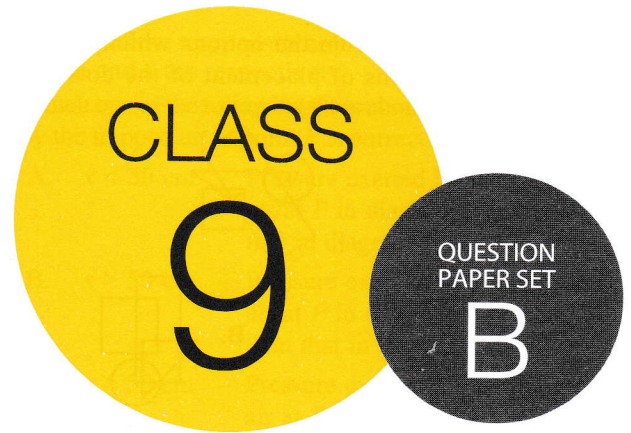




**SOF NATIONAL SCIENCE
OLYMPIAD 2023-24**



DO NOT OPEN THIS BOOKLET UNTIL ASKED TO DO SO

Total Questions: 50 | Time: 1 hr.

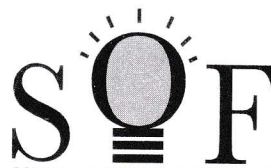
Guidelines for the Candidate

1. You will get additional ten minutes to fill up information about yourself on the OMR Sheet, before the start of the exam.
2. Write your **Name, School Code, Class, Section, Roll No.** and **Mobile Number** clearly on the **OMR Sheet** and do not forget to sign it. We will share your marks / result and other information related to SOF exams on your mobile number.
3. The Question Paper comprises three sections:
Logical Reasoning (10 Questions), **Science** (35 Questions) and **Achievers Section** (5 Questions)
Each question in Achievers Section carries 3 marks, whereas all other questions carry one mark each.
4. All questions are compulsory. There is no negative marking. Use of calculator is not permitted.
5. There is only ONE correct answer. Choose only ONE option for an answer.
6. To mark your choice of answers by darkening the circles on the OMR Sheet, use **HB Pencil** or **Blue / Black ball point pen** only. E.g.
Q.16: In the water cycle, condensation is the process of
A. Water vapour cooling down and turning into a liquid B. Ice warming up and turning into a liquid
C. Liquid cooling down and turning into ice D. Liquid warming up and turning into water vapour
As the correct answer is option A, you must darken the circle corresponding to option A on the OMR Sheet.
7. Rough work should be done in the blank space provided in the booklet.
8. Return the OMR Sheet to the invigilator at the end of the exam.
9. Please fill in your personal details in the space provided before attempting the paper.
10. **For classes 8, 9 & 10, "Innovation Challenge" is being conducted by Techfest IIT Bombay in association with SOF. For details and to participate, please turn to last page.**

16. ● (B) (C) (D)

Name:.....

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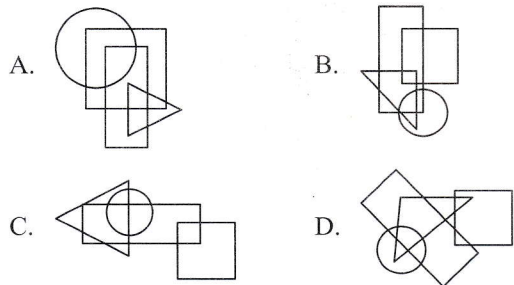
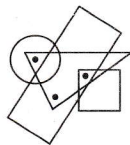
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LOGICAL REASONING

1. Select a figure from the options which satisfies the same conditions of placement of the dots as in the given figure.



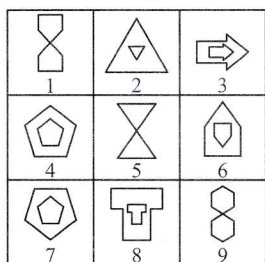
2. If the first and third digits of each of the given numbers are interchanged and then numbers are arranged in the ascending order, then what will be the sum of the digits of the second highest number formed?

725 396 815 437 526

- A. 18 B. 13 C. 14 D. 17

3. Group the given figures into three classes on the basis of their identical properties using each figure only once.

- A. 1, 5, 9; 2, 4, 7; 3, 6, 8
 B. 1, 4, 7; 2, 5, 9; 3, 6, 8
 C. 1, 5, 9; 2, 6, 7; 3, 4, 8
 D. 1, 5, 8; 2, 6, 7; 3, 4, 9

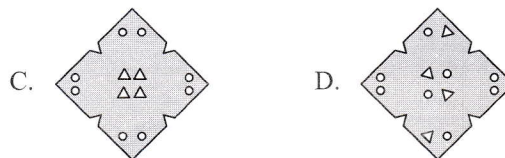
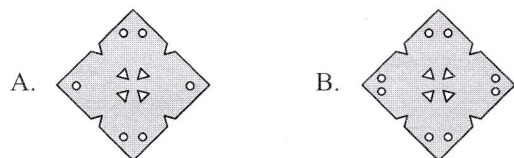
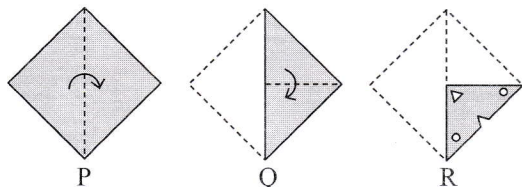


4. In the given letter series, some of the letters are missing which are given in that order as one of the options below it. Select the correct option.

a _ b _ acb _ _ c b d a c _ d

- A. bcdda B. cddba C. abdc b D. cddab

5. The given question consists of a set of three figures P, Q and R showing a sequence of folding of a piece of paper. Fig. R shows the manner in which the folded paper has been cut. Select a figure from the options which would most closely resemble the unfolded form of Fig. R.



6. The following alphabets are coded as follows :

Alphabets	S	E	N	A	C	I	M	T
Codes	@	#	5	↑	+	↓	*	%

While coding the given word, following conditions are also to be observed.

Conditions:

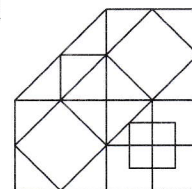
- (i) If the first alphabet is a vowel and the last alphabet is a consonant, then their codes are to be interchanged.
- (ii) If the exact middle alphabet is a vowel, then it is to be coded as >.
- (iii) If the first alphabet is a consonant and the last alphabet is a vowel, then they are to be coded as \$.
- (iv) If the exact middle alphabet is a consonant, then it is to be coded as <.

Find the code for INSTANT.

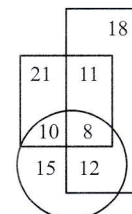
- A. ↓5@>↑5↓ B. %5@>↑5↓
 C. %5@<↑5↓ D. ↓5@↑5%

7. Find the number of squares formed in the given figure.

- A. 13
 B. 14
 C. 15
 D. More than 15

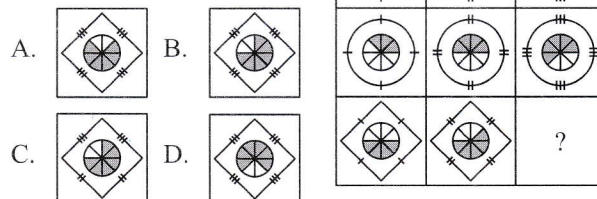


8. In the given Venn diagram, rectangle represents cricketers, square represents people who are vegetarian and circle represents people who are left handed. Which of the following numbers represents left handed cricketers who are non-vegetarian?



- A. 12 B. 11 C. 10 D. 8

9. Which of the following options will complete the given figure matrix?

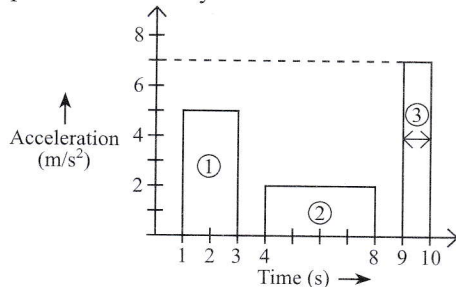


10. If '@' denotes '×', '#' denotes '-', '\$' denotes '+' and '*' denotes '÷', then which of the following options is correct?

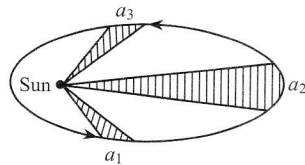
- A. 18 @ 3 * 3 \$ 7 # 12 = 18
 B. 18 * 3 @ 3 # 7 \$ 12 = 23
 C. 18 \$ 3 * 3 @ 7 # 12 = 40
 D. 18 \$ 3 @ 3 * 7 # 12 = 15

11. A particle moves along a straight line with constant acceleration starting from rest. The percentage increase in its displacement during 5th second compared to that in the 4th second is
 A. 35.21% B. 40% C. 28.57% D. 45.55%

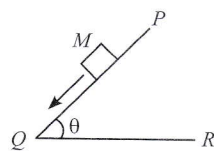
12. A particle is moving along x -axis subjected to three periods of accelerations as shown in the given figure. Arrange them in descending order of the magnitude of the particle's velocity.



- A. (1) > (3) > (2) B. (1) > (2) > (3)
 C. (3) < (2) < (1) D. (2) > (3) > (1)
13. While moving around the Sun, a planet sweeps out area a_1 in 3 days, a_2 in 4 days and a_3 in 12 days. Which one of the following is the correct relation among a_1 , a_2 and a_3 ?

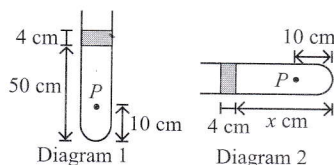


- A. $3a_1 = 2a_2 = a_3$
 B. $2a_1 = 3a_2 = 6a_3$
 C. $6a_1 = 3a_2 = 6a_3$
 D. $4a_1 = 3a_2 = a_3$
14. In the given figure, a block of mass M placed on an inclined plane PQ slides with a uniform acceleration. Read the given statements and select the option that correctly identifies them as true (T) and false (F) ones.



- (i) The weight of the body acts perpendicular to the inclined plane PQ .
 (ii) The sum of the forces acting downward along the plane are equal to the sum of the forces acting upward along the plane.
 (iii) The normal reaction on the block is acting perpendicular to the horizontal plane QR .
 (iv) The component of weight $Mg\cos\theta$, acts perpendicular to the inclined plane PQ .
- | | | | |
|------|------|-------|------|
| (i) | (ii) | (iii) | (iv) |
| A. T | F | F | F |
| B. F | T | F | T |
| C. T | F | T | F |
| D. F | F | F | T |

15. Air is trapped in a gas tube by mercury that is of 4.0 cm in length. When the tube is oriented in positions as shown in the given diagrams, the

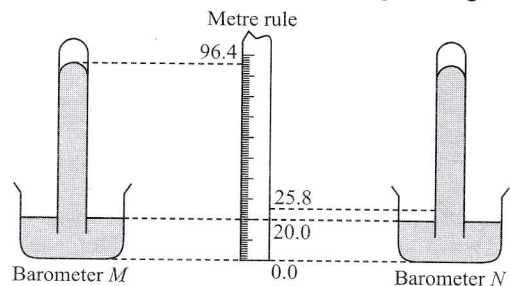


lengths of the trapped air columns are measured to be 50 cm and x cm respectively.

Which one of the following pairs about x and the pressure by the trapped air at point P is correct?

- A. $x < 50$ cm – Pressure exerted by the trapped air at P in diagram 1 is less than that in diagram 2.
 B. $x > 50$ cm – Pressure exerted by the trapped air at P in diagram 1 is greater than that in diagram 2.
 C. $x > 50$ cm – Pressure exerted by the trapped air at P is same in both the diagrams.
 D. $x < 50$ cm – Pressure exerted by the trapped air at P is constant.

16. A scientist keen to determine the height of Mt. Everest, installed two mercury barometers on the Mt. Everest. One barometer, M was installed at the base of the mountain while the other barometer, N was installed at the top, and readings were taken using a metre rule placed against them as shown in the given figures.



If the density of mercury is $13,600 \text{ kg/m}^3$ and gravitational field strength is 10 N/kg , then the air pressure at the base of the mountain is

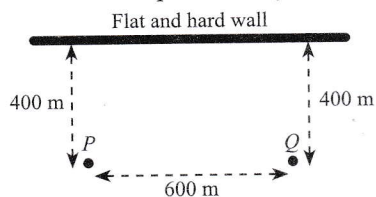
- A. $1.04 \times 10^3 \text{ N m}^{-2}$ B. $7.88 \times 10^3 \text{ N m}^{-2}$
 C. $1.04 \times 10^5 \text{ N m}^{-2}$ D. $7.88 \times 10^5 \text{ N m}^{-2}$

17. Match column I with column II and select the correct option from the given codes.

Column I	Column II
P. When a body does work against friction, its kinetic energy	(i) Independent of time
Q. Work done by a body	(ii) Varies inversely with time
R. Power of a body	(iii) Force must be conservative
S. When work done over a closed path is zero	(iv) Decreases
	(v) Force must be non-conservative

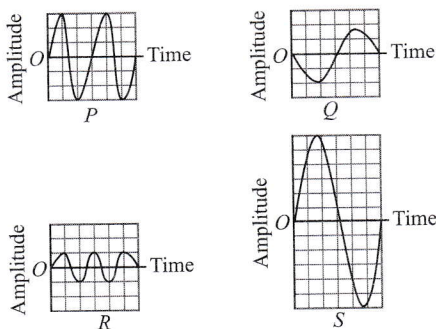
- A. P–(i), Q–(iv), R–(iii), S–(v)
 B. P–(iv), Q–(i), R–(ii), S–(iii)
 C. P–(ii), Q–(iii), R–(i), S–(v)
 D. P–(iv), Q–(ii), R–(i), S–(iii)

18. In the given figure, two men P and Q are facing a flat and hard wall. When man P makes a clap, man Q hears two claps. If the speed of sound is 320 m/s , the time interval between the two claps heard by man Q is



- A. 1.25 s
B. 2.50 s
C. 1.75 s
D. 0.75 s

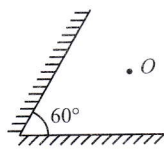
19. Consider the following amplitude-time graphs for different sound waves.



Which of the given statements is/are correct for these sound waves?

- (i) Sound wave R is the loudest.
(ii) Sound wave S has the highest pitch.
(iii) Sound wave R has highest pitch but is soft in nature.
(iv) Sound wave S is the loudest.
- A. (i) and (iv) only B. (ii) only
C. (iii) and (iv) only D. (ii) and (iv) only

20. Two plane mirrors are placed at an angle of 60° as shown in the given figure. The number of images of the point object O is

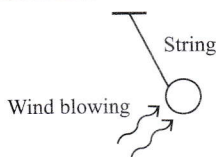


- A. 3 B. 7
C. 6 D. 5

21. Read the given statements and select the correct option.
Statement 1 : Mountaineers often encounter problem like nose bleeding on reaching high altitudes.
Statement 2 : Atmospheric pressure decreases with increasing altitude.

- A. Both statements 1 and 2 are true and statement 2 is the correct explanation of statement 1.
B. Both statements 1 and 2 are true but statement 2 is not the correct explanation of statement 1.
C. Statement 1 is true but statement 2 is false.
D. Both statements 1 and 2 are false.

22. The given figure depicts the scenario of a bob held stationary by applied forces. Which option correctly represents the forces acting on the bob?



23. Select the correct statements.

- I. Increasing temperature and reducing pressure can liquefy gases.
II. Ice at 273 K is more effective in cooling than water at 273 K .
III. The dissolution of salt in water indicates that the nature of matter is continuous.
IV. Evaporation and fusion processes involve absorption of heat.
- A. I and IV only B. II and IV only
C. II and III only D. I and III only

24. Match column I with column II and select the correct option from the given codes.

Column I	Column II
P. Burning of LPG	(i) Explosion
Q. Burning of crackers	(ii) Slow combustion
R. Rusting of iron	(iii) Spontaneous combustion
S. Burning of sodium	(iv) Rapid combustion

A. P - (i), Q - (iii), R - (iv), S - (ii)
B. P - (iv), Q - (iii), R - (ii), S - (i)
C. P - (iv), Q - (i), R - (ii), S - (iii)
D. P - (iii), Q - (ii), R - (i), S - (iv)

25. Read the following statements carefully and select the option that correctly identifies them as true (T) and false (F) ones.

- I. The chemical formula of zinc sulphate is $\text{Zn}(\text{SO}_4)_2$.
II. Phosphorus and chlorine are diatomic and monatomic respectively.
III. In magnesium sulphide, magnesium and sulphur are present in 3 : 4 mass ratio.
IV. The formula unit mass of ammonium sulphate is 96 u.

I	II	III	IV
A. F	T	F	T
B. F	T	T	F
C. F	F	T	F
D. T	T	F	T

26. Read the given statements and select the correct option.
Statement 1 : Strong heating of coal in the absence of air to form different products is called destructive distillation of coal.

Statement 2 : Kerosene and diesel are obtained as a result of destructive distillation of coal.

- A. Both statement 1 and statement 2 are true and statement 2 is the correct explanation of statement 1.
B. Both statement 1 and statement 2 are true but statement 2 is not the correct explanation of statement 1.
C. Statement 1 is true but statement 2 is false.
D. Both statement 1 and statement 2 are false.

27. Which of the following solutions has the lowest mass by mass percentage?
- 8 g of sodium bicarbonate in 160 g of water
 - 50 g of potassium dichromate in 250 g of water
 - 30 g of calcium chloride in 190 g of water
 - 3 g of sugar in 90 g of water

28. Which of the following statements are correct?
- Kerosene is combustible while dried grass is a non-combustible substance.
 - Carbon dioxide is the best extinguisher for fires involving oil and petrol.
 - The calorific value of biogas is higher than that of petrol.
 - The rubbing surface present on the matchbox has powdered glass and a little red phosphorus.
- I and III only
 - I and IV only
 - II and IV only
 - II and III only

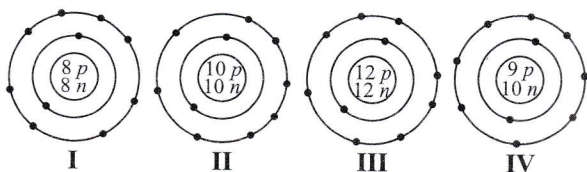
29. Substance *P* is obtained by the destructive distillation of wood and is a constituent of gun powder. Substance *Q* is the purest form of amorphous carbon, which is obtained by dehydrating sugar with conc. H_2SO_4 . *P* and *Q* are respectively
- Animal charcoal and Lamp black
 - Gas carbon and Sugar charcoal
 - Wood charcoal and Animal charcoal
 - Wood charcoal and Sugar charcoal.

30. Match column I with column II and select the correct option from the given codes.

Column I (Molecule)	Column II (Mass ratio of elements)
(P) Carbon monoxide (C : O)	(i) 1 : 35.5
(Q) Hydrochloric acid (H : Cl)	(ii) 3 : 4
(R) Carbon dioxide (C : O)	(iii) 7 : 16
(S) Nitrogen dioxide (N : O)	(iv) 3 : 8

- (P) - (ii), (Q) - (i), (R) - (iv), (S) - (iii)
- (P) - (iii), (Q) - (ii), (R) - (i), (S) - (iv)
- (P) - (i), (Q) - (iv), (R) - (iii), (S) - (ii)
- (P) - (iv), (Q) - (iii), (R) - (ii), (S) - (i)

31. Which of the following schematic structures represent(s) anion(s)?



- I only
 - II and III only
 - III only
 - I and IV only
32. An organic compound '*X*' has a melting point of $-33^\circ C$ and a boiling point of $66^\circ C$. Which of the following is true about this substance?
- At $-100^\circ C$, *X* exists in solid state.
 - At $0^\circ C$, *X* exists in liquid state.

- At $90^\circ C$, *X* exists in gaseous state.
- All of these

33. Take a clean glass slide and put a few drops of water on it. Now mount a thin peel of *Rhoeo* leaf in water and examine the cells of leaf under a high power of compound microscope. Put a few drops of concentrated salt/sugar solution on the mounted *Rhoeo* leaf on the glass slide. Wait for few minutes and again observe the leaf under the high power of microscope.

What will be your observation after few minutes?

- Cell contents are separated from the cell wall.
 - Cytoplasm along with plasma membrane has come to lie on one side of cell wall.
 - A clear space is seen between the cell wall and protoplast of the cell.
 - All of these
34. Select the incorrect match.
- Golgi apparatus – Formation of lysosomes
 - Lysosome – Autophagy
 - Vacuole – Osmoregulation
 - Chloroplast – Turgidity and rigidity

35. Read the given statements (i-iv) and select the option that correctly fills any two of the blanks.

- _____ epithelium is present in oviducts and helps in movement of egg from ovary to the uterus.
 - _____ muscles cause peristalsis in the alimentary canal.
 - _____ tissue joins skin to muscles and fastens peritoneum to the body wall and viscera.
 - Blood enters the _____ through Haversian canals.
- (i)-Cuboidal, (ii)-Striated
 - (iii)-Areolar, (iv)-Cartilage
 - (ii)-Smooth, (iii)-Areolar
 - (i)-Ciliated, (iv)-Ligament

36. Refer to the given list of diseases.

Aspergillosis, Bird flu, Ranikhet, Tuberculosis, Cholera, Rinderpest, Anthrax

How many of the given diseases occur in fowls due to virus?

- 5
- 2
- 3
- 4

37. Refer to the given table showing different fish species and their feeding zones in a composite fish culture system. Identify *L*, *M* and *N* and select the correct option.

Species of fish	Feeding zone
<i>Catla</i>	<i>L</i>
<i>M</i>	Middle
Common carp	<i>N</i>

- | | | |
|------------|-------------|----------|
| <i>L</i> | <i>M</i> | <i>N</i> |
| A. Bottom | Rohu | Surface |
| B. Surface | Silver carp | Surface |
| C. Surface | Rohu | Bottom |
| D. Bottom | Mrigal | Bottom |

38. Read the following statements carefully and select the option that correctly identifies them as true (T) and false (F) ones.

- (i) The worker bees are provided with hypopharyngeal glands for secretion of bee milk.
- (ii) Karan-Swiss is a high yielding cross breed cattle variety while Frieswal is an indigenous cattle breed of India.
- (iii) Milch breeds are milk-yielding while draught breeds are working animals.
- (iv) Ayrshire is an Indian breed of cow.

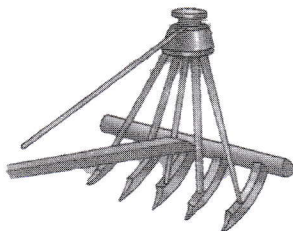
	(i)	(ii)	(iii)	(iv)
A.	F	F	T	T
B.	T	F	T	F
C.	T	T	T	F
D.	F	F	T	F

39. Refer to the given analogy and select the option that correctly identifies X .

$Rhizobium$: Nitrogen fixation :: X : Nitrification

- A. *Pseudomonas*
- B. *Nitrosomonas*
- C. *Nitrobacter*
- D. Both B and C

40. Identify the given agricultural implement and select the correct statement regarding it.



- A. It is used to sow seeds at equal distance and proper depth.
- B. It is used for proper irrigation in fields.
- C. It is used to separate grains from the stem.
- D. It is used to separate grains from chaff.

41. Which of the following statements is/are correct?

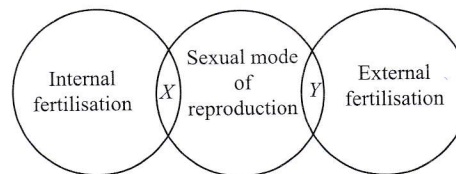
- (i) *Penicillin* is obtained from a multicellular fungi.

- (ii) Yeast is used to make vitamin B-complex tablets.
 - (iii) DPT vaccine gives protection against the bacterium causing typhoid.
 - (iv) *Salmonella* is used in the production of cheese.
- A. (i) and (iv) only B. (iii) only
C. (i) and (ii) only D. (iii) and (iv) only

42. Select the odd one out on the basis of methods of biodiversity conservation.

- A. Zoological park
- B. National park
- C. Botanical garden
- D. Gene bank

43. Refer to the given Venn diagram and select the option that correctly identifies organisms X and Y .



- | X | Y |
|-------------|---------|
| A. Seahorse | Lizard |
| B. Ostrich | Penguin |
| C. Pigeon | Salmon |
| D. Emu | Snake |

44. Which among the given hormones lowers the calcium level in blood?

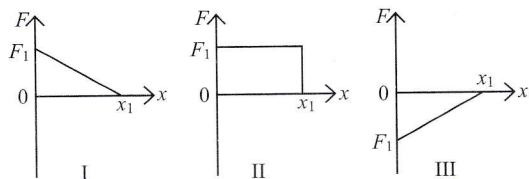
- A. Calcitonin
- B. Thyroxine
- C. Adrenaline
- D. Melatonin

45. Which of the following statements is incorrect regarding meristematic tissues?

- (i) They are differentiated cells which do not possess the power of division.
 - (ii) They are compactly arranged without intercellular spaces.
 - (iii) They are multinucleated with dense cytoplasm.
 - (iv) They contain few vacuoles or vacuoles are absent.
- A. (i) and (ii) only B. (i) and (iii) only
C. (ii) and (iv) only D. None of these

ACHIEVERS SECTION

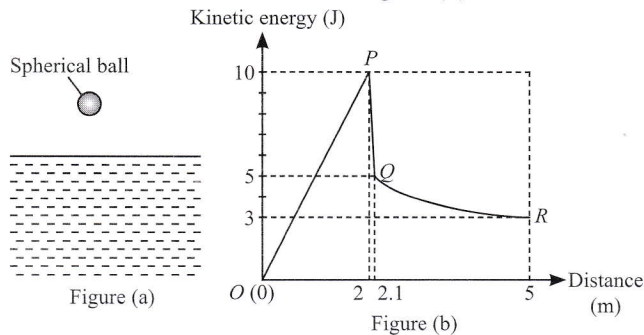
46. For a particle moving along the positive x -axis from origin to $x = x_1$, the variation of the magnitude of force on the particle is depicted in the given graphs. The force is parallel to the x -axis and is conservative. The maximum magnitude of force F_1 has the same value for all the graphs.



On the basis of given graphs, which of the following statements are correct?

- (i) The change in potential energy is maximum in graph II.
 - (ii) The change in potential energy is minimum in graph II.
 - (iii) The change in potential energy is greater in graph III as compared to graph I.
 - (iv) The change in potential energy is smaller in graph III as compared to graph I.
- A. (i) and (iii) only B. (iii) and (iv) only
C. (ii) and (iii) only D. (ii) and (iv) only

47. A spherical ball of mass 0.5 kg is dropped in air and it strikes a pond as shown in the figure (a). A graph of the kinetic energy of the ball against the distance descended is shown in the figure (b).

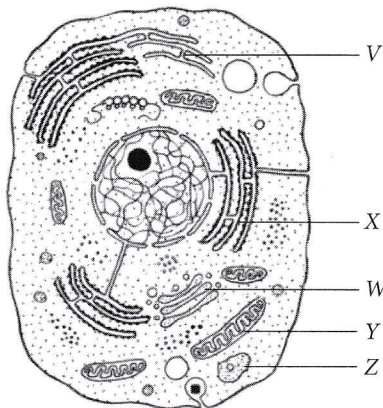


Fill in the blanks by selecting the correct option. (Take $g = 10 \text{ m/s}^2$)

The height above the surface of the pond from where the ball has been dropped is (i) m. The average acceleration of the ball in first part of the graph (OP) is (ii) ms^{-2} . The average resistive force provided by the water against the ball during the journey from P to Q is (iii) N.

- | | (i) | (ii) | (iii) |
|----|-----|------|-------|
| A. | 2 | 10 | 90 |
| B. | 10 | 2 | 50 |
| C. | 2 | 10 | 55 |
| D. | 10 | 2 | 100 |

48. Refer to the given figure and identify the labelled parts (V-Z).

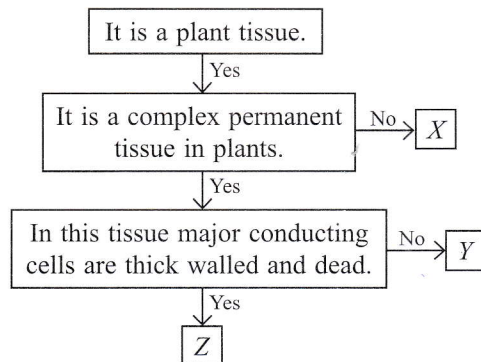


Now, select the incorrect statement regarding V-Z.

- A. X is specialised to synthesise proteins whereas Z removes worn out cellular organelles by digesting them.
 B. V helps in detoxification of toxic substances in liver whereas Y provides intermediates for the synthesis of chlorophyll.

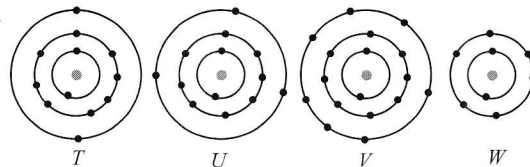
- C. Y is single membrane bound structure whereas W is a double membrane bound structure.
 D. W gives rise to acrosome in an animal sperm whereas enzymes of Z present in acrosome enable the entry of sperm into the ovum.

49. Refer to the given flow chart and select the incorrect statement regarding it.



- A. X could perform photosynthesis whereas Y helps in conduction of organic solutes.
 B. Movement of substances is unidirectional in Z whereas it is bidirectional in Y.
 C. X could form hard covering of seeds and nuts whereas Z provides mechanical strength to the plant.
 D. Conducting elements are tracheids and vessels in Y whereas sieve tubes are the conducting elements in Z.

50. The schematic atomic structures of four elements T, U, V and W are given as :



Select the incorrect statements regarding the given elements.

- I. T and V combine to form T_3V type compound.
 II. T and W form cations while U and V form anions.
 III. U and V combine to form UV_3 type compound.
 IV. V will gain two electrons while W will lose one electron to form a stable compound.
 V. U and W combine to form U_2W type compound.
 A. II, III and IV only
 B. I, II, IV and V only
 C. III, IV and V only
 D. I, II, III and IV only

SPACE FOR ROUGH WORK



SOF-TECHFEST IIT BOMBAY INNOVATION CHALLENGE

About the Challenge:

Techfest is Asia's Largest Science and Technology Festival and the Annual Science and Technology Festival of IIT Bombay. Techfest IIT Bombay is conducting Innovation Challenge in association with Science Olympiad Foundation for school students across the globe.

Guidelines:

- Appearing in the Innovation Challenge is not compulsory. No registration fee is to be paid.
- To participate, read the following problem statement and email the answer at ic.iitbombay@sofworld.org.
- Answers should be submitted as per the following schedule:

NSO Set-A 17 th October	NSO Set-B 21 st November	NSO Set-C 5 th December
By 22 nd October	By 26 th November	By 10 th December

PROBLEM STATEMENT

Green Innovation : Technological Breakthroughs for a Sustainable Tomorrow

In a rapidly evolving world, where the demand for resources and energy continues to rise, green innovation offers a pathway to mitigate environmental impact while promoting economic growth and societal well-being. Some of how innovative technologies are reshaping industries, practices, and lifestyles to align with sustainable principles are:

- **Sustainable Plastic Waste Management** - Without affecting the usage of plastic
- **Sustainable Habitat** - Zero or low energy consumption, low embodied energy and low construction waste
- **Sustainable Agriculture** - Focus on soil degradation, excessive water usage, detrimental effects of pesticides, insecticides, and fertilisers

Choose ANY ONE of the above topics and answer in the following format :

Title - Write the title of the chosen topic.

Problems - Describe the social, industrial, and environmental challenges corresponding to the topic and need for sustainable solutions (in about 100-150 words).

Solutions - Innovate and explain the sustainable solutions to the problems stated above (in about 150-200 words).

Conclusion - Justify your solutions concerning their implementation and impact (in about 50-100 words).

Rewards:

- Each participant will be awarded a Certificate of Participation from SOF-Techfest, IIT Bombay.
- Top 20 students will be invited to Techfest 2023-24 with an accompanying adult from 27th to 29th December 2023 with travel and accommodation provided by Techfest, IIT Bombay.
- Winners will be awarded trophies, gifts, merit certificates, and a visit to ISRO's Vikram Sarabhai Space Centre, Thiruvananthapuram with expenses reimbursed.



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National Office: Plot 99, Sector 44 Institutional area, Gurugram -122 003 (HR) India
Email: info@sofworld.org | Website: www.sofworld.org