

### Section : Physics

In an electron microscope, the resolution that can be achieved is of the order of the wavelength of electrons used. To resolve a width of  $7.5 \times 10^{-12}$  m, the minimum electron energy required is close to :

Q.1

- Options 1. 500 keV  
 2. 100 keV  
 3. 1 keV  
 4. 25 keV

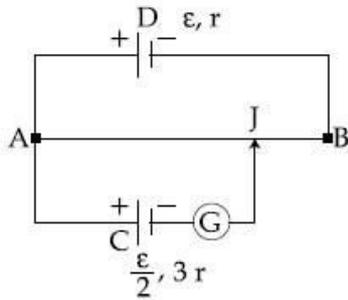
To mop-clean a floor, a cleaning machine presses a circular mop of radius  $R$  vertically down with a total force  $F$  and rotates it with a constant angular speed about its axis. If the force  $F$  is distributed uniformly over the mop and if coefficient of friction between the mop and the floor is  $\mu$ , the torque, applied by the machine on the mop is :

Q.2

- Options 1.  $\mu FR/3$   
 2.  $\mu FR/6$   
 3.  $\mu FR/2$   
 4.  $\frac{2}{3}\mu FR$

Q.3

A potentiometer wire AB having length  $L$  and resistance  $12r$  is joined to a cell D of emf  $\varepsilon$  and internal resistance  $r$ . A cell C having emf  $\varepsilon/2$  and internal resistance  $3r$  is connected. The length AJ at which the galvanometer as shown in fig. shows no deflection is :



Options

1.  $\frac{11}{12} L$
2.  $\frac{11}{24} L$
3.  $\frac{13}{24} L$
4.  $\frac{5}{12} L$

Q.4

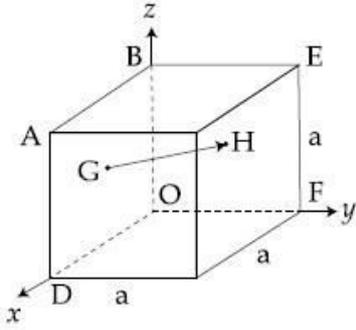
A TV transmission tower has a height of 140 m and the height of the receiving antenna is 40 m. What is the maximum distance upto which signals can be broadcasted from this tower in LOS (Line of Sight) mode ? (Given : radius of earth =  $6.4 \times 10^6$  m).

Options

1. 65 km
2. 48 km
3. 80 km
4. 40 km

Q.5

In the cube of side 'a' shown in the figure, the vector from the central point of the face ABOD to the central point of the face BEFO will be :



Options

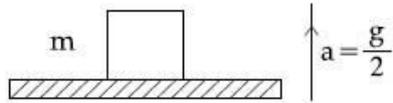
1.  $\frac{1}{2}a(\hat{k} - \hat{i})$
2.  $\frac{1}{2}a(\hat{i} - \hat{k})$
3.  $\frac{1}{2}a(\hat{j} - \hat{i})$
4.  $\frac{1}{2}a(\hat{j} - \hat{k})$

Q.6 A uniform metallic wire has a resistance of  $18 \Omega$  and is bent into an equilateral triangle. Then, the resistance between any two vertices of the triangle is :

- Options
1.  $4 \Omega$
  2.  $8 \Omega$
  3.  $12 \Omega$
  4.  $2 \Omega$

Q.7

A block of mass  $m$  is kept on a platform which starts from rest with constant acceleration  $g/2$  upward, as shown in fig. Work done by normal reaction on block in time  $t$  is :



Options

1.  $\frac{m g^2 t^2}{8}$
2.  $\frac{m g^2 t^2}{8}$
3. 0
4.  $\frac{3m g^2 t^2}{8}$

Q.8 In a Young's double slit experiment with slit separation  $0.1 \text{ mm}$ , one observes a bright fringe at angle  $\frac{1}{40}$  rad by using light of wavelength  $\lambda_1$ . When the light of wavelength  $\lambda_2$  is used a bright fringe is seen at the same angle in the same set up. Given that  $\lambda_1$  and  $\lambda_2$  are in visible range ( $380 \text{ nm}$  to  $740 \text{ nm}$ ), their values are :

- Options
1.  $625 \text{ nm}, 500 \text{ nm}$
  2.  $380 \text{ nm}, 525 \text{ nm}$
  3.  $380 \text{ nm}, 500 \text{ nm}$
  4.  $400 \text{ nm}, 500 \text{ nm}$

Q.9

Two guns A and B can fire bullets at speeds 1 km/s and 2 km/s respectively. From a point on a horizontal ground, they are fired in all possible directions. The ratio of maximum areas covered by the bullets fired by the two guns, on the ground is :

- Options
- 1 : 16
  - 1 : 2
  - 1 : 4
  - 1 : 8

Q.10 The density of a material in SI units is  $128 \text{ kg m}^{-3}$ . In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is :

- Options
- 40
  - 16
  - 640
  - 410

Q.11 A magnet of total magnetic moment  $10^{-2} \hat{i} \text{ A}\cdot\text{m}^2$  is placed in a time varying magnetic field,  $B \hat{i}(\cos \omega t)$  where  $B=1$  Tesla and  $\omega=0.125 \text{ rad/s}$ . The work done for reversing the direction of the magnetic moment at  $t=1$  second, is :

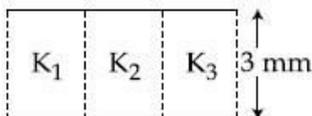
- Options
- 0.01 J
  - 0.007 J
  - 0.028 J
  - 0.014 J



Q.12 A heat source at  $T=10^3$  K is connected to another heat reservoir at  $T=10^2$  K by a copper slab which is 1 m thick. Given that the thermal conductivity of copper is  $0.1 \text{ WK}^{-1}\text{m}^{-1}$ , the energy flux through it in the steady state is :

- Options
1.  $90 \text{ Wm}^{-2}$
  2.  $120 \text{ Wm}^{-2}$
  3.  $65 \text{ Wm}^{-2}$
  4.  $200 \text{ Wm}^{-2}$

Q.13 A parallel plate capacitor is of area  $6 \text{ cm}^2$  and a separation 3 mm. The gap is filled with three dielectric materials of equal thickness (see figure) with dielectric constants  $K_1=10$ ,  $K_2=12$  and  $K_3=14$ . The dielectric constant of a material which when fully inserted in above capacitor, gives same capacitance would be :



- Options
1. 4
  2. 14
  3. 12
  4. 36

Q.14

A charge  $Q$  is distributed over three concentric spherical shells of radii  $a, b, c$  ( $a < b < c$ ) such that their surface charge densities are equal to one another.

The total potential at a point at distance  $r$  from their common centre, where  $r < a$ , would be :

Options

1.  $\frac{Q}{12\pi\epsilon_0} \frac{ab + bc + ca}{abc}$

2.  $\frac{Q(a^2 + b^2 + c^2)}{4\pi\epsilon_0(a^3 + b^3 + c^3)}$

3.  $\frac{Q}{4\pi\epsilon_0(a + b + c)}$

4.  $\frac{Q(a + b + c)}{4\pi\epsilon_0(a^2 + b^2 + c^2)}$

Q.15 Three Carnot engines operate in series between a heat source at a temperature  $T_1$  and a heat sink at temperature  $T_4$  (see figure). There are two other reservoirs at temperature  $T_2$  and  $T_3$ , as shown, with  $T_1 > T_2 > T_3 > T_4$ . The three engines are equally efficient if :

$T_1$

$\epsilon_1$

$T_2$

$\epsilon_2$

$T_3$

$\epsilon_3$

$T_4$

Options

1.  $T_2 = (T_1 T_4)^{1/2}; T_3 = (T_1^2 T_4)^{1/3}$

2.  $T_2 = (T_1^2 T_4)^{1/3}; T_3 = (T_1 T_4^2)^{1/3}$

3.  $T_2 = (T_1 T_4^2)^{1/3}; T_3 = (T_1^2 T_4)^{1/3}$

$$4. T_2 = (T_1^3 T_4)^{1/4}; T_3 = (T_1 T_4^3)^{1/4}$$

Q.16 A satellite is moving with a constant speed  $v$  in circular orbit around the earth. An object of mass ' $m$ ' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of ejection, the kinetic energy of the object is :

- Options
1.  $2 m v^2$
  2.  $m v^2$
  3.  $\frac{1}{2} m v^2$
  4.  $\frac{3}{2} m v^2$

Q.17 Water flows into a large tank with flat bottom at the rate of  $10^{-4} \text{ m}^3 \text{ s}^{-1}$ . Water is also leaking out of a hole of area  $1 \text{ cm}^2$  at its bottom. If the height of the water in the tank remains steady, then this height is :

- Options
1. 5.1 cm
  2. 1.7 cm
  3. 4 cm
  4. 2.9 cm

Q.18

A string of length 1 m and mass 5 g is fixed at both ends. The tension in the string is 8.0 N. The string is set into vibration using an external vibrator of frequency 100 Hz. The separation between successive nodes on the string is close to :

- Options
1. 10.0 cm
  2. 33.3 cm
  3. 16.6 cm
  4. 20.0 cm

Q.19 A train moves towards a stationary observer with speed 34 m/s. The train sounds a whistle and its frequency registered by the observer is  $f_1$ . If the speed of the train is reduced to 17 m/s, the frequency registered is  $f_2$ . If speed of sound is 340 m/s, then the ratio  $f_1/f_2$  is :

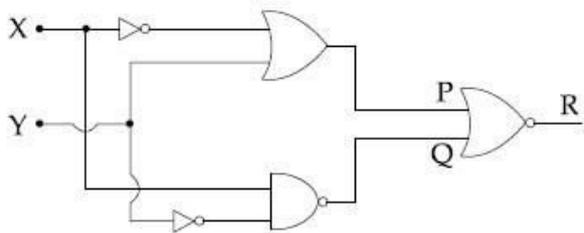
- Options
1. 18/17
  2. 19/18
  3. 20/19
  4. 21/20

Q.20 A plano convex lens of refractive index  $\mu_1$  and focal length  $f_1$  is kept in contact with another plano concave lens of refractive index  $\mu_2$  and focal length  $f_2$ . If the radius of curvature of their spherical faces is R each and  $f_1 = 2f_2$ , then  $\mu_1$  and  $\mu_2$  are related as :

- Options
1.  $\mu_1 + \mu_2 = 3$
  2.  $2\mu_1 - \mu_2 = 1$
  3.  $3\mu_2 - 2\mu_1 = 1$
  4.  $2\mu_2 - \mu_1 = 1$

Q.21

To get output '1' at R, for the given logic gate circuit the input values must be :



- Options
1.  $X=0, Y=1$
  2.  $X=1, Y=1$
  3.  $X=1, Y=0$
  4.  $X=0, Y=0$

Q.22

If the magnetic field of a plane electromagnetic wave is given by (The speed of light =  $3 \times 10^8$  m/s)

$$B = 100 \times 10^{-6} \sin \left[ 2\pi \times 2 \times 10^{15} \left( t - \frac{x}{c} \right) \right]$$

then the maximum electric field associated with it is :

- Options
1.  $6 \times 10^4$  N/C
  2.  $3 \times 10^4$  N/C
  3.  $4 \times 10^4$  N/C
  4.  $4.5 \times 10^4$  N/C

Q.23

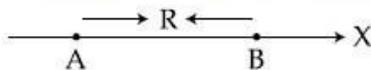
Using a nuclear counter the count rate of emitted particles from a radioactive source is measured. At  $t=0$  it was 1600 counts per second and at  $t=8$  seconds it was 100 counts per second. The count rate observed, as counts per second, at  $t=6$  seconds is close to :

- Options
1. 200
  2. 150
  3. 400
  4. 360

Q.24 A solid metal cube of edge length 2 cm is moving in a positive  $y$ -direction at a constant speed of 6 m/s. There is a uniform magnetic field of 0.1 T in the positive  $z$ -direction. The potential difference between the two faces of the cube perpendicular to the  $x$ -axis, is :

- Options
1. 12 mV
  2. 6 mV
  3. 1 mV
  4. 2 mV

Q.25 Two electric dipoles, A, B with respective dipole moments  $\vec{d}_A = -4qa\hat{i}$  and  $\vec{d}_B = -2qa\hat{i}$  are placed on the  $x$ -axis with a separation  $R$ , as shown in the figure



The distance from A at which both of them produce the same potential is :

- Options
1.  $\frac{R}{\sqrt{2} + 1}$

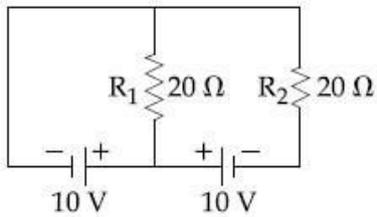
2.  $\frac{\sqrt{2} R}{\sqrt{2} + 1}$

3.  $\frac{R}{\sqrt{2} - 1}$

4.  $\frac{\sqrt{2} R}{\sqrt{2} - 1}$

Q.26

In the given circuit the cells have zero internal resistance. The currents (in Amperes) passing through resistance  $R_1$  and  $R_2$  respectively, are :

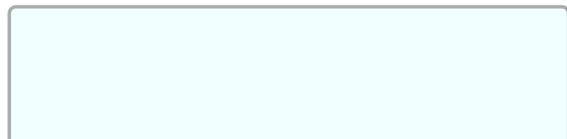


- Options
1. 1, 2
  2. 2, 2
  3. 0.5, 0
  4. 0, 1

Q.27

A 2 W carbon resistor is color coded with green, black, red and brown respectively. The maximum current which can be passed through this resistor is :

- Options
1. 20 mA
  2. 100 mA
  3. 0.4 mA
  4. 63 mA



Q.28 A piece of wood of mass 0.03 kg is dropped from the top of a 100 m height building. At the same time, a bullet of mass 0.02 kg is fired vertically upward, with a velocity  $100 \text{ ms}^{-1}$ , from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is :  
( $g = 10 \text{ ms}^{-2}$ )

- Options
1. 20 m
  2. 30 m
  3. 40 m
  4. 10 m

Q.29 An insulating thin rod of length  $l$  has a linear charge density  $\rho(x) = \rho_0 \frac{x}{l}$  on it. The rod is rotated about an axis passing through the origin ( $x=0$ ) and perpendicular to the rod. If the rod makes  $n$  rotations per second, then the time averaged magnetic moment of the rod is :

- Options
1.  $\pi n \rho l^3$
  2.  $\frac{\pi}{3} n \rho l^3$
  3.  $\frac{\pi}{4} n \rho l^3$
  4.  $n \rho l^3$

Q.30

A homogeneous solid cylindrical roller of radius  $R$  and mass  $M$  is pulled on a cricket pitch by a horizontal force. Assuming rolling without slipping, angular acceleration of the cylinder is :

- Options
1.  $\frac{3F}{2mR}$
  2.  $\frac{F}{3mR}$
  3.  $\frac{F}{2mR}$
  4.  $\frac{2F}{3mR}$

## Section : Chemistry

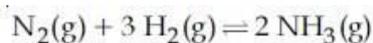
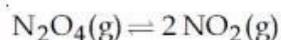
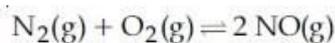
Q.1 The total number of isomers for a square planar complex  $[M(F)(Cl)(SCN)(NO_2)]$  is :

- Options
1. 16
  2. 8
  3. 4
  4. 12

Q.2 A process has  $\Delta H = 200 \text{ J mol}^{-1}$  and  $\Delta S = 40 \text{ JK}^{-1} \text{ mol}^{-1}$ . Out of the values given below, choose the minimum temperature above which the process will be spontaneous :

- Options
1. 20 K
  2. 12 K
  3. 5 K
  4. 4 K

Q.3 The values of  $K_p/K_c$  for the following reactions at 300 K are, respectively :  
(At 300 K,  $RT = 24.62 \text{ dm}^3 \text{ atm mol}^{-1}$ )



- Options
1.  $24.62 \text{ dm}^3 \text{ atm mol}^{-1}$ ,  
 $606.0 \text{ dm}^6 \text{ atm}^2 \text{ mol}^{-2}$
  2.  $24.62 \text{ dm}^3 \text{ atm mol}^{-1}$ ,  
 $1.65 \times 10^{-3} \text{ dm}^{-6} \text{ atm}^{-2} \text{ mol}^2$
  3.  $4.1 \times 10^{-2} \text{ dm}^{-3} \text{ atm}^{-1} \text{ mol}$ ,  
 $606 \text{ dm}^6 \text{ atm}^2 \text{ mol}^{-2}$
  4.  $24.62 \text{ dm}^3 \text{ atm mol}^{-1}$ ,  
 $606.0 \text{ dm}^6 \text{ atm}^2 \text{ mol}^{-2}$ ,  
 $1.65 \times 10^{-3} \text{ dm}^{-6} \text{ atm}^{-2} \text{ mol}^2$

Q.4 The total number of isotopes of hydrogen and number of radioactive isotopes among them, respectively, are :

- Options
1. 3 and 1
  2. 3 and 2
  3. 2 and 1
  4. 2 and 0

Q.5 Water filled in two glasses A and B have BOD values of 10 and 20, respectively. The correct statement regarding them, is :

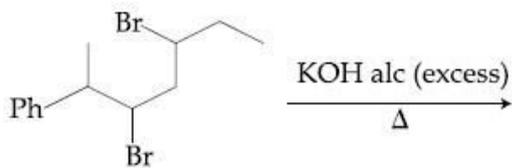
- Options
1. B is more polluted than A.
  2. A is suitable for drinking, whereas B is not.

3. Both A and B are suitable for drinking.
4. A is more polluted than B.

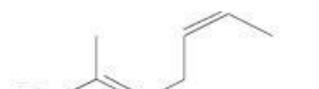
Q.6 Which primitive unit cell has unequal edge lengths ( $a \neq b \neq c$ ) and all axial angles different from  $90^\circ$  ?

- Options
1. Triclinic
  2. Hexagonal
  3. Monoclinic
  4. Tetragonal

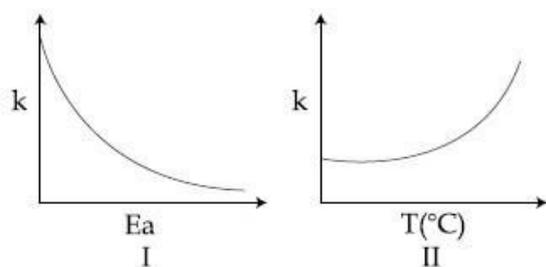
Q.7 The major product of the following reaction is :



Options

1. 
2. 
3. 
4. 

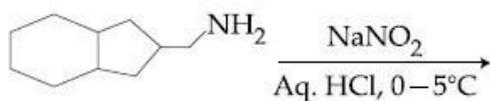
Q.8 Consider the given plots for a reaction obeying Arrhenius equation ( $0^{\circ}\text{C} < T < 300^{\circ}\text{C}$ ) : ( $k$  and  $E_a$  are rate constant and activation energy, respectively)



Choose the correct option :

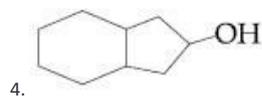
- Options
1. I is right but II is wrong
  2. Both I and II are correct
  3. I is wrong but II is right
  4. Both I and II are wrong

Q.9 The major product formed in the reaction given below will be :



Options

- 1.
- 2.
- 3.



Q.10 Wilkinson catalyst is :

Options

1.  $[(\text{Ph}_3\text{P})_3\text{IrCl}]$
2.  $[(\text{Et}_3\text{P})_3\text{RhCl}]$
3.  $[(\text{Ph}_3\text{P})_3\text{RhCl}]$  (Et =  $\text{C}_2\text{H}_5$ )
4.  $[(\text{Et}_3\text{P})_3\text{IrCl}]$

Q.11 If dichloromethane (DCM) and water ( $\text{H}_2\text{O}$ ) are used for differential extraction, which one of the following statements is correct ?

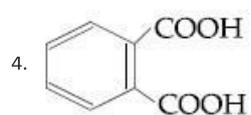
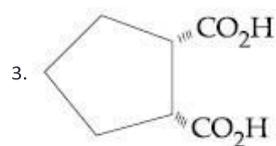
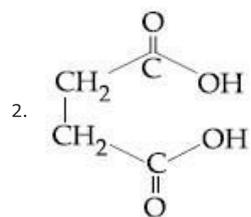
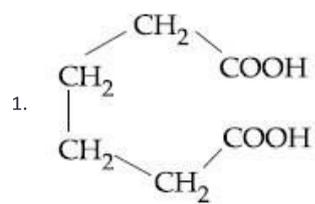
Options

1. DCM and  $\text{H}_2\text{O}$  would stay as lower and upper layer respectively in the S.F.
2. DCM and  $\text{H}_2\text{O}$  will make turbid/colloidal mixture
3. DCM and  $\text{H}_2\text{O}$  would stay as upper and lower layer respectively in the separating funnel (S.F.)
4. DCM and  $\text{H}_2\text{O}$  will be miscible clearly

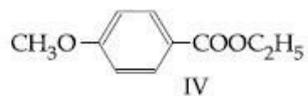
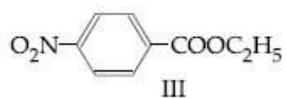
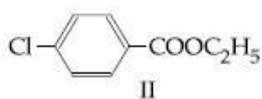
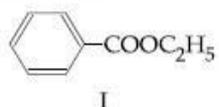
Which dicarboxylic acid in presence of a dehydrating agent is least reactive to give an anhydride ?

Q.12

Options



Q.13 The decreasing order of ease of alkaline hydrolysis for the following esters is



Options 1. III > II > IV > I

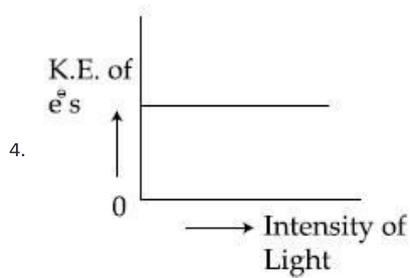
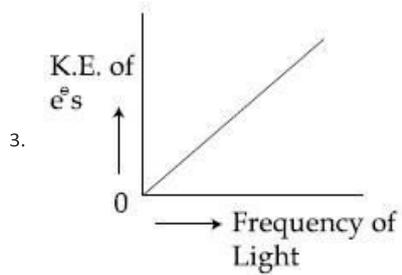
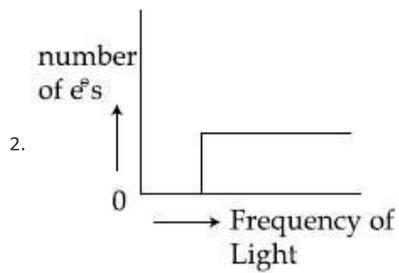
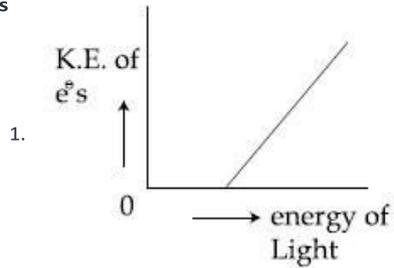
2. III > II > I > IV

3. IV > II > III > I

4. II > III > I > IV

Q.14 Which of the graphs shown below does not represent the relationship between incident light and the electron ejected from metal surface ?

Options



Q.15 Which of the following is not an example of heterogeneous catalytic reaction ?

Options<sub>1</sub>. Ostwald's process

2. Combustion of coal

Haber's process

3.

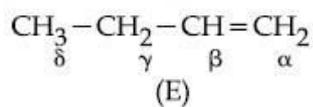
4.

Q.16  
Options

The effect of lanthanoid contraction in the lanthanoid series of elements by and large means :

1. increase in both atomic and ionic radii
2. decrease in atomic radii and increase in ionic radii
3. decrease in both atomic and ionic radii
4. increase in atomic radii and decrease in ionic radii

Which hydrogen in compound (E) is easily replaceable during bromination reaction in presence of light ?



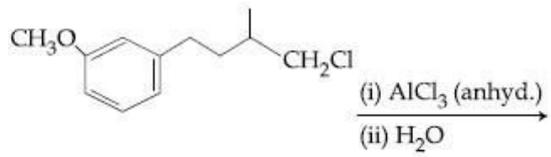
Q.17

Options 1.

1.  $\alpha$  - hydrogen
2.  $\gamma$  - hydrogen
3.  $\delta$  - hydrogen
4.  $\beta$  - hydrogen

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The major product of the following reaction is :



Options

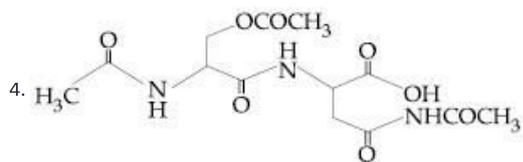
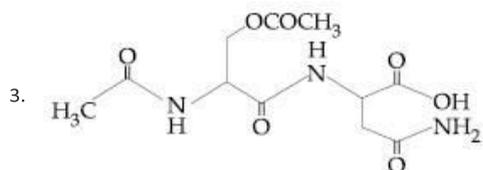
- 1.
- 2.
- 3.
- 4.

Q.19 The correct structure of product 'P' in the following reaction is :



Options

- 1.
- 2.



Q.20 The type of hybridisation and number of lone pair(s) of electrons of Xe in  $\text{XeOF}_4$ , respectively, are :

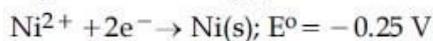
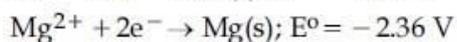
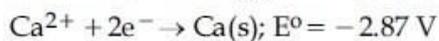
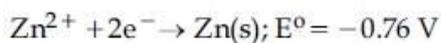
- Options
1.  $\text{sp}^3\text{d}^2$  and 1
  2.  $\text{sp}^3\text{d}$  and 2
  3.  $\text{sp}^3\text{d}^2$  and 2
  4.  $\text{sp}^3\text{d}$  and 1

Q.21 The electronegativity of aluminium is similar to :

- Options
1. Carbon
  2. Beryllium
  3. Boron
  4. Lithium

Q.22

Consider the following reduction processes :



The reducing power of the metals increases in the order :

- Options
1.  $\text{Ca} < \text{Zn} < \text{Mg} < \text{Ni}$
  2.  $\text{Ni} < \text{Zn} < \text{Mg} < \text{Ca}$
  3.  $\text{Zn} < \text{Mg} < \text{Ni} < \text{Ca}$
  4.  $\text{Ca} < \text{Mg} < \text{Zn} < \text{Ni}$

Q.23 The chemical nature of hydrogen peroxide is :

- Options
1. Oxidising agent in acidic medium, but not in basic medium.
  2. Reducing agent in basic medium, but not in acidic medium.
  3. Oxidising and reducing agent in acidic medium, but not in basic medium.
  4. Oxidising and reducing agent in both acidic and basic medium.

Q.24 A mixture of 100 m mol of  $\text{Ca(OH)}_2$  and 2 g of sodium sulphate was dissolved in water and the volume was made up to 100 mL. The mass of calcium sulphate formed and the concentration of  $\text{OH}^{-}$  in resulting solution, respectively, are : (Molar mass of  $\text{Ca(OH)}_2$ ,  $\text{Na}_2\text{SO}_4$  and  $\text{CaSO}_4$  are 74, 143 and 136  $\text{g mol}^{-1}$ , respectively ;  $K_{\text{sp}}$  of  $\text{Ca(OH)}_2$  is  $5.5 \times 10^{-6}$ )

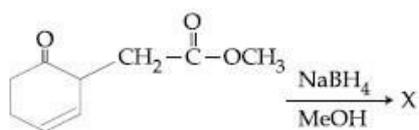
- Options
1. 1.9 g,  $0.28 \text{ mol L}^{-1}$

2. 13.6 g,  $0.28 \text{ mol L}^{-1}$
3. 1.9 g,  $0.14 \text{ mol L}^{-1}$
4. 13.6 g,  $0.14 \text{ mol L}^{-1}$

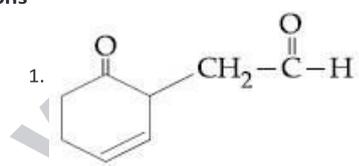
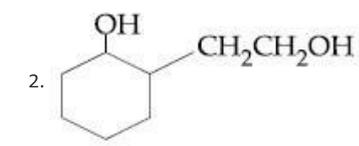
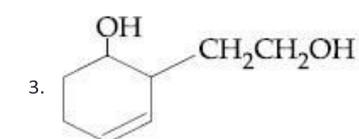
Q.25 Liquids A and B form an ideal solution in the entire composition range. At 350 K, the vapor pressures of pure A and pure B are  $7 \times 10^3 \text{ Pa}$  and  $12 \times 10^3 \text{ Pa}$ , respectively. The composition of the vapor in equilibrium with a solution containing 40 mole percent of A at this temperature is :

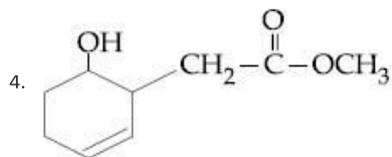
- Options
1.  $x_A = 0.37 ; x_B = 0.63$
  2.  $x_A = 0.28 ; x_B = 0.72$
  3.  $x_A = 0.4 ; x_B = 0.6$
  4.  $x_A = 0.76 ; x_B = 0.24$

Q.26 The major product 'X' formed in the following reaction is :



Options

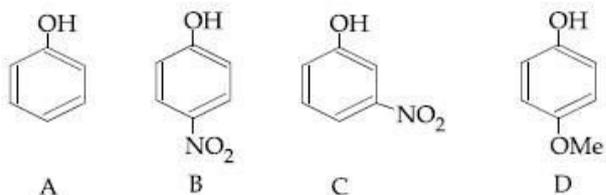
1. 
2. 
3. 



Q.27 The metal used for making X-ray tube window is :

- Options
1. Mg
  2. Na
  3. Be
  4. Ca

Q.28 The increasing order of the pKa values of the following compounds is :



- Options
1.  $C < B < A < D$
  2.  $B < C < D < A$
  3.  $D < A < C < B$
  4.  $B < C < A < D$

Q.29 Hall-Heroult's process is given by :

- Options
1.  $\text{Cu}^{2+}(\text{aq}) + \text{H}_2(\text{g}) \rightarrow \text{Cu}(\text{s}) + 2\text{H}^+(\text{aq})$

- $\text{Cr}_2\text{O}_3 + 2 \text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2 \text{Cr}$
- $2 \text{Al}_2\text{O}_3 + 3 \text{C} \rightarrow 4 \text{Al} + 3 \text{CO}_2$
- $\text{ZnO} + \text{C} \xrightarrow{\text{Coke, 1673 K}} \text{Zn} + \text{CO}$

Q.30 Two pi and half sigma bonds are present in :

Options

- $\text{O}_2^+$
- $\text{N}_2$
- $\text{O}_2$
- $\text{N}_2^+$

## Section : Mathematics

Q.1 An unbiased coin is tossed. If the outcome is a head then a pair of unbiased dice is rolled and the sum of the numbers obtained on them is noted. If the toss of the coin results in tail then a card from a well-shuffled pack of nine cards numbered 1, 2, 3, ..., 9 is randomly picked and the number on the card is noted. The probability that the noted number is either 7 or 8 is :

Options

- $\frac{13}{36}$
- $\frac{15}{72}$
- $\frac{19}{72}$
- $\frac{19}{36}$

Q.2 The shortest distance between the point

$\left(\frac{3}{2}, 0\right)$  and the curve  $y = \sqrt{x}$ , ( $x > 0$ ), is :

Options

1.  $\frac{\sqrt{5}}{2}$

2.  $\frac{\sqrt{3}}{2}$

3.  $\frac{3}{2}$

4.  $\frac{5}{4}$

Q.3 The plane passing through the point  $(4, -1, 2)$  and parallel to the lines

$$\frac{x+2}{3} = \frac{y-2}{-1} = \frac{z+1}{2} \text{ and } \frac{x-2}{1} = \frac{y-3}{2} = \frac{z-4}{3}$$

also passes through the point :

Options 1.  $(1, 1, -1)$

2.  $(1, 1, 1)$

3.  $(-1, -1, -1)$

4.  $(-1, -1, 1)$

Q.4 The mean of five observations is 5 and their variance is 9.20. If three of the given five observations are 1, 3 and 8, then a ratio of other two observations is :

Options 1. 10 : 3

2. 4 : 9

5:8

6:7

3.

4.

Q.5  
Options

If 5, 5r, 5r<sup>2</sup> are the lengths of the sides of a triangle, then r cannot be equal to :

1.  $\frac{3}{4}$

2.  $\frac{5}{4}$

3.  $\frac{7}{4}$

4.  $\frac{3}{2}$

If  $\sum_{i=1}^{20} \left( \frac{{}^{20}C_{i-1}}{{}^{20}C_i + {}^{20}C_{i-1}} \right)^3 = \frac{k}{21}$ , then k

Q.6 equals :

Options 1. 400

2. 50

3. 200

4. 100

The sum of all values of  $\theta \in \left(0, \frac{\pi}{2}\right)$  satisfying

$$\sin^2 2\theta + \cos^4 2\theta = \frac{3}{4} \text{ is :}$$

Q.7

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Options

1.  $\pi$
2.  $\frac{5\pi}{4}$
3.  $\frac{\pi}{2}$
4.  $\frac{3\pi}{8}$

Q.8 Consider the quadratic equation  $(c-5)x^2 - 2cx + (c-4) = 0, c \neq 5$ . Let S be the set of all integral values of c for which one root of the equation lies in the interval  $(0, 2)$  and its other root lies in the interval  $(2, 3)$ . Then the number of elements in S is :

- Options
1. 18
  2. 12
  3. 10
  4. 11

Q.9 If  $\frac{dy}{dx} + \frac{3}{\cos^2 x} y = \frac{1}{\cos^2 x}, x \in \left(-\frac{\pi}{3}, \frac{\pi}{3}\right)$ ,

and  $y\left(\frac{\pi}{4}\right) = \frac{4}{3}$ , then  $y\left(-\frac{\pi}{4}\right)$  equals :

- Options
1.  $\frac{1}{3} + e^6$
  2.  $\frac{1}{3}$
  3.  $-\frac{4}{3}$
  4.  $\frac{1}{3} + e^3$

**Q.10** In a class of 140 students numbered 1 to 140, all even numbered students opted Mathematics course, those whose number is divisible by 3 opted Physics course and those whose number is divisible by 5 opted Chemistry course. Then the number of students who did not opt for any of the three courses is :

- Options**
1. 102
  2. 42
  3. 1
  4. 38

**Q.11** If the third term in the binomial expansion of  $(1+x^{\log_2 x})^5$  equals 2560, then a possible value of  $x$  is :

- Options**
1.  $\frac{1}{4}$
  2.  $4\sqrt{2}$
  3.  $\frac{1}{8}$
  4.  $2\sqrt{2}$

**Q.12** If the parabolas  $y^2 = 4b(x - c)$  and  $y^2 = 8ax$  have a common normal, then which one of the following is a valid choice for the ordered triad  $(a, b, c)$  ?

- Options**
1.  $\left(\frac{1}{2}, 2, 3\right)$

2.  $(1, 1, 3)$

3.  $\left(\frac{1}{2}, 2, 0\right)$

4.  $(1, 1, 0)$

Q.13

If the system of equations

$$x + y + z = 5$$

$$x + 2y + 3z = 9$$

$$x + 3y + \alpha z = \beta$$

has infinitely many solutions, then  $\beta - \alpha$  equals :

Options 1. 21

2. 8

3. 18

4. 5

Q.14

For each  $t \in \mathbf{R}$ , let  $[t]$  be the greatest integer less than or equal to  $t$ . Then,

$$\lim_{x \rightarrow 1^+} \frac{(1 - |x| + \sin |1 - x|) \sin \left( \frac{\pi}{2} [1 - x] \right)}{|1 - x| [1 - x]}$$

Options 1. equals 1

2. equals 0

3. equals  $-1$

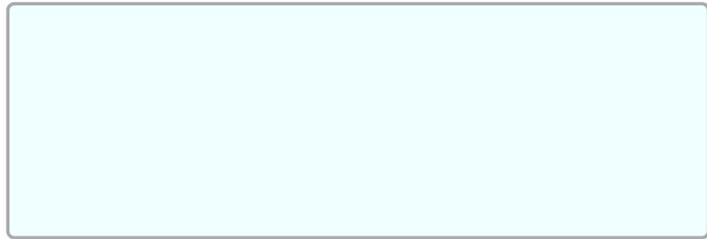
4. does not exist

Q.15 Let  $d \in \mathbb{R}$ , and

$$A = \begin{bmatrix} -2 & 4+d & (\sin \theta) - 2 \\ 1 & (\sin \theta) + 2 & d \\ 5 & (2 \sin \theta) - d & (-\sin \theta) + 2 + 2d \end{bmatrix},$$

$\theta \in [0, 2\pi]$ . If the minimum value of  $\det(A)$  is 8, then a value of  $d$  is :

- Options
1.  $-5$
  2.  $-7$
  3.  $2(\sqrt{2} + 1)$
  4.  $2(\sqrt{2} + 2)$



Q.16 Let  $z_1$  and  $z_2$  be any two non-zero complex numbers such that  $3|z_1| = 4|z_2|$ .

If  $z = \frac{3z_1}{2z_2} + \frac{2z_2}{3z_1}$  then :

- Options
1.  $\operatorname{Re}(z) = 0$
  2.  $|z| = \sqrt{\frac{5}{2}}$
  3.  $|z| = \frac{1}{2} \sqrt{\frac{17}{2}}$
  4.  $\operatorname{Im}(z) = 0$



Q.17 Let  $I = \int_a^b (x^4 - 2x^2) dx$ . If  $I$  is minimum then the ordered pair  $(a, b)$  is :

- Options
1.  $(0, \sqrt{2})$
  2.  $(-\sqrt{2}, 0)$
  3.  $(\sqrt{2}, -\sqrt{2})$

4.  $(-\sqrt{2}, \sqrt{2})$

Q.18  
Options

A point P moves on the line  $2x - 3y + 4 = 0$ .  
If Q(1, 4) and R(3, -2) are fixed points, then  
the locus of the centroid of  $\Delta PQR$  is a line :

1. with slope  $\frac{3}{2}$
2. parallel to  $x$ -axis
3. with slope  $\frac{2}{3}$
4. parallel to  $y$ -axis

Let  $f(x) = \begin{cases} \max\{|x|, x^2\}, & |x| \leq 2 \\ 8 - 2|x|, & 2 < |x| \leq 4 \end{cases}$

Let S be the set of points in the interval  $(-4, 4)$  at which  $f$  is not differentiable.

Then S :

Q.19

- Options
1. is an empty set
  2. equals  $\{-2, -1, 0, 1, 2\}$
  3. equals  $\{-2, -1, 1, 2\}$
  4. equals  $\{-2, 2\}$

If a circle C passing through the point (4, 0) touches the circle  $x^2 + y^2 + 4x - 6y = 12$  externally at the point (1, -1), then the radius of C is :

Q.20

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1.  $2\sqrt{5}$
2. 4
3. 5
4.  $\sqrt{57}$

**Q.21** Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be a function such that  
 $f(x) = x^3 + x^2 f'(1) + x f''(2) + f'''(3), x \in \mathbb{R}$ .  
 Then  $f(2)$  equals :

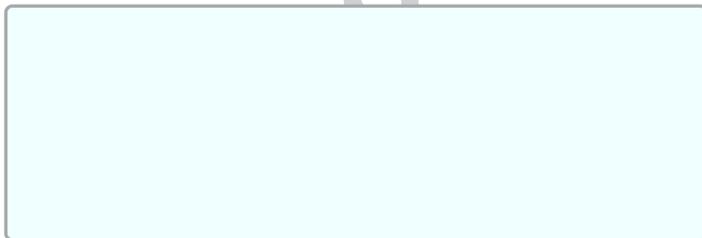
- Options**
1. -4
  2. 30
  3. -2
  4. 8

**Q.22** Let  $\vec{a} = 2\hat{i} + \lambda_1 \hat{j} + 3\hat{k}$ ,  $\vec{b} = 4\hat{i} + (3 - \lambda_2)\hat{j} + 6\hat{k}$   
 and  $\vec{c} = 3\hat{i} + 6\hat{j} + (\lambda_3 - 1)\hat{k}$  be three vectors  
 such that  $\vec{b} = 2\vec{a}$  and  $\vec{a}$  is perpendicular  
 to  $\vec{c}$ . Then a possible value of  $(\lambda_1, \lambda_2, \lambda_3)$   
 is :

- Options**
1. (1, 3, 1)
  2.  $\left(-\frac{1}{2}, 4, 0\right)$
  3.  $\left(\frac{1}{2}, 4, -2\right)$
  4. (1, 5, 1)

Q.23 Let A be a point on the line  $\vec{r} = (1-3\mu)\hat{i} + (\mu-1)\hat{j} + (2+5\mu)\hat{k}$  and B(3, 2, 6) be a point in the space. Then the value of  $\mu$  for which the vector  $\vec{AB}$  is parallel to the plane  $x-4y+3z=1$  is :

- Options
1.  $\frac{1}{4}$
  2.  $\frac{1}{8}$
  3.  $\frac{1}{2}$
  4.  $-\frac{1}{4}$



Q.24 Let  $n \geq 2$  be a natural number and  $0 < \theta < \pi/2$ .

Then  $\int \frac{(\sin^n \theta - \sin \theta)^n \cos \theta}{\sin^{n+1} \theta} d\theta$  is equal to :

(where C is a constant of integration)

- Options
1.  $\frac{n}{n^2-1} \left(1 - \frac{1}{\sin^{n-1} \theta}\right)^{\frac{n+1}{n}} + C$
  2.  $\frac{n}{n^2+1} \left(1 - \frac{1}{\sin^{n-1} \theta}\right)^{\frac{n+1}{n}} + C$
  3.  $\frac{n}{n^2-1} \left(1 + \frac{1}{\sin^{n-1} \theta}\right)^{\frac{n+1}{n}} + C$
  4.  $\frac{n}{n^2-1} \left(1 - \frac{1}{\sin^{n+1} \theta}\right)^{\frac{n+1}{n}} + C$



Q.25 Consider a triangular plot ABC with sides  $AB = 7$  m,  $BC = 5$  m and  $CA = 6$  m. A vertical lamp-post at the mid point D of AC subtends an angle  $30^\circ$  at B. The height (in m) of the lamp-post is :

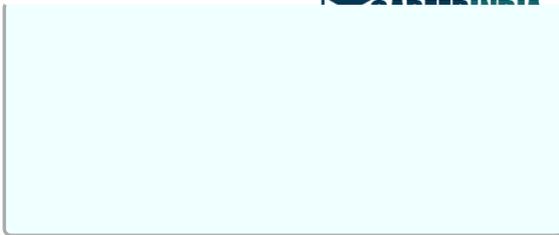
- Options
1.  $\frac{3}{2}\sqrt{21}$
  2.  $\frac{2}{3}\sqrt{21}$
  3.  $2\sqrt{21}$
  4.  $7\sqrt{3}$

Q.26 The equation of a tangent to the hyperbola  $4x^2 - 5y^2 = 20$  parallel to the line  $x - y = 2$  is :

- Options
1.  $x - y + 1 = 0$
  2.  $x - y + 7 = 0$
  3.  $x - y + 9 = 0$
  4.  $x - y - 3 = 0$

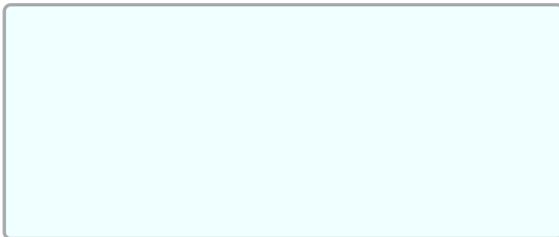
Q.27 If the line  $3x + 4y - 24 = 0$  intersects the  $x$ -axis at the point A and the  $y$ -axis at the point B, then the incentre of the triangle OAB, where O is the origin, is :

- Options
1. (3, 4)
  2. (2, 2)
  3. (4, 3)
  4. (4, 4)



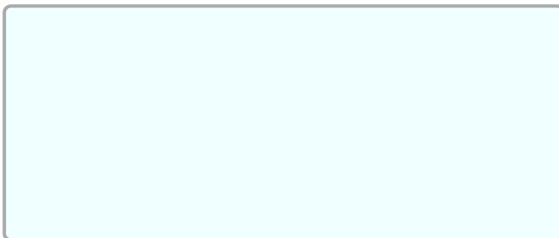
**Q.28** The sum of all two digit positive numbers which when divided by 7 yield 2 or 5 as remainder is :

- Options**
1. 1256
  2. 1465
  3. 1365
  4. 1356



**Q.29** If the area enclosed between the curves  $y = kx^2$  and  $x = ky^2$ , ( $k > 0$ ), is 1 square unit. Then k is :

- Options**
1.  $\frac{\sqrt{3}}{2}$
  2.  $\frac{1}{\sqrt{3}}$
  3.  $\sqrt{3}$
  4.  $\frac{2}{\sqrt{3}}$



**Q.30** Consider the statement : "P(n) :  $n^2 - n + 41$  is prime." Then which one of the following is true ?

- Options**
1. Both P(3) and P(5) are true.
  2. P(3) is false but P(5) is true.
  3. Both P(3) and P(5) are false.
  4. P(5) is false but P(3) is true.



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