottle which escaped from the bottle on tilting in the water filled in the tub. However, it was found that the students have concluded that oxygen was present. It seems that students are **confused between air and oxygen.** The activity (b) was related to condensation of water from the air around the surface of glass which was filled with ice cubes. In this case some students have not given the reasons and some had sketched the diagram which was already given in the question. 55% students left this question un-attempted. It appears that most of the students had **difficulty in comprehending the question.** This could possibly be due to the deficiency in language.

CLASS VII

Question 1: The question is aimed at assessing the knowledge of the students about the correct sequence of steps involved in obtaining woolen fabric from its fibre; Part (b) is concerned with the stage in the life cycle of the moth which produces silk fibre. In the first part of the question many students (38.40%) were able to give partially correct sequence of steps. Most of the students were **unable to identify the stage in the life cycle of moth** from which fibre is produced.

Question 2: The question aims at assessing the application of known concept in a given situation. The students had to give scientific reason behind choice of colour of the tent during summers. This question fetched varied answers from the students. 13% students answered this question correctly. Many students chose white or a light colour but could not give **exact scientific explanation as white colour being a good reflector.**

Question 3: The question is related to test the understanding of the students about neutralization reaction. They were expected to identify bases from the list of given substances. Besides this they were expected to predict the change of colour of litmus during neutralization. Most of the students were able to identify only

one or two basic substances. 40% students responded to this question incorrectly. It appears most of the students **did not have a hands- on experience of use of litmus paper.**

Question 4: The question pertains to identification of acid, bases and neutral solutions with turmeric as an indicator. Though this concept has been dealt beautifully in the book with interesting card making activity, most of the students could not answer it correctly (32%), rather they gave uses of turmeric in cooking, as an antibiotic and for healing of wounds, thus connecting it with their daily life experiences. Almost 60% students did not attempt the question. It seems that most of them did not comprehend the question. **Hands on experience of the activity given in the book might have improved the performance.**

Question 5: The question is aimed at classifying the given changes as physical or chemical. Most students were able to identify physical changes correctly while only few could identify chemical changes. 69% students gave partially correct response to this question. **Exposure to various physical and chemical changes might have improved the performance.**

Question 6: The question is to ascertain whether the students are aware of purification of polluted water by aeration, filtration and chlorination. Students were asked to identify the type of impurities removed by each of these processes. Also, they had to give two causes responsible for cholera, typhoid, dysentery. Some students gave correct answer for the role of chlorination. Some had given correct answer for removal of impurities by sand filter. Nearly 50% students did not attempt part B of the question, although **it could have been answered on the basis of general awareness.**

Class VIII

Question 1: Students found difficulty in identifying the materials which are fire resistant, material of which handle of pressure cooker is made and the material which can be dried easily. 91% students gave partially correct answer. **Exposure and discussion on various materials could have improved the performance.**

Question 2: Most students could relate the property (acidic nature of oxide) with the nature of element (non-metals). However, they generally marked one or two correct choices out of three. **Reason for the answer** was not given by majority of students.

Question 3: Students were mostly familiar with properties of metals and non-metals but there is **confusion regarding some of the properties** such as reaction with acids, bases, formation of acidic oxides and basic oxides. Most of the students seemed to believe either acid reacts with metals or with non-metals. Therefore, even the properties common to both- metals and non-metals, were marked only against one of these. 80% students gave partial response to this question.

Question 4: The concept of **exhaustible and inexhaustible sources of energy is generally not clear** to the students. Only 1% students could identify exhaustible and inexhaustible sources of energy. 9% students attempted this question incorrectly. Most of them gave partially correct (74%) response.

Question 5: Most of the students do not seem to have **clear concepts about spontaneous combustion and ignition temperature.** They were not able to choose correct or incorrect sentences. 80% students gave partial response.

Question 6: Most of the students could not relate to pollution and measures to control it. From their responses it appears that students are exposed to different kinds of pollution and their effects, but awareness has not been created in them about the causes and measures to control it. Although this question was **related to day-to-day life**, even then 43% students did not attempt this question.

Limitations of this study

Some of the factors which might have affected the outcome of this study are:

- The test was administered without any advance notice to avoid examination- related stress among the children. Lack of preparedness might have affected the performance of students.
- Students were informed that achievement in the test will not affect their score in any manner. Some of the students might have taken the test casually.
- Most of the questions appeared long because of the format adopted but their expected answers were in fact short. However, it is possible that the length of some questions might have turned some students off.
- Generally, in the present assessment system students are assessed by questions having only one part. However, in the present study questions had more than one part. Due to this, it is possible that performance of the students may have been affected.
- The intention was not to ask direct questions. So, only a few questions were memory based and most of the questions were application based. It is likely that the children were not trained to answer such questions.
- The lack of proficiency of language (English/Hindi) may have affected the performance.

Conclusion

From the analysis of data, it has been revealed that students have given partially correct answers to most of the questions. This suggests that either students have not understood the concept(s) or the concepts(s) has/have not been transacted in the classroom effectively.

The present set of science textbooks were written in accordance with the recommendations of NCF-2005, with the hope that they will wean children away from rote learning and promote skill of reasoning and self-expression. With these objectives in mind, activities were introduced as part of teaching- learning process. The idea was that students will not only learn doing things by hand, but will arrive at conclusion after discussion with other students, in the process developing skill not only of reasoning but also of data presentation, argumentation and counter argumentation and expressing themselves in cogent logical terms. One of the major structural problems that plague science education at this level is the **lack of experimental facilities**. Many activities at this stage can be **performed with ‘low cost’ material**, it is unfair to deny children the opportunities of handling simple devices such as, magnet, litmus paper, test tubes, tumblers etc.

This study shows, unfortunately, that the teachers are not being able to use the textbooks in the way expected, perhaps due to **lack of desired infrastructure and environment** conducive for teaching-learning process.

The study reveals that students are severely handicapped because of deficiency in language. Some of the students cannot write correctly words of everyday use. Many of them cannot **comprehend question**

consisting of a few simple sentences. When they are asked to write even a single sentence giving reason for their answer, they find it difficult. With this kind of severe language disability, it is unreasonable to expect students to understand science, which contains technical terms which are difficult even to pronounce and spell correctly. This study suggests that in earlier classes the focus should be on **developing language skill** so that subject like science can be learnt more meaningfully in later years.

In spite of these constraints, it must be appreciated that even without prior notice students appeared in this test without creating any fuss. They even sought clarification where ever questions were not clear to them. **This shows clearly that students are eager to learn; only necessary conditions need to be created to satisfy their urge for learning.**

Recommendations

Some of the recommendations to improve teaching-learning process in the school system are as follows:

- NCERT has developed science kits for the upper primary stage which can be used to carry out almost all the activities suggested in the textbooks. Teachers need to be given training for the usage of kits on massive scale, so that these kits can be used effectively in the classroom by both students and teachers during teaching-learning process.
- Teachers need in-depth training in activity-based teaching-learning where they can relate new knowledge to children's local environment and prior experience.
- They should be trained as facilitators of knowledge rather than transmitters of knowledge during their pre-service programmes.
- For learning of science at middle level (upper primary level), it is important to emphasize on developing language abilities at primary level.

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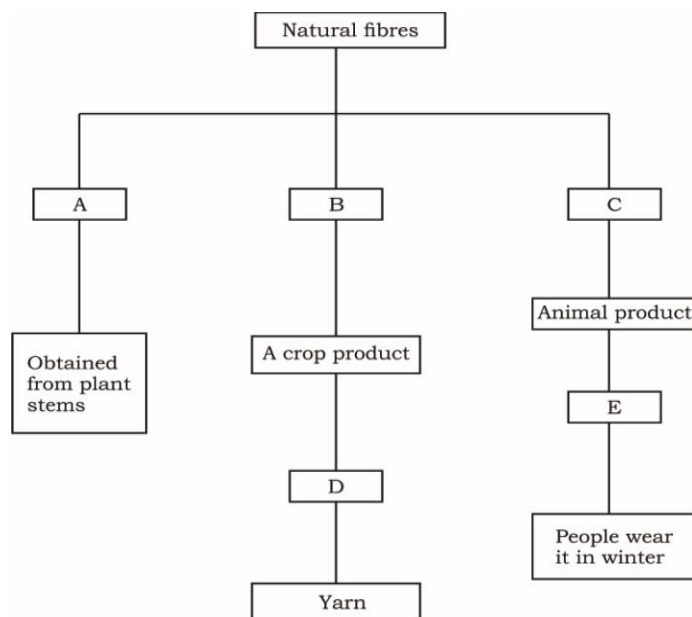
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Annexure

CLASS VI – SCIENCE

Try to attempt all the questions

1. Identify the natural fibres A, B, C, and the processes D and E from the following figure.



- A
- B
- C
- D
- E

2. Find the odd one out in each of the following lists on the basis of hint given in the bracket.
- Book, notebook, pen, newspaper (material of which the objects are made).
 - Salt, sugar, sand, glucose (solubility in water).
 - Plastic lid, table tennis ball, iron key, small piece of wood (floats in water).
 - Cardboard, wooden door, glass window, aluminium foil (transparency).
 - Vinegar, kerosene, lemon juice, milk (mixes well with water).
3. Identify the following statements as right or wrong. If wrong, then write a correct statement for it.
- A mixture of oil and water can be separated by filtration.
 - Salt can be separated from a salt solution by the process of evaporation.
 - Farmers separate husk from seeds of grain by threshing.
 - A mixture of sawdust and iron balls can be separated by hand picking.
 - Pebbles are separated from sand by sieving.
 - Only a limited amount of salt can be dissolved in water.
4. (a) Riya is provided with a mixture of iron filings, sand, common salt and kidney beans. Help her in deciding the sequence of separation of components and the method used in each step from the following.
- Filtration
 - Hand picking
 - Winnowing
 - Use of magnet (separation by magnet)
 - Evaporation
 - Decantation
 - Threshing
 - Dissolution in water
- (b) Which device would you require to carry out the separation of husk and flour?
5. Some changes can be reversed and some cannot be reversed. Tick Mark (✓) your response in the appropriate column for the following changes:

S. No.	Change	Can be reversed	Cannot be reversed
1.	Rolling of chapatti		
2.	Melting of ice cream		
3.	Bursting of a balloon		

4.	Threading a needle		
5.	Drying of a wet cloth		
6.	Folding a paper to make a toy aeroplane		
7.	Burning of a candle		
8.	Evaporation of water		
9.	Falling of leaf from a tree		
10.	Blooming of flower		

6. Two activities are given here. What do you conclude from these? Write each answer in not more than two sentences.

- a) Shambhavi dipped the open mouth of an empty bottle into a tub filled with water (as shown in Fig. A) and then tilted it slightly (as shown in Fig. B). She observed bubbles coming out of water.



Fig. (A)



Fig. (B)

- b) Kamal took a glass half-filled with water. Then he added some ice cubes in it. After two minutes he observed water droplets all around the outer surface of the glass.



Fig. Drops of water appear on the surface of the glass containing ice cold water

CLASS VII – SCIENCE

Try to attempt all the questions

1. a) Wool is obtained from fleece of sheep or yak. Arrange the following steps in correct sequence which are involved in the processing of the fibre into woollen fabric: Sorting, picking out burr from hair, shearing, dyeing, spinning and weaving, scouring
 b) A particular type of fibre is produced by feeding a moth on mulberry leaves.
 (i) At which stage of the life cycle of the moth the fibre is obtained.
 (ii) Name the process in which these moths are reared for obtaining this particular type of fibre.
2. At a camp site, the tents are made from fabrics of two shades - white and black.
 (i) Under tent of which colour would you prefer to rest on a hot summer afternoon?
 (ii) Give reasons for your choice.
3. (a) Which of the following substances can be neutralised by adding vinegar?
 Baking soda, lemon juice, milk of magnesia, soap solution, common salt solution?
 (b) How will you identify the above neutralisation reaction with the help of litmus paper?
4. (a) You are provided with acidic, basic and neutral solutions separately in three test tubes. With the help of turmeric solution how will you identify all the three solutions?
 (b) What is the role of turmeric powder in this activity?
 (c) Name any other substance which can be used in place of turmeric powder.
5. Read the following processes carefully and tick (✓) mark them in appropriate column.

S. No.	Process	Physical change (which can be reversed)	Physical change (which cannot be reversed)	Chemical change
i.	Shaving of wooden block			
ii.	Melting of wax			
iii.	Burning of fire- crackers			
iv.	Dissolving common salt into water			
v	Digestion of food			
vi.	Preparation of sugar candy from sugar solution			
vii.	Combustion of magnesium ribbon			
viii.	Melting of ice			
ix.	Rusting of iron			
x.	Tearing of paper			

6. (a). You are provided with a sample of polluted water. Aeration, filtration and chlorination are the steps for its purification, answer the following:
- (i) What types of impurities are removed by the sand filter?
 - (ii) What is the role of chlorination?
 - (iii) Which step changes the odour of the water?
- (b). Mention two causes that are responsible for many diseases such as cholera, typhoid, and dysentery.

CLASS VIII- SCIENCE

Try to attempt all the questions

1. Some articles/uses are given in the following Table. Select and tick mark (✓) the more appropriate material out of the two choices given in the next column. Write reason(s) for your choice in the last column.

S. No.	Use/Article	Material	Reason(s)
(a)	Umbrella	Cotton ☐	
		Polyester ☐	
(b)	Fire-resistant object	Melamine ☐	
		PVC ☐	
(c)	Handle of pressure cooker	Iron ☐	
		Bakelite ☐	
(d)	Covering of electrical wire	Tin metal ☐	
		PVC ☐	
(e)	Quick drying fabric	Natural fibre ☐	
		Synthetic fibre ☐	

2. A substance X burns in air and forms its oxide. The oxide is shaken with water and strips of both red and blue litmus are put in it. (See Fig.)

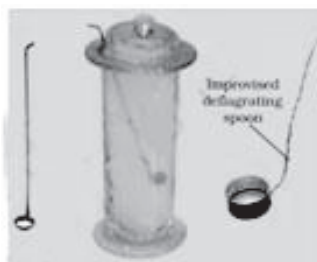


Fig. a



Fig. b

After sometimes, it was observed that both the litmus paper strips are red in colour.
Which substance/substances would show behavior similar to that of the substance X ?

- (i) Iron (ii) Sulphur (iii) Copper (iv) Charcoal
(v) Phosphorus (vi) Magnesium

Given reason(s) for your answer.

c)

3. Some general properties of metals and non-metals are listed in the first column of the given Table. Mark (✓) against each property in the relevant column/columns.

S.No.	Property	Metals	Non-Metals
i.	Poor conductor of heat and electricity		
ii.	Reaction with water		
iii.	Reaction with air		
iv.	Malleability		
v.	Reaction with acids		
vi.	Reaction with bases		
vii.	Formation of acidic oxides		
viii.	Formation of basic oxides		

4. Answer the following questions:

A. What are exhaustible and inexhaustible sources of energy?

B. Classify the following sources of energy as exhaustible or inexhaustible. Mark tick (✓) in the appropriate column in the given Table.

S.No.	Source of energy	Exhaustible	Inexhaustible
i.	Solar energy		
ii.	Coke		
iii.	Liquefied Petroleum Gas (LPG)		
iv.	Wind energy		
v.	Fossil fuels		
vi.	Hydroelectric energy		

5. Mark the following sentences as *correct* or *incorrect*. Write the incorrect sentences after making corrections.

- Burning of LPG is spontaneous combustion.
- A substance does not catch fire below its ignition temperature.

- iii. Essential requirements for production of fire are fuel, air and heat.
 - iv. Goldsmiths blow the middle zone of the flame with a metallic blow pipe for melting gold and silver because it is the hottest zone of the flame.
 - v. Substances with very low ignition temperature are called inflammable substances.
 - vi. White phosphorus catches fire on its own on keeping in air. Its combustion is spontaneous.
6. During the past 5-10 years, the quality of air and water has drastically gone down. Following Table gives a list of the types of pollution or their effects in Column-1, Write any one measure to control in Column-2.

Column-1 Pollution or its effect	Column-2 Measure to control
Air pollution	
Water pollution	
Acid rain	
Green house effect	
Damage to ozone layer	