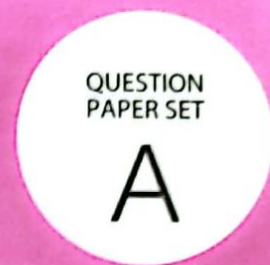


**SOF NATIONAL SCIENCE  
OLYMPIAD 2023-24**



**DO NOT OPEN THIS BOOKLET UNTIL ASKED TO DO SO**

Total Questions: 50 | Time: 1 hr.

### Guidelines for the Candidate

- You will get additional ten minutes to fill up information about yourself on the OMR Sheet, before the start of the exam.
- 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.
- 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)
- 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.
- All questions are compulsory. There is no negative marking. Use of calculator is not permitted.
- There is only ONE correct answer. Choose only ONE option for an answer.
- 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.
- Rough work should be done in the blank space provided in the booklet.
- Return the OMR Sheet to the invigilator at the end of the exam.
- Please fill in your personal details in the space provided before attempting the paper.
- 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](http://www.sofworld.org/sof-techfest-iit-bombay-innovation-challenge2023)**

16. ● (B) (C) (D)

Name:.....

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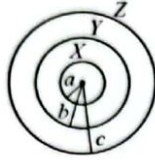
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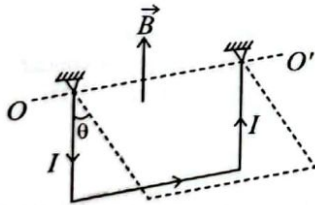
**SECTION-1**  
**PHYSICS**

1. A dielectric medium of dielectric constant  $K$  is filled between conducting shells  $X$  and  $Y$  as shown in the given figure. Then, potential difference between the shells,  $X$  and  $Z$  is



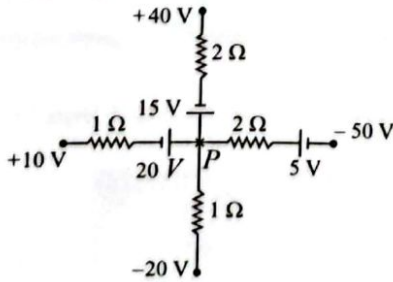
- A.  $\frac{q}{4\pi\epsilon_0 Kabc} [c(b-a) + Ka(c-b)]$   
 B.  $\frac{q}{4\pi\epsilon_0 Kabc} [Kc(b-a) + a(c-b)]$   
 C.  $\frac{q}{4\pi\epsilon_0 Kabc} [Kc(a-b) + a(b-c)]$   
 D.  $\frac{q}{4\pi\epsilon_0 K} abc [(a-b) + (b-c)]$

2. A copper wire of density  $\rho$ , with cross-sectional area  $S$  is bent to make three sides of a square frame which can turn about a horizontal axis  $OO'$  as shown in the given figure. The wire is located in a vertical uniform magnetic field  $\vec{B}$ . The magnitude of  $\vec{B}$ , if on passing a current  $I$  through the wire, the frame gets deflected by an angle  $\theta$  and comes to equilibrium position, is



- A.  $\frac{2S\rho g}{I} \sin \theta$       B.  $\frac{2\rho g S}{I} \tan \theta$   
 C.  $\frac{2S\rho g}{I} \cos \theta$       D.  $\frac{2S\rho g}{3I} \tan \theta$

3. The potential of point  $P$  is



- A. 10 V      B. 7 V  
 C. 5 V      D. 2 V

4. Output of a faulty inverter is expressed for one cycle

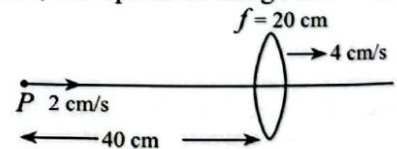
$$\text{as } emf = E(\theta) = \begin{cases} \frac{E_m}{\alpha} \theta, & 0 < \theta \leq \alpha \\ E_m, & \alpha \leq \theta \leq \pi - \alpha \\ -\frac{E_m}{\alpha} \theta, & \pi - \alpha \leq \theta \leq \pi \end{cases}$$

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

Column I	Column II
(i) The average value of $emf$ for $0 < \theta \leq \alpha$	a. $\frac{E_m}{2}$
(ii) The ratio of $rms$ and average value of $emf$ for $\frac{\pi}{6} \leq \theta \leq \frac{5\pi}{6}$	b. 1
(iii) The magnitude of average value of $emf$ for $\frac{5\pi}{6} \leq \theta \leq \pi$	c. $5.5 E_m$

- A. (i)  $\rightarrow$  c, (ii)  $\rightarrow$  b, (iii)  $\rightarrow$  a  
 B. (i)  $\rightarrow$  b, (ii)  $\rightarrow$  c, (iii)  $\rightarrow$  a  
 C. (i)  $\rightarrow$  a, (ii)  $\rightarrow$  c, (iii)  $\rightarrow$  b  
 D. (i)  $\rightarrow$  a, (ii)  $\rightarrow$  b, (iii)  $\rightarrow$  c

5. At  $t = 0$ , the separation between point object  $P$  (moving with speed 2 cm/s) and the thin convex lens (moving with speed 4 cm/s) is 40 cm, as shown in the given figure. Then, the speed of image at  $t = 10$  s is

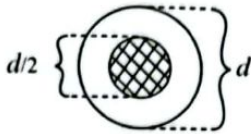


- A. 2 cm/s  
 B. 1 cm/s  
 C. 4.5 cm/s  
 D. 0.5 cm/s

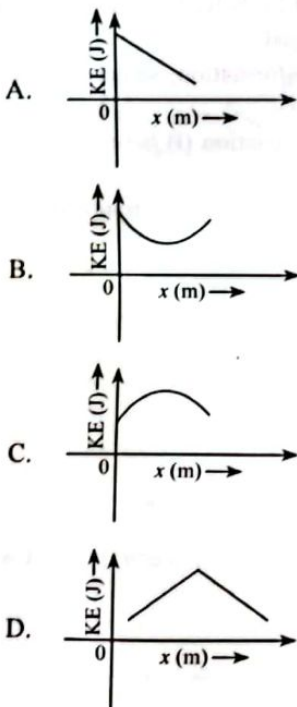
6. A parallel plate capacitor with plate area  $A$  is charged as such it has charge,  $q = I_0 t$  at an instant  $t$ . Assume a plane surface of area  $\frac{A}{2}$  parallel to the plates and drawn symmetrically between the plates. The value of displacement current through this area is

- A.  $\frac{I_0}{2}$       B.  $\frac{I_0}{3}$   
 C.  $\frac{I_0}{4}$       D.  $\frac{I_0}{5}$

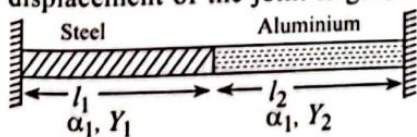
7. For a certain position of a lens, current through a photocell is  $I$ . Now, the central part of the lens (of diameter  $d/2$ ) is covered with a black opaque paper as shown in the given figure. Keeping all the other parameters same, the current passing through the photocell will be



- A.  $I$                       B.  $\frac{I}{2}$   
 C.  $\frac{3I}{4}$                      D.  $\frac{2}{3}I$
8. A particle is projected up with a certain velocity at an angle  $30^\circ$  to the horizontal. The variation of its kinetic energy (KE) with horizontal displacement ( $x$ ) is best represented by



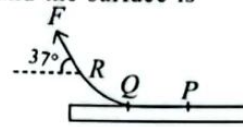
9. Two rods one of steel and the another of aluminium (having equal cross-sectional areas) are joined together and the free ends of the rods are fixed between two rigid supports as shown in the given figure. If the temperature of the surroundings is increased by  $T^\circ\text{C}$ , then the displacement of the joint is given by



- A.  $\frac{l_1 l_2 (Y_1 \alpha_1 - Y_2 \alpha_2) T}{Y_1 l_1 - Y_2 l_2}$   
 B.  $\frac{l_1 l_2 (Y_1 \alpha_1 - Y_2 \alpha_2) T}{Y_2 l_1 + Y_1 l_2}$

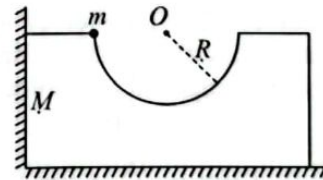
- C.  $\frac{l_1 l_2 (Y_1 \alpha_1 + Y_2 \alpha_2) T}{Y_1 l_1 - Y_2 l_2}$   
 D.  $\frac{l_1 l_2 (Y_1 \alpha_1 + Y_2 \alpha_2) T}{Y_2 l_1 + Y_1 l_2}$

10. A uniform massive rope  $PQR$  has length of 6 m. The rope is held by applying a force  $F$  at an angle of  $37^\circ$  with the horizontal as shown in the given figure. If length of hanging part of the rope is less than 2 m, then the rope does not slip on the horizontal rough surface. The value of coefficient of static friction between rope and the surface is



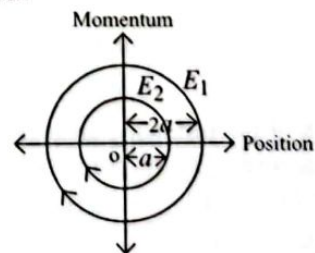
- A. 0.5                      B.  $\frac{3}{5}$   
 C.  $\frac{5}{6}$                       D.  $\frac{2}{3}$

11. In the given figure, the wedge and the particle are resting through the support of the vertical wall. The particle having mass  $m (= \frac{M}{2})$  is released from rest from the position shown. The wedge has mass  $M$ . The maximum height reached by the particle on the circular groove is  $\frac{2R}{x}$ , the value of  $x$  is (assume all the surfaces are smooth)



- A. 1                          B. 2  
 C. 3                          D. 4

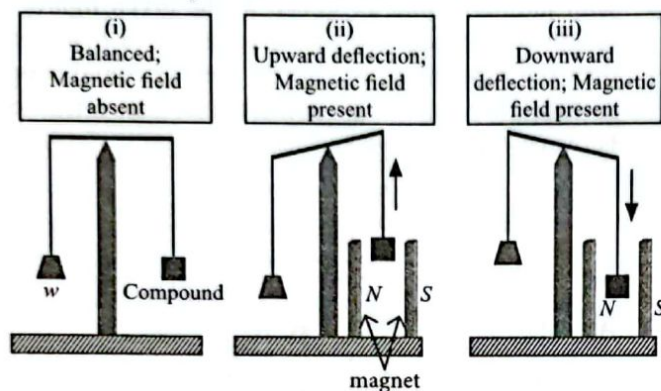
12. The phase space diagram of a simple harmonic motion is a circle centred at the origin as shown in the given figure. Here, the two circles represent the same oscillator but of different initial conditions,  $E_1$  and  $E_2$  as the corresponding total mechanical energies. Then



- A.  $E_1 = \sqrt{2}E_2$                       B.  $E_1 = 2E_2$   
 C.  $E_1 = 4E_2$                           D.  $E_1 = 16E_2$



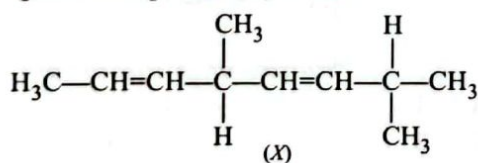
13.  $w$  g of two compounds  $K_2[Ni(CN)_4]$  and  $K_3[Fe(CN)_6]$  are taken one by one in a container which is loaded in a balance as shown in the given figure. In presence of magnetic field, the pan with the compound is either deflected upwards or downwards.



Identify the correct statement from the following.

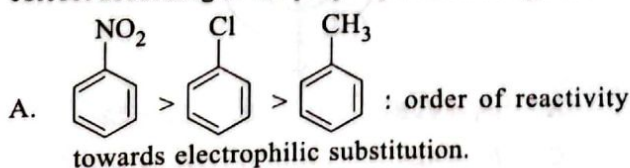
- Deflection of the pan is upwards for both the compounds.
  - Deflection of the pan is downwards for both the compounds.
  - Deflection of the pan is upwards for  $K_2[Ni(CN)_4]$  and downwards for  $K_3[Fe(CN)_6]$ .
  - Deflection of the pan is upwards for  $K_3[Fe(CN)_6]$  and downwards for  $K_2[Ni(CN)_4]$ .
14. Read the given statements carefully and select the correct option.

**Statement 1 :** The number of optically active products obtained after the complete ozonolysis of the given compound ( $X$ ) is one.

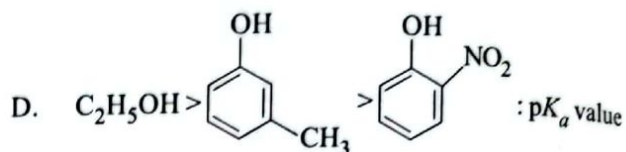


**Statement 2 :** In the given compound ( $X$ ), all the atoms lie in one plane.

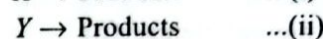
- Both statement 1 and statement 2 are correct.
  - Both statement 1 and statement 2 are incorrect.
  - Statement 1 is correct but statement 2 is incorrect.
  - Statement 1 is incorrect but statement 2 is correct.
15. In which of the following arrangements, the order is correct according to the property indicated against it?



- B.  $CH_4 > C_2H_4 > C_2H_2$  : percentage of  $s$ -character



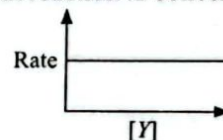
16. Read the following observations carefully about these two reactions :



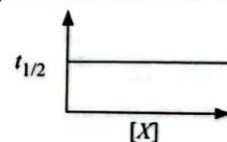
- If concentration of  $X$  is doubled, the rate of reaction (i) becomes double.
- If concentration of  $Y$  is halved, the rate of reaction (ii) remains unchanged.

Based on the above information, select the incorrect statement.

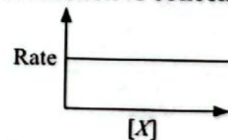
- The order of the reaction (i) is one and order of the reaction (ii) is zero.
- Plot of rate of reaction vs concentration of  $Y$  will be



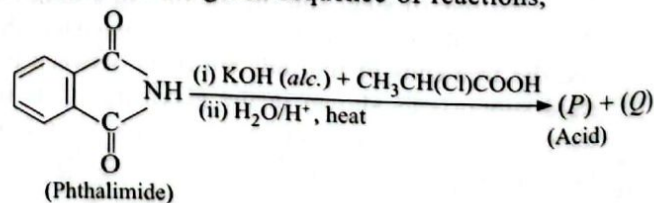
- C. Plot of  $t_{1/2}$  vs concentration of  $X$  will be



- D. Plot of rate of reaction vs concentration of  $X$  will be



17. Based on the given sequence of reactions,



select the correct statement.

- The IUPAC name of  $P$  is benzene-1, 3-dicarboxylic acid.
- $Q$  is an essential amino acid.
- $Q$  is optically active.
- On reaction of  $(P)$  with ammonia, the salt produced on strong heating gives benzoic acid and acetamide.



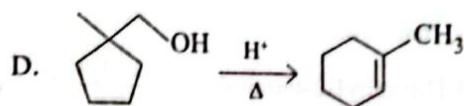
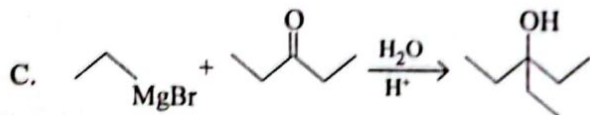
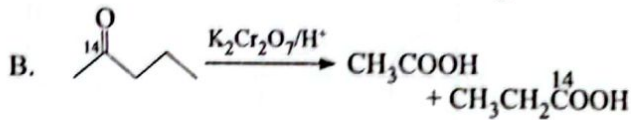
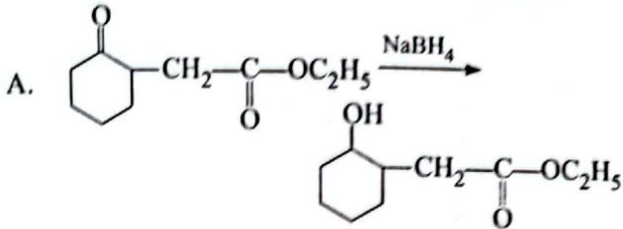
18.  $E_1$ ,  $E_2$  and  $E_3$  are the emfs of the following three galvanic cells (i), (ii) and (iii) respectively.

- (i)  $Zn_{(s)}|Zn^{2+}(0.1 M)||Cu^{2+}(1 M)|Cu_{(s)}$   
 (ii)  $Zn_{(s)}|Zn^{2+}(1 M)||Cu^{2+}(1 M)|Cu_{(s)}$   
 (iii)  $Zn_{(s)}|Zn^{2+}(1 M)||Cu^{2+}(0.1 M)|Cu_{(s)}$

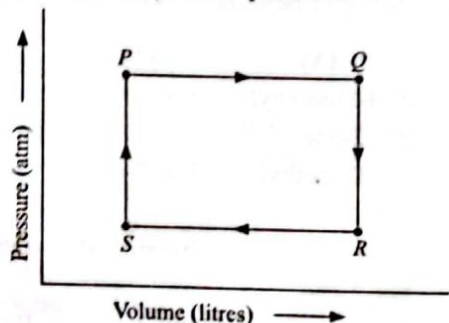
Which one of the following is the correct order?

- A.  $E_2 > E_1 > E_3$       B.  $E_1 > E_2 > E_3$   
 C.  $E_3 > E_1 > E_2$       D.  $E_3 > E_2 > E_1$

19. Which of the following reactions is incorrect?



20. The given figure represents  $P$ - $V$  diagram of different stages of a thermodynamic process.



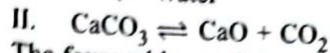
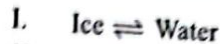
Select the correct option among the following.

- A. For the process  $P \rightarrow Q$ ,  $W = -ve$  and for the process  $R \rightarrow S$ ,  $W = 0$   
 B. For the process  $Q \rightarrow R$ ,  $W = 0$  and for the process  $S \rightarrow P$ ,  $W = -ve$   
 C. For the process  $P \rightarrow Q$ ,  $W = +ve$  and for the process  $S \rightarrow P$ ,  $W = -ve$   
 D. For the process  $R \rightarrow S$ ,  $W = +ve$  and for the process  $Q \rightarrow R$ ,  $W = 0$

21. Hypothetically, in a hydrogen atom, an orbit has a diameter of  $9.6 \text{ \AA}$ . The maximum number of electrons that can be accommodated in that orbit is

- A. 18      B. 32  
 C. 8      D. 2

22. Consider the following two equilibrium reactions :



The favourable conditions for the reactions to move in forward direction are

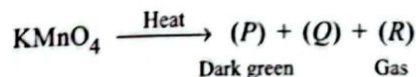
- A. High temperature for reaction I and high pressure for reaction II.  
 B. High pressure for reaction I and low temperature for reaction II.  
 C. High pressure for reaction I and low pressure for reaction II.  
 D. Low temperature for reaction I and high temperature for reaction II.

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

- I. The melting points and solubility in water of amino acids are generally higher than that of the corresponding haloacids.  
 II. Lactose on hydrolysis gives glucose and sucrose.  
 III. Hydrolysis of sucrose brings about a change in the sign of rotation, from laevo (-) to dextro (+) and the product is named as invert sugar.

- |    | I | II | III |
|----|---|----|-----|
| A. | T | F  | F   |
| B. | T | T  | F   |
| C. | F | F  | T   |
| D. | F | T  | T   |

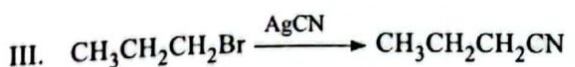
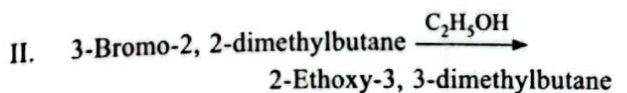
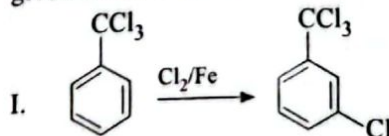
24. When potassium permanganate is heated, it decomposes to (P), (Q) and (R) as shown :



Select the correct statement regarding P, Q and R.

- A. Bond order of (R) is one.  
 B. The anion of (P) is tetrahedral.  
 C. Oxidation state of central atom in (Q) is + 6.  
 D. Both B and C.

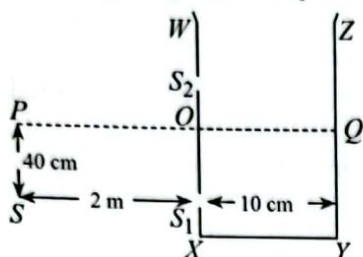
25. In which of the following reactions, the major product given is/are correct?



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

**Direction (Q. No. 26 and 27):** Refer to the given passage and answer the following questions.

A vessel  $WXYZ$  of 10 cm width has two small slits  $S_1$  and  $S_2$  sealed with identical glass plates of equal thickness.



The distance between the slits is 0.8 cm.  $POQ$  is line perpendicular to the plane  $WX$  and passing through  $O$ , the middle point of  $S_1$  and  $S_2$ . A monochromatic light source is kept at  $S$ , 40 cm below  $P$  and 2 m from the vessel, to illuminate the slits as shown in the given figure.

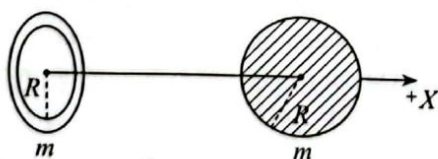
26. The position of the central bright fringe on the other wall  $ZY$  with respect to the line  $OQ$  is

- A. 2 cm                      B. 4 cm  
C. 5 cm                      D. 6 cm

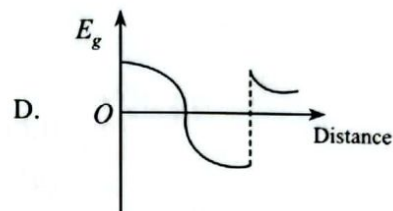
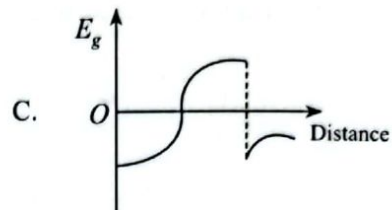
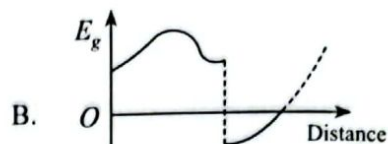
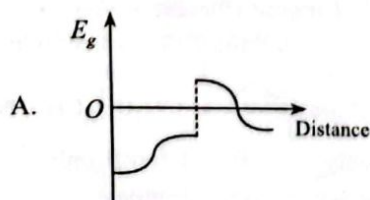
27. Now a liquid is poured into the vessel and filled upto  $OQ$ . The central bright fringe is found to be at  $Q$ . The refractive index of liquid is

- A. 1.07                      B. 1.002  
C. 1.3                        D. 1.2

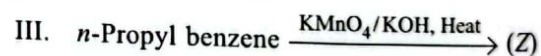
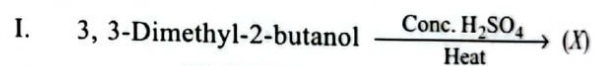
28. A ring of radius  $R$ , mass  $m$  and a solid sphere of mass  $m$  and same radius  $R$  are placed with their centres on positive  $X$ -axis.



The observer is moving from some finite distance on negative  $X$ -axis towards positive  $X$ -axis. The plane of the ring is perpendicular to  $X$ -axis. If the observer moves only up to the surface of the solid sphere, then the net gravitational field ( $E_g$ ) varies with the distance moved along  $X$ -axis as

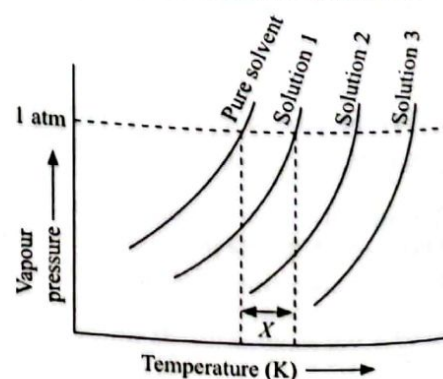


29. Identify the major products ( $X$ ), ( $Y$ ) and ( $Z$ ) in the following reactions :



	(X)	(Y)	(Z)
A.	2, 3-Dimethyl but-2-ene	Butan-1-al	2-Phenyl propanoic acid
B.	3,3-Dimethyl but-1-ene	But-2-enal	Benzoic acid
C.	2,3-Dimethyl but-2-ene	Butan-1-al	Benzoic acid
D.	2,3-Dimethyl but-2-ene	But-2-enal	Benzoic acid

30. The vapour pressure curves of the same solute (non-volatile and non-electrolyte) of different amount in the same amount of solvent are shown as :





Which of the following statements are correct?

- I. The boiling point of a solution is always higher than that of the boiling point of the pure solvent.  
 II. The concentration of the solutions are in the order  $3 > 2 > 1$ .

III. If the amount of the solute dissolved is doubled but that of solvent is quadrupled then value of  $X$  is doubled.

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

### SECTION-3

### MATHEMATICS

31. The order and degree of the differential equation

$$\frac{d^4 y}{dx^4} + \sin(y''') = 0 \text{ respectively are}$$

- A. 4 and 1  
 B. 1 and 2  
 C. 4 and 4  
 D. 4 and not defined

32. Six positive numbers are in G.P., such that their product is 1000. If the fourth term is 1, then the last term is

- A. 1000  
 B. 100  
 C.  $\frac{1}{100}$   
 D.  $\frac{1}{1000}$

33. In solving the LPP :

“minimize  $f = 6x + 10y$  subject to constraints  $x \geq 6$ ,  $y \geq 2$ ,  $2x + y \geq 10$ ,  $x \geq 0$ ,  $y \geq 0$ ” redundant constraints are

- A.  $x \geq 6$ ,  $y \geq 2$   
 B.  $2x + y \geq 10$ ,  $x \geq 6$ ,  $y \geq 0$   
 C.  $x \geq 6$   
 D. None of these

34.  $\frac{d}{dx} \left( x\sqrt{a^2 - x^2} + a^2 \sin^{-1} \left( \frac{x}{a} \right) \right)$  is equal to

- A.  $\sqrt{a^2 - x^2}$   
 B.  $2\sqrt{a^2 - x^2}$   
 C.  $\frac{1}{\sqrt{a^2 - x^2}}$   
 D. None of these

35. If  $f(x) = \begin{cases} x, & \text{if } x \text{ is rational} \\ 0, & \text{if } x \text{ is irrational} \end{cases}$   
 and  $g(x) = \begin{cases} 0, & \text{if } x \text{ is rational} \\ x, & \text{if } x \text{ is irrational} \end{cases}$   
 then  $f - g$  is

- A. Neither one-one nor onto  
 B. One-one and onto  
 C. One-one and into  
 D. Many-one and onto

36. Find the equation of the circle passing through the points  $(1, -2)$ ,  $(5, 4)$  and  $(10, 5)$ .

- A.  $x^2 + y^2 - 18x + 6y + 25 = 0$   
 B.  $x^2 - y^2 + 18x + 6y + 25 = 0$   
 C.  $x^2 - y^2 - 18x + 6y + 25 = 0$   
 D.  $x^2 + y^2 + 18x + 6y + 25 = 0$

37. For the function  $f(x) = 4x^3 - 18x^2 + 27x - 7$ , which of the following statement(s) is/are true?

- I.  $f(x)$  has no maxima  
 II.  $f(x)$  has no minima  
 A. Only I is true  
 B. Only II is true  
 C. Both I and II are true  
 D. Neither I nor II is true

38. If  $\int_2^e \left( \frac{1}{\log x} - \frac{1}{(\log x)^2} \right) dx = a + \frac{b}{\log 2}$ , then

- A.  $a = e$ ,  $b = -2$   
 B.  $a = e$ ,  $b = 2$   
 C.  $a = -e$ ,  $b = 2$   
 D. None of these

39. The number of ways of distributing 50 identical things among 8 persons in such a way that three of them get 8 things each, two of them get 7 things each, and remaining 3 get 4 things each, is equal to

- A.  $\frac{(50!)(8!)}{(8!)^3 (3!)^2 (7!)^2 (4!)^3 (2!)}$   
 B.  $\frac{(50!)(8!)}{(8!)^3 (7!)^3 (4!)^3}$   
 C.  $\frac{(50!)}{(8!)^3 (7!)^2 (4!)^3}$   
 D.  $\frac{(8!)}{(3!)^2 (2!)}$

40. If  $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$ ,  $\vec{b} = \hat{i} + \hat{j} - 2\hat{k}$  and  $\vec{c} = \hat{i} + 3\hat{j} - \hat{k}$ , then the value of  $\lambda$ , such that  $\vec{a}$  is perpendicular to  $\lambda\vec{b} + \vec{c}$  is
- A. -1  
B. -2  
C. 2  
D. 1

41. The following system of inequalities

$$\frac{x}{2x+1} \geq \frac{1}{4}, \frac{6x}{4x-1} < \frac{1}{2} \text{ have}$$

- A. Infinitely many solutions  
B. Unique solution  
C. No solution  
D. None of these

42. If  $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}$  and  $I$  is the unit matrix of

order 3, then  $A^2 + 2A^4 + 4A^6$  is equal to

- A.  $7A$   
B.  $8A^7$   
C.  $8A^8$   
D.  $7A^8$

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

**Statement 1 :** The domain of the function  $f(x) = \sin^{-1} \sqrt{x-1}$  is  $[-1, 1]$ .

**Statement 2 :** The domain of the function  $\cos^{-1}(2x-1)$  is  $[-1, 1]$ .

- A. Both Statement 1 and Statement 2 are true.  
B. Both Statement 1 and Statement 2 are false.  
C. Statement 1 is true but Statement 2 is false.  
D. Statement 1 is false but Statement 2 is true.

44. The mean deviation about the mean for the following data is

Class	Frequency
0 - 20	17
20 - 40	28
40 - 60	32
60 - 80	24
80 - 100	19
<b>Total</b>	<b>120</b>

- A. 20.67  
B. 26.70  
C. 24.32  
D. 36.67

45. Find the angle between the pair of lines given by

$$\vec{r} = 3\hat{i} + 2\hat{j} - 4\hat{k} + \lambda(\hat{i} + 2\hat{j} + 2\hat{k})$$

$$\text{and } \vec{r} = 5\hat{i} - 2\hat{j} + \mu(3\hat{i} + 2\hat{j} + 6\hat{k}).$$

A.  $\cos^{-1}\left(\frac{19}{21}\right)$

B.  $\cos^{-1}\left(\frac{23}{19}\right)$

C.  $\cos^{-1}\left(\frac{17}{13}\right)$

D.  $\cos^{-1}\left(\frac{13}{9}\right)$

46. In an entrance test, there are multiple choice questions. There are four possible answers to each question of which one is correct. The probability that a student knows the answer to a question is 90%. If he gets the correct answer to a question, then the probability that he was guessing is

A.  $\frac{37}{40}$

B.  $\frac{1}{37}$

C.  $\frac{36}{37}$

D. None of these

47. The smallest positive integer  $n$ , for which

$$(1+i)^{2n} = (1-i)^{2n} \text{ is}$$

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

48. Find the value of  $x$  for which the matrix

$$A = \begin{bmatrix} 3-x & 2 & 2 \\ 2 & 4-x & 1 \\ -2 & -4 & -1-x \end{bmatrix} \text{ is singular.}$$

- A. 0, 1  
B. 1, 3  
C. 0, 3  
D. 3, 2

49. If the area between  $x = y^2$  and  $x = 4$  is divided into two equal parts by the line  $x = a$ , then the value of  $a$  is

- A.  $(4)^{1/3}$   
B.  $(4)^{4/3}$   
C.  $(4)^{2/3}$   
D. None of these

50. Evaluate :  $(x^2 - \sqrt{1-x^2})^4 + (x^2 + \sqrt{1-x^2})^4$

- A.  $2x^8 + 12x^6 - 14x^4 + 4x^2 + 2$   
B.  $2x^8 - 12x^6 + 14x^4 - 4x^2 + 2$   
C.  $2x^8 - 12x^6 - 14x^4 + 4x^2 - 2$   
D.  $x^8 - 6x^6 + 7x^4 - 2x^2 + 1$



31. In a plant species, yellow flower colour is dominant over white, and round fruit shape is dominant over elongated. A cross was performed between two pure lines- one having yellow flower and round fruit, and another having white flower and elongated fruit. About 20 plants survived in  $F_1$  progeny. Plants of  $F_1$  were allowed to self-fertilise, and about 960 plants survived in  $F_2$ . If both the traits followed Mendelian inheritance, then the number of plants having yellow flower and round fruit in  $F_1$  and  $F_2$  would be respectively
- A. 20, 960                      B. 20, 540  
C. 20, 180                      D. 10, 540.

32. The glucose and lactose are both absent from the growth medium, still the *lac* structural genes are expressed efficiently. Which of the following could be the most probable reason for this?
- A. The cell has a mutation in the operator of the *lac* operon.  
B. The cell has mutation in the promoter of the *lac* structural gene.  
C. The cell has mutation in the *lac i* gene.  
D. Both A and C

33. In castor and maize plants,
- A. Both autogamy and xenogamy are prevented  
B. Autogamy is prevented but not geitonogamy  
C. The anthers and stigma are placed at different positions in same flower to encourage cross pollination  
D. Both autogamy and geitonogamy are prevented.

34. The birth and death rates of four countries (W-Z) are given below.

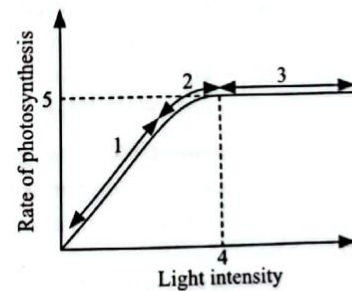
Country	Birth rate	Death rate
W	38	27
X	45	19
Y	56	53
Z	29	23

Which of the following has the highest and least population growth rate?

- |    | Highest | Least |
|----|---------|-------|
| A. | W       | Y     |
| B. | Z       | X     |
| C. | W       | Z     |
| D. | X       | Y     |

35. Read the given statements regarding stem cells and select the incorrect ones.
- (i) Stem cells can be induced to differentiate by environmental signals.  
(ii) Stem cells are easily isolated, maintained and propagated.  
(iii) All types of stem cells are able to develop into whole organism if planted into the womb.  
(iv) Stem cells can make more stem cells under appropriate conditions.
- A. (i) and (ii) only  
B. (ii) and (iii) only  
C. (i) and (iv) only  
D. (ii), (iii) and (iv) only

36. Refer to the given graph showing the effect of light intensity on the rate of photosynthesis.



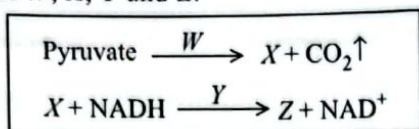
Match column I with column II and select the correct option from the given codes.

	Column I		Column II
P.	Limiting factor in region (1)	I.	Some factor other than light intensity is becoming limiting
Q.	(2) represents	II.	Light is no longer a limiting factor
R.	(3) represents	III.	Light intensity
S.	(4) represents	IV.	Maximum rate of photosynthesis
T.	(5) represents	V.	Saturation point for light intensity

- A. P - III ; Q - I ; R - II ; S - IV ; T - V  
B. P - III ; Q - I ; R - II ; S - V ; T - IV  
C. P - IV ; Q - II ; R - V ; S - III ; T - I  
D. P - V ; Q - IV ; R - III ; S - II ; T - I



37. Refer to the given equations regarding anaerobic respiration in plants and select the option that correctly identifies *W*, *X*, *Y* and *Z*.



	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
A.	Pyruvate dehydrogenase	Lactate	Alcohol decarboxylase	Ethanol
B.	Pyruvate decarboxylase	Ethanal	Alcohol dehydrogenase	Ethanol
C.	Pyruvate decarboxylase	Ethanol	Alcohol dehydrogenase	Ethanal
D.	Pyruvate dehydrogenase	Ethanal	Alcohol decarboxylase	Ethanol

38. Refer to the given passage where few words have been italicised and select the incorrect option regarding it.

*Net primary productivity* is the total organic matter synthesised by the producers during the process of *photosynthesis* per unit time and area. It includes the weight of *inorganic* matter added in the body of the producers plus the losses suffered by them due to *respiration*, etc. On the other hand, *gross primary productivity* is the weight of organic matter stored by the *producers* in a unit area/volume per unit time.

- A. *Net primary productivity* and *gross primary productivity* should be interchanged.  
 B. *Photosynthesis* and *respiration* should be interchanged.  
 C. *Inorganic* should be replaced with *organic*.  
 D. *Producers* should not be replaced as it is correctly mentioned.

39. Identify the given plants (I-IV) and select the correct statement regarding them.



- A. II cultivated in Japan, is one of the most important ingredients used in delicacies like sushi whereas I is used to obtain algin.  
 B. III is rich source of iodine whereas IV is rich source of sago seeds.  
 C. II and III are used to obtain alginic acid and carrageenan respectively.  
 D. I and II belong to Rhodophyta whereas III and IV belong to Phaeophyta.

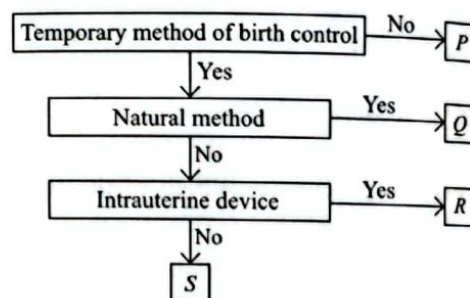
40. A permanent slide of a plant shows the following characteristics.

- (i) Epidermal cells having conspicuous cuticle  
 (ii) Stomata having kidney-shaped guard cells  
 (iii) Mesophyll differentiated into palisade and spongy tissues  
 (iv) Xylem lies towards the upper side of leaf while phloem is found towards lower side  
 (v) Parenchymatous bundle sheath extension

The given permanent slide is of

- A. *Helianthus* stem      B. *Helianthus* leaf  
 C. *Zea mays* stem      D. *Zea mays* leaf.

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



- A. In *P*, a small part of the vas deferens is removed or tied up to prevent sperm transport.  
 B. In *Q*, a soft rubber cup is used by females to cover the entrance of uterus to prevent sperm reaching an egg.  
 C. *R* releases hormone that makes uterus unsuitable for implantation and the cervix hostile to the sperms.  
 D. *S* could be oral pills that inhibit ovulation and make uterus unsuitable for implantation.

42. Given below are names of pre-historic men in the human evolution.

- (i) *Australopithecus*      (ii) *Homo erectus*,  
 (iii) *Ramapithecus*      (iv) *Neanderthal man*  
 (v) *Homo habilis*      (vi) *Homo sapiens*

Select the correct sequence of their origin.

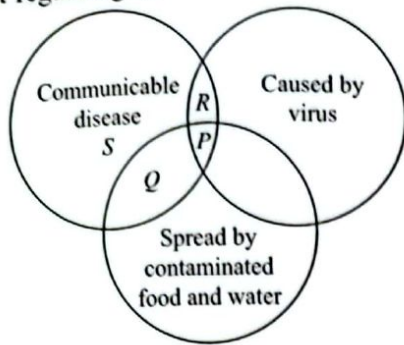
- A. (v) → (iv) → (iii) → (i) → (ii) → (vi)  
 B. (i) → (ii) → (iv) → (vi) → (iii) → (v)  
 C. (iii) → (i) → (v) → (ii) → (iv) → (vi)  
 D. (iii) → (i) → (v) → (ii) → (vi) → (iv)

43. Select the incorrectly matched pair.

Organic acid	Source
A. Butyric acid	– <i>Clostridium acetobutylicum</i>
B. Gluconic acid	– <i>Aspergillus niger</i>
C. Citric acid	– <i>Bacillus polymyxa</i>
D. Lactic acid	– <i>Streptococcus lactis</i>



44. Refer to the given Venn diagram and select the incorrect statement regarding it.



- A. P could be dengue fever caused by flavi-ribo virus.  
 B. Q could be typhoid caused by *Salmonella typhi*.  
 C. R could be influenza caused by Orthomyxovirus.  
 D. S could be ringworm caused by *Trichophyton*.

45. Which among the following does not belong to the same phylum as the other three?

- A. *Pheretima*  
 B. *Palaemon*  
 C. *Palinurus*  
 D. *Pediculus*

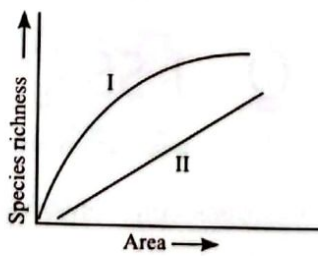
46. Given below are few statements related to a cell organelle.

- Double membrane bound
- Takes part in oxidative phosphorylation
- Provides important intermediates for synthesis of biochemicals like cytochromes, steroids, etc.

Identify the cell organelle and select the correct option.

- A. Leucoplast  
 B. Mitochondria  
 C. Endoplasmic reticulum  
 D. Chromoplast

47. Select the correct equations for curves I and II, in the given graph of species - area relationship.



- |   |  |
|---|--|
| <b>I</b>  | <b>II</b>  |
| A. $S = CA^z$   | $\text{Log } S = \text{Log } C + Z \text{ Log } A$ |
| B. $\text{Log } S = \text{Log } C + Z \text{ Log } A$ | $S = CA^z$   |
| C. $\text{Log } C = \text{Log } S + Z \text{ Log } A$ | $S = CA^z$   |
| D. $S = CA^z$   | $\text{Log } C = \text{Log } S + Z \text{ Log } A$ |

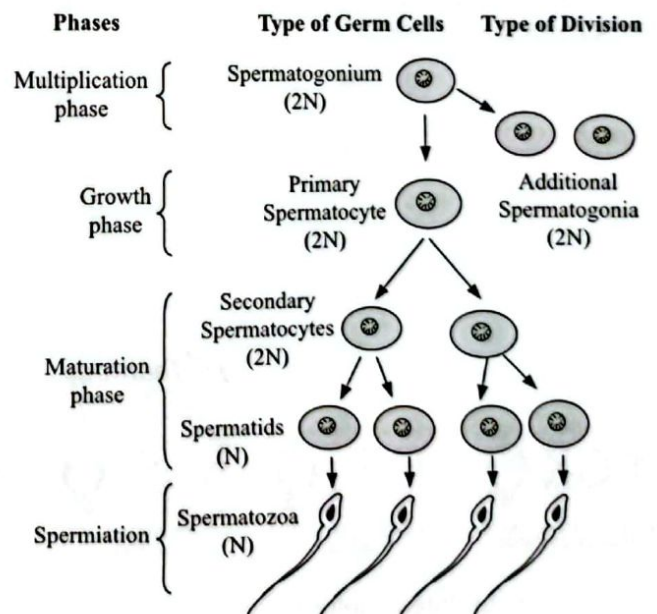
48. Which among the given factors control(s) respiratory centre of the brain?

- I. Low oxygen level in blood.  
 II. High carbon dioxide level in blood.  
 III. High hydrogen ion concentration in blood.  
 A. I and II only  
 B. III only  
 C. II and III only  
 D. I only

49. Select the correct option.

	Aquatic amphibians	Reptiles	Land snails
A.	Ammonotelic	Uricotelic	Uricotelic
B.	Ammonotelic	Ureotelic	Uricotelic
C.	Ureotelic	Ammonotelic	Ureotelic
D.	Uricotelic	Uricotelic	Ammonotelic

50. Archit was asked to draw diagrammatic representation of spermatogenesis. He drew the given diagram but with few mistakes. Identify the mistakes and select the correct statement.



- A. Growth phase and maturation phase must be interchanged.  
 B. Secondary spermatocytes must be mentioned as N as they are haploid.  
 C. Spermatids and spermatozoa must be interchanged.  
 D. Spermiation must not be changed as it is correctly mentioned.