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SOF NATIONAL SCIENCE OLYMPIAD 2023-24

CLASS 11

QUESTION PAPER SET A

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 :
   Section - 1 : **Physics & Chemistry** (25 Questions)
   Section - 2 : **Achievers Section** (5 Questions)
   Section - 3 : **Mathematics** (20 Questions) or **Biology** (20 Questions)
4. **Section-1 and 2 are compulsory for all**. In Section-3 opt for Mathematics OR Biology and mark the same on the OMR Sheet. Each question in Achievers Section carries 3 marks, whereas all other questions carry one mark each.
5. All questions are compulsory. There is no negative marking. Use of calculator is not permitted.
6. There is only ONE correct answer. Choose only ONE option for an answer.
7. 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.

   16. ● Ⓑ Ⓒ Ⓓ
8. Rough work should be done in the blank space provided in the booklet.
9. Return the OMR Sheet to the invigilator at the end of the exam.
10. Please fill in your personal details in the space provided before attempting the paper.
11. ***For classes 8, 9 & 10, "Innovation Challenge" is being conducted by Techfest IIT Bombay in association with SOF. For details, please visit : www.sofworld.org/sof-techfest-iit-bombay-innovation-challenge2023***

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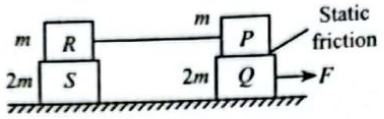
1. Four blocks are arranged on a smooth horizontal surface as shown in the given figure. Masses of the blocks are given. The coefficient of static friction is 0.2. The maximum value of the horizontal force F, applied to one of the blocks, so that it makes all four blocks to move with the same acceleration, is



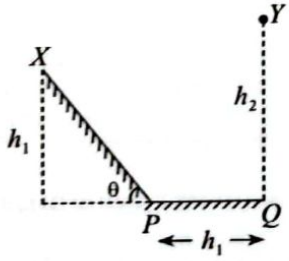
A. $\frac{3}{10}mg$

B. $\frac{2}{10}mg$

C. $\frac{1}{10}mg$

D. $\frac{4}{10}mg$

2. Two particles are simultaneously released from points X and Y as shown in the given figure. How should the value of h_2 be adjusted in order that the two particles collide? (Ignore the dissipative forces)



A. $\frac{h_1}{2}\left(\frac{\sqrt{2}+\sin\theta}{\sin\theta}\right)$

B. $\frac{h_1}{2}\left(\frac{2+\sin\theta}{\sin\theta}\right)$

C. $\frac{h_1}{4}\left(\frac{2+\cos\theta}{\tan\theta}\right)$

D. $\frac{h_1}{4}\left(\frac{2+\tan\theta}{\cos\theta}\right)$

3. Let us assume that a thin square plate floating on a viscous liquid in a large tank. The height h of the liquid in the tank is much less than the width of the tank. The floating plate is pulled horizontally with a velocity u_o (constant). Now, consider the given statements.

(i) A resistive force of the liquid on the plate is inversely proportional to height of liquid h.

(ii) The resistive force of the liquid on the plate is independent of the area of the plate.

(iii) The tangential stress on the floor of the tank increases with u_o.

(iv) The tangential stress on the plate varies linearly with the viscosity η of the liquid.

Which of the given statements are correct?

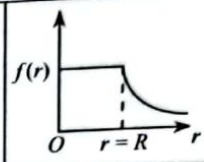
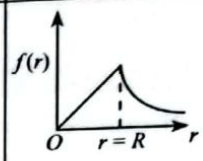
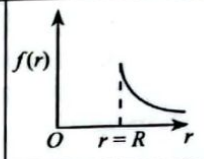
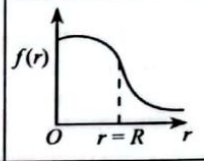
A. (i), (ii) and (iii) only

B. (i), (iii), (iv) only

C. (ii) and (iii) only

D. (iii) and (iv) only

4. Consider a physical quantity of magnitude $f(r)$ which varies as a function of r (distance from centre of spherical distribution of radius R). Then, match column I with column II and select the correct option from the given codes.

Column I		Column II	
(i)		(a)	$f(r)$ is the variation of gravitational field intensity for a uniform spherical shell.
(ii)		(b)	$f(r)$ is the variation of gravitational field intensity for a uniform volumetric spherical distribution of mass.
(iii)		(c)	$f(r)$ is the variation of gravitational potential for a uniform spherical shell.
(iv)		(d)	$f(r)$ is the variation of gravitational potential for a uniform volumetric spherical distribution of mass.

A. (i) → (c), (ii) → (b), (iii) → (a), (iv) → (d)

B. (i) → (a), (ii) → (b), (iii) → (d), (iv) → (c)

C. (i) → (b), (ii) → (c), (iii) → (a), (iv) → (d)

D. (i) → (c), (ii) → (d), (iii) → (a), (iv) → (b)

5. Consider the following statements, for the given displacement (y)-time (t) graphs of two waves having same speed.

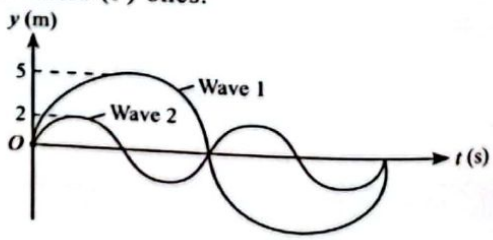
(i) The ratio of average intensities of waves 1 and 2 is 25 : 16.

(ii) The frequency of wave 1 is less than the frequency of wave 2.

(iii) The time period of wave 1 is greater than the time period of wave 2.

(iv) The phase difference between waves 1 and 2 is 180°.

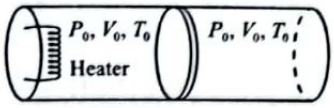
Select the correct option which identifies them as true (T) and false (F) ones.



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

6. There is a cylindrical container having non-conducting walls with two equal portions such that the volume of each portion is V_0. A movable non-conducting and a frictionless piston is kept between the two parts. The gas on the left is heated slowly so that the gas on right is compressed upto volume $V_0/8$. The final temperature, if initial pressure and temperature are P_0 and T_0 respectively, is (number of moles in each part is n)

A. $60\ T_0$
B. $40\ T_0$
C. $30\ T_0$
D. $20\ T_0$



Monoatomic gas

7. There is a nuclear weapon in the shape of a ball of radius 0.5 m. When it is detonated, its temperature reaches to 10^6 K and the weapon can be treated as a black body. If it is surrounded by water at 30°C, how much water can evaporate by absorbing 10% of the energy produced in 1 s?
($S_w = 4186$ J/kgK, $L = 22.6 \times 10^5$ J/Kg).

A. 7×10^8 kg
B. 7×10^9 kg
C. 8×10^9 kg
D. 8×10^8 kg

8. A solid sphere of metal of density ρ_1, floats in mercury of density ρ_2. The coefficients of expansion of the solid and mercury are γ_1 and γ_2 respectively. The temperatures of both mercury and sphere are increased by ΔT. On the basis of given changes, match column I with column II and select the correct option from the given codes.

Column I		Column II	
(i)	If $\gamma_2 > \gamma_1$	(a)	No effect on fraction of sphere submerged in mercury
(ii)	If $\gamma_2 = \gamma_1$	(b)	Fraction of the volume of sphere submerged in mercury increases
(iii)	If $\gamma_2 < \gamma_1$	(c)	The sphere sinks
		(d)	The sphere lifts up

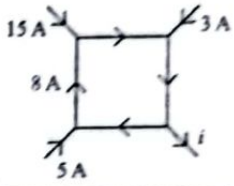
A. (i) → (a), (ii) → (c), (iii) → (b)
B. (i) → (b), (ii) → (a), (iii) → (d)
C. (i) → (d), (ii) → (a), (iii) → (c)
D. (i) → (a), (ii) → (b), (iii) → (c)

9. A gun is fired from a moving platform and the ranges of shot are observed to be X_1 and X_2, when the platform is moving forward or backward respectively with speed u. The angle of elevation of the gun is

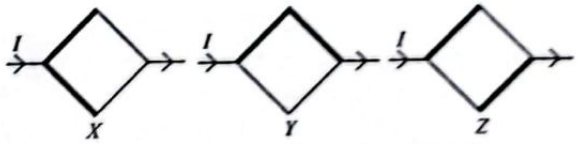
A. $\sin^{-1}\left[\frac{g(X_1 - X_2)^2}{4u^2(X_1 + X_2)}\right]$
B. $\cos^{-1}\left[\frac{g(X_1 + X_2)^2}{2u^2(X_1 - X_2)}\right]$
C. $\tan^{-1}\left[\frac{g(X_1 - X_2)^2}{4u^2(X_1 + X_2)}\right]$
D. $\sin^{-1}\left[\frac{g(X_1 + X_2)^2}{4u^2(X_1 - X_2)}\right]$

10. The given figure shows a network of currents with their magnitudes and directions. Then, current i will be

A. 3 A
B. 13 A
C. 23 A
D. –3 A



11. Two thick wires and two thin wires, all of the same length form a square in the three different ways, X, Y and Z as shown in the given figure. With the connections shown (here, I is current), the magnetic field at the centre of the square is zero in case of



A. X only
B. X and Y only
C. Y and Z only
D. X and Z only

12. Two plane mirrors P and Q each of length 1 m are separated by 1 cm. A ray of light is incident on one end of mirror Q at an angle 45°. Then, consider the given statements.

(i) The light ray undergoes 51 reflections before coming out from the other end.
(ii) The deviation produced in the final reflected ray from initial light ray is of 135°.
(iii) The light ray undergoes 101 reflections before coming out from the other end.
(iv) The final reflected ray and incident ray are parallel to each other.

Select the correct statements.

A. (i) and (iv) only
B. (ii) and (iii) only
C. (iii) and (iv) only
D. (ii), (iii) and (iv) only

13. A convex lens of focal length 100 cm and a concave lens of focal length 10 cm are placed coaxially at a separation of 90 cm. If a parallel beam of light is incident on convex lens, then after passing through the two lenses the beam

A. Converges
B. Diverges
C. Remains parallel
D. Disappears.

CHEMISTRY

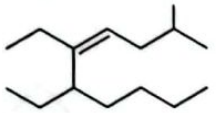
14. If the angular momentum of electron of Li^{2+} ion is found to be $7h/11$, then the distance of the electron from the nucleus is

A. 295 pm
B. 605 pm
C. 110 pm
D. 282 pm

15. When X is heated at 373 K, Y is obtained. During this reaction, X loses three-fourth of its water of crystallisation. Y is used in hospitals for setting fractured bones. X and Y respectively are

A. Baking soda and washing soda
B. Gypsum and plaster of Paris
C. Plaster of Paris and gypsum
D. Bleaching powder and caustic soda.

16. IUPAC name of the given compound is



A. 5, 6-diethyl-2-methyldec-4-ene
B. 4-ethyl-3-hexenyloctane
C. 5,6-diethyl-9-methyldec-6-ene
D. 3-(isoheptyl)-6-methylhept-3-ene.

17. Study the given reaction and fill in the blanks by selecting the correct option.

$$Pb(NO_3)_{2(aq)} + xNaI_{(aq)} \longrightarrow PbI_{2(s)} + yNaNO_{3(aq)}$$

In the given reaction, the value of x is __(i)__ and that of y is __(ii)__ . The given reaction is an example of __(iii)__ reaction. The colour of the precipitate is __(iv)__.

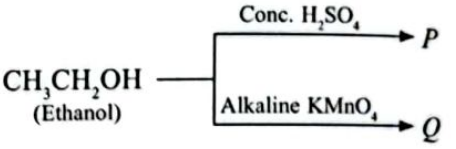
	(i)	(ii)	(iii)	(iv)
A.	2	3	Displacement	Red
B.	3	2	Double displacement	Yellow
C.	3	3	Displacement	Orange
D.	2	2	Double displacement	Yellow

18. In which of the following arrangements, the order is not according to the property indicated against it?

I. Na > Al > Mg > Be – Atomic radius
II. $Cs_2O > K_2O > SrO > MgO$ – Basic character
III. Si > Mg > Al > Na – First ionization energy
IV. B < N < O < C < F – Electron gain enthalpy

A. I and IV only
B. II and III only
C. IV only
D. I, II, III, IV

19. Study the following reactions carefully:



Select the correct statement about P and Q.

A. P is a saturated hydrocarbon with general formula C_nH_{2n+2}.
B. Q is an organic compound having –CHO functional group.
C. Q reacts with ethanol to form a sweet-smelling substance.
D. P reacts with sodium metal to form sodium ethoxide.

20. The correct order of amount of $O_{2(g)}$ consumed per gram of reactant for the given reactions is

(Given : Atomic mass of Fe = 56 u, O = 16 u, Mg = 24 u, P = 31 u, C = 12 u, H = 1 u)

I. $C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(l)}$
II. $4Fe_{(s)} + 3O_{2(g)} \longrightarrow 2Fe_2O_{3(s)}$
III. $P_{4(s)} + 5O_{2(g)} \longrightarrow P_4O_{10(s)}$
IV. $2Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$

A. II < IV < I < III
B. I > III > IV > II
C. II > IV > III > I
D. I > III > II > IV

21. Read the given statements carefully and select the correct option.

Statement 1 : Thermite reaction is endothermic in nature.

Statement 2 : In thermite reaction, aluminium is used as an oxidising agents.

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

I. NaCl is more ionic than $AlCl_3$.
II. Bond order of N_2^- is greater than O_2^+.
III. $SnCl_2$, NH_2^- and $HgCl_2$ are isostructural.
IV. Bond angle of H_2O is greater than OF_2.

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

23. Select the incorrect statements from the following.

I. Calcium and lead are obtained by reduction of their oxides with carbon.
II. Metals like aluminium, iron and zinc react with steam to form the metal oxide and hydrogen.
III. Non-metals displace hydrogen from dilute acids.
IV. Bronze is an alloy of copper and zinc, while brass is an alloy of lead and tin.

A. II and III only
B. I, II and IV only
C. I, III and IV only
D. I, II and III only

24. Standard enthalpy of combustion at 25 °C of hydrogen, cyclohexene (C_6H_{10}) and cyclohexane (C_6H_{12}) are −240 kJ/mol, −3800 kJ/mol and −3920 kJ/mol respectively. The heat of hydrogenation of cyclohexene is

A. − 120 kJ mol^{-1}
B. − 1900 kJ mol^{-1}
C. 120 kJ mol^{-1}
D. 1900 kJ mol^{-1}

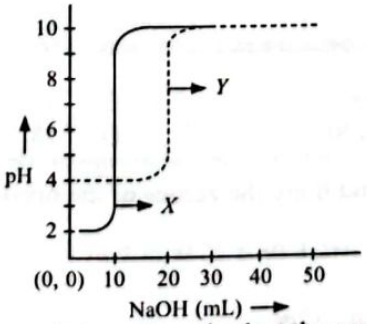
25. Match column I with column II and select the correct option from the given codes.

Column I		Column II	
(P)	$3I_2 + 6NaOH \longrightarrow NaIO_3 + 5NaI + 3H_2O$; ($I_2$ acts as)	(i)	Neither oxidant nor reductant
(Q)	$BaCl_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2NaCl$; ($BaCl_2$ acts as)	(ii)	Reductant
(R)	$AlCl_3 + 3Na \longrightarrow 3NaCl + Al$; ($AlCl_3$ acts as)	(iii)	Both oxidant and reductant
(S)	$SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$; ($H_2S$ acts as)	(iv)	Oxidant

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

SECTION-2
ACHIEVERS SECTION

26. When 100 mL of two different monobasic acids *X* and *Y* are titrated with 0.1 M NaOH solution, the following titration curve is obtained.



Read the given statements and select the correct one(s).

I. *Y* is weaker acid than *X*.
II. [*X*] = 0.02 M and [*Y*] = 0.01 M
III. Salt of acid *X* will have lower pH than that of *Y* in aqueous solution, if their concentrations are same.
IV. *X* has lower concentration than *Y*.

A. I, III and IV only
B. I and III only
C. II only
D. I, II, III and IV

Direction (Q. No. 27 and 28) : Read the given passage and answer the following questions.

P, *Q* and *R* are three isomers having molecular formula, C_5H_8, and they undergo following sets of reactions.

'*P*' $\xrightarrow[\text{silver nitrate}]{\text{Ammoniacal}}$ White ppt.

'*Q*' $\xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } O_3}$ Formaldehyde + Propan-1,3-dial

'*R*' $\xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } O_3}$ Pentan-1,5-dial

27. Select the correct statements regarding compounds *P*, *Q* and *R*.

A. The compound *Q* is terminal diene.
B. The compound *R* is cyclic diene.
C. The compound *P* is terminal alkyne.
D. Both A and C.

28. The compounds P, Q and R respectively are

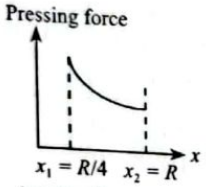
A. $CH_3(CH_2)_2C{\equiv}CH$; $CH_2{=}CHCH{=}CHCH_3$;

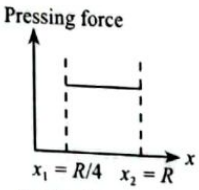
B. $CH_3C{\equiv}CCH_2CH_3$; $CH_2{=}CHCH_2CH{=}CH_2$;

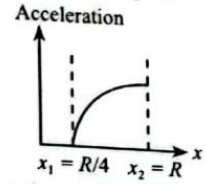
C. $CH_3(CH_2)_2C{\equiv}CH$; $CH_2{=}CHCH_2CH{=}CH_2$;

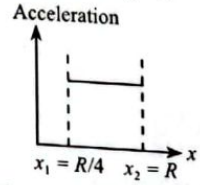
D. $CH_2{=}CHCH{=}CHCH_3$; $CH_3CH_2C{\equiv}CCH_3$;

29. There is a tunnel dug along a chord of the Earth at a perpendicular distance $R/4$ from the Earth's centre. The wall of the tunnel may be assumed to be frictionless. A particle is released from one end of the tunnel. The variation of pressing force by the particle on the wall and the acceleration of the particle with x (distance of the particle from the centre) are shown in the given graphs.

I. 

II. 

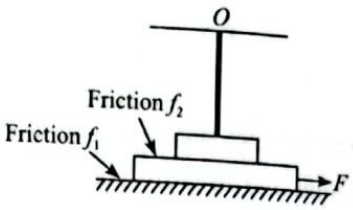
III. 

IV. 

Select the option which represents correct variations of pressing force and acceleration with x.

A. II and III only
B. I and III only
C. II and IV only
D. I and IV only

30. A horizontal plane supports a plank with a block placed on it. A light elastic cord is attached to the block, which is attached to a fixed point O. Initially, the cord is unstretched and vertical. The plank is slowly shifted to right until the block starts sliding over it. It occurs at the moment when the cord deviates from vertical by an angle θ. The work done by the force (F) is equivalent to the



(i) Energy lost against friction f_1 plus strain energy in cord
(ii) Work done against total friction acting on the plank alone
(iii) Work done against total friction acting on the plank plus strain energy in the chord
(iv) Work done against total friction acting on the plank plus strain energy in the cord minus work done by friction acting on the block.

Which of the given statements are correct?

A. (i) and (ii) only
B. (i), (ii) and (iii) only
C. (i), (ii) and (iv) only
D. (ii), (iii) and (iv) only

SECTION-3
MATHEMATICS

31. Expand: $\left(x^2+\frac{3}{x}\right)^4, x \neq 0$

A. $x^8+12x^5+54x^2+\frac{108}{x}+\frac{81}{x^4}$

B. $x^8-12x^5+54x^2-\frac{108}{x}-\frac{81}{x^4}$

C. $x^8-12x^5-54x^2+\frac{108}{x}+\frac{81}{x^4}$

D. None of these

32. How many numbers can be made with the digits 3, 4, 5, 6, 7, 8 lying between 3000 and 4000 which are divisible by 5 while repetition of any digit is not allowed in any number?

A. 60
B. 12
C. 120
D. 24

33. If α and β are the zeroes of the quadratic polynomial $f(x) = ax^2 + bx + c$, then find the value of $\frac{\alpha^2}{\beta^2}+\frac{\beta^2}{\alpha^2}$.

A. $\frac{b^2-2ac}{a^2c^2}$

B. $\frac{(b^2-2ac)-ac}{a^2c^2}$

C. $\frac{(b^2-2ac)^2-2a^2c^2}{a^2c^2}$

D. None of these

34. Find the value of

$\sin(40° + \theta)\cos(10° + \theta) - \cos(40° + \theta)\sin(10° + \theta)$.

A. 1/2
B. 1/4
C. 1
D. 0

35. A spaceship is made in such a way that it is conical at one end, hemispherical at other end and cylindrical in middle. If the radius is 6 metre for each part while height of conical part is 2 metre and that of cylindrical part is 4 metre, then find the volume of space inside the spaceship. (Use: $\pi = 3.14$)

A. 745.59 m^3
B. 760.25 m^3
C. 979.68 m^3
D. 765.68 m^3

36. If $y = \frac{1}{1+x+x^2}$, then $\frac{dy}{dx}$ is equal to

A. $y^2(1 + 2x)$
B. $\frac{-(1+2x)}{y^2}$
C. $\frac{(1+2x)}{y^2}$
D. $-y^2(1 + 2x)$

37. What is the conjugate of $\frac{\sqrt{5+12i}+\sqrt{5-12i}}{\sqrt{5+12i}-\sqrt{5-12i}}$?

A. $-3i$
B. $3i$
C. $\frac{3}{2}i$
D. $-\frac{3}{2}i$

38. If $A(-2, -1)$, $B(a, 0)$, $C(4, b)$ and $D(1, 2)$ are the vertices of a parallelogram taken in order, then find the values of a and b.

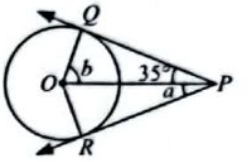
A. $a = 3, b = -3$
B. $a = 3, b = 5$
C. $a = 1, b = -3$
D. $a = 1, b = 3$

39. If $f(x) = \frac{1}{\sqrt{x+2\sqrt{2x-4}}} + \frac{1}{\sqrt{x-2\sqrt{2x-4}}}$ for $x > 2$, then $f(11)$ equals

A. $\frac{7}{6}$
B. $\frac{5}{6}$
C. $\frac{6}{7}$
D. $\frac{5}{7}$

40. In the given figure, PQ and PR are tangents drawn from point P to a circle with centre O. If $\angle OPQ = 35°$, then values of a and b respectively are

A. 30°, 60°
B. 35°, 55°
C. 40°, 50°
D. 55°, 45°



41. Consider the experiment "tossing a coin twice" and probability of outcomes are as $P(HH) = \frac{1}{4}$, $P(HT) = \frac{1}{7}$, $P(TH) = \frac{2}{7}$ and $P(TT) = \frac{9}{28}$.

Based on above experiment, read the given statements carefully and select the correct option.

Statement-I : Probability of the event E : 'both the tosses yield the same result' is $\frac{4}{7}$.

Statement-II : Probability of the event F : 'exactly two heads' is $\frac{1}{4}$.

A. Both Statement-I and Statement-II are false.
B. Both Statement-I and Statement-II are true.
C. Statement-I is true but Statement-II is false.
D. Statement-I is false but Statement-II is true.

42. The curved surface area of a cylinder is 264 m^2 and its volume is 924 m^3. The ratio of its diameter to its height is

A. 3 : 7
B. 7 : 3
C. 6 : 7
D. 7 : 6

43. Find the point on x-axis which is equidistant from the point $A(3, 2, 2)$ and $B(5, 5, 4)$.

A. (16, 0, 0)
B. $\left(\frac{5}{4}, 0, 0\right)$
C. (9, 0, 0)
D. $\left(\frac{49}{4}, 0, 0\right)$

44. If $U = \{x : x \in N \text{ and } x \leq 10\}$ be the universal set, $A = \{x : x \text{ is prime}\}$ and $B = \{x : x \text{ is factor of } 24\}$, then which of the following is correct?

I. $A - B = A \cap B'$
II. $(A \cup B)' = A' \cap B$

A. Both I and II
B. Only I
C. Only II
D. Neither I nor II

45. The perimeters of two similar triangles are 30 cm and 20 cm. If one altitude of the former triangle is 12 cm, then the length of the corresponding altitude of the latter triangle is

A. 8 cm
B. 10 cm
C. 12 cm
D. 15 cm

46. The first two terms of a geometric progression add up to 12. The sum of the third and fourth terms is 48. If the terms of the geometric progression are alternately positive and negative, then the first term is

A. –4
B. –12
C. 12
D. 4

47. A man on the top of a vertical tower observes a car moving at a uniform speed coming directly towards it. If it takes 12 minutes for the angle of depression to change from 30° to 45°, then how soon after this will the car reach the tower? (Use: $\sqrt{3} = 1.732$)

A. 15 minutes
B. 16 minutes
C. 15 minutes 53 seconds
D. None of these

48. Find the mean deviation about the mean for the following data.

Marks obtained	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Number of students	2	3	8	14	8	3	2

A. 12
B. 10
C. 11
D. 9

49. If α and β are the roots of the quadratic equation $4y^2 - 8y + 12 = 0$, then the value of $(4\alpha - 8)^{-2} + (4\beta - 8)^{-2}$ is

A. $\frac{9}{52}$
B. 0
C. $-\frac{1}{72}$
D. 1

50. Find the equation of the circle when the end points of a diameter are $A(-2, 3)$ and $B(3, -5)$.

A. $x^2 + y^2 - x + 2y - 21 = 0$
B. $x^2 + y^2 - 2x + 3y + 18 = 0$
C. $2x^2 + 2y^2 + 4x - 2y + 10 = 0$
D. $3x^2 + 4y^2 + 5x - 3y + 10 = 0$

OR

BIOLOGY

31. Given below are statements related to few classification systems. Identify the incorrect one.

A. Artificial system of classification may use habit and habitat as criteria for grouping.
B. Natural system of classification utilises either one or two morphological traits.
C. Fossils play a vital role in elucidation of evolutionary relationship in phylogenetic system of classification.
D. Presence of similar banding pattern of chromosomes forms the basis of classification in cytotaxonomy.

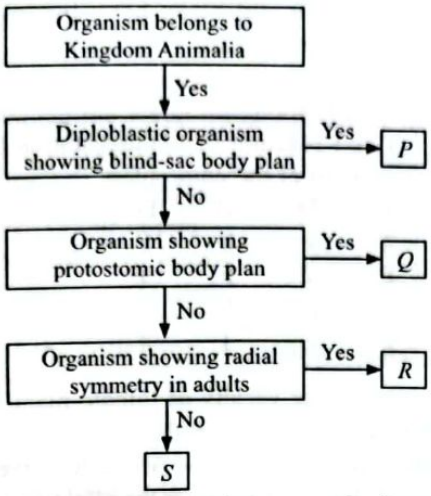
32. During renovation of a school laboratory, two slides X and Y of dicot stem and dicot root, respectively are found. A student while examining these slides writes down the given characteristic features.

(i) There are prominent Casparian strips in endodermal cells.
(ii) The outermost layer shows additional multicellular hair-like structures.
(iii) Vascular bundles are radially arranged.
(iv) Endodermal cells lack Casparian strips.
(v) Vascular bundles are present in the form of a ring.
(vi) Unicellular tubular outgrowths are arising from cells of outermost layer.
(vii) Prominent pith is observed.
(viii) Pith is small or inconspicuous.

Select the option that correctly matches these characteristics with X and Y.

	X	Y
A.	(i), (ii), (iii) and (iv)	(v), (vi), (vii) and (viii)
B.	(i), (iii), (iv) and (vi)	(ii), (v), (vii) and (viii)
C.	(i), (ii), (vii) and (viii)	(iii), (iv), (v) and (vi)
D.	(ii), (iv), (v) and (vii)	(i), (iii), (vi) and (viii)

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



A. *P* could be *Adamsia* that uses stinging cells for defence and offence.
B. *Q* could be earthworm in which coelomic fluid serves as a hydroskeleton.
C. *R* could be *Dentalium* that has open type of blood vascular system.
D. *S* could be *Balanoglossus* that has a single proboscis gland as excretory organ.

34. The cell wall of algal members of class *X* possesses cellulose, pectic compounds and phycocolloids such as funori. The major pigments of this class are chlorophyll *a*, *d* and phycoerythrin. Select the correct statement regarding the members of class *X*.

A. They possess flagellated male gamete known as spermatium.
B. The reserve food is mannitol and laminarin.
C. The female sex organ remains attached to the plant and forms carposporophyte.
D. The vegetative cells have a cellulosic wall usually covered by algin.

35. Read the given sentence and select the option that correctly fills in the blanks.

Heart of frog is __(i)__ and __(ii)__ chambered.

	(i)	(ii)
A.	Myogenic	Three
B.	Neurogenic	Three
C.	Myogenic	Two
D.	Neurogenic	Two

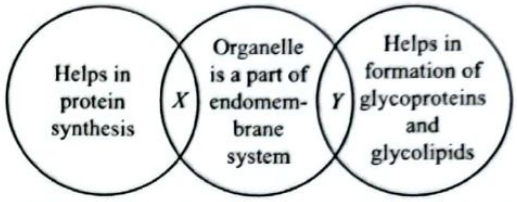
36. A certain plant family has following distinguishing features :

(i) Solitary, axillary or cymose inflorescence
(ii) Bisexual, actinomorphic flowers
(iii) Gamopetalous corolla with valvate aestivation
(iv) Epipetalous androecium with five stamens
(v) Bicarpellary, bilocular, superior, obliquely placed ovary

Identify the family and select the correct option regarding this family.

A. Non-endospermic seeds
B. Persistent calyx
C. Parietal placentation
D. Drupe fruit

37. Refer to the given Venn diagram and select the correct statement regarding it.



A. *X* is single membrane bound whereas *Y* is double membrane bound.
B. Both *X* and *Y* take part in synthesis of ATP.
C. In a cell, *X* helps in intracellular digestion whereas *Y* helps in extracellular digestion.
D. *X* provides precursors of different secretory substances to *Y*.

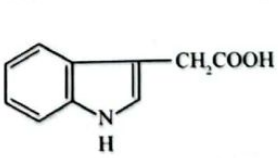
38. The given table shows reactions occurring in a plant cell and their respective locations.

	Reaction	Location in the cell
1.	$RuBP + CO_2 \rightarrow$ Glycerate-3-phosphate	Stroma
2.	Glucose + ATP → Glucose-6-phosphate + ADP	Cytosol
3.	$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	Stroma
4.	Oxaloacetate + Acetyl CoA + $H_2O \rightarrow$ Citrate + CoA	Matrix

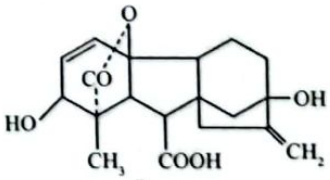
Select the correctly matched pair(s).

A. 1 and 3 only B. 2 only
C. 1, 2 and 4 only D. 4 only

39. Identify the given structures *P* and *Q* and select the incorrect statement regarding them.



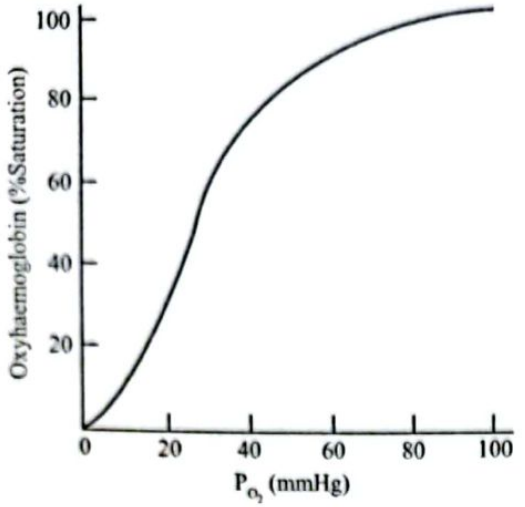
P



Q

A. The precursor for *P* is tryptophan whereas the precursor for *Q* is mevalonic acid.
B. *P* causes bolting in rosette plants and seed germination whereas *Q* is essential for callus growth and ripening of climacteric fruits.
C. *P* has feminising effect on some plants whereas *Q* has masculinising effect on some plants.
D. *P* transport is basipetal in stem whereas *Q* transport is both basipetal and acropetal in stem.

40. Given below is a normal oxygen-haemoglobin dissociation curve.



Which set of conditions will shift the curve to right?

I. Decrease in partial pressure of oxygen
II. Increased body temperature
III. Increase in partial pressure of carbon dioxide
IV. High pH

A. I and III only
B. I and IV only
C. I, II and III only
D. II, III and IV only

41. Which among the given statements is/are incorrect regarding distal convoluted tubule?

I. Under the influence of aldosterone, sodium ions are actively reabsorbed from the filtrate.
II. It is capable of reabsorption of HCO_3^-.
III. Hydrogen ions are secreted into the filtrate.
IV. It is impermeable to water.

A. I only
B. II and III only
C. I and IV only
D. IV only

42. A diploid cell has 8 chromosomes and total amount of DNA before DNA replication in the cell is denoted by '*X*'.

Select the correct option on the basis of the information given.

	Cell cycle phase	No. of chromosomes per cell	Amount of DNA per cell
A.	Interphase	16	$2X$
B.	Metaphase of meiosis I	8	X
C.	Telophase of mitosis	16	X
D.	Anaphase of meiosis II	8	X

43. Read the given statements and select the option that correctly identifies them as true (T) and false (F) ones.

I. In mammalian liver, α-cells produce glucagon hormone which converts glycogen to glucose.
II. Reptiles and birds have incompletely four-chambered heart.
III. High temperature and high humidity favour transpiration.
IV. Light reaction of photosynthesis takes place in granum of the chloroplast.

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

44. In a particular variety of tomato plant, the allele for red fruit colour (A) is dominant over the allele for orange fruit (a) and the allele for green base when ripe (B) is dominant over the allele for no green base when ripe (b).

When Rohan crossed two different plants of tomato, he observed the following phenotypes in the ratio of 9:3:3:1.

1. Red fruit with green base = 9
2. Red fruit with no green base = 3
3. Orange fruit with green base = 3
4. Orange fruit with no green base = 1

Which of the following options correctly represents the phenotype of the parents?

A. AABB × aabb
B. AaBb × AaBb
C. AaBb × aabb
D. aaBb × aabb

45. Names of few contraceptive methods are given in the box.

(i) Condoms (ii) Oral pills (iii) Tubectomy (iv) Femidom (v) Diaphragm

How many among them belong to the category of barrier methods of contraception?

A. 2
B. 3
C. 4
D. 5

46. Government has installed green and blue dustbins to dispose of the waste generated in local areas. Green dustbins are used to discard biodegradable waste whereas blue dustbins are used to discard non-biodegradable waste.
From the given list, how many of them will be discarded in green and blue dustbins, respectively?

Cotton boll, Fruit peels, Knives, Needles, Used tea leaves, Rotten eggs, Glass, Damaged fluorescent bulbs, Leftover food, Cold drink cans, Plastic bottle, Bakelite

A. 5, 7
B. 6, 6
C. 4, 8
D. 8, 4

47. Which among the given traits studied by Mendel in garden pea is recessive?

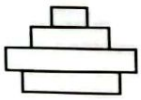
A. Terminal flower position on stem
B. Green colour of pod
C. Violet colour of flower
D. Yellow colour of seed

48. Which of the following is correct regarding dark reaction?

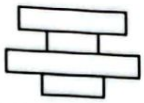
A. It takes place only in the presence of light.
B. It occurs in grana lamellae of chloroplast.
C. The end product is ATP and $NADPH_2$.
D. No oxygen is evolved during dark reaction.

49. What will be the shape of pyramid of number in an aquatic ecosystem?

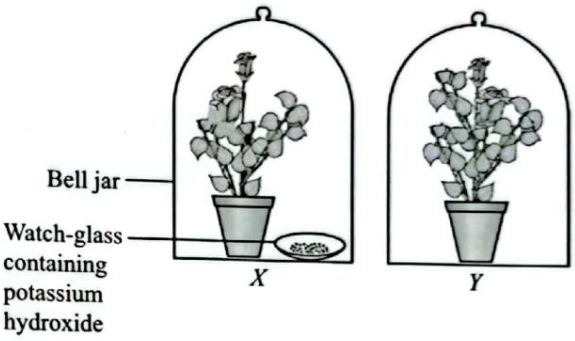
A. 

B. 

C. 

D. 

50. Refer to the given figure representing an activity. During this activity, two healthy potted plants *X* and *Y* were kept in the dark for 72 hours. After 72 hours, KOH was kept in the watch glass beside plant *X*. Both the setups were air tight and were kept in light for 6 hours. After 6 hours, iodine test was performed with one leaf from each of the two plants *X* and *Y*.



Which of the following is incorrect regarding the experiment?

A. This experiment is used to prove essentiality of CO_2 in photosynthesis.
B. The function of KOH is to absorb carbon dioxide.
C. Leaf of plant *X* will turn blue-black whereas there will be no change in colour in leaf of plant *Y*.
D. All of these

SPACE FOR ROUGH WORK