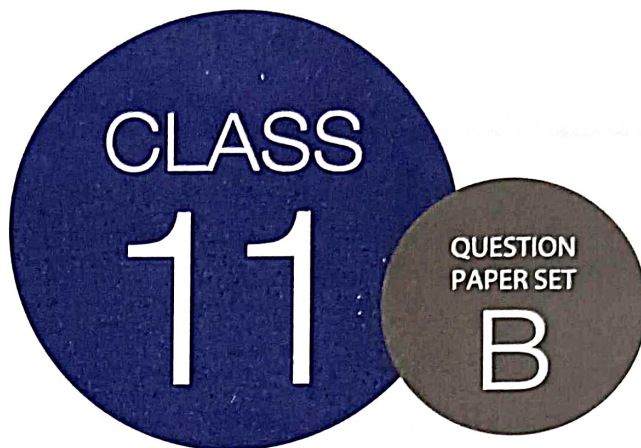


**SOF NATIONAL SCIENCE  
OLYMPIAD 2022-23**



**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, 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.
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 on this page before attempting the paper.

16.  A  B  C  D



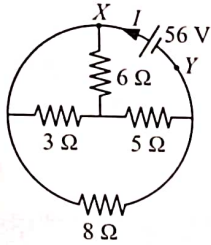
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SOF Olympiad Roll No.:..... Contact No.:.....

# SECTION-1

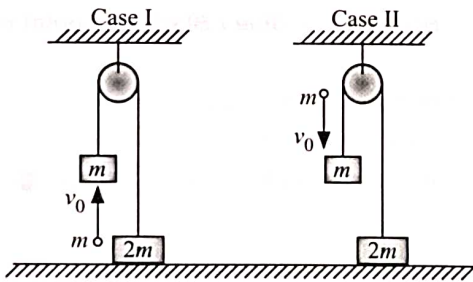
## PHYSICS

1. Different resistors and a cell of emf 56 V are connected between two points X and Y as shown in the circuit diagram. The value of current  $I$  is



- A.  $\frac{56}{15}$  A                      B.  $\frac{15}{56}$  A  
C.  $\frac{1}{4}$  A                         D. 15 A

2. Consider two small blocks of masses  $2m$  and  $m$ , which are connected by an in-extensible light string as shown in the given figure. The string is passing over a light frictionless pulley. The block of mass  $2m$  is resting on a surface and the block of mass  $m$  is hanging in air. A particle having mass  $m$  strikes the block of mass  $m$  from below in case I with a velocity  $v_0$  and in case II it strikes the block of mass  $m$  with a velocity  $v_0$  from the top and sticks to it.

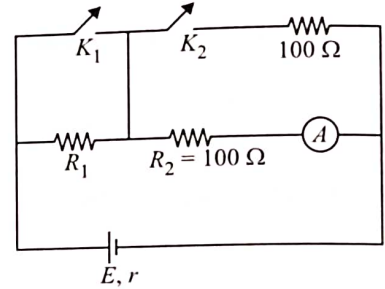


Which of the following statements is correct?

- A. The conservation of linear momentum can be applied in both the cases, just before and just after collision.  
B. The conservation of linear momentum can be applied in case I but cannot be applied in case II, just before and just after collision.  
C. The ratio of velocities of mass  $m$ , just after collision in first and second case is  $\frac{1}{2}$ .  
D. The ratio of velocities of mass  $m$ , just after collision in first and second case is 4.

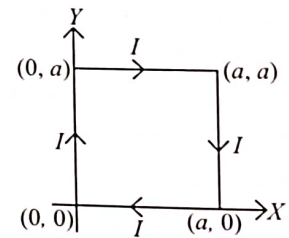
3. Consider the circuit shown, when key  $K_1$  is closed, then the ammeter reads 10 A whether  $K_2$  is open or closed. But when  $K_1$  is open the ammeter reads 5 A. When  $K_2$  is closed, the values of  $r$  and  $R_1$  are respectively

(Assuming that ammeter resistance is much less than  $R_2$ ).



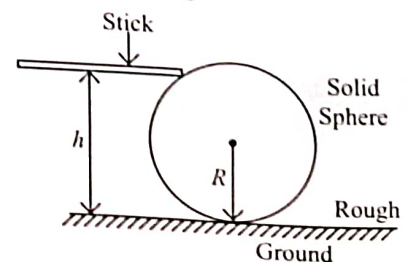
- A. 100  $\Omega$ , 50  $\Omega$                       B. 50  $\Omega$ , 100  $\Omega$   
C. 0  $\Omega$ , 100  $\Omega$                          D. 0  $\Omega$ , 50  $\Omega$

4. A square shaped current carrying loop as shown in the given figure is placed in a magnetic field which is given by  $\vec{B} = \frac{B_0 z}{a} \hat{j}$ , where  $B_0$  is a positive constant. Which of the following statements is correct?



- A. Force on side (0, 0) to (0, a) is  $\left(\frac{B_0 I a}{8}\right) \hat{i}$ .  
B. Force on side (0, a) to (a, a) is  $-4B_0 I a \hat{j}$ .  
C. Net magnetic force on the loop is zero.  
D. Force on side (a, 0) to (0, 0) is  $\frac{B_0 I a}{16} \hat{k}$ .

5. Consider a solid sphere having mass  $M$  and radius  $R$ . This sphere is placed on a rough horizontal surface, having coefficient of friction  $\mu$ . Now, this sphere is struck by a horizontal stick at height  $h$  ( $R < h < 2R$ ), as shown in the given figure.





The value of  $h$ , so that the sphere performs pure rolling motion immediately after it has been struck is

- A.  $\frac{R}{5}$                       B.  $\frac{2R}{3}$   
 C.  $\frac{7R}{5}$                       D.  $\frac{3R}{5}$

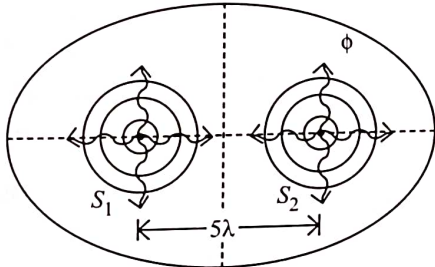
6. Read the given statements and select the correct option.

**Statement 1 :** A parallel beam of light travelling in air, when it is incident on a parallel slab, it can be displaced laterally by the parallel transparent slab through a distance more than the thickness of the slab.

**Statement 2 :** The lateral displacement of light travelling in the slab increases with the increase in its refractive index of slab.

- 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. Statement 1 is false but statement 2 is true.

7.  $S_1$  and  $S_2$  are two coherent sound sources situated along major axis of an elliptical boundary  $\phi$ , as shown in the given figure.



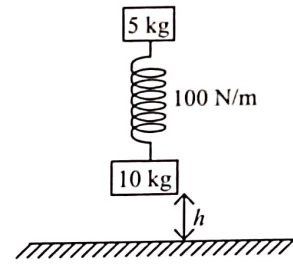
Separation between these sources is  $5\lambda$ , where  $\lambda$  is wavelength of sound, emitted by  $S_1$  and  $S_2$ . Consider the following statements.

- I. Number of maxima located along the boundary  $\phi$  is twenty.  
 II. Number of maxima located along the boundary  $\phi$  is four.  
 III. Number of minima located along the boundary  $\phi$  is sixteen.  
 IV. Number of minima located along the boundary  $\phi$  is twenty.

Which of the given statements are correct?

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

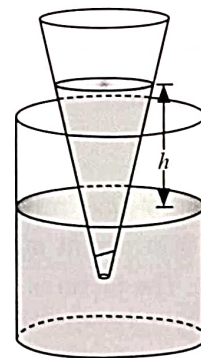
8. Two blocks are connected through a spring as shown in the given figure.



When the system is released, the spring was in its natural length. Find the possible value of  $h$  such that after perfectly inelastic collision with the ground, the larger block may be lifted off the ground.

- A. 1 m                      B. 1.5 m  
 C. 3 m                      D. 1.75 m

9. A capillary tube is made up of glass. Radius of its two ends are  $r_1$  and  $r_2$  and the tube is in the shape of a truncated cone. Now, the capillary tube is dipped in a liquid vertically, such that the liquid rises in it to a height  $h$  as shown in the given figure, where the radius of its cross section is  $r$ . If surface tension of the liquid is  $T$ , its density is  $\rho$ , and its contact angle with glass is  $\theta$ , and apex angle of the cone is  $\alpha$ , then consider the following statements ( $g$  is the acceleration due to gravity).

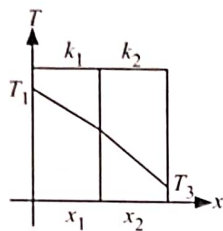


- I. The value of  $h$  is  $\frac{2T}{r\rho g} \sin\left(\theta + \frac{\alpha}{2}\right)$ .  
 II. If  $\theta \gg \alpha$ , then  $h$  is approximately  $\frac{T\alpha}{r\rho g}$ .  
 III. The value of  $h$  is  $\frac{2T}{r\rho g} \cos\left(\theta + \frac{\alpha}{2}\right)$ .

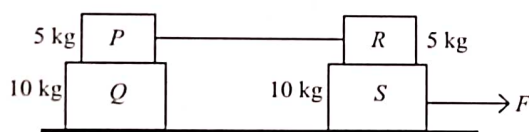
Which of the given statements is/are incorrect?

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

10. The variation of temperature ( $T$ ) and distance ( $x$ ) through each layer of a double layer furnace wall is shown in the given figure. Let the external temperatures  $T_1$  and  $T_3$  are maintained constant, and  $T_1 > T_3$ . If the thickness of both the layers  $x_1$  and  $x_2$  are same, which of the following is correct?

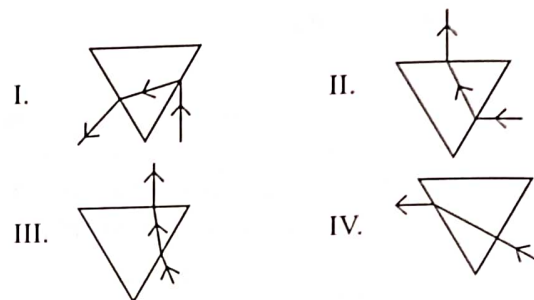
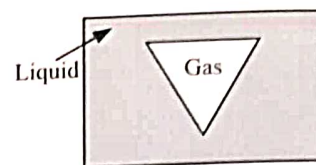


- A.  $k_1 > k_2$   
 B.  $k_1 < k_2$   
 C.  $k_1 = k_2$ , but rate of heat flowing through first layer is larger than through second layer  
 D.  $k_1 = k_2$ , but rate of heat flowing through first layer is lesser than through second layer
11. Four blocks arrangement, connected through a light string is as shown in the given figure. If the coefficient of static friction between the top and the bottom blocks is 0.2, then the maximum value of the horizontal force  $F$ , applied to one of the bottom blocks that makes all the four blocks move with the same acceleration, is



- A. 15 N                      B. 10 N  
 C. 25 N                      D. 30 N
12. Consider a hollow "gas prism" which is made with walls of thin transparent material and is sealed to be liquid tight. The prism is immersed in a liquid as shown in the given figure. A ray of light enters the prism from the liquid on the right. The following diagrams represent possible paths of the ray entering the prism, passing through it and emerging back in the liquid. Here, the walls of the prism have to be

treated as having negligible thickness and playing no significant role in the path of refraction.



Which of the given ray diagrams is/are correct?

- A. I only                      B. II and IV only  
 C. III only                      D. III and IV only
13. Given diagram shows  $O$  as object and  $I$  as image. The responsible optical system can be, a spherical mirror, plane mirror or a thin lens. In the cases of the lens and spherical mirror, the straight line shows the principal axis. Match column I and column II and select the correct option from the given codes:
- |    | Column I      | Column II                                   |
|----|---------------|---|
| P. | $\frac{O}{I}$ | (i) Concave mirror between $O$ and $I$      |
| Q. | $\frac{I}{O}$ | (ii) Diverging lens between $O$ and $I$     |
| R. | $\frac{O}{I}$ | (iii) Convex mirror between $O$ and $I$     |
| S. | $\frac{O}{I}$ | (iv) Converging lens between $O$ and $I$    |
|    |               | (v) Inclined plane mirror somewhere between |
- A. P-(i), (ii); Q-(ii), (iii); R-(iii), (iv); S-(iv), (v)  
 B. P-(iv), (v); Q-(iii), (iv); R-(ii), (iii); S-(i)  
 C. P-(v); Q-(i); R-(ii), (iii); S-(iv)  
 D. P-(iii), (v); Q-(iii), (v); R-(iv), (v); S-(iv), (v)

## CHEMISTRY

14. Select the incorrect order :
- A. Atomic radius :  $\text{Li} > \text{Be} > \text{C} > \text{N} > \text{O}$   
 B. Electronegativity :  $\text{F} > \text{O} > \text{N} > \text{B}$   
 C. Metallic Character :  $\text{Na} > \text{K} > \text{Rb} > \text{Cs}$   
 D. Basic Character of Oxides :  $\text{Sr} > \text{Ca} > \text{Mg} > \text{Be}$

15. The correct order of boiling points of 2,2-dimethylpropane, 2-methylbutane and  $n$ -pentane is
- A.  $n$ -pentane  $>$  2,2-dimethylpropane  $>$  2-methylbutane  
 B.  $n$ -pentane  $>$  2-methylbutane  $>$  2,2-dimethylpropane  
 C. 2,2-dimethylpropane  $>$  2-methylbutane  $>$   $n$ -pentane  
 D. 2-methylbutane  $>$   $n$ -pentane  $>$  2,2-dimethylpropane.



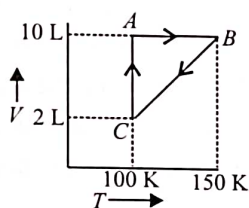
16. B has a smaller first ionization enthalpy than Be. Which among the following could not be the reason for this fact?

- It is difficult to remove 2s electron than 2p electron.
- 2p electron of B is more shielded from the nucleus by the inner core electrons than the 2s electrons of Be.
- 2s electron has more penetration power than 2p electron.
- Atomic radius of B is less than Be.

(Atomic number B = 5, Be = 4)

- I only
- II and III only
- IV only
- I and IV only

17. Consider the given diagram for 1 mole of a gas X and answer the following question.



The process  $A \rightarrow B$  represents

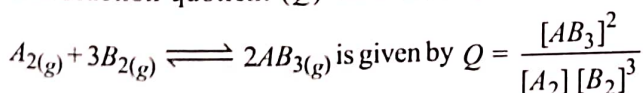
- Isobaric change
- Isothermal change
- Adiabatic change
- Isochoric change.

18. Arrange the following in decreasing order of stability.

- $(\text{CH}_3)_2 - \overset{+}{\text{C}} - \text{CH}_2 - \text{CH}_3$
- $(\text{CH}_3)_3 - \overset{+}{\text{C}}$
- $(\text{CH}_3)_2 - \overset{+}{\text{C}}\text{H}$
- $\text{CH}_3 - \overset{+}{\text{C}}\text{H}_2$
- $\overset{+}{\text{C}}\text{H}_3$

- $2 > 3 > 5 > 1 > 4$
- $2 > 1 > 3 > 4 > 5$
- $5 > 3 > 1 > 2 > 4$
- $4 > 2 > 1 > 3 > 5$

19. The reaction quotient ( $Q$ ) for reaction,



The reaction will proceed from left to right if

- $Q = K_c$
- $Q < K_c$
- $Q > K_c$
- Any of these.

20. pH of different solutions are given in the table below.

Solution	pH
W	11.4 - 12.2
X	1.2 - 2.4
Y	9.0 - 10.0
Z	5.6 - 6.2

Arrange these solutions in the increasing order of  $\text{H}^+$  ion concentration.

- $W < Z < X < Y$
- $X < Y < W < Z$
- $X < Z < Y < W$
- $W < Y < Z < X$

21. Three students Neha, Priya and Abhishek performed the experiment to study the reactivity of various metals in  $\text{ZnSO}_4$  solution. They tabulated their observations in the following table :

here  $\times$  - Reaction will not take place

$\checkmark$  - Reaction will take place

	Set 1	Set 2	Set 3	Set 4
<b>Metals</b>	Fe	Mg	Cu	Al
<b>Neha</b>	$\times$	$\checkmark$	$\times$	$\checkmark$
<b>Priya</b>	$\checkmark$	$\checkmark$	$\times$	$\times$
<b>Abhishek</b>	$\times$	$\checkmark$	$\checkmark$	$\times$

The incorrect observation(s) was/were made by

- Neha only
- Priya only
- Both Priya and Abhishek
- Both Neha and Priya.

22. The density of a 2 M sodium sulphite ( $\text{Na}_2\text{SO}_3$ ) solution is 2.63 g/mL. Calculate the percent by mass of sodium sulphite.

- 12.64%
- 9.58%
- 0.87%
- 8.21%

23. Read the given statements and select the correct option.

**Statement 1 :** As the molecular mass increases in any homologous series, no gradation in physical properties is observed.

**Statement 2 :** This is because the functional group changes as one moves across a given homologous series.

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

24. Select the incorrect match(es).
- Heating the mixture of hydrogen and copper (II) oxide- Redox reaction
  - Heating of ferrous sulphate - Double displacement reaction
  - Exposure of silver chloride to sunlight- Combination reaction
  - Burning of coal - Combination reaction
- A. I and II only  
B. III only

- C. II and III only  
D. I and IV only

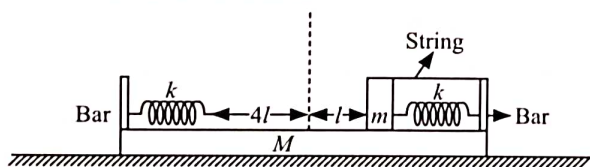
25.  $Mn^{3+}$  ions are unstable in solution and undergo disproportionation to give  $Mn^{2+}$ ,  $MnO_2$  and  $H^+$  ions. What will be the balanced ionic equation for this reaction?

- A.  $3Mn^{3+} + 4H_2O \rightarrow MnO_2 + Mn^{2+} + 8H^+$   
B.  $Mn^{3+} + 4H_2O \rightarrow MnO_2 + Mn^{2+} + 4H^+$   
C.  $Mn^{3+} + 2H_2O \rightarrow MnO_2 + Mn^{2+} + 4H^+$   
D.  $2Mn^{3+} + 2H_2O \rightarrow MnO_2 + Mn^{2+} + 4H^+$

## SECTION-2

### ACHIEVERS SECTION

26. Consider a plank of mass  $M$  which is placed on a smooth horizontal surface. Two identical light springs of spring constant  $k$  are rigidly connected to bars, at the ends of the plank as shown in the given figure. When the springs are in their unextended position the distance between their free ends is  $4l$ . A block of mass  $m$  is placed on the plank and pressed against one of the springs, so that it is compressed by  $l$ . To keep the block at rest it is connected to the right bar by means of a light string, initially the system is at rest. Now if the string is burnt, then time period of oscillations of the block is



- A.  $(2\pi + 4) \sqrt{\frac{2Mm}{k(M+m)}}$   
B.  $(\pi + 8) \sqrt{\frac{2Mm}{k(M+m)}}$   
C.  $(\pi + 4) \sqrt{\frac{Mm}{k(M+m)}}$   
D.  $2(\pi + 4) \sqrt{\frac{Mm}{k(M+m)}}$

27. Three moles of an ideal gas is initially in state  $A$ , having pressure  $1.01 \times 10^5 \text{ N/m}^2$  and temperature  $400 \text{ K}$ . Keeping pressure constant, the gas is taken to state  $B$ . Temperature at  $B$  is  $600 \text{ K}$ . The gas is then taken to state  $C$  in such a way that its temperature increases and volume decreases. Also from  $B$  to  $C$  the magnitude of  $\frac{dT}{dV}$  increases. The volume of gas at  $C$  is equal to

volume of gas at  $A$ . Now, the gas is taken to initial state  $A$  keeping volume constant. A total of  $1400 \text{ J}$  of heat is withdrawn from the sample in the cyclic process. The  $T$ - $V$  graph for the cyclic process and work done in path  $B$  to  $C$  are respectively.

(Take  $R = 8.3 \text{ J/k mol}$ .)

- A. and  $-6380 \text{ J}$
- B. and  $-630 \text{ J}$
- C. and  $-6380 \text{ J}$
- D. and  $-4980 \text{ J}$

**Direction (Q.No. 28 and 29) :** Read the given passage and answer the questions that follow :

Atomic orbitals are precisely distinguished by what are known as quantum numbers. Each orbital is distinguished by three quantum numbers. The fourth quantum number is called electron spin quantum number which helps in distinguishing the two orientations of the electron.



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

- I. 'n' is also known as subsidiary quantum number and it defines the three-dimensional shape of the orbital.
- II. A value of 'l' equal to 3 corresponds to f subshell.
- III. For any subshell (defined by 'l' value), 2l-1 values of  $m_l$  are possible.
- IV. The values of n, l and  $m_l$  for a 4p orbital are 4, 2 and -1, 0, +1 respectively.

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

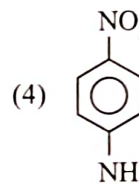
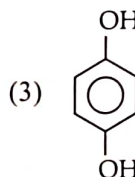
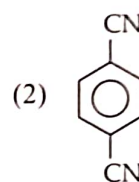
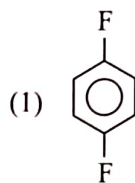
29. The correct quantum numbers n, l,  $m_l$ ,  $m_s$  for the unpaired electron of fluorine atom respectively are

- A. 3, 0, 0,  $+\frac{1}{2}$
- B. 3, 0, 0,  $-\frac{1}{2}$

C. 2, 1, -2,  $+\frac{1}{2}$

D. 2, 1, 1,  $+\frac{1}{2}$

30. Which of the following molecule(s) has/have significant value of dipole moment?



- A. (3) and (4) only
- B. (1) and (3) only
- C. (1) and (2) only
- D. (3) only

### SECTION-3

### MATHEMATICS

31. If A.M. between two positive numbers a and b is 15 and G.M. between a and b is 9, then the numbers are

- A. 3, 27
- B. 2, 27
- C. 3, 26
- D. -3, -27

32. The equation  $\frac{x^2}{14-a} + \frac{y^2}{9-a} = 1$  represents a/an

- A. Ellipse, if  $a > 9$
- B. Hyperbola, if  $9 < a < 14$
- C. Hyperbola, if  $a > 14$
- D. Ellipse, if  $9 < a < 14$

33. If  $\frac{1}{3}$  is a root of the equation  $x^2 + kx - \frac{5}{9} = 0$ , then find the value of k.

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

34. The value of k such that the quadratic polynomial  $x^2 - (k+6)x + 2(2k+1)$  has sum of the zeroes as half of their product, is

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

35. Solve for x :  $-(x-3) + 4 > -2x + 5$

- A.  $(-2, \infty)$
- B.  $(-\infty, 2]$
- C. (2, 4)
- D.  $(0, \infty)$

36. The number of spherical bullets that can be made out of a solid cube of lead whose edge measures 88 cm, each bullet being 4 cm in diameter, is

- |          |          |
|----------|----------|
| A. 25000 | B. 25440 |
| C. 20328 | D. 25140 |

37. The modulus of  $\frac{1+2i}{1-(1-i)^2}$  is

- |               |               |
|---------------|---------------|
| A. $\sqrt{2}$ | B. 2          |
| C. 1          | D. $\sqrt{3}$ |

38. Find the derivative of  $f(x) = 1 + x + x^2 + x^3 + \dots + x^{50}$  at  $x = 1$ .
- A. 1275  
B. 1200  
C. 1326  
D. 1542

39. There are 8 lamps in a hall. Each one of them can be switched on independently. The number of ways in which the hall can be illuminated is
- A. 8!  
B. 16  
C. 255  
D.  $2^8$

40. Find the median class for the following data.

Class interval	20-40	40-60	60-80	80-100
Frequency	10	12	20	22

- A. 20-40  
B. 40-60  
C. 60-80  
D. 80-100

41. 6 boys and 6 girls sit in a row at random. Find the probability that all the girls sit together.

- A.  $\frac{1}{40}$   
B.  $\frac{1}{68}$   
C.  $\frac{1}{132}$   
D. None of these

42. Find the length of an arc of a circle of radius 3 cm, if the angle subtended at the centre is  $30^\circ$ . (Use :  $\pi = 3.14$ )

- A. 1.50 cm  
B. 1.35 cm  
C. 1.57 cm  
D. 1.20 cm

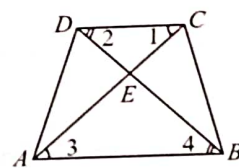
43. Find a relation between  $x$  and  $y$  such that the point  $(x, y)$  is equidistant from the points  $(9, 3)$  and  $(5, 7)$ .

- A.  $x - y = 2$   
B.  $x + y = 3$   
C.  $x - y = 4$   
D.  $x + y = -2$

44. If  $\cos \theta = -\frac{1}{2}$  and  $\pi < \theta < \frac{3\pi}{2}$ , then find the value of  $4 \tan^2 \theta - 3 \operatorname{cosec}^2 \theta$ .

- A. 0  
B.  $\frac{1}{4}$   
C. 8  
D. None of these

45. In the given figure,  $\angle 1 = \angle 3$ ,  $\angle 2 = \angle 4$ ,  $DE = 4$  units,  $CE = (x + 1)$  units,  $AE = (2x + 4)$  units and  $BE = (4x - 2)$  units. Find the value of  $x$ .



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

46. If  $A = \{1, 2, 4\}$ ,  $B = \{2, 4, 5\}$ ,  $C = \{2, 5\}$ , then  $(A - B) \times (B - C) =$

- A.  $\{(1, 2), (1, 5), (2, 5)\}$   
B.  $\{(1, 4)\}$   
C.  $\{(1, 5)\}$   
D. None of these

47. The total number of terms in the expansion of  $(x + a)^{51} - (x - a)^{51}$  after simplification is

- A. 102  
B. 25  
C. 26  
D. 23

48. Evaluate :  $\lim_{x \rightarrow 2} \left( \frac{x^2 - 3x + 2}{x^2 + x - 6} \right)$

- A.  $\frac{1}{5}$   
B.  $\frac{2}{5}$   
C.  $\frac{3}{5}$   
D. 1

49. If the numerator of a fraction is increased by 2 and the denominator is decreased by 4, then it becomes 2. If the numerator is decreased by 1 and the denominator is increased by 2, then it becomes  $\frac{1}{3}$ . Find the fraction.

- A.  $\frac{3}{4}$   
B.  $\frac{4}{7}$   
C.  $\frac{5}{3}$   
D.  $\frac{3}{8}$

50. Find the angle between the  $x$ -axis and the line joining the points  $(3, -1)$  and  $(4, -2)$ .

- A.  $130^\circ$   
B.  $135^\circ$   
C.  $150^\circ$   
D. None of these



31. In a dihybrid cross where two parents differ in two pairs of contrasting traits like seed colour yellow (YY) and seed colour green (yy) with seed shape round (RR) and seed shape wrinkled (rr), the number of green coloured seeds (yy) among sixteen products of F<sub>2</sub> generation will be

- A. 2                                      B. 4  
C. 6                                      D. 8.

32. The correct sequence of reproductive stages seen in flowering plants is

- A. Gametes, Zygote, Embryo, Seedling  
B. Zygote, Gametes, Embryo, Seedling  
C. Seedling, Embryo, Zygote, Gametes  
D. Gametes, Embryo, Zygote, Seedling.

33. Which of the following statement(s) is/are true about heart?

- (i) Left atrium receives oxygenated blood from different parts of body while right atrium receives deoxygenated blood from lungs.  
(ii) Left ventricle pumps oxygenated blood to different body parts except lungs while right ventricle pumps deoxygenated blood to lungs.  
(iii) Left atrium transfers oxygenated blood to right ventricle which sends it to different body parts.  
(iv) Right atrium receives deoxygenated blood from different body parts except lungs while left ventricle pumps oxygenated blood to different body parts except lungs.

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

34. Which of the following is most appropriate for aerobic respiration?

- A.  $\text{Glucose} \xrightarrow{\text{Mitochondria}} \text{Pyruvate} \xrightarrow{\text{Cytoplasm}} \text{CO}_2 + \text{H}_2\text{O} + \text{Energy}$   
B.  $\text{Glucose} \xrightarrow{\text{Cytoplasm}} \text{Pyruvate} \xrightarrow{\text{Mitochondria}} \text{CO}_2 + \text{H}_2\text{O} + \text{Energy}$   
C.  $\text{Glucose} \xrightarrow{\text{Cytoplasm}} \text{Pyruvate} + \text{Energy} \xrightarrow{\text{Mitochondria}} \text{CO}_2 + \text{H}_2\text{O}$   
D.  $\text{Glucose} \xrightarrow{\text{Cytoplasm}} \text{Pyruvate} + \text{Energy} \xrightarrow{\text{Mitochondria}} \text{CO}_2 + \text{H}_2\text{O} + \text{Energy}$

35. Read the given statements and select the correct option.

**Statement 1 :** *Sphagnum* is slowly carbonised, compressed and fossilised over thousands of years to produce a dark spongy mass called peat.

**Statement 2 :** Peat helps to keep soil porous and it also improves water holding capacity of the soil.

- 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.

36. Select the characters which are not applicable to the anatomy of dicot roots.

- (a) Presence of conjunctive tissue  
(b) Presence of protein compounds in the Casparian strips  
(c) Presence of polyarch xylem bundles  
(d) Presence of pericycle  
A. (a) and (b) only                      B. (b) and (d) only  
C. (c) and (d) only                      D. (b) and (c) only

37. Arrange the following events of meiosis in correct sequence.

- (i) Crossing over  
(ii) Synapsis  
(iii) Terminalisation of chiasmata  
(iv) Disappearance of nucleolus  
A. (i), (ii), (iii), (iv)                      B. (ii), (iii), (iv), (i)  
C. (ii), (i), (iv), (iii)                      D. (ii), (i), (iii), (iv)

38. Consider the following statements regarding photosynthesis and select the correct ones.

- (a) The first carbon dioxide acceptor in C<sub>4</sub> cycle is PGA.  
(b) In C<sub>3</sub> plants, the first stable product of photosynthesis during dark reaction is RuBP.  
(c) Cyclic photophosphorylation results in the formation of ATP.  
(d) Oxygen which is liberated during photosynthesis comes from water.

- A. (a) and (b) only                      B. (a) and (c) only  
C. (c) and (d) only                      D. (b) and (c) only

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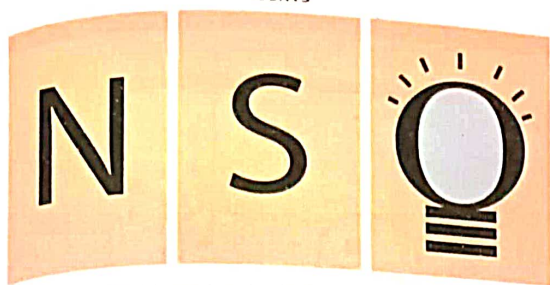
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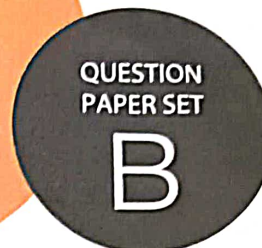
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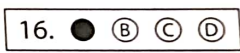


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Total Questions: 50 | Time: 1 hr.

### 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, 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.
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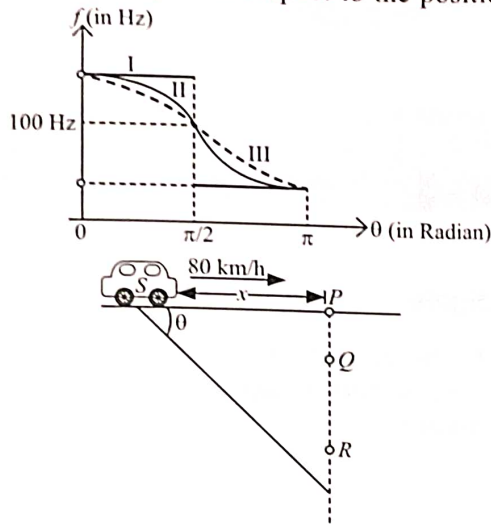


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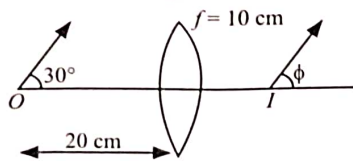
**SECTION-1**  
**PHYSICS**

1. A car is moving with a speed of 80 km/h on a straight road. It whistles horn with a frequency of 100 Hz. There are three persons  $P$ ,  $Q$  and  $R$ .  $P$  on track,  $Q$  at a perpendicular distance of  $y$  from the track and  $R$  at a perpendicular distance of  $2y$  from the track as shown in the given figure. The variation of the observed frequency with respect to the position  $x$  is



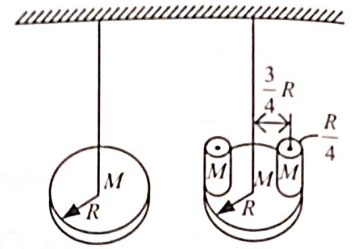
- A.  $P - I, Q - II, R - III$   
 B.  $P - II, Q - I, R - III$   
 C.  $P - III, Q - II, R - I$   
 D.  $P - I, Q - III, R - II$

2. Let an object  $O$  starts moving in front of a convex lens of focal length  $+10$  cm, at an angle of  $30^\circ$  with the principal axis as shown in the given figure. If  $\phi$  denotes the angle with the principal axis at which the image  $I$  starts moving, then



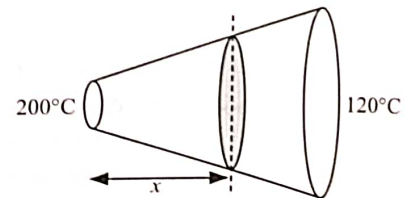
- A.  $\phi = \frac{3\pi}{4}$       B.  $\phi = \frac{\pi}{2}$   
 C.  $\phi = \frac{\pi}{6}$       D.  $\phi = -\frac{\pi}{6}$

3. Find the ratio of square of time periods, of two torsional pendulums as shown in the given figure. The two differs only by the addition of cylindrical masses. The radius of each additional mass is  $\frac{1}{4}$  the radius of the disc. Each cylinder and disc have equal mass.



- A.  $\frac{4}{9}$       B.  $\frac{8}{27}$   
 C.  $\frac{3}{8}$       D.  $\frac{9}{8}$

4. Consider a metallic conductor of non-uniform cross-section as shown in the given figure.

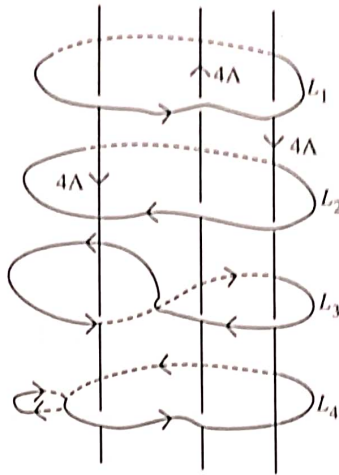


Material of the conductor is isotropic and its curved surface is thermally isolated from surroundings. Its ends are maintained at temperatures  $200^\circ\text{C}$  and  $120^\circ\text{C}$ . If in steady state, heat flow rate is equal to  $H$ , then which of the following graphs correctly depicts the variation of  $H$  with distance  $x$  from the left end?

- A.
- B.
- C.
- D.



5. Three current carrying wires carrying same current in different directions are as shown in the given figure.



Now, consider following statements.

- I. Along  $L_1$   $\vec{B} \cdot d\vec{l}$  is  $4\mu_0$ .
- II. Along  $L_2$   $\vec{B} \cdot d\vec{l}$  is  $4\mu_0$ .
- III. Along  $L_3$   $\vec{B} \cdot d\vec{l}$  is  $-4\mu_0$ .
- IV. Along  $L_4$   $|\vec{B} \cdot d\vec{l}|$  is  $4\mu_0$ .

Which of the given statements is/are correct?

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

6. A hypothetical atom is having different energy levels as shown in the given figure.

$n = \infty$	0 eV
$n = 5$	-0.80 eV
$n = 4$	-1.45 eV
$n = 3$	-3.08 eV
$n = 2$	-5.30 eV
$n = 1$	-15.6 eV

Now, consider the following statements

- I. Ionization potential of the atom is 15.6 eV.
- II. The shortest wavelength limit of the series terminating at  $n = 2$  is 2339 Å.

- A. Both I and II are correct
- B. Both I and II are incorrect
- C. Only I is correct
- D. Only II is correct

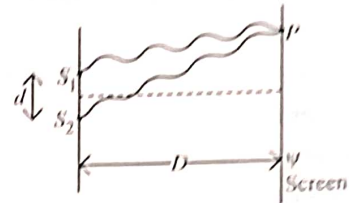
7. Read the given statements and select the correct option.

**Statement 1 :** A charged particle can never move along a magnetic field line in absence of any other force.

**Statement 2 :** Force on a charged particle of charge  $q$  moving with velocity  $\vec{v}$  due to magnetic field  $\vec{B}$  is given by  $\vec{F} = q(\vec{v} \times \vec{B})$ .

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

8. An experimental setup of Young's double slit experiment is shown below.



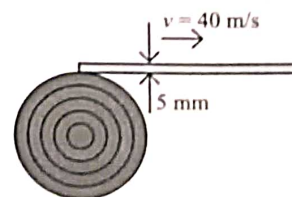
Now, a thin transparent sheet of refractive index  $\mu$  is introduced in front of the source  $S_1$ . Match the column I with column II and select the correct option from the given codes

	Column I	Column II
P.	Intensity of maxima will	(i) Increase
Q.	Intensity of minima will	(ii) Decrease
R.	Fringe width will	(iii) Remains same
S.	Fringe pattern will	(iv) Shift upward
		(v) Shift downward

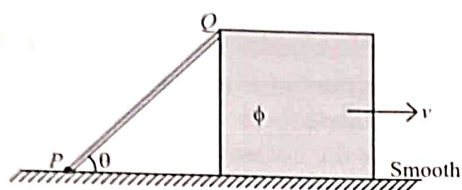
	P	Q	R	S
A.	(i)	(ii)	(iii)	(iv)
B.	(ii)	(i)	(iii)	(iv)
C.	(iii)	(i)	(ii)	(iv)
D.	(ii)	(i)	(iii)	(v)

9. In a continuous printing process, paper is drawn into the press at a constant speed of 40 m/s. If 20 cm be the radius of paper on the roll at any given time and 5 mm be the thickness of the paper, then angular acceleration of the roll is



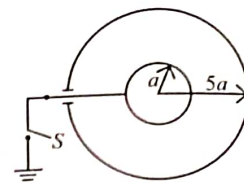
- A. 250 rev/s<sup>2</sup>
- B. 25 rev/s<sup>2</sup>
- C. 50 rev/s<sup>2</sup>
- D. 500 rev/s<sup>2</sup>

10. A rod  $PQ$  and a block  $\phi$  are connected as shown in the given figure. End  $P$  of the rod is fixed through a frictionless axle on the ground.

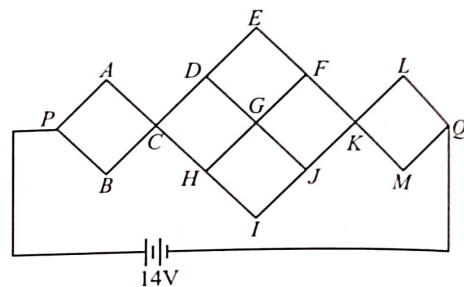


Now, select the correct option.

- A. When  $\theta = 60^\circ$  and  $v = 1$  m/s, speed of end  $Q$  is 2 m/s.  
 B. When  $\theta = 45^\circ$  and  $v = 2$  m/s, speed of end  $Q$  is  $\sqrt{2}$  m/s.  
 C. When  $\theta = 30^\circ$  and  $v = \sqrt{3}$  m/s, speed of end  $Q$  is 2 m/s.  
 D. When  $\theta = 60^\circ$  and  $v = \sqrt{3}$  m/s, speed of end  $Q$  is 2 m/s.
11. Two conducting thin concentric shells of radii  $a$  and  $5a$  are shown in the given figure. The outer shell carries a charge of  $100 \mu\text{C}$  and the inner shell is neutral. The amount of charge which flows, from inner shell to the earth after the switch  $S$  is closed, is equal to



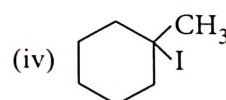
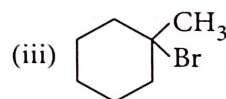
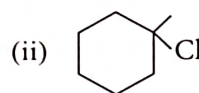
- A.  $20 \mu\text{C}$   
 B.  $-40 \mu\text{C}$   
 C.  $500 \mu\text{C}$   
 D.  $-500 \mu\text{C}$
12. A resistor grid is connected with a battery as shown in the given figure. Resistance of each straight section is  $1 \Omega$ . Current through the circuit is.



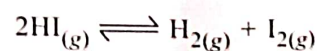
- A. 1 A  
 B. 2 A  
 C. 3 A  
 D. 4 A

## CHEMISTRY

13. The  $IE$  of early actinoids are lower than those of early lanthanoids, because
- A.  $5f$ -orbitals penetrate less into the inner core of electrons  
 B.  $5f$ -electrons are more effectively shielded from the nuclear charge than  $4f$ -electrons of the corresponding lanthanoids.  
 C. Both A and B  
 D. Neither A nor B.
14.  $\text{Al}_2\text{O}_3$  is reduced by electrolysis at low potentials and high currents. If  $4.0 \times 10^4$  ampere of current is passed through molten  $\text{Al}_2\text{O}_3$  for 6 hours, what mass of aluminium is produced? (Assume 100% current efficiency and At. mass of  $\text{Al} = 27 \text{ g mol}^{-1}$ )
- A.  $1.3 \times 10^4 \text{ g}$   
 B.  $2.4 \times 10^4 \text{ g}$   
 C.  $8.1 \times 10^4 \text{ g}$   
 D.  $9.0 \times 10^4 \text{ g}$

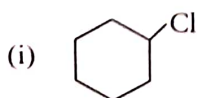


- A. (i) < (ii) < (iii) < (iv)  
 B. (iv) < (iii) < (ii) < (i)  
 C. (iii) < (i) < (ii) < (iv)  
 D. (ii) < (iv) < (iii) < (i)
16. A sample of  $\text{HI}_{(g)}$  is placed in a flask at a pressure of 0.4 atm. At equilibrium, partial pressure of  $\text{HI}_{(g)}$  is 0.08 atm. What is  $K_p$  for the given equilibrium?



- A. 0.04  
 B. 0.4  
 C. 40  
 D. 4

15. Predict the order of reactivity of the following compounds in  $\text{S}_{\text{N}}1$  reactions.



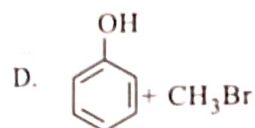
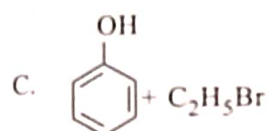
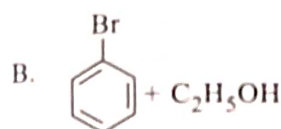
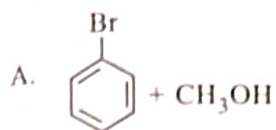


17. Match column I with column II and select the correct option from the given codes.

Column I		Column II	
(P)	$[\text{Co}(\text{CN})_6]^{3-}$	(i)	5.92 BM
(Q)	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$	(ii)	0 BM
(R)	$[\text{Mn}(\text{CN})_6]^{4-}$	(iii)	4.90 BM
(S)	$[\text{Co}(\text{H}_2\text{O})_6]^{3+}$	(iv)	1.73 BM

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

18. The reaction of anisole with HBr produces



19. In the following reaction,



the total number of carbon atoms present in the product P, is

- A. 21                      B. 9  
 C. 24                      D. 18

20. Which of the following bonds will be most polar?

- A. N - Br  
 B. O - F  
 C. N - F  
 D. O - O

21. The correct order of extent of hydration of the given salts is

- A.  $\text{LiCl} < \text{NaCl} < \text{KCl}$   
 B.  $\text{KCl} < \text{NaCl} < \text{LiCl}$   
 C.  $\text{NaCl} < \text{KCl} < \text{LiCl}$   
 D.  $\text{LiCl} < \text{KCl} < \text{NaCl}$

22. A 4.50 molal solution of  $\text{KOH}_{(aq)}$  has a density  $1.88 \text{ g cm}^{-3}$ . The molarity of the solution is [Atomic masses : K : 39.0 u; O : 16.0 u; H : 1.0 u]  
 A. 8.68 M  
 B. 6.75 M  
 C. 9.23 M  
 D. 7.72 M

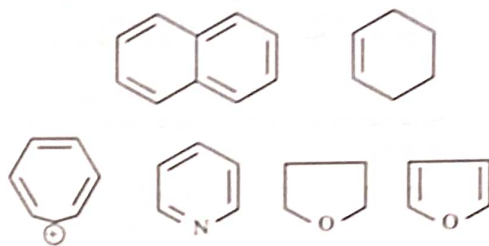
23. In the following reaction,



P and Q are respectively

- A. Benzoic acid and *p*-nitrobenzoic acid  
 B. Toluene and benzoic acid  
 C. Benzaldehyde and *m*-nitrobenzaldehyde  
 D. Benzyl alcohol and *o*-nitrobenzenol

24. Study the following structures carefully.



The total number of aromatic compounds is

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

25. Read the given statements carefully and select the incorrect ones.

- I. Complete hydrolysis of DNA (or RNA) produces a pentose sugar, sulphuric acid and sulphur containing heterocyclic compounds.  
 II. RNA contains four bases, *i.e.*, adenine, guanine, cytosine and thymine.  
 III. Keratin and myosin are examples of fibrous proteins.  
 IV. Thiamine and riboflavin are fat soluble vitamins while vitamins E and K are water soluble.  
 A. I, III and IV only  
 B. III and IV only  
 C. I and II only  
 D. I, II and IV only





**SECTION-3**  
**MATHEMATICS**

31. Let  $A = \{1, 2, 3, 4\}$  and  $R$  be a relation in  $A$  given by  $R = \{(1, 1), (2, 2), (3, 3), (4, 4), (1, 2), (2, 1), (3, 3)\}$ . Then,  $R$  is
- Transitive only
  - Symmetric only
  - An equivalence relation
  - None of these
32. If  $A$  and  $B$  are the points  $(-3, 4, -8)$  and  $(5, -6, 4)$  respectively, then find the ratio in which  $yz$ -plane divides  $\overline{AB}$ .
- 5 : 2
  - 7 : 5
  - 3 : 5
  - 5 : 3
33. The numbers  $a, b, c$  are in A.P. and  $a + b + c = 60$ . The numbers  $(a - 2), b, (c + 3)$  are in G.P. Then which of the following is not the possible values of  $a^2 + b^2 + c^2$ ?
- 1208
  - 1218
  - 1298
  - None of these
34. If  $A^{-1} = \begin{bmatrix} 5 & -2 \\ -7 & 4 \end{bmatrix}$  and  $B^{-1} = \frac{1}{2} \begin{bmatrix} 9 & -7 \\ -8 & 6 \end{bmatrix}$ , then find  $(AB)^{-1}$ .
- $\begin{bmatrix} 47 & -23 \\ -41 & 20 \end{bmatrix}$
  - $\begin{bmatrix} 40 & 20 \\ 45 & 21 \end{bmatrix}$
  - $\begin{bmatrix} 47 & 23 \\ -21 & 45 \end{bmatrix}$
  - None of these
35. Simplify :  $\int \Delta e^{x^2} dx$
- $-\frac{e^{x^2}}{2} + C$
  - $\frac{e^{x^2}}{2} + C$
  - $\frac{e^x}{2} + C$
  - $-\frac{e^x}{2} + C$
36. Find the angle (in radian) through which a pendulum swings and its length is 75 cm and tip describes an arc of length 21 cm.
- 7/25
  - 6/25
  - 8/25
  - 3/25
37. Find the area enclosed between the curve  $x^2 + y^2 = 16$  and the coordinate axes in the first quadrant.
- $(4\pi)$  sq. units
  - $(3\pi)$  sq. units
  - $(2\pi)$  sq. units
  - $(\pi)$  sq. units
38. The complex number,  $z = \frac{(-\sqrt{3} + 3i)(1-i)}{(3 + \sqrt{3}i)(i)(\sqrt{3} + \sqrt{3}i)}$
- lies on real axis
  - lies on imaginary axis
  - lies in first quadrant
  - lies in second quadrant
39. Read the given statements carefully and select the correct option.
- Statement-I :** Let  $A$  and  $B$  are two symmetric matrices of order 3, then  $A(BA)$  and  $(AB)A$  are symmetric matrices.
- Statement-II :**  $AB$  is symmetric matrix, if matrix multiplication of  $A$  and  $B$  is commutative.
- Both Statement-I and Statement-II are true.
  - Both Statement-I and Statement-II are false.
  - Statement-I is true but Statement-II is false.
  - Statement-I is false but Statement-II is true.
40. If the median of the data 6, 7,  $x - 2$ ,  $x$ , 18, 21 written in ascending order is 16, then the variance of that data is
- $30\frac{1}{5}$
  - $31\frac{1}{3}$
  - $32\frac{1}{2}$
  - $33\frac{1}{3}$
41. The function  $f(x) = x + \cos x$  is
- always increasing
  - always decreasing
  - increasing for certain range of  $x$
  - None of these
42. A flashlight has 8 batteries out of which 3 are dead. If two batteries are selected without replacement and tested, then the probability that both are dead is
- $\frac{33}{56}$
  - $\frac{9}{64}$
  - $\frac{1}{14}$
  - $\frac{3}{28}$

43. Find the value of  $\tan^{-1} \left[ 2 \sin \left( 2 \cos^{-1} \frac{\sqrt{3}}{2} \right) \right]$ .

- A.  $\frac{\pi}{2}$                                       B.  $\frac{\pi}{6}$   
C.  $\frac{\pi}{3}$                                       D.  $\frac{\pi}{4}$

44. Let  $f(x) = \begin{cases} \frac{x^3 + x^2 - 16x + 20}{(x-2)^2}, & x \neq 2 \\ k, & x = 2 \end{cases}$

If  $f(x)$  is continuous for all  $x$ , then  $k =$

- A. 3  
B. 5  
C. 7  
D. 9

45. Find the value of  $\begin{vmatrix} a-b & b-c & c-a \\ b-c & c-a & a-b \\ c-a & a-b & b-c \end{vmatrix}$ .

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

46. If  $A$  and  $B$  are two sets such that  $n(A) = 3$ ,  $n(B) = 4$  and  $n(A \cap B) = 2$ , then find  $n\{(A \times B) \cap (B \times A)\}$ .

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

47. If  $\frac{dy}{dx} = y \sin 2x$  and  $y(0) = 1$ , then the particular solution of the given differential equation is,

- A.  $y = e^{\sin^2 x}$   
B.  $y = \sin^2 x$   
C.  $y = \cos^2 x$   
D.  $y = e^{\cos^2 x}$

48. Solve the following linear inequation.

$$\frac{2x-3}{4} + 1 < x + \frac{4}{3}; x \in R$$

- A.  $(-\infty, \frac{-5}{6})$                                   B.  $(\frac{-5}{6}, \infty)$   
C.  $(\frac{5}{3}, \infty)$                                   D.  $(-\frac{13}{6}, \infty)$

49. Let  $y = t^{10} + 1$  and  $x = t^8 + 1$ , then  $\frac{d^2y}{dx^2}$  is equal to

- A.  $\frac{5}{2}t$   
B.  $20t^8$   
C.  $\frac{5}{16t^6}$   
D. None of these

50. Consider the linear programming problem:  
Max.  $Z = 4x + y$

Subject to  $x + y \leq 50$ ;  $x + y \geq 100$ ;  $x, y \geq 0$

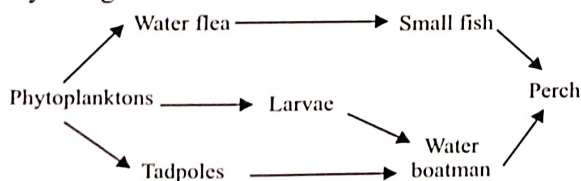
The maximum value of  $Z$  is

- A. 0    B. 50  
C. 100    D. Does not exist

OR

BIOLOGY

31. Study the given food web.



Select the incorrect statement regarding it.

- A. Small fish and water boatman act as both predator and prey.  
B. Phytoplanktons belong to the level of primary consumer.  
C. Small fish is a secondary consumer and perch is a tertiary consumer.  
D. All of these

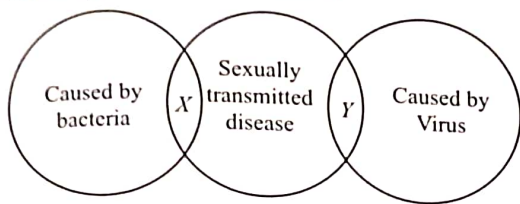
32. Refer to the given figure of a type of connective tissue and select the incorrect statement regarding it.



- A. It contains clear, large amount of translucent matrix with less fibres.  
B. It is hard and non-elastic and therefore forms vertebrae of shark.  
C. It forms articular surfaces at the joints of long bones.  
D. It forms skeleton of cartilaginous fishes.



33. Refer to the given Venn diagram and select the option that correctly identifies  $X$  and  $Y$ .



$X$

$Y$

- |    |                |             |
|----|----------------|-------------|
| A. | Genital herpes | Chancroid   |
| B. | Gonorrhoea     | Hepatitis-B |
| C. | Trichomoniasis | Scabies     |
| D. | Chlamydia      | Syphilis    |

34. In corn, purple kernels are dominant to yellow. A random sample of 100 kernels is taken from a population in Hardy-Weinberg equilibrium. It is found that 16 kernels are yellow and 84 are purple. What is the percentage of yellow allele in the population?
- A. 0.36  
B. 0.16  
C. 0.4  
D. 0.016

35. Read the given statements and select the correct option.

**Statement 1 :** Centrioles are capable of replication.

**Statement 2 :** In animal cells, centriole replication is independent of cell division.

- 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.

36. Select the option that correctly fills up the given blanks.

- (i) Biogas is a mixture of gases which is produced by \_\_\_\_\_ breakdown of biomass.  
(ii) Methanogens are commonly found in the \_\_\_\_\_ during sewage treatment.  
(iii) \_\_\_\_\_ species are free-living fungi and effective biocontrol agents of several plant pathogens.
- A. (i) Anaerobic, (ii) Anaerobic sludge, (iii) *Trichoderma*  
B. (i) Aerobic, (ii) Primary sludge, (iii) *Trichoderma*  
C. (i) Anaerobic, (ii) Anaerobic sludge, (iii) *Azotobacter*  
D. (i) Aerobic, (ii) Primary sludge, (iii) *Glomus*

37. Given are the names of different types of germ cells in a human male.

- |       |                        |
|-------|------------------------|
| (i)   | Spermatid              |
| (ii)  | Primary spermatocyte   |
| (iii) | Secondary spermatocyte |
| (iv)  | Spermatogonium         |
| (v)   | Spermatozoa            |

Select the option that correctly segregates them as haploid and diploid cells.

- |    | Haploid cells   | Diploid cells     |
|----|-----------------|-------------------|
| A. | (i), (iii), (v) | (ii), (iv)        |
| B. | (i), (v)        | (ii), (iii), (iv) |
| C. | (ii), (iii)     | (i), (iv), (v)    |
| D. | (ii), (iv)      | (i), (iii), (v)   |

38.  $X$  are substances which are incapable of inducing antibody formation by themselves but can be made capable of inducing antibodies on combining with larger molecules which serve as carriers.  $X$  are
- A. Complete antigens  
B. Antibodies  
C. Epitopes  
D. Haptens.

39. Cellular level of body organisation, inner layer consisting of highly specialised flagellated choanocytes and body consisting of a system of pores and canals are the characteristics of Phylum
- A. Porifera  
B. Coelenterata  
C. Annelida  
D. Arthropoda.

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

- | Column I                           | Column II   |
|------------------------------------|---|
| P. PCT                             | (i) Minimum reabsorption  |
| Q. DCT                             | (ii) Filtration of blood  |
| R. Ascending limb of loop of Henle | (iii) Reabsorption of 70-80% electrolytes                           |
| S. Counter current mechanism       | (iv) Conditional reabsorption of $\text{Na}^+$                      |
| T. Glomerulus                      | (v) Maintenance of concentration gradient in medullary interstitium |
- A. P-(iii), Q-(iv), R-(i), S-(v), T-(ii)  
B. P-(iii), Q-(v), R-(iv), S-(ii), T-(i)  
C. P-(i), Q-(iii), R-(ii), S-(v), T-(iv)  
D. P-(iii), Q-(i), R-(iv), S-(v), T-(ii)

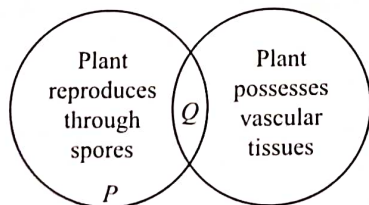
41. To understand the concept of cleistogamous flower, Mohan has chosen two plants which can produce assured seed set even without pollinating agents.

Select the option that correctly identifies the plants with the reason for producing the assured seed set.

- A. Plants: *Allium cepa*, Tobacco; By promoting cross-pollination  
 B. Plants: *Mirabilis*, *Oxalis*; Both plants have exposed anthers and stigma  
 C. Plants: *Commelina*, *Oxalis*; The flowers of both plants are bisexual and closed  
 D. Plants: *Viola*, Tobacco; In both the plants pollens are transferred from the anther to the stigma of other flowers on the same plant.
42. In genetic engineering, a DNA segment (gene) of interest is transferred to the host cell through a vector. Which among the following agents (i-iv) given in the box can be used as a vector(s)?

(i) <i>Amoeba</i>	(ii) Plasmid
(iii) <i>Plasmodium</i>	(iv) Bacteriophage

- A. (i), (ii) and (iv) only  
 B. (ii) only  
 C. (i) and (iii) only  
 D. (ii) and (iv) only
43. If a pea plant produces 2560 seeds during a dihybrid cross between homozygous round-yellow and wrinkled-green plant, then how many seeds are wrinkled-yellow, round-yellow and wrinkled-green, respectively?
- A. 640, 480, 1280  
 B. 480, 1440, 160  
 C. 640, 1280, 320  
 D. 160, 1440, 480
44. Refer to the given Venn diagram and select the correct option regarding *P* and *Q*.



- A. *P* could be an alga or a bryophyte whereas *Q* could be a pteridophyte.  
 B. True roots, stems and leaves are present in *P* but absent in *Q*.  
 C. Antheridium in *Q* is sessile whereas that in *P* (if present) is stalked.  
 D. *P* is exclusively xerophytic whereas *Q* is amphibious by nature.

45. Bt proteins are produced by the soil bacterium, *Bacillus thuringiensis*. These proteins are delta-endotoxins that possess toxic properties and can be used as biopesticides, as well as a source of genes for the construction of transgenic plants resistant to insects. These toxins do not kill the bacteria that produce them because

- A. These recognise only insect-specific targets  
 B. They do not have proteases enzymes to break their cell membrane  
 C. The endotoxin that accumulates in the bacterium is an inactive precursor  
 D. They do not have the alkaline environment for the activation of Bt protein.
46. 3' AAATGCGCGATA 5' is the sequence of nucleotides on a gene; after transcription the mRNA formed against it and the sequence of bases in the corresponding anticodons will be
- A. 5' UUUACGCGCUAU 3' and 3' AAAUGCGCGAUA 5'  
 B. 5' UAUCGCGCAUUU 3' and 3' AUAGCGCGUAAA 5'  
 C. 5' UUUACCTUGUAU 3' and 3' AAAUGGUACAUA 5'  
 D. 5' UAUGUTCCAUUU 3' and 3' AUACAUGGUAAA 5'.

47. Identify the family which shows the given diagnostic features.

Pentamerous flowers, epipetalous-bicarpellary, syncarpous, superior ovary, bilocular, placenta swollen with many ovules

- A. Solanaceae  
 B. Fabaceae  
 C. Liliaceae  
 D. Poaceae
48. Which of the following statements are correct about crossing over/genetic recombination?
- (i) It occurs in tetrad stage. It occurs in pachytene stage of prophase I of meiosis I.  
 (ii) It occurs between non-sister chromatids of homologous chromosomes.  
 (iii) It is a recombinase enzyme mediated process.  
 (iv) It is also the reciprocal transfer of genes between the non homologous chromosomes.
- A. (iii) and (iv) only  
 B. (i), (ii) and (iii) only  
 C. (ii), (iii) and (iv) only  
 D. (i), (ii), (iii) and (iv)



49. How many among the following are the free living nitrogen fixing organisms?

*Nostoc, Anabaena, Rhizobium, Frankia, Azotobacter, Rhodospirillum, Beijerinckia, Bacillus, Nitrobacter and Thiobacillus*

- A. 5
- B. 8
- C. 7
- D. 6

50. Select the incorrect statement regarding mutualism.


- A. Lichen represents an intimate mutualistic relationship between fungus and alga or cyanobacterium.
- B. Mycorrhizae are beneficial associations between fungi and roots of higher plants.
- C. Plants reward animal pollinators with nectar for aiding pollination.
- D. An orchid growing as an epiphyte on a mango branch is a classic example of mutualism.

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