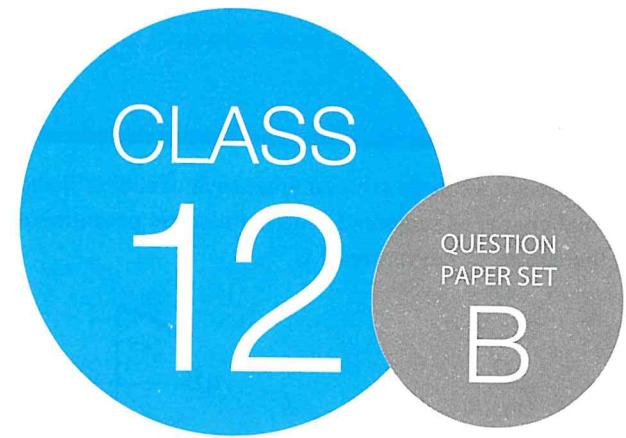




SOF NATIONAL SCIENCE  
OLYMPIAD 2019-20



DO NOT OPEN THIS BOOKLET UNTIL ASKED TO DO SO

Total Questions: 50 | Time: 1 hr.

Name:.....

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

#### Guidelines for the Candidate

1. You will get additional ten minutes to fill up information about yourself on the OMR Sheet, before the start of the exam.
2. Write your **Name, School Code, Class, Section, Roll No.** and **Mobile Number** clearly on the **OMR Sheet** and do not forget to sign it. We will share your marks / result and other information related to SOF exams on your mobile number.
3. The Question Paper comprises three sections :  
Section - 1: **Physics & Chemistry** (25 Questions)  
Section - 2: **Achievers Section** (5 Questions)  
Section - 3 : **Mathematics** (20 Questions) or **Biology** (20 Questions)
4. **Section-1 and 2 are compulsory for all.** In Section-3 opt for Mathematics OR Biology and mark the same on the OMR Sheet. Each question in Achievers Section carries 3 marks, whereas all other questions carry one mark each.
5. All questions are compulsory. There is no negative marking. Use of calculator is not permitted.
6. There is only ONE correct answer. Choose only ONE option for an answer.
7. To mark your choice of answers by darkening the circles on the OMR Sheet, use **HB Pencil or Blue / Black ball point pen** only. E.g.  
Q.16: In the water cycle, condensation is the process of  
A. Water vapour cooling down and turning into a liquid      B. Ice warming up and turning into a liquid  
C. Liquid cooling down and turning into ice      D. Liquid warming up and turning into water vapour  
As the correct answer is option A, you must darken the circle corresponding to option A on the OMR Sheet.

16.  (B)  (C)  (D)

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.

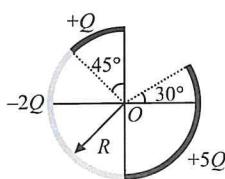
10. Please fill in your personal details in the space provided on this page before attempting the paper.

## SECTION-1

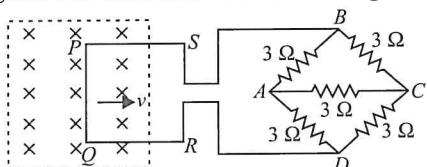
### PHYSICS

1. Figure shows three circular arcs, each of radius  $R$  and total charge as indicated. The net electric potential at the centre of curvature  $O$  is

- A.  $\frac{Q}{2\pi\epsilon_0 R}$
- B.  $\frac{Q}{4\pi\epsilon_0 R}$
- C.  $\frac{2Q}{\pi\epsilon_0 R}$
- D.  $\frac{Q}{\pi\epsilon_0 R}$



2. A square metal wire loop  $PQRS$  of side 10 cm and resistance  $1 \Omega$  is moved with a constant velocity  $v$  in a uniform magnetic field of  $2 \text{ Wb m}^{-2}$ , as shown in the figure. The magnetic field lines are perpendicular to the plane of the loop (directed into the paper). The loop is connected to a network  $ABCD$  of resistors each of value  $3 \Omega$ . The speed of the loop so as to have a steady current of  $1 \text{ mA}$  in the loop is (Neglect the resistance of connecting wires.)



- A.  $2 \text{ m s}^{-1}$
- B.  $2 \times 10^{-2} \text{ m s}^{-1}$
- C.  $20 \text{ m s}^{-1}$
- D.  $200 \text{ m s}^{-1}$

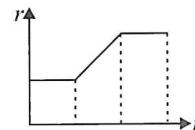
3. The potential energy (in SI units) of a particle of mass  $2 \text{ kg}$  in a conservative field is  $U = 6x - 8y$ . If the initial velocity of the particle is  $\vec{u} = (7.5 \hat{i} + 2 \hat{j}) \text{ m s}^{-1}$ , then the total distance travelled by the particle in first two seconds is

- A.  $10 \text{ m}$
- B.  $12 \text{ m}$
- C.  $15 \text{ m}$
- D.  $18 \text{ m}$

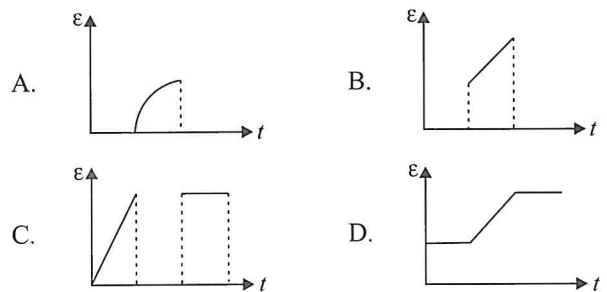
4. Time period of a spring-block system is  $T$ . Now this spring is cut into two pieces such that one piece is double the length of the other. If the smaller spring is connected to the same block, then new time period of this spring-block system will be

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

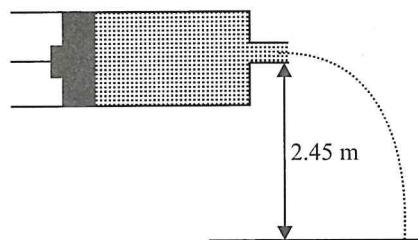
5. Radius of a circular ring is changing with time and the ring is placed in a uniform magnetic field perpendicular to its plane. The variation of radius  $r$  with time  $t$  is shown in the figure.



The magnitude of induced emf ( $\varepsilon$ ) is best represented by

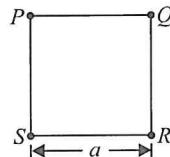


6. A tube has two area of cross-sections as shown in the figure. The diameters of the cross-sections are  $16 \text{ mm}$  and  $4 \text{ mm}$ . Find the range of water falling on horizontal surface, if piston is moving with a constant velocity of  $0.25 \text{ m s}^{-1}$ . (Take  $g = 10 \text{ m s}^{-2}$ )



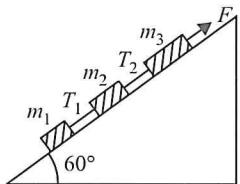
- A.  $2.45 \text{ m}$
- B.  $2.80 \text{ m}$
- C.  $3.15 \text{ m}$
- D.  $4.00 \text{ m}$

7. Four girls  $P, Q, R, S$  are initially at the four corners of a square of side  $a$ . Each girl now moves with a uniform speed  $v$  in such a way that  $P$  always moves directly towards  $Q$ ,  $Q$  directly towards  $R$ ,  $R$  directly towards  $S$ , and  $S$  directly towards  $P$ . The four girls will meet at a time



- A.  $\frac{a}{v}$
- B.  $\frac{a}{\sqrt{2}v}$
- C.  $\frac{\sqrt{2}a}{v}$
- D.  $\frac{2a}{v}$

8. Three blocks of masses  $m_1 = 1.0 \text{ kg}$ ,  $m_2 = 2.0 \text{ kg}$  and  $m_3 = 3.0 \text{ kg}$  are connected by light strings on a frictionless inclined plane of  $60^\circ$ , as shown in the figure.

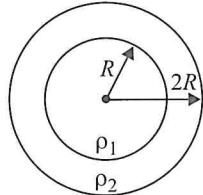


A force  $F = 60 \text{ N}$  is applied upward along the incline to the uppermost block, causing an upward movement of the blocks. Find the tensions  $T_1$  and  $T_2$  in the strings.

- A.  $T_1 = 20 \text{ N}$ ,  $T_2 = 60 \text{ N}$
- B.  $T_1 = 30 \text{ N}$ ,  $T_2 = 30 \text{ N}$
- C.  $T_1 = 30 \text{ N}$ ,  $T_2 = 10 \text{ N}$
- D.  $T_1 = 10 \text{ N}$ ,  $T_2 = 30 \text{ N}$

9. When one of the slits of Young's double slit experiment is covered with a transparent sheet of thickness  $4.8 \text{ mm}$ , the central fringe shifts to a position originally occupied by the  $30^{\text{th}}$  bright fringe. What should be the thickness of the sheet if the central fringe has to shift to the position occupied by  $10^{\text{th}}$  bright fringe?
- A.  $3.8 \text{ mm}$
  - B.  $1.6 \text{ mm}$
  - C.  $7.6 \text{ mm}$
  - D.  $3.2 \text{ mm}$
10. The density of the core of a planet is  $\rho_1$  and that of the outer shell is  $\rho_2$ . The radii of the core and that of the planet are  $R$  and  $2R$  respectively. The acceleration due to gravity at the surface of the

planet is same as at a depth  $R$ . The ratio of  $\rho_1$  to  $\rho_2$  is



- A.  $7 : 3$
- B.  $5 : 3$
- C.  $8 : 3$
- D.  $1 : 3$

11. The wavelength of radiation emitted is  $\lambda_0$  when an electron jumps from the third to the second orbit of hydrogen atom. When the electron jump from the fourth to the second orbit of the hydrogen atom, the wavelength of radiation emitted will be
- A.  $\frac{16}{25} \lambda_0$
  - B.  $\frac{20}{27} \lambda_0$
  - C.  $\frac{27}{20} \lambda_0$
  - D.  $\frac{25}{16} \lambda_0$
12. An electromagnetic wave travelling along  $z$ -axis is given as  $E = E_0 \cos(kz - \omega t)$ . Choose the incorrect option from the following.
- A. The associated magnetic field is given as  $\vec{B} = \frac{1}{c} \hat{z} \times \vec{E}$
  - B. The electric field can be written in terms of the associated magnetic field as  $\vec{E} = c(\vec{B} \times \hat{z})$ .
  - C.  $\hat{z} \cdot \vec{E} = 0, \hat{z} \cdot \vec{B} = 0$ .
  - D.  $\hat{z} \cdot \vec{E} = 0, \hat{z} \times \vec{B} = 0$ .

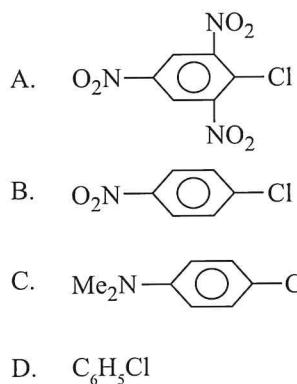
## CHEMISTRY

13. Select the correct statement(s) from the following :
- I. Nitrogen has the highest first ionisation enthalpy among group 15 elements.
  - II. Basicity of orthophosphoric acid and orthophosphorous acid is 2 and 3 respectively.
  - III. Ozone is a violet-black solid having bent structure and is paramagnetic in nature.
  - IV. Red phosphorus is thermodynamically most stable at room temperature and consists of discrete tetrahedral  $P_4$  molecule.
- A. I and IV only
  - B. II, III and IV only
  - C. I only
  - D. I, II, III and IV
14. Which of the following statements is/are correct?
- I.  $CN^-$  and  $O_2^-$  have same bond order and both are paramagnetic.
  - II. Dissociation energy of  $N_2$  is greater than that of  $N_2^+$ .
- III.  $XeO_3$  and  $IO_3^-$  are not isostructural species.
- IV.  $BrF_5$  and  $SF_4$ , both have one lone pair of electrons.
- A. II and IV only
  - B. I and III only
  - C. II only
  - D. I, II, III and IV
15. An element crystallises into a structure which may be described by a cubic type of unit cell having one atom on each corner of the cube and two atoms on one of its diagonals. If the volume of this unit cell is  $24 \times 10^{-24} \text{ cm}^3$  and density of element is  $7.2 \text{ g cm}^{-3}$ , the number of atoms present in 200 g of the element is \_\_\_\_\_.
- A.  $3.5 \times 10^{24}$
  - B.  $5.7 \times 10^{23}$
  - C.  $6.3 \times 10^{20}$
  - D.  $1 \times 10^{10}$

16. On being heated in oxygen, 3.120 g of a metal 'M' gets converted to 4.560 g of its oxide (atomic weight of  $M = 52.0$  u). Mark the correct statement(s).

- I. Equivalent wt. of metal 'M' = 17.33
  - II. Number of equivalents of oxygen reacted with metal 'M' = 0.09
  - III. Metal 'M' forms the halide  $MCl_2$ .
  - IV. The simplest formula of the metal oxide formed is  $M_2O_3$ .
- A. I, III and IV only  
 B. II and III only  
 C. IV only  
 D. I and IV only
- 

17. Which chloro derivative of benzene among the following would undergo hydrolysis most readily with aqueous sodium hydroxide to furnish the corresponding hydroxy derivative?



18. Select the incorrect trend(s) of the properties mentioned.

- I. Strength of Lewis acids –  $BCl_3 > AlCl_3 > GaCl_3$
  - II. Inert pair effect –  $Al > Ga > In$
  - III. Oxidising property –  $Al^{3+} > In^{3+} > Tl^{3+}$
  - IV. First ionization enthalpy –  $B > Al > Tl$
- A. I and III only  
 B. II, III and IV only  
 C. III only  
 D. I, II, III and IV
- 

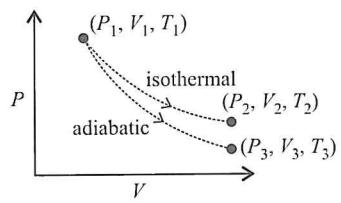
19. Match column I with column II and select the correct option from the given codes.

Column I	Column II
(P) Self reduction	1. Lead
(Q) Carbon reduction	2. Nickel
(R) Thermal decomposition of carbonyl	3. Copper
(S) Decomposition of iodide	4. Titanium

A. P – 1, 2; Q – 1, 4; R – 2; S – 4  
 B. P – 1, 2; Q – 2, 4; R – 3; S – 2  
 C. P – 1, 3; Q – 1, 3; R – 2; S – 4  
 D. P – 1, 4; Q – 1, 3, 4; R – 2; S – 3

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20. The reversible expansion of an ideal gas under adiabatic and isothermal conditions is shown in the figure. Which of the following options is correct?



- A.  $T_1 \neq T_2$   
 B.  $\Delta U_{\text{isothermal}} = \Delta U_{\text{adiabatic}} = 0$   
 C.  $T_1 > T_3$   
 D.  $w_{\text{adiabatic}} > w_{\text{isothermal}}$
- 

21. Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20 g of phenol in 1.0 kg of benzene has its freezing point lowered by 0.69 K. Calculate the fraction of phenol that has dimerised.

(Given :  $K_f$  for benzene = 5.1 K m<sup>-1</sup>)

- A. 50%  
 B. 73%  
 C. 95%  
 D. 63.5%
- 

22. An organic compound  $P$ , on treatment with dilute sulphuric acid containing mercuric sulphate gives a compound  $Q$  which can also be obtained from a reaction of benzene with an acid chloride in the presence of anhydrous aluminium chloride. The compound  $Q$ , when treated with iodine in aqueous KOH, yields  $R$  and a yellow compound  $S$ . Identify  $P$ ,  $Q$  and  $R$  respectively.

- A.  $C_6H_5C\equiv CH$ ,  $C_6H_5COCH_3$  and  $C_6H_5COOH$   
 B.  $C_6H_5CH=CH_2$ ,  $C_6H_5COCH_3$  and  $C_6H_5COOH$   
 C.  $C_6H_5CH_3$ ,  $C_6H_5CHO$  and  $C_6H_5COOCH_3$   
 D.  $C_6H_5C\equiv CH$ ,  $C_6H_5CH_2CHO$  and  $C_6H_5CONH_2$
- 

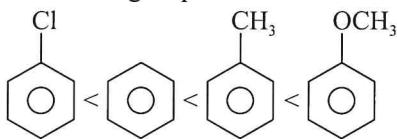
23. Find the incorrect match(es).

- I.  $[Co(NH_3)_4Cl_2]^+$  – Optical isomerism
  - II.  $[Fe(CN)_6]^{3-}$  –  $d^2sp^3$  hybridisation
  - III.  $[Zn(NH_3)_6]^{2+}$  – Outer orbital complex
  - IV.  $[Cu(NH_3)_4]^{2+}$  – Tetrahedral and 1.73 BM
- A. II and III only  
 B. I and IV only  
 C. I only  
 D. IV only
- 

24. Select the correct statement(s) among the following:

- I.  $p$ -Fluoroanilinium ion is more acidic than anilinium ion.
- II. The correct order of reactivity towards HCN is :  $C_2H_5COCH_3 > CH_3COCH_3 > CH_3CHO > HCHO$

- III. The correct order of reactivity towards sulphonation with fuming sulphuric acid is :

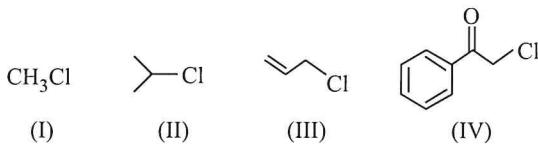


- IV. do not exhibit tautomerism.

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

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

25. The rates of reactivity of following compounds towards  $S_N2$  reactions vary as



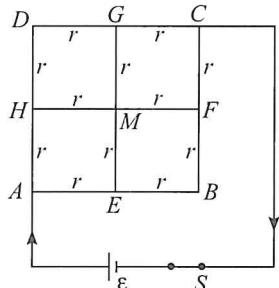
- A. I > II > III > IV  
B. IV > I > III > II  
C. I > III > II > IV  
D. III > I > IV > II

## SECTION-2

### ACHIEVERS SECTION

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

In the figure, each of the segments (e.g.,  $AE$ ,  $EB$ ,  $BF$ , etc.) has resistance  $r$ . A battery of emf  $\epsilon$  is connected between the points  $A$  and  $C$ . Internal resistance of the battery is negligible.



26. What is the equivalent resistance of the system between points  $A$  and  $C$ ?

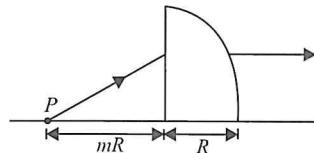
- A.  $r$   
B.  $\frac{r}{2}$   
C.  $\frac{3r}{2}$   
D.  $2r$

27. If a potentiometer circuit having potential gradient  $k$  is connected across the points  $E$  and  $C$ , then the balancing length shown by the potentiometer is

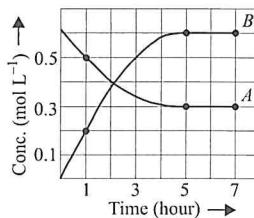
- A.  $\frac{\epsilon}{k}$   
B.  $\frac{2\epsilon}{3k}$   
C.  $\frac{3\epsilon}{2k}$   
D. None of these

28. A quarter cylinder of radius  $R$  and refractive index 1.5 is placed on a table. A point object  $P$  is kept at a distance  $mR$  from it. Find the value of  $m$  for which a ray from  $P$  will emerge parallel to the table as shown in the figure.

- A. 0.5  
B. 1  
C.  $\frac{3}{2}$   
D.  $\frac{4}{3}$



29. The given figure represents the progress of the reaction,  $A \rightleftharpoons nB$ , with time.



Find the values of  $n$ , equilibrium constant and the initial rate of conversion of  $A$  respectively.

- A. 2, 1.2 and  $1.05 \text{ mol L}^{-1} \text{ hour}^{-1}$   
B. 1, 2.3 and  $0.1 \text{ mol L}^{-1} \text{ hour}^{-1}$   
C. 2, 1.2 and  $0.1 \text{ mol L}^{-1} \text{ hour}^{-1}$   
D. 3, 1.45 and  $0.34 \text{ mol L}^{-1} \text{ hour}^{-1}$

30. Read the given paragraph carefully and fill in the blanks by selecting an appropriate option.

An organic compound (P) on treatment with acetic acid in the presence of sulphuric acid produces an ester (Q). (P) on mild oxidation, gives (R). (R) with 50% potassium hydroxide followed by acidification with dilute hydrochloric acid generates (P) and (S). (S) with phosphorus pentachloride followed by reaction with ammonia gives (T) and (T) on dehydration produces hydrocyanic acid.

- | $P$                                | $Q$                                  | $R$                        | $S$                               | $T$                                 |
|------------------------------------|--------------------------------------|----------------------------|-----------------------------------|-------------------------------------|
| A. $\text{C}_2\text{H}_5\text{OH}$ | $\text{CH}_3\text{COOC}_2\text{H}_5$ | $\text{CH}_3\text{CHO}$    | $\text{CH}_3\text{COOH}$          | $\text{CH}_3\text{CONH}_2$          |
| B. $\text{CH}_3\text{OH}$          | $\text{HCOOCH}_3$                    | $\text{CH}_3\text{COCH}_3$ | $\text{HCOOH}$                    | $\text{HCONH}_2$                    |
| C. $(\text{CH}_3)_2\text{COH}$     | $\text{HCOOCH}_3$                    | $\text{HCHO}$              | $\text{C}_2\text{H}_5\text{COOH}$ | $\text{C}_2\text{H}_5\text{CONH}_2$ |
| D. $\text{CH}_3\text{OH}$          | $\text{CH}_3\text{COOCH}_3$          | $\text{HCHO}$              | $\text{HCOOH}$                    | $\text{HCONH}_2$                    |

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

31. The maximum value of  $f = x + 4y$  subject to the constraints  $x + y \leq 8$ ,  $2x + y \leq 10$ ,  $x \geq 0$ ,  $y \geq 0$  is  
 A. 36  
 B. 26  
 C. 40  
 D. 32
- 
32. If  $f(x) + f(1-x) = 10$ , then find the value of  $f\left(\frac{1}{10}\right) + f\left(\frac{2}{10}\right) + \dots + f\left(\frac{9}{10}\right)$ .  
 A. 45  
 B. 50  
 C. 90  
 D. 40
- 
33. Let  $L$  be the set of all straight lines in the Euclidean plane. Two lines  $l_1$  and  $l_2$  are said to be related by the relation  $R$  iff  $l_1$  is parallel to  $l_2$ . Then, the relation  $R$  is  
 A. Reflexive and symmetric only  
 B. Reflexive and transitive only  
 C. Transitive only  
 D. None of these
- 
34. Let  $f(x) = \sin x$ ,  $g(x) = [x+1]$  and  $h(x) = gof(x)$ , where  $[ \cdot ]$  is the greatest integer function. Then,  $h'\left(\frac{\pi}{2}\right)$  is  
 A. 1  
 B. -1  
 C. Non-existent  
 D. None of these
- 
35. If the angle  $\theta$  between the line  $\frac{x+1}{1} = \frac{y-1}{2} = \frac{z-2}{2}$  and the plane  $2x - y + \sqrt{\lambda}z + 4 = 0$  is such that  $\sin \theta = \frac{1}{3}$ , then the value of  $\lambda$  is  
 A.  $-\frac{3}{5}$   
 B.  $\frac{5}{3}$   
 C.  $-\frac{4}{3}$   
 D.  $\frac{3}{4}$
- 
36. The value of the determinant  

$$\begin{vmatrix} \log_a(x/y) & \log_a(y/z) & \log_a(z/x) \\ \log_b(y/z) & \log_b(z/x) & \log_b(x/y) \\ \log_c(z/x) & \log_c(x/y) & \log_c(y/z) \end{vmatrix}$$
 is

- A. 1  
 B. -1  
 C.  $\log_a xyz$   
 D. None of these

37. 28 is divided into 4 parts which are in A.P. The ratio of the product of the first and third to the product of the second and fourth is 8 : 15. The largest part is

- A. 6  
 B. 8  
 C. 10  
 D. 12

38. Study the following statements carefully and select the correct option.

**Statement-1 :**  $\tan^{-1}\left(\frac{3}{4}\right) + \tan^{-1}\left(\frac{1}{7}\right) = \frac{\pi}{4}$

**Statement-2 :** For  $x > 0$ ,  $y > 0$ ,

$$\tan^{-1}\left(\frac{x}{y}\right) + \tan^{-1}\left(\frac{y-x}{y+x}\right) = \frac{\pi}{4}$$

- 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.

39. Mean and standard deviation of 100 observations were found to be 40 and 10 respectively. If at the time of calculation two observations were wrongly taken as 30 and 70 in place of 3 and 27 respectively, then find the correct variance.

- A. 106.28  
 B. 98.45  
 C. 104.89  
 D. 101.45

40.  $\int_{-3\pi/2}^{-\pi/2} \{(x+\pi)^3 + \cos^2(x+3\pi)\} dx$  is equal to

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

41. The letters of the word PROBABILITY are written down at random in a row. If  $E_1$  denotes the event that two I's are together and  $E_2$  denotes the event that two B's are together, then which of the following is/are true?

I.  $P(E_1) = P(E_2) = \frac{2}{11}$

II.  $P(E_1 \cap E_2) = \frac{2}{55}$

III.  $P(E_1 \cup E_2) = \frac{18}{55}$

IV.  $P(E_1 / E_2) = \frac{1}{5}$

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

42. Find the value of  $p$  and  $q$  for which the function

$$f(x) = \begin{cases} \frac{\sin(p+1)x + \sin x}{x}; & x < 0 \\ q; & x = 0 \\ \frac{\sqrt{x+x^2} - \sqrt{x}}{x^{3/2}}; & x > 0 \end{cases}$$

is continuous for all  $x$  in  $\mathbb{R}$ .

- A.  $p = \frac{1}{2}, q = -\frac{3}{2}$   
B.  $p = \frac{5}{2}, q = \frac{1}{2}$   
C.  $p = -\frac{3}{2}, q = \frac{1}{2}$   
D.  $p = \frac{1}{2}, q = \frac{3}{2}$

43. If the coefficient of  $x^7$  in  $\left(ax + \frac{1}{x}\right)^9$  and  $x^{-7}$  in  $\left(bx - \frac{1}{x}\right)^9$  are equal, then

- A.  $a^7 - b^2 = 0$   
B.  $a^8 - b = 0$   
C.  $a - b^8 = 0$   
D.  $a^2 - b^7 = 0$

44. The ratio in which  $\hat{i} + 2\hat{j} + 3\hat{k}$ , divides the join of  $-2\hat{i} + 3\hat{j} + 5\hat{k}$  and  $7\hat{i} - \hat{k}$ , is

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

45. A kite is moving horizontally at a height of 151.5 m. If the speed of the kite is 10 m/s, then how fast is the string being let out, when the kite is 250 m from

the boy who is flying the kite, the height of the boy being 1.5 m?

- A. 4 m/s  
B. 8 m/s  
C. 16 m/s  
D. 32 m/s

46. The solution of  $e^{xy}(xy^2 dy + y^3 dx) + e^{x/y}(ydx - xdy) = 0$  is

- A.  $e^{xy} - e^{x/y} + c = 0$   
B.  $e^{xy} - e^{y/x} + c = 0$   
C.  $e^{xy} + e^{x/y} + c = 0$   
D. None of these

47. Let  $M$  be a  $2 \times 2$  symmetric matrix with integral entries. Then  $M$  is invertible if

- A. The first column of  $M$  is the transpose of the second row of  $M$ .  
B.  $M$  is a diagonal matrix with non-zero entries in the main diagonal.  
C. Both A and B  
D. Neither A nor B

48. If a hyperbola passes through a focus of the ellipse  $\frac{x^2}{25} + \frac{y^2}{16} = 1$  and its transverse and conjugate axes coincide with major and minor axes of the ellipse, and the product of their eccentricities is 1, then which of the following options is correct?

- A. The equation of hyperbola is  $\frac{x^2}{9} - \frac{y^2}{16} = 1$   
B. The equation of hyperbola is  $\frac{x^2}{9} - \frac{y^2}{25} = 1$   
C. Focus of the hyperbola is (5, 0)  
D. Both A and C

49. The letters of the word COCHIN are permuted and all permutations are arranged in alphabetical order as in a dictionary. The number of words that appear before the word COCHIN is

- A. 360  
B. 192  
C. 96  
D. 48

50. The area bounded by the curve  $y = 6 + 4x - x^2$  and the line  $2x - y = 2$  is

- A. 12 sq. units  
B. 24 sq. units  
C. 36 sq. units  
D. 48 sq. units

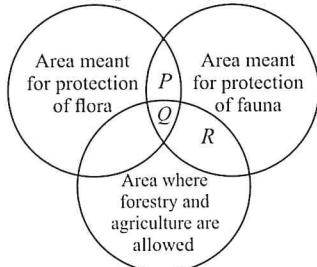
31. Read the given passage carefully.

*X* is a type of pollination in which a complete flower is pollinated by its own pollen, *Y* is the transfer of pollen grains from the anther to the stigma of different flowers present in the same inflorescence or on the same plant. *Z* is the process of transfer of pollen grains from anther of one flower to the stigma of another flower of genetically different plants of same species.

Select the correct statement regarding processes *X*, *Y* and *Z*.

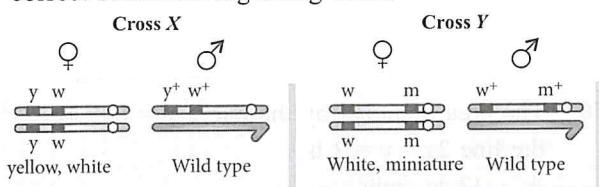
- A. Unisexuality of flowers prevents processes *X*, *Y* and *Z*.
- B. Seed setting is assured in process *X* even in the absence of pollinators.
- C. Process *Z* is not possible in cucurbits and date palm.
- D. In processes *Y* and *Z*, genetically different pollen grains are brought to stigma.

32. Identify *P*, *Q* and *R* in the given Venn diagram and select the correct option regarding them.



- A. *P* is an *in situ* method of biodiversity conservation whereas *Q* is an *ex situ* method of biodiversity conservation.
- B. Human activities are allowed only in the core zone of *Q* however the buffer zone remains undisturbed.
- C. *P* is an area that is owned and protected by National Government for betterment of wildlife whereas private ownership is permitted in *R*.
- D. Hunting of animals is allowed in *R*.

33. Refer to the given crosses *X* and *Y* and select the correct statement regarding them.

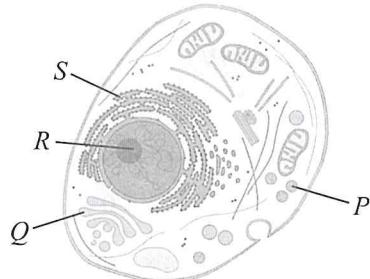


Note : (+) sign in superscript represents dominant wild type alleles

- A. In cross *X*, the strength of linkage between genes *y* and *w* is higher than the cross *Y* genes *w* and *m*.

- B. In cross *X*, the strength of linkage between genes *y* and *w* is lesser than the cross *Y* genes *w* and *m*.
- C. The percentage of recombinants produced in cross *X* and cross *Y* is equal.
- D. The percentage of recombinants produced in cross *X* is higher than cross *Y*.

34. Identify the cell organelles (*P*, *Q*, *R*, *S*) in the given figure of animal cell and select the option that correctly matches them with the characteristics I-IV.



- I. Contain glycoproteins and also synthesises serum proteins and membrane proteins.
- II. Brings about recycling of plasma membrane.
- III. Bounded by single membrane and involved in natural defence of the body.
- IV. Essential for spindle formation during nuclear division.

<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>
A. II	IV	I	III
B. III	II	IV	I
C. I	III	IV	II
D. III	II	I	IV

35. Match column I (Hormone) with column II (Endocrine gland) and column III (Function), and select the correct option from the given codes.

**Column I      Column II      Column III**

P. Insulin	a. Adrenal cortex	(i) Increasing the rate of heart beat in emergency
Q. Prolactin	b. Pancreas	(ii) Reduces breakdown and oxidation of fat
R. Aldosterone	c. Adrenal medulla	(iii) Stimulate milk production by mammary glands
S. Adrenaline	d. Anterior lobe of pituitary	(iv) Increase sodium and water in the blood

<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>
A. (b),(ii)	(d),(iii)	(a),(iv)	(c),(i)
B. (b),(ii)	(a),(i)	(d),(iv)	(c),(iii)
C. (b),(i)	(d),(iv)	(a),(iii)	(c),(ii)
D. (b),(i)	(a),(iii)	(d),(ii)	(c),(iv)

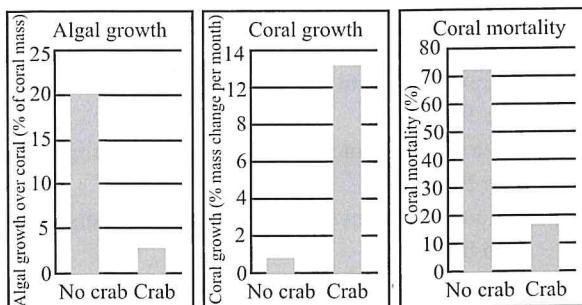
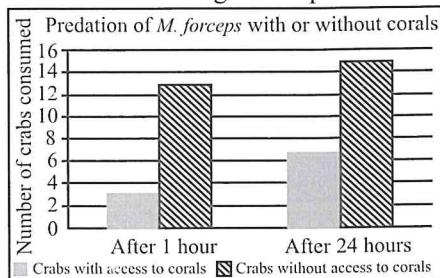
36. How many of the given characters are associated with brown algae?

Laminarin, Sulphated phycocolloids, Floridean starch, Fucoxanthin, Heterokont flagellation, Carposporophyte, Lateral flagella, Carpogonium, Trumpet hyphae, Chlorophyll c.

- A. Eight
- B. Six
- C. Seven
- D. Five

37. Consider a diploid organism with  $2n$  value of 4. How many chromosomes and DNA molecules respectively are present in the  $G_1$  and  $G_2$  phases of a somatic cell of this organism? (Consider only nuclear DNA)
- A.  $G_1$ : 4 and 4;  $G_2$ : 4 and 4
  - B.  $G_1$ : 4 and 8;  $G_2$ : 4 and 8
  - C.  $G_1$ : 4 and 4;  $G_2$ : 4 and 8
  - D.  $G_1$ : 8 and 8;  $G_2$ : 4 and 4

38. An experiment to understand the relationship between a herbivorous crab *Mithrax forceps* and the coral *Oculina arbuscula* was undertaken in a shallow water coastal ecosystem. Observation on predation of crab, growth of algae, growth and mortality of corals were made. The following graphs indicate the results obtained during the experiment.



A few statements based on the results obtained are made.

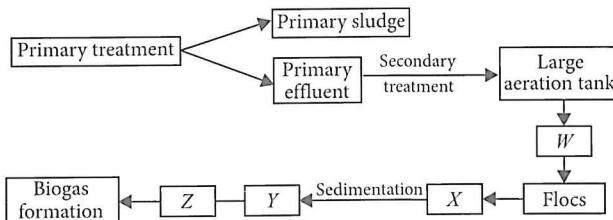
- (i) The presence of crabs has a negative influence on algal growth and positive influence on coral growth.

- (ii) Presence of *M. forceps* is obligatory for the survival of *O. arbuscula*.
  - (iii) The coral species plays an important role in preventing predation of *M. forceps*.
  - (iv) Algae and coral show commensalism.
- Which of these statements are true?
- A. (i), (ii) and (iii) only
  - B. (i) and (iv) only
  - C. (i), (iii) and (iv) only
  - D. (iii) and (iv) only

39. Read the given statements each with one or two blanks and select the option which correctly fill the blanks in any two of them.

- (a) The embryo with 8 to 16 blastomeres is called a\_(i).
  - (b) Embedding of the\_(i) in the endometrium of the uterus is called implantation and it leads to\_(ii).
  - (c) After implantation, finger like projections appear on the trophoblast called\_(i), which become interdigitated with uterine tissue to form\_(ii).
  - (d) The cells of the trophoblast which are in contact with the inner cell mass are called\_(i).
- A. (a)-(i) Morula, (c)-(i) Chorionic villi, (ii)-Placenta
  - B. (b)-(i) Blastocyst, (ii) Pregnancy, (d)-(i) Uterine tissue
  - C. (a)-(i) Blastula, (d)-(i) Cells of Rauber
  - D. (b)-(i) Morula, (ii) Parturition, (c)-(i) Fimbriae, (ii)-Placenta

40. Given below is the flow chart of sewage treatment.



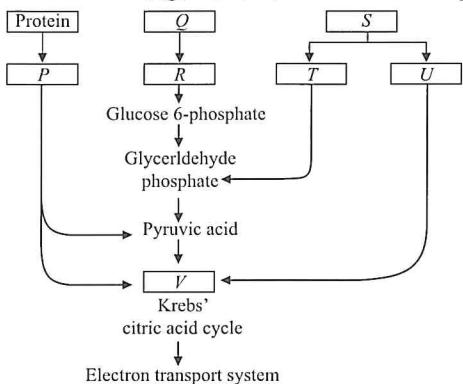
Identify *W*, *X*, *Y* and *Z* and select the correct option.

- A. *W*-Mechanical agitation; *X*-Increased BOD  
*Y*-Aerobic sludge digesters; *Z*-Activated sludge
- B. *W*-Microbial digestion; *X*-Activated sludge  
*Y*-Increased BOD; *Z*-Anaerobic sludge digesters
- C. *W*-Mechanical agitation; *X*-Decreased BOD  
*Y*-Activated sludge; *Z*-Anaerobic sludge digesters
- D. *W*-Microbial digestion; *X*-Mechanical agitation  
*Y*-Decreased BOD; *Z*-Aerobic sludge digesters

41. *Eco RI* and *Rsa I* restriction endonucleases require 6 and 4 bp sequences respectively for cleavage. In a 10 kb DNA fragment how many probable cleavage sites are present for these enzymes?

- A. 0 *Eco RI* and 10 *Rsa I*
- B. 1 *Eco RI* and 29 *Rsa I*
- C. 4 *Eco RI* and 69 *Rsa I*
- D. 2 *Eco RI* and 39 *Rsa I*

42. Refer to the following flow chart representing the cellular respiration and select the option that correctly fill the blanks *P*, *Q*, *R*, *S*, *T*, *U* and *V* are respectively



- A. *P*-Amino acids, *Q*-Carbohydrate, *R*-Glucose, *S*-Fats, *T*-Glycerol, *U*-Fatty acid, *V*-Acetyl Co-A
- B. *P*-Fats, *Q*-Acetyl Co-A, *R*-Amino acid, *S*-Fatty acid, *T*-Carbohydrate, *U*-Glycerol, *V*-Glucose
- C. *P*-Fatty acid, *Q*-Glucose, *R*-Acetyl Co-A, *S*-Glycerol, *T*-Fats, *U*-Carbohydrate, *V*-Amino acid
- D. *P*-Carbohydrate, *Q*-Fats, *R*-Glycerol, *S*-Fatty acids, *T*-Amino acid, *U*-Glucose, *V*-Acetyl Co-A.

43. In which one of the following options the genus name, its two characters and its Class/Phylum are correctly matched?

Genus name	Characters	Class/Phylum
A. <i>Taenia</i>	(i) Pseudocoelom (ii) Males and females distinct	Platyhelminthes
B. <i>Ichthyophis</i>	(i) Sinus venosus absent (ii) Fertilisation is external	Amphibia
C. <i>Sphenodon</i>	(i) Skin possesses hair (ii) Oviparous	Mammalia
D. <i>Obelia</i>	(i) Cnidoblasts (ii) Tissue level of organisation	Coelenterata

44. In a large isolated population, alleles *p* and *q* at a locus are at Hardy-Weinberg equilibrium. The frequencies are *p* = 0.6 and *q* = 0.4. The proportion of the heterozygous genotype in the population is

- A. 0.24
- B. 1
- C. 0.48
- D. 0.12.

45. The sequences of four DNA molecules are given below. Which one of these DNA molecules will have the highest melting temperature (*T<sub>m</sub>*)?

- A. TATATATATATA  
ATATATATATAT

- B. TTTCCCGGGAAA  
AAAGGGCCCTTT
- C. TTGCGTTGCGCC  
AACGCAACGCCG
- D. GCCGGATCCGGC  
CGGCCTAGGCCG

46. Select the incorrect statement.

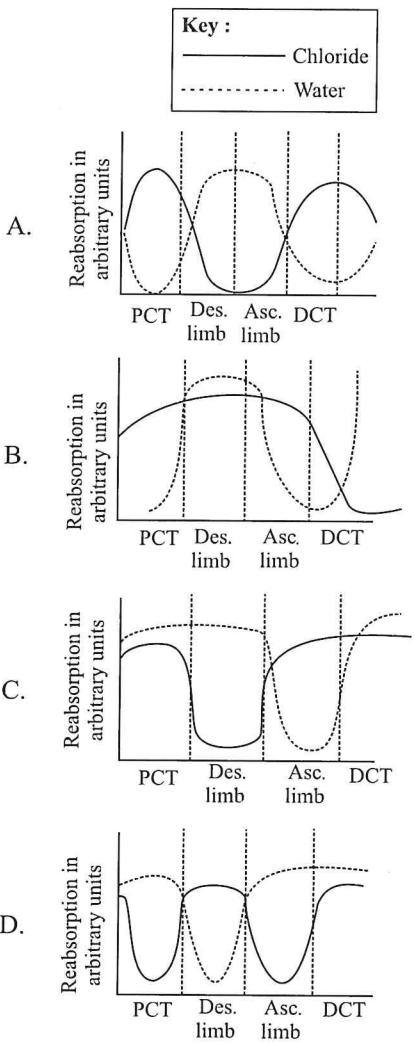
- A. Net primary productivity is the amount of organic matter synthesised by producers per unit time and area.
- B. Net primary productivity is equal to organic matter synthesised by photosynthesis minus utilisation in respiration and other losses.
- C. Net primary productivity depends upon gross primary productivity as well as amount of consumption of photosynthates.
- D. Both A and C

47. In an experiment represented in the schematic below, a plant species was grown in different day and night cycles and its photoperiodic flowering behaviour was noted. This species is a

Light	Dark	
16 hrs	6 hrs	No Flower
16 hrs	7 hrs	No Flower
16 hrs	8 hrs	No Flower
16 hrs	9 hrs	Flower
16 hrs	10 hrs	Flower
16 hrs	11 hrs	Flower
8 hrs	10 hrs	Flower
10 hrs	10 hrs	Flower
12 hrs	10 hrs	Flower
8 hrs	8 hrs	No Flower
10 hrs	8 hrs	No Flower
12 hrs	8 hrs	No Flower

- A. Short day plant and actually measures day length to flower
- B. Short day plant and actually measures night length to flower
- C. Long day plant and actually measures night length to flower
- D. Long day plant and actually measures day length to flower.

48. Which of the following graphs best depicts the reabsorption of chloride and water at specific sites in the kidney tubule?



49. Given below are four statements (a-d) each with one or two blanks. Select the option which correctly fills up the blanks in the two statements.

- (a) Plague is caused by (i), a deadly bacterium. (ii), the most common form of plague is characterised by high fever, weakness and acute painful swellings of the lymph nodes.
- (b) Filariasis is characterised by swelling of the (i) and of other parts of the body. The disease, therefore, is commonly known as (ii) due to its resemblance to leg of an elephant.
- (c) (i) is the resistance to infection which an individual possesses by virtue of his/her genetic and constitutional make up.
- (d) (i) literally means “protection against self”; (ii) is an example of it.
- A. (b)-(i) Neck, (ii) Ascariasis  
 (d)-(i) Autoimmunity, (ii) Diabetes mellitus
- B. (a)-(i) *Bordetella pertussis*, (ii) Pulmonary plague  
 (c)-(i) Passive immunity
- C. (a)-(i) *Yersinia pestis*, (ii) Bubonic plague  
 (d)-(i) Autoimmunity, (ii) Rheumatoid arthritis
- D. (b)-(i) Leg, (ii) Elephantiasis  
 (c)-(i) Acquired immunity

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

**Statement 1 :** Active immunity is developed when a person's own cells produce antibodies in response to infection or vaccine.

**Statement 2 :** Injection of snake antivenom against snake bite is an example of active immunisation.

- 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.

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**National Office:** Plot 99, First Floor, Sector 44 Institutional area, Gurugram - 122 003 (HR) India

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