

Question Paper

Physics Single Correct (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

A particle executes SHM and is located at $x = a$, $x = b$ and $x = c$, at $t = t_0$, $t = 2t_0$ and $t = 3t_0$ respectively. The angular frequency of oscillation is

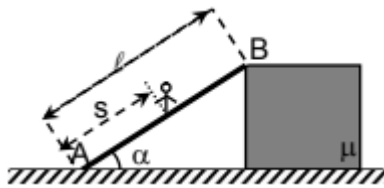
- A. $\frac{1}{t_0} \sin^{-1} \left(\frac{a+c}{2b} \right)$
- B. $\frac{1}{t_0} \sin^{-1} \left(\frac{a+c}{b} \right)$
- C. $\frac{1}{t_0} \cos^{-1} \left(\frac{a+c}{b} \right)$
- D. $\frac{1}{t_0} \cos^{-1} \left(\frac{a+c}{2b} \right)$

Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

A thin rod of mass m_2 and length ℓ is leaning on a block with a mass m_1 at angle α with the horizontal (see figure). What is maximum distance S from A upto which a person of mass M at point A can go on the rod keeping block in equilibrium. It is given that rod is fixed at point A on ground. The coefficient of friction between block and ground is μ .



- A. $S = \left(\frac{\mu m_1}{\sin \alpha - \mu \cos \alpha} - m_2 \cos \alpha \right) \frac{\ell}{M \cos \alpha}$
- B. $S = \left(\frac{\mu m_1}{\sin \alpha + \mu \cos \alpha} - \frac{m_2 \cos \alpha}{2} \right) \frac{\ell}{M \cos \alpha}$
- C. $S = \left(\frac{\mu m_1}{\sin \alpha - \mu \cos \alpha} - \frac{m_2 \cos \alpha}{2} \right) \frac{\ell}{M \cos \alpha}$
- D. $S = \left(\frac{\mu m_1}{\sin \alpha + \mu \cos \alpha} - m_2 \tan \alpha \right) \frac{\ell}{M \cos \alpha}$

Question No. 3

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Each angle of a prism is 60° and the refractive index of a monochromatic light is $\sqrt{3}$. This light is incident at correct angle for minimum deviation. The deviation of the portion of the light which finally emerges from the prism after having one internal reflection.

- A. 120°
- B. 240°
- C. 270°
- D. 180°

Question No. 4

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Two slabs A and B of equal surface area are placed one over the other such that their surface are completely in contact. The thickness of slab A is twice that of B . The coefficient of thermal conductivity of slab A is twice that of B . The first surface of slab A is maintained at 100°C , while the second surface of slab B is maintained at 25°C . The temperature at the contact of their surface is.

- A. 62.5°C
- B. 45°C
- C. 55°C
- D. 85°C

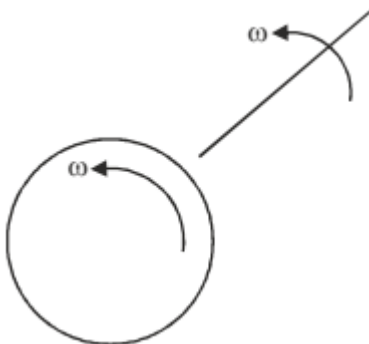
Physics Question Stem (Maximum Marks: 8)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

On a certain planet which is a uniform solid sphere of mass M and Radius R . Due to rotation about its polar axis, ratio of maximum to minimum values of apparent acceleration due to gravity at the surface is $3 : 2$.



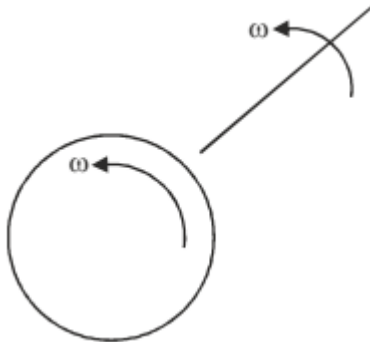
What is the length of a Geostationary satellite which is a vertical uniform rigid rod with its one end very close to planet's surface ? (Make ratio of length and radius as answer)

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

On a certain planet which is a uniform solid sphere of mass M and Radius R . Due to rotation about its polar axis, ratio of maximum to minimum values of apparent acceleration due to gravity at the surface is $3 : 2$.



Ignore the gravitational interaction between the elements of the satellite. If the rod is suddenly stopped and released, then immediately after release (just before collision with earth), what is the ratio of Tension in the rod at the distance of $\frac{\ell}{3}$ and distance of $\frac{2\ell}{3}$?

Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

A village with a demand of 800 kW electric power at 220 V is located 30 km from an electric plant generating power at 440 V . The resistance of the two wire line carrying power is $0.25 \Omega/\text{km}$. The village gets power from the line through a $4000 \text{ V} - 220 \text{ V}$ step down transformer at a sub-station in the village. Assume negligible power loss in the transformers. Estimate the power loss in form of heat in the transmission line. (Mark answer in kW)

Question No. 4

Numerical Type

The answer has to be filled into the input box provided below.

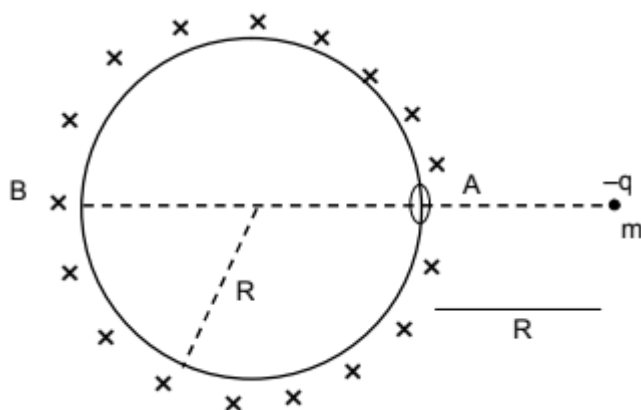
A village with a demand of 800 kW electric power at 220 V is located 30 km from an electric plant generating power at 440 V . The resistance of the two wire line carrying power is $0.25 \Omega/\text{km}$. The village gets power from the line through a $4000 \text{ V} - 220 \text{ V}$ step down transformer at a sub-station in the village. Assume negligible power loss in the transformers. How much power must the plant supply assuming same loss? (Mark answer in kW)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Consider a uniformly charged non conducting, uniform spherical shell of radius R . Net charge on the shell is Q . There is a small hole in the shell at 'A' shown in the figure. A point charge $-q$ is released at a distance $2R$ from the centre as shown in the figure. The shell and point charge have same mass m . After release the point charge will move toward shell, passes through the hole and hit the shell at 'B'. Choose the correct option(s):



- A. The distance traveled by point charge till it hit the shell at B is $\frac{5R}{2}$
- B. Speed of the point charge when it hit the shell is $\sqrt{\frac{kQq}{2mR}}$
- C. Time taken by the point charge to travel from A to B is $\sqrt{\frac{8mR^3}{kQq}}$
- D. The distance traveled by the shell with constant velocity is R

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A radio active nuclei A decays in B with decay constant λ . The nucleus B may further decay in stable nuclei C or D with decay constant λ and 2λ respectively. Initially at $t = 0$, the number of nuclei of A is N_0 and number of all other nuclei is zero. If N_1, N_2, N_3 and N_4 , are number of nuclei of A, B, C and D respectively at any time t . Then select correct relations.

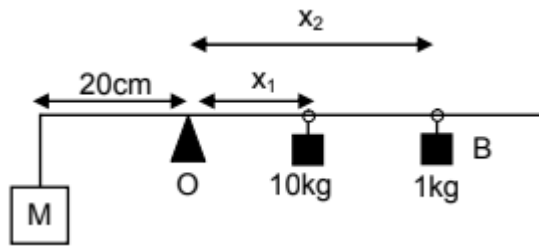
- A. $N_1 = N_0 e^{-\lambda t}$
- B. $N_2 = \frac{N_0}{2} (e^{-\lambda t} - e^{-3\lambda t})$
- C. $N_3 = \frac{1}{2} (N_0 - N_1 - N_2)$
- D. $N_4 = \frac{2}{3} (N_0 - N_1 - N_2)$

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A beam balance with light rod is used to determine the unknown mass M . The rod is hinged from O . Two standard masses $A(10\text{ kg})$ and $B(1\text{ kg})$ can slide on the rod x_1 and x_2 are set to balance the rod in horizontal position and they are measured with maximum permissible error 0.1 cm . Select correct alternatives.



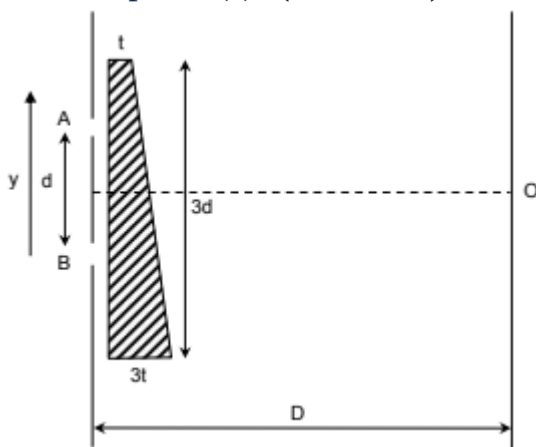
- A. The maximum absolute error in M depends on absolute values of x_1 and x_2 .
If $x_1 = 5.0\text{ cm}$ and $x_2 = 10.0\text{ cm}$ then the maximum permissible error in
- B. M is 0.055 kg
If $x_1 = 10.0\text{ cm}$ and $x_2 = 20.0\text{ cm}$ then percentage error in measurement
- C. of M is approximately 0.9%
The percentage error in measurement of M depend on absolute values of x_1
- D. and x_2

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

In a standard YDSE two slits are covered by a wedge shape film of refractive index μ as shown in the figure. The thickness of film varies linearly from t to $3t$ from one end as shown in the figure. The distance between the two slits is d . The screen is at distance D from slits. White light is used in experiment. Choose the correct option (s): ($d \ll D$)



Select correct alternative(s)

- A. Central maxima is formed at distance $\frac{2t(\mu-1)D}{3d}$ below O
If the film is displaced $\frac{d}{2}$ along $+y$ axis the central maxima will shift away
- B. from O
If the film is displaced $\frac{d}{2}$ along $-y$ -axis the central maxima will shift away
- C. from O

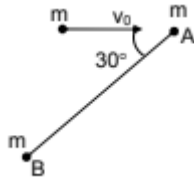
D. If the film is displaced $\frac{d}{2}$ along +y axis the fringe width will remain same

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A particle of mass m strikes another particle A of same mass which is connected to a particle B, also of same mass, by means of a light rigid rod of length L , placed on smooth horizontal surface. Striking particle comes to rest as soon as it strikes A and the line of motion of striking particle makes an angle of 30° with the rod as shown in the figure.



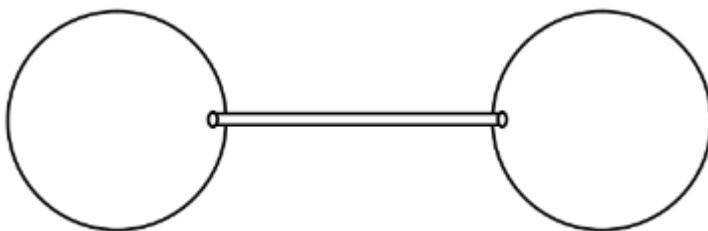
- A. the angular velocity of the rod after impact is $\frac{v_0}{2L}$
- the instantaneous axis of rotation of the rod AB at the instant after the
- B. impact passes through a point which lies on AB
- C. velocity of particle A after the impact would be $\frac{v_0}{4} \sqrt{7}$
- D. the collision between striking particle and particle A is elastic

Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Two spherical soap bubbles in vacuum are connected through a narrow tube. Radius of left bubble is R and that of other is slightly smaller than R . Air flows from right to left very slowly. At any instant r_1, A_1, V_1, n_1 are radius, surface area, volume and number of moles of gas in the left bubble and r_2, A_2, V_2, n_2 are same for right bubble. Assume that temperature remains constant :



Suppose at any instant number of moles in left bubble is 4 times of number of moles in right bubble then select correct statement(s):

- A. $r_2 = R\sqrt{\frac{2}{5}}$
- B. $r_1 = R\sqrt{\frac{8}{5}}$
- C. $A_1 + A_2 = \text{constant}$
- D. $V_1 + V_2 = \text{constant}$

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of the vacuum, and $[\mu_0]$ that of the permeability of the vacuum. If $M =$ mass, $L =$ Length, $T =$ time and $I =$ electric current. Choose the correct option.

- A. $[\epsilon_0] = M^{-1} L^{-3} T^2 I$
- B. $[\epsilon_0] = M^{-1} L^{-3} T^4 I^2$
- C. $[\mu_0] = M L^2 T^{-1} I$
- D. $[\mu_0] = M L T^{-2} I^{-2}$

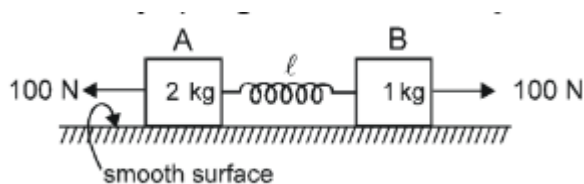
Physics Numerical (Maximum Marks: 12)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

In the figure shown initially spring is in relaxed state & blocks are at rest. Now 100 N force is applied on block A & B as shown in figure. After some time velocity of 'A' becomes 2 m/s and that of 'B' 4 m/s and block A displaced by amount 10 cm towards left and spring is stretched by amount 30 cm. Then work done by spring force on A is W_0 Joule. Find $|W_0|$.

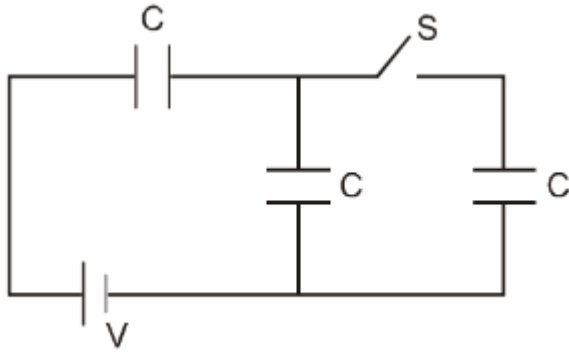


Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

Given circuit is in steady state. Potential energy stored in the capacitors is U . Now switch S is closed. Heat produced after closing the switch S is H . Find $\frac{U}{H}$.

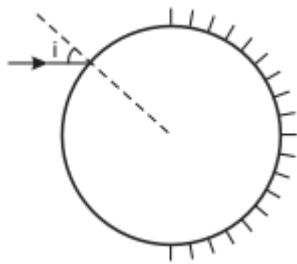


Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

A ray of light is incident on the surface of a sphere of refractive index $\sqrt{7/2}$. Other half of the sphere is silvered. After refraction it is reflected and then refracted out of the sphere again such that the total deviation is minimum. Find :



the angle of incidence of the ray

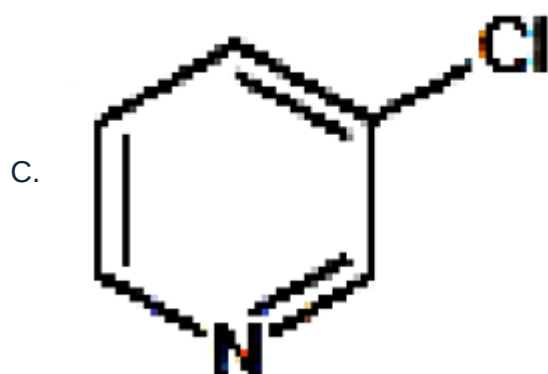
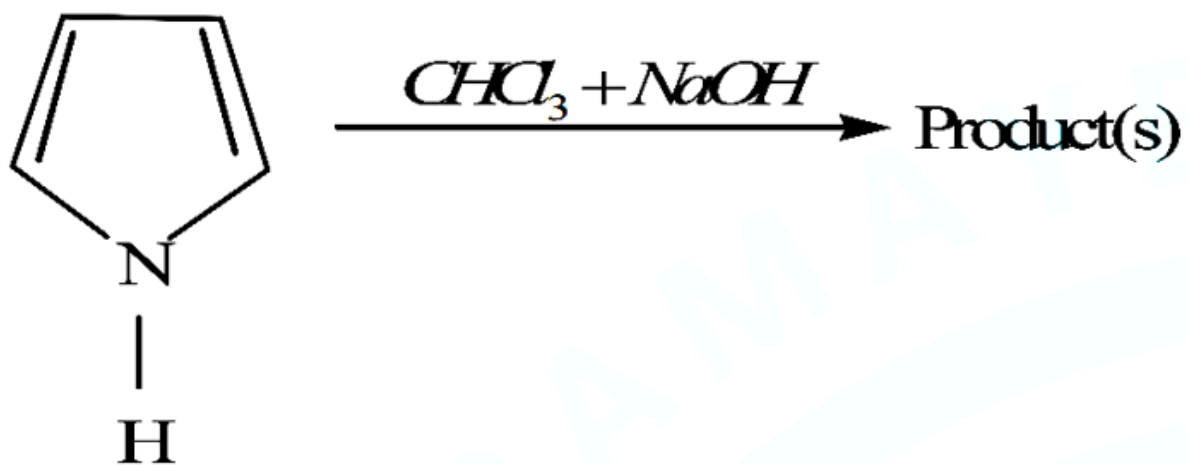
Chemistry Single Correct (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

In the following reaction, the product (s) formed is/are



D.



Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Calculate the pH of a $0.1\text{MK}_3\text{PO}_4$ solution. The third dissociation constant of phosphoric acid is 10^{-12} . Given $(0.41)^{1/2} = 0.64$; $\log 3 = 0.48$

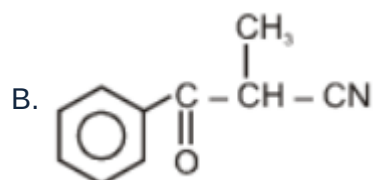
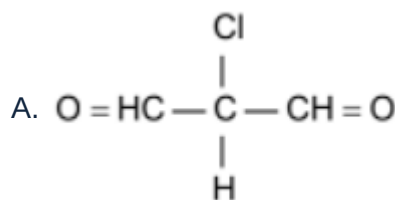
- A. 12.5
- B. 12.44
- C. 12.25
- D. 12

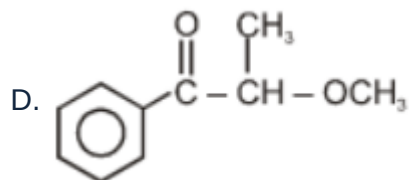
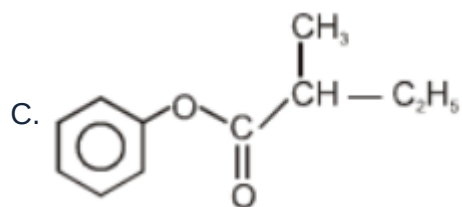
Question No. 3

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Compound 'X' has significant amount of enol 'Y'. 'X' racemises during enolisation. 'X' can be :





Question No. 4

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Radius of 3rd orbit of Li^{2+} ion is x cm then de-Broglie wave length of electrons in 1st orbit is

- A. $\frac{2\pi x}{3}$ cm
- B. $\frac{2\pi x}{9}$ cm
- C. $3\pi x$ cm
- D. $\frac{2\pi x}{6}$ cm

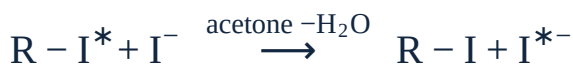
Chemistry Question Stem (Maximum Marks: 8)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

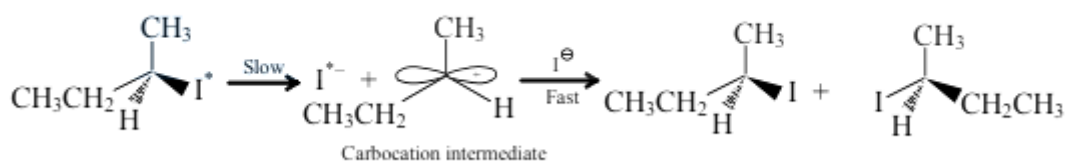
Paragraph : When optically pure 2 -iodobutane having radioactive iodide is treated with non radioactive KI in acetone-water solvent, the following reaction takes place:



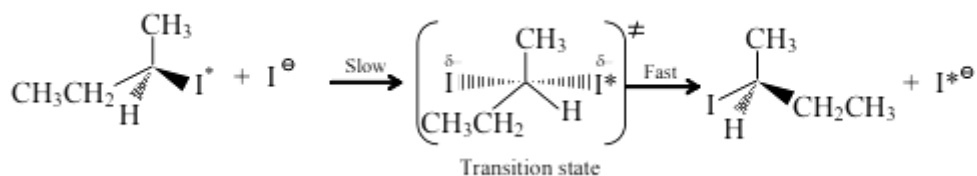
where R is sec-butyl group.

The exchange reaction may occur through S_N1 as well as through S_N2 pathway. These are indicated below:

S_N1 process:



S_N2 process:



To determine the extent of reaction going by S_N1 or S_N2 pathway, the rate of loss of radioactivity in the substrate is measured and compared with the rate of loss of optical activity or rate of racemization. Assume that the optical rotation of radioactive 2 -iodobutane and nonradioactive 2 -iodobutane are same.

Question : If the rate law at 30°C is given as

$$\text{Rate} = 3 \times 10^{-5} [2\text{-iodobutane}^*][I^-] + 1 \times 10^{-5} [2\text{-iodobutane}^*]$$

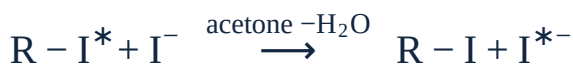
What percentage of the reaction takes place by S_N2 mechanism if $[I^-] = 1.00\text{M}$?

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

Paragraph : When optically pure 2-iodobutane having radioactive iodide is treated with non radioactive KI in acetone-water solvent, the following reaction takes place:



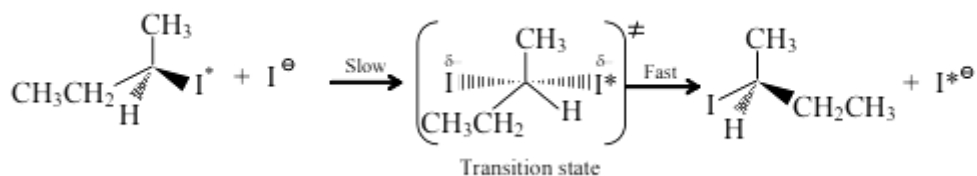
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S_N1 process:



S_N2 process:



To determine the extent of reaction going by S_N1 or S_N2 pathway, the rate of loss of radioactivity in the substrate is measured and compared with the rate of loss of optical activity or rate of racemization. Assume that the optical rotation of radioactive 2-iodobutane and nonradioactive 2-iodobutane are same.

Question : In one such experiment starting with optically pure radioactive 2-iodobutane, the rate of racemization was found to be 1.75 times the rate of loss of radioactivity of the substrate. The percentage of reaction that proceeded by S_N1 mechanism is

Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

Paragraph:

A diprotic acid (A) produces CO & CO₂ gas in 1 : 1 molar ratio on reaction with conc. H₂SO₄. The soluble salt of bivalent anion of (A) is capable to produce white precipitate with CaCl₂(aq.) which is insoluble in acetic acid. 9 gm of (A) is dissolved in water to make 1000 ml solution. 200 ml of this solution is mixed with 2.56 gm potassium salt of monovalent ion of (A) to make solution (B) without change in volume of solution. (pK_{a1} of A = 3, pK_{a2} of A = 6)

Question:

Find pH of the resultant solution at $\frac{1}{3}$ rd neutralization, if (B) is titrated against 0.1 M KOH solution.

Question No. 4

Numerical Type

The answer has to be filled into the input box provided below.

Paragraph:

A diprotic acid (A) produces CO & CO₂ gas in 1 : 1 molar ratio on reaction with conc. H₂SO₄. The soluble salt of bivalent anion of (A) is capable to produce white precipitate with CaCl₂(aq.) which is insoluble in acetic acid. 9 gm of (A) is dissolved in water to make 1000 ml solution. 200 ml of this solution is mixed with 2.56 gm potassium salt of monovalent ion of (A) to make solution (B) without change in volume of solution. (pK_{a1} of A = 3, pK_{a2} of A = 6)

Question:

Find the ratio of volume of 0.2 M KMnO₄ solution to completely titrate the solution (B) in redox titration & volume of $\frac{3}{8}$ M NaOH to completely titrate the solution (B) in acid-base titration.

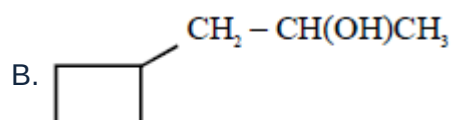
Chemistry Multiple Correct (Maximum Marks: 28)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following compound(s) can produce a precipitate of CHI₃ when react with NaOH/I₂ ?



- c. $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_3$
 d. $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

The standard reduction potential data at 25°C is given below.

$$E^\circ(\text{Fe}^{3+} \cdot \text{Fe}^{2+}) = +0.77 \text{ V} ;$$

$$E^\circ(\text{Fe}^{2+} \cdot \text{Fe}) = -0.44 \text{ V} ;$$

$$E^\circ(\text{Cu}^{2+} \cdot \text{Cu}) = +0.34 \text{ V} ;$$

$$E^\circ(\text{Cu}^+ \cdot \text{Cu}) = +0.52 \text{ V};$$

$$E^\circ(\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}) = +1.23 \text{ V} ;$$

$$E^\circ(\text{O}_2(\text{g}) + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-) = +0.40 \text{ V}$$

$$E^\circ(\text{Cr}^{3+} \cdot \text{Cr}) = -0.74 \text{ V};$$

$$E^\circ(\text{Cr}^{2+} \cdot \text{Cr}) = -0.91 \text{ V}$$

Which of the following statements is/are correct on the basis of above data :

- A. O_2 is a better oxidising agent in acidic medium.
 B. Cr^{2+} show disproportionation to Cr and Cr^{3+} in water.
 C. O_2 oxidises Fe^{2+} to Fe^{3+} in acidic medium.
 D. Cu^+ oxidises Fe to Fe^{2+} and H_2O to O_2 in acidic medium.

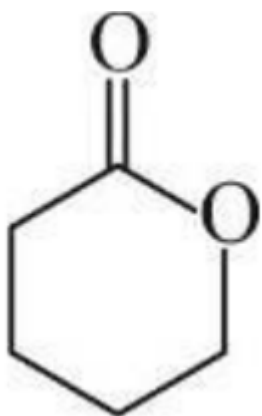
Question No. 3

One or More Options Correct Type

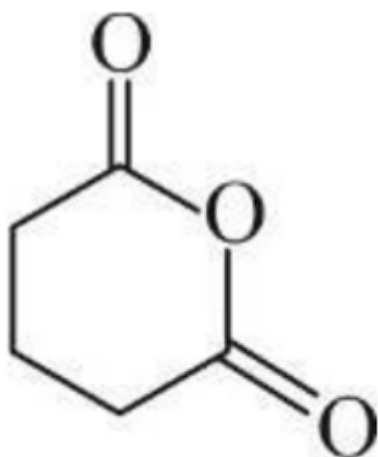
The question has multiple options out of which ONE or MORE is/are correct.

The compound(s) that are soluble in hot aq. NaOH is/are:

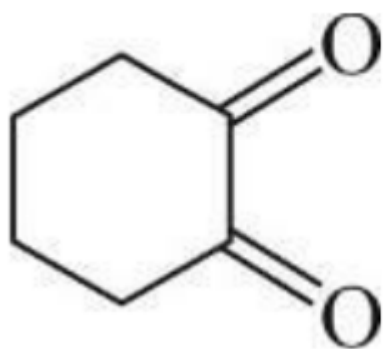
A.



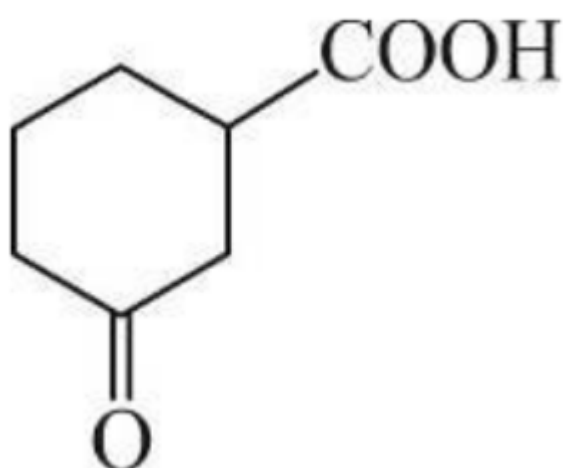
B.



C.



D.



Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Pyrolusite is MnO_2 used to prepare KMnO_4 . Steps are,

$\text{MnO}_2 \xrightarrow{\text{I}} \text{MnO}_4^{2-} \xrightarrow{\text{II}} \text{MnO}_4^-$. Steps I and II are respectively :

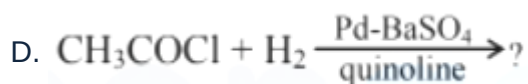
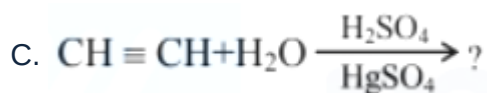
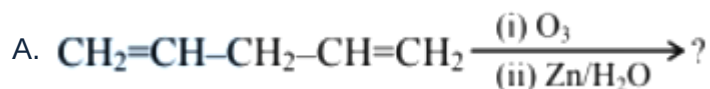
- A. fuse with KOH / air and electrolytic oxidation.
- B. fuse with KOH/KNO_3 and electrolytic oxidation.
- C. fuse with conc. HNO_3 / air and electrolytic reduction.
- D. dissolve in H_2O and oxidation.

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following reactions will produce acetaldehyde only (or as one of the product)?

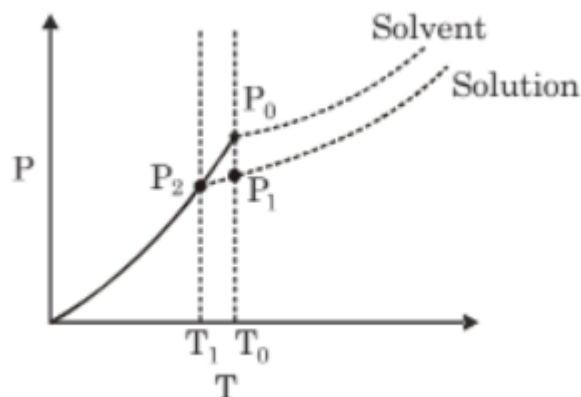


Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

From the phase diagram of water and an aqueous solution containing non volatile solute, identify the correct options:



At temperature T_0 , vapour pressure of solid solvent and vapour pressure of
A. liquid solvent will be same.

B. Order of vapour pressure (P_0, P_1, P_2) are $P_0 > P_1 > P_2$.

C. $P_0 = P_2 e^{\frac{\Delta H_{\text{fusion}}}{R} \frac{[T_0 - T_1]}{T_0 T_1}}$

D. $P_1 = P_2 e^{\frac{\Delta H_{\text{vap}}}{R} \frac{[T_0 - T_1]}{T_0 T_1}}$

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following statements are true?

- A. ClO_2 in alkaline solution undergoes disproportionation.
- B. Ionisation enthalpy of molecular oxygen is very close to that of xenon.
- C. Hydrolysis of XeF_6 may involve a redox reaction.
- D. Both P_4O_6 and P_4O_{10} contain 12 P – O bonds

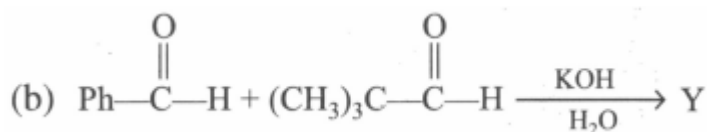
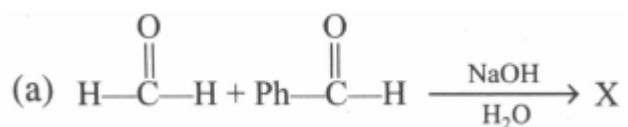
Chemistry Numerical (Maximum Marks: 12)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

Find out the number of products obtained by cross Cannizzaro's reaction between the



What is $\text{X} + \text{Y}$?

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

In the following sequence of reactions, the amount of D (in g) formed from 72 g of Mg is

(The yield (%) corresponding to the product in each step is given in the parenthesis)



Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

Total number of complexes among the following which are optically active?



Mathematics Single Correct (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

The value of $\lim_{x \rightarrow \infty} \frac{2(x)^{1/2} + 3(x)^{1/3} + 4(x)^{1/4} + \dots + (x)^{1/n}}{(2x-3)^{1/2} + (2x-3)^{1/3} + \dots + (2x-3)^{1/n}}$ is

- A. $\sqrt{2}$
- B. 2
- C. $\frac{1}{\sqrt{3}}$
- D. 0

Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

A function $f : \mathbb{R} \rightarrow \mathbb{R}$ satisfies the differential equation $2xy + (1 + x^2)y' = 1$, where $f(0) = 0$, then

- A. $f(x)$ is odd
- B. $f(x) = 1$ has no real solution
- C. $f(x) = -1$ has no real solution
- D. All of the above

Question No. 3

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

A semicircle is contained in a square of unit side, then maximum value of its radius is -

- A. $\frac{1}{2}$
- B. $2 - \sqrt{2}$
- C. $3 - \sqrt{5}$
- D. $6 - \sqrt{32}$

Question No. 4

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

The value of definite integral $\int_{\frac{-1}{\sqrt{3}}}^{\frac{1}{\sqrt{3}}} \frac{\cos^{-1}\left(\frac{2x}{1+x^2}\right) + \tan^{-1}\left(\frac{2x}{1-x^2}\right)}{e^x + 1} dx$ is equal to:

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

Mathematics Question Stem (Maximum Marks: 8)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

Paragraph:

Let $A_1, A_2, A_3, \dots, A_n$ be regular polygon of n sides whose centre is at origin O . Let the complex numbers representing vertices $A_1, A_2, A_3, \dots, A_n$ be z_1, z_2, \dots, z_n respectively.

Let $OA_1 = OA_2 = \dots = OA_n = 1$.

Question:

The value of $|A_1A_2||A_1A_3| \dots |A_1A_n|$ must be (assume value of $n = 10$)

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

Paragraph:

Let $A_1, A_2, A_3, \dots, A_n$ be regular polygon of n sides whose centre is at origin O . Let the complex numbers representing vertices $A_1, A_2, A_3, \dots, A_n$ be z_1, z_2, \dots, z_n respectively.

Let $OA_1 = OA_2 = \dots = OA_n = 1$.

Question:

The value of $|A_1A_2|^2 + |A_1A_3|^2 + \dots + |A_1A_n|^2$ is (assume value of $n = 10$)

Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

A function $f(x)$ having the following properties:

(i) $f(x)$ is continuous except at $x = 3$

(ii) $f(x)$ is differentiable except at $x = -2$ and $x = 3$

(iii) $f(0) = 0, \lim_{x \rightarrow 3} f(x) \rightarrow -\infty, \lim_{x \rightarrow -\infty} f(x) = 3, \lim_{x \rightarrow \infty} f(x) = 0$

(iv) $f'(x) > 0 \forall x \in (-\infty, -2) \cup (3, \infty)$ and $f'(x) \leq 0 \forall x \in (-2, 3)$

(v) $f''(x) > 0 \forall x \in (-\infty, -2) \cup (-2, 0)$ and $f''(x) < 0 \forall x \in (0, 3) \cup (3, \infty)$

The maximum possible number of solutions of $f(x) = |x|$ is(are)

Question No. 4

Numerical Type

The answer has to be filled into the input box provided below.

A function $f(x)$ having the following properties:

(i) $f(x)$ is continuous except at $x = 3$

(ii) $f(x)$ is differentiable except at $x = -2$ and $x = 3$

(iii) $f(0) = 0, \lim_{x \rightarrow 3} f(x) \rightarrow -\infty, \lim_{x \rightarrow -\infty} f(x) = 3, \lim_{x \rightarrow \infty} f(x) = 0$

(iv) $f'(x) > 0 \forall x \in (-\infty, -2) \cup (3, \infty)$ and $f'(x) \leq 0 \forall x \in (-2, 3)$

(v) $f''(x) > 0 \forall x \in (-\infty, -2) \cup (-2, 0)$ and
 $f''(x) < 0 \forall x \in (0, 3) \cup (3, \infty)$

If $f'(0) = 0$, the graph of function $y = f(-|x|)$ is non-differentiable at

Mathematics Multiple Correct (Maximum Marks: 28)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let $A = \begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \end{bmatrix}$ be a non-singular square matrix such that $A \begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$.

Let on xy plane, the distance between points $A(x_1, y_1)$ and $B(x_2, y_2)$ is ' d ' and the point having coordinates (α, β) is situated at distance ' p ' from the origin (O) , then the area of $\triangle OAB$, is

- A. pd
- B. $\frac{1}{2} pd$
- C. $\frac{d}{2p}$
- D. $\frac{p}{2d}$

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let ' C ' be the chord of a circle ' S ' of radius r which subtends angle $\frac{2\pi}{3}$ at the centre of S . If ' R ' represents the region consisting of all points inside S which are closer to C than to the circumference of S , then

- A. Area of R is $\frac{2}{\sqrt{3}} r^2$
- B. Area of R is $\frac{\sqrt{3}}{2} r^2$
- C. C divides the region R in the ratio $1 : 3$
- D. C divides the region R in the ratio $1 : 4$

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

From a point on $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, two tangents are drawn to $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and the corresponding chord of contact meets $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 0$ at points Q and R then

A. The locus of mid-point of QR is $x^2 + y^2 = a^2$

B. The locus of mid-point of QR is $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

C. The locus of image of mid-point of QR in x -axis is $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

The locus of foot of perpendicular from point $(\sqrt{a^2 + b^2}, 0)$ to QR is

D. $x^2 + y^2 = a^2$

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following functions is an injective (one-one) function in their respective domain?

A. $f(x) = 2017x + \sin 2018x$

B. $f(x) = 2018x + \sin 2017x$

C. $f(x) = \frac{2^x - 1}{4^x + 1}$

D. $f(x) = \frac{2^x + 1}{4^x - 1}$

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Consider a cube of side length 9 units. Let (x, y, z) be coordinates of points on or inside the cube such that $x, y, z \in I$ and $0 \leq x, y, z \leq 9$. If total number of ways of selecting two distinct points among these such that their mid-point is also having integral coordinates is N , then

A. N is divisible by 30

B. N is divisible by 31

C. N is divisible by 32

D. Number of factors of N is 40

Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

If a, b, c be three unequal positive numbers in HP, then

- A. $a^4 + c^4 > 2b^4$
- B. $a^5 + c^5 > 2b^5$
- C. $a^{100} + c^{100} > 2b^{100}$
- D. $a^3 + c^3 > 2b^3$

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

The value of the definite integral $\int_{-\infty}^a \frac{(\sin^{-1} e^x + \sec^{-1} e^{-x})}{(\tan^{-1} e^a + \tan^{-1} e^x)(e^x + e^{-x})} dx$ (where $a \in R$) is

- A. Independent of a
- B. dependent on a
- C. $\frac{\pi}{2} \ln 2$
- D. $\frac{\pi}{2} \ln 2(2\tan^{-1} e^a)$

Mathematics Numerical (Maximum Marks: 12)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

ABCD is a tetrahedron and O be any point. If the lines joining O to the vertices meet the opposite faces in P, Q, R, S respectively, then

$$\frac{OP}{AP} + \frac{OQ}{BQ} + \frac{OR}{CR} + \frac{OS}{DS} =$$

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

Let $(2x^2 + 3x + 4)^{10} = \sum_{r=0}^{20} a_r x^r$ where $a_0, a_1, a_2, \dots, a_{20}$ are constant, then find the value of $\frac{a_7}{a_{13}}$

Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

In a $\triangle ABC$, least value of $\frac{e^A}{A} + \frac{e^B}{B} + \frac{e^C}{C}$ is equal to of the form $\frac{K}{\pi} e^{\frac{\pi}{3}}$, then find the value of K