Question Paper

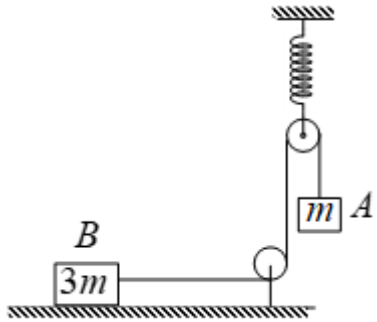
Physics Numerical (Maximum Marks: 28)

Question No. 1

Numerical Type

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

In the given figure, string, spring and pulleys are massless. Block A is performing SHM of amplitude 1 m and time period $\pi/2$sec . If block B remains at rest, then minimum value of co-efficient of friction between block B and surface will be K , find 30 K. (g = 10 m/s^2)



Question No. 2

Numerical Type

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

In Coolidge tube experiment, if applied voltage is increased to three times, the short wavelength limit of continuous X-ray spectrum shifts by 20pm. What is the initial voltage applied to the tube in kV ? (nearest integer)

Question No. 3

Numerical Type

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

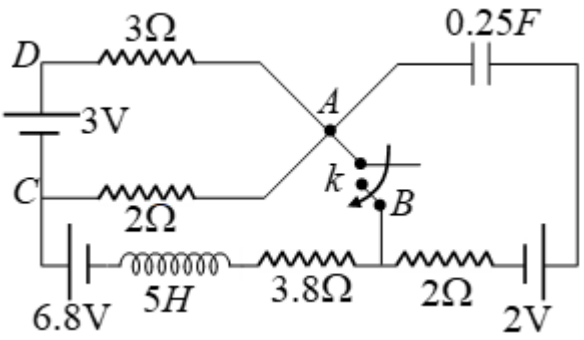
A wheel of mass m can be assumed to be a ring. Its radius is R. It is on a level ground. An external couple is applied to it about its axis. $\tau = \frac{mgR}{2}$. If it rolls purely, what is the friction force exerted by the ground. (Ans in N) (Take mass = 8 kg)

Question No. 4

Numerical Type

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

In the circuit shown in the figure if the key k is closed at the instant $t = 0$, then the minimum current in mA through the switch (key) is $160n$. Find the value of $n(\ln \frac{4}{5} = 0.47)$



Question No. 5

Numerical Type

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

The element curium ${}_{96}\mathrm{Cm}^{248}$ has a mean life of 10^{13} second. Its primary decay modes are spontaneous fission and α-decay, the former with a probability of 8% and the latter with a probability of 92%. Each fission releases 200MeV of energy. The mass involved in decay are as follows:
${}_{96}\mathrm{Cm}^{248} = 248.072220u$, ${}_{2}\mathrm{He}^{4} = 4.002603u$ and ${}_{94}\mathrm{Pu}^{244} = 244.064100u$.
If the power output in microwatt from a sample of $10^{20}\mathrm{Cm}$ atoms is P then, find the approx value of $\frac{P}{11}$. (nearest integer in μW)(Given $1u = 931\mathrm{MeV}/c^2$.)

Question No. 6

Numerical Type

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

A particle is projected up an inclined plane of inclination β at an elevation of α to the horizontal. Find the ratio between α and β, if the particle strikes the plane horizontally.

Question No. 7

Numerical Type

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

Two parallel wires carrying equal currents in opposite directions are placed at $x = \pm \ a$ parallel to y-axis with $z = 0$. Magnetic field at origin O is B_1 and at $P(2a, 0, 0)$ is B_2. Then, the ratio B_1/B_2 is

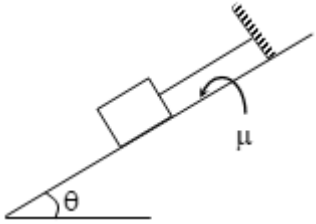
Physics Multiple Correct (Maximum Marks: 28)

Question No. 1

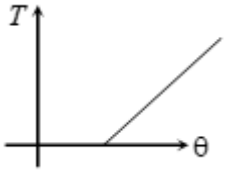
One or More Options Correct Type

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

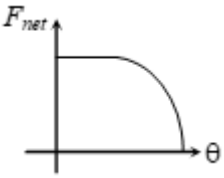
A block of mass m is put on a rough inclined plane of inclination θ and is attached with a light thread as shown. Inclination θ is increased gradually from $\theta = 0^\circ$ to $\theta = 90^\circ$ then



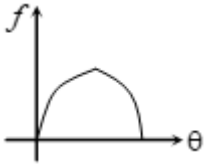
Tension in the thread versus θ has the following graph

A. 

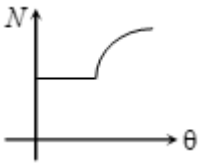
Net interaction force between the block and the incline versus θ has the following graph

B. 

Friction force between the block and the incline versus θ graph is

C. 

Normal reaction between the block and the incline versus θ graph is

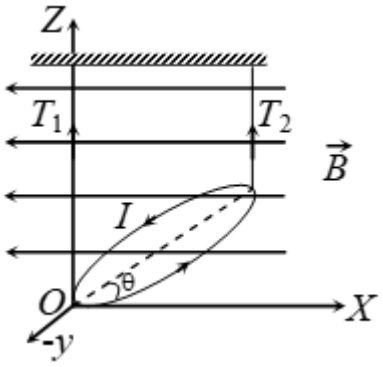
D. 

Question No. 2

One or More Options Correct Type

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

A current carrying circular coil of single turn of mass m is hanging by two ideal strings as shown in the figure. A constant magnetic field $\vec{B}$ is set up in the horizontal direction. Then [given $\pi BIR = \frac{mg}{4}$ and $\theta = 45^\circ$]



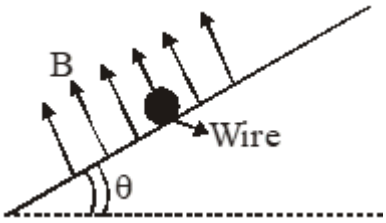
A. $T_1 = \frac{3mg}{8}$
B. $T_1 = \frac{5mg}{8}$
C. $T_2 = \frac{3mg}{8}$
D. $T_2 = \frac{5mg}{8}$

Question No. 3

One or More Options Correct Type

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

A wire of mass m and length ℓ is placed on a smooth incline making an angle θ with the horizontal, whose front view is shown in figure. When a finite amount of charge is passed through it in an infinitesimal time, the wire immediately acquires some velocity v and then ascends the incline by a distance s. For this small duration, we can neglect the gravity force because the current can be considered very large due to small time duration. The amount of charge passed through the wire is



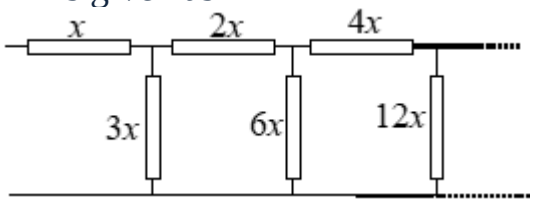
A. $\frac{m\sqrt{2gs\sin\theta}}{B\ell}$
B. $\frac{mv}{B\ell}$
C. $\frac{m\sqrt{2gs\sin\theta}}{B\ell\cos\theta}$
D. information insufficient

Question No. 4

One or More Options Correct Type

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

In the given infinite circuit. The equivalent quantity (x_{eq}) of the circuit across AB is given as



A. If x represents a resistance then $x_{eq} = 3x$
B. If x represents a inductor then $x_{eq} = 3x$
C. If x represents a capacitor then $x_{eq} = x/3$
D. all of the above

Question No. 5

One or More Options Correct Type

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

A thin spherical glass lens produces a real three times laterally magnified image of an object, when the whole system is in air. If the system, with the same distance between the object and the lens, is immersed in water. ($\mu_{glass} = 3/2$ and $\mu_{water} = 4/3$)

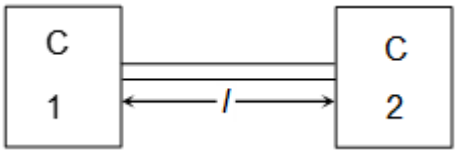
A. the focal length of the lens increases to 4 times its original value.
B. the power of the lens increases to 4 times its original value.
C. a real magnified image of the object will be formed.
D. a virtual magnified image of the object will be formed.

Question No. 6

One or More Options Correct Type

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

Two bodies each having a heat capacity of $C = 500$ J/K are joined together by a rod of length $L = 40.0$ cm , thermal conductivity 20 W/mK and cross-sectional area of $S = 3.00$ cm^2. The bodies are joined with the help of a thermally insulated rod. The time (in min) after which temperature difference diminishes $\eta = 2$ times is (Disregard the heat capacity of the rod)



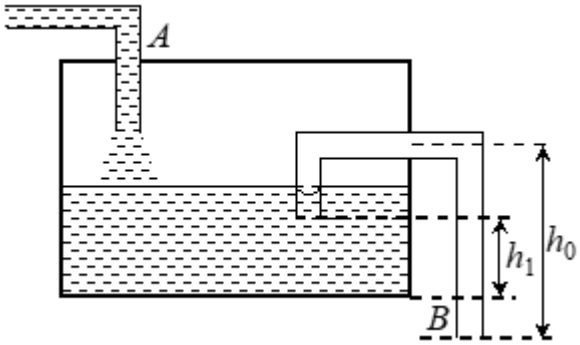
A. > 180 min
B. < 200 min
C. < 190 min
D. > 190 min

Question No. 7

One or More Options Correct Type

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

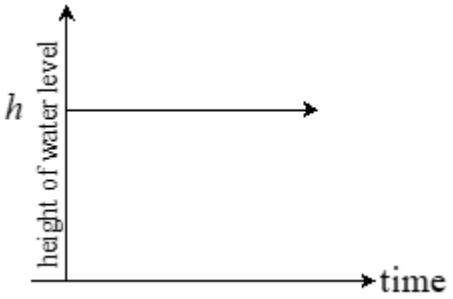
In the given figure velocity of the water flowing from infeed pipe A is less than the velocity of water flowing from the siphon B, then choose the correct options



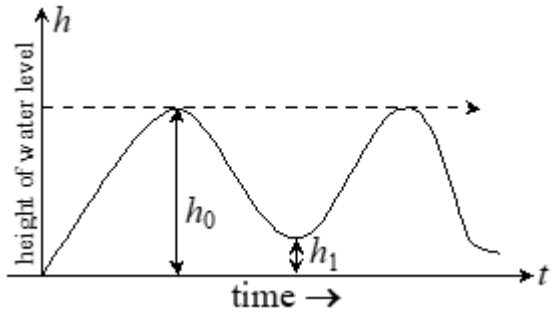
A. the water level will rise to a particular height and stays there itself

B. the water level will perform periodic oscillatory motion

C.



D.



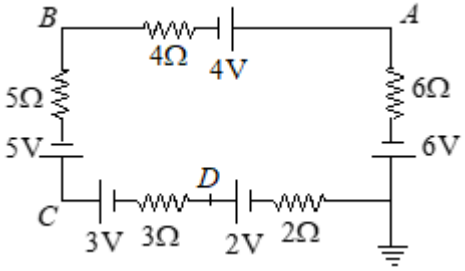
Physics Question Stem (Maximum Marks: 8)

Question No. 1

Numerical Type

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

In the given figure, all the batteries are ideal.



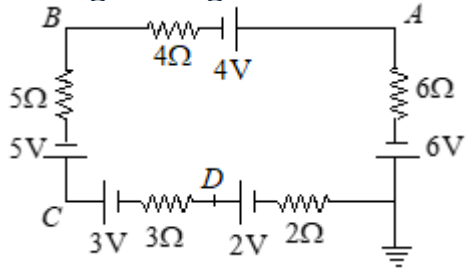
Potential of point C (in V) is

Question No. 2

Numerical Type

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

In the given figure, all the batteries are ideal.



Potential of point A (in V) is K, find -2 K .

Question No. 3

Numerical Type

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

An incident wave $y = A\sin(ax + bt + \frac{\pi}{2})$ is reflected by a rigid obstacle at $x = 0$ which reduces intensity of reflected wave by 36%. Due to superposition, the resulting wave consists of a standing wave and a traveling wave, which is given by $Y = -dA\sin ax \cdot \sin bt + cA\cos(bt + ax)$ where A, a, b, c are positive constants.
Amplitude of reflected wave is _____ A

Question No. 4

Numerical Type

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

An incident wave $y = A\sin(ax + bt + \frac{\pi}{2})$ is reflected by a rigid obstacle at $x = 0$ which reduces intensity of reflected wave by 36%. Due to superposition, the resulting wave consists of a standing wave and a traveling wave, which is given by $Y = -dA\sin ax \cdot \sin bt + cA\cos(bt + ax)$ where A, a, b, c are positive constants.
Value of c is _____

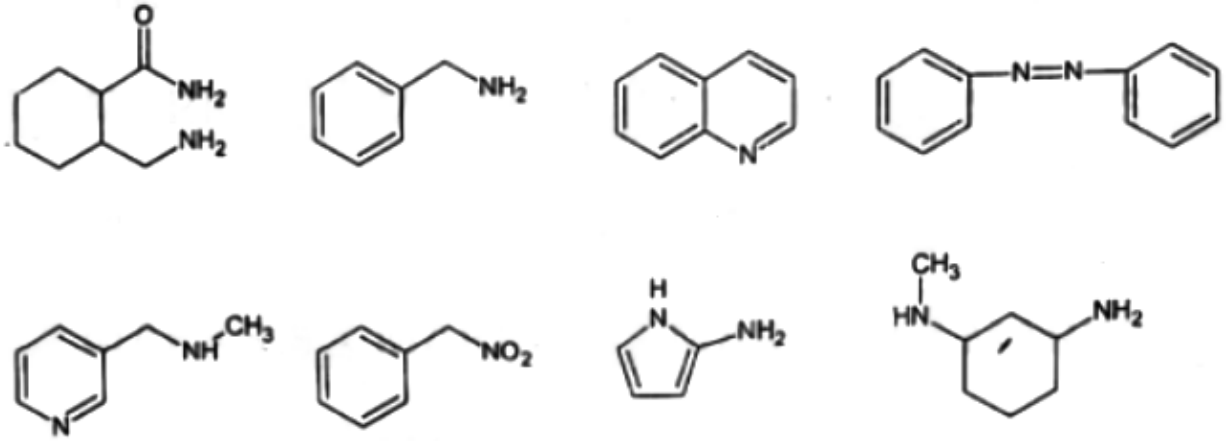
Chemistry Numerical (Maximum Marks: 28)

Question No. 1

Numerical Type

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

In how many of the following molecules, nitrogen can be estimated completely by using Kjeldhal method?



Question No. 2

Numerical Type

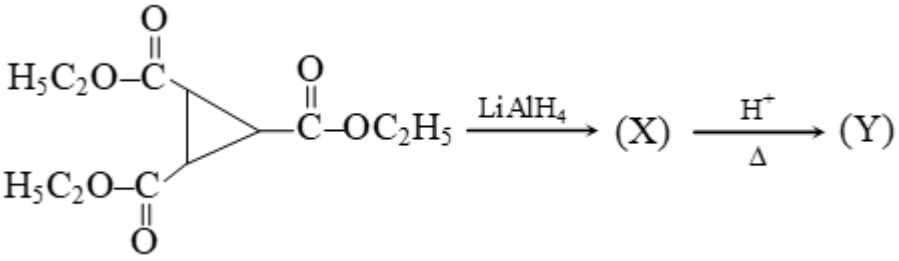
The answer has to be filled into the input box provided below.

Consider that AgX crystallizes in rock salt structure. The density of AgX is 6477 kg m^{-3} and unit cell length is 577.5pm. Atomic weight of Ag is 107.87 g mol^{-1}. The atomic weight of X (in $gmol^{-1}$, rounded off to nearest integer) is _____.

Question No. 3

Numerical Type

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



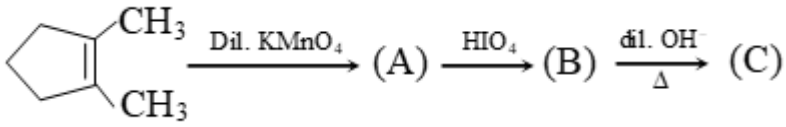
Find the number of moles of Br_2 used if the product (Y) is treated with excess of Br_2/CCl_4 ?

Question No. 4

Numerical Type

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

Give the number of carbon atoms present in the ring formed in compound (C).



Question No. 5

Numerical Type

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

At $25^{\circ}C, \lambda_0(H^+) = 3.4982 \times 10^{-2}$ S m^2 mol^{-1} and $\lambda_0(OH^-) = 1.98 \times 10^{-2}$ S m^2 mol^{-1} . Given κ (specific conductance) $= 5.7 \times 10^{-6}$ S m^{-1} for H_2O. Determine pH of H_2O to closest whole number. ($\log 1.042 = 0.017$)

Question No. 6

Numerical Type

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

Find the quantum number ' n ' corresponding to the excited state of He^+ ion, if on transition to the ground state, the ion emits two photons in succession with wavelength 108.5 nm and 30.4 nm.

Question No. 7

Numerical Type

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

A symmetrical bridged complex cation made of Co (III), NH_3 molecules and oxygen (in the proper ligand form) is found to have the following composition: Co = 36.875%; NH_3 = 53.125%; O = 10% . The complex cation exists in three ionic forms with cationic charges (A): $(n^+ ; (B) : (n-1)^+$ and $(C) : (n-2)^+$ such that $O-O$ bond length in all of them is found to be more than that in $O_2[PtF_6]$. Calculate the value of ' n '. (Atomic weight: Co = 59).

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.

The rate law for the reaction $A \rightarrow B$ is found to be $-\frac{d[A]}{dt} = k[A]^{1/2}$. If $[A_0]$ is the initial concentration of A, then which of the following is/are correct for this reaction?

A. $k = \frac{2}{t}\{[A_0]^{1/2} - [A]^{1/2}\}$

B. $k = \frac{2}{t}\{[A]^{1/2} - [A_o]^{1/2}\}$

C. $t_{1/2} = \frac{\sqrt{2}(\sqrt{2}-1)}{k}[A_0]^{1/2}$

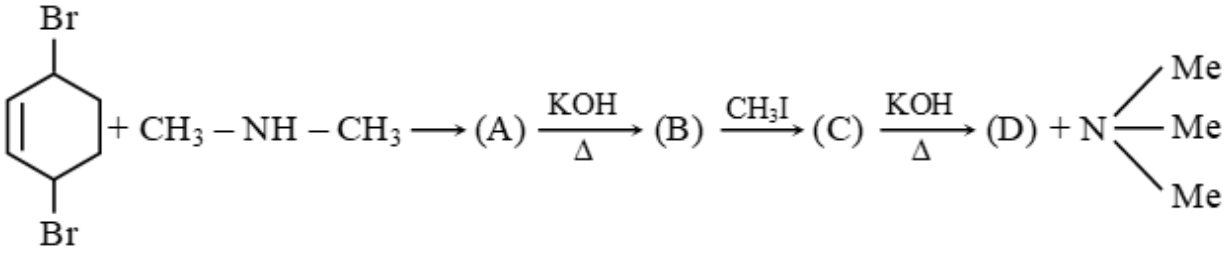
D. $t_{1/2} = \frac{(\sqrt{2}-1)}{\sqrt{2}k}[A_0]^{1/2}$

Question No. 2

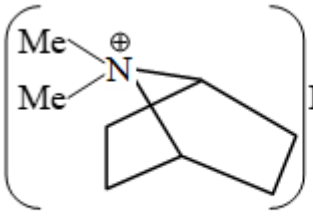
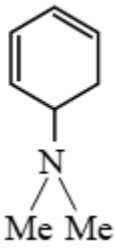
One or More Options Correct Type

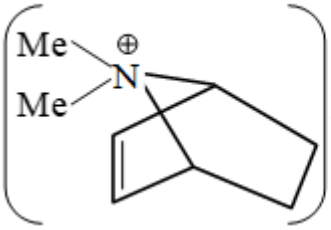
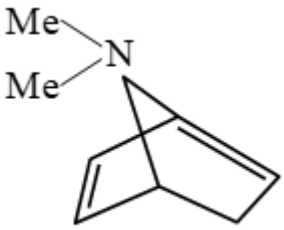
The question has multiple options out of which ONE or MORE is/are correct.

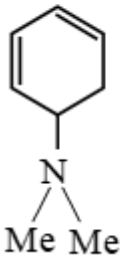
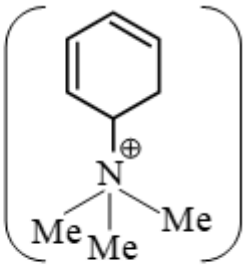
In the following sequence of reaction,

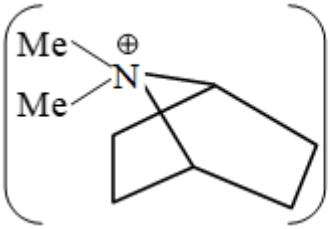


the correct statement(s) is/are

A. (A) is  and (B) is 

B. (A) is  and (B) is 

C. (B) is  and (C) is 

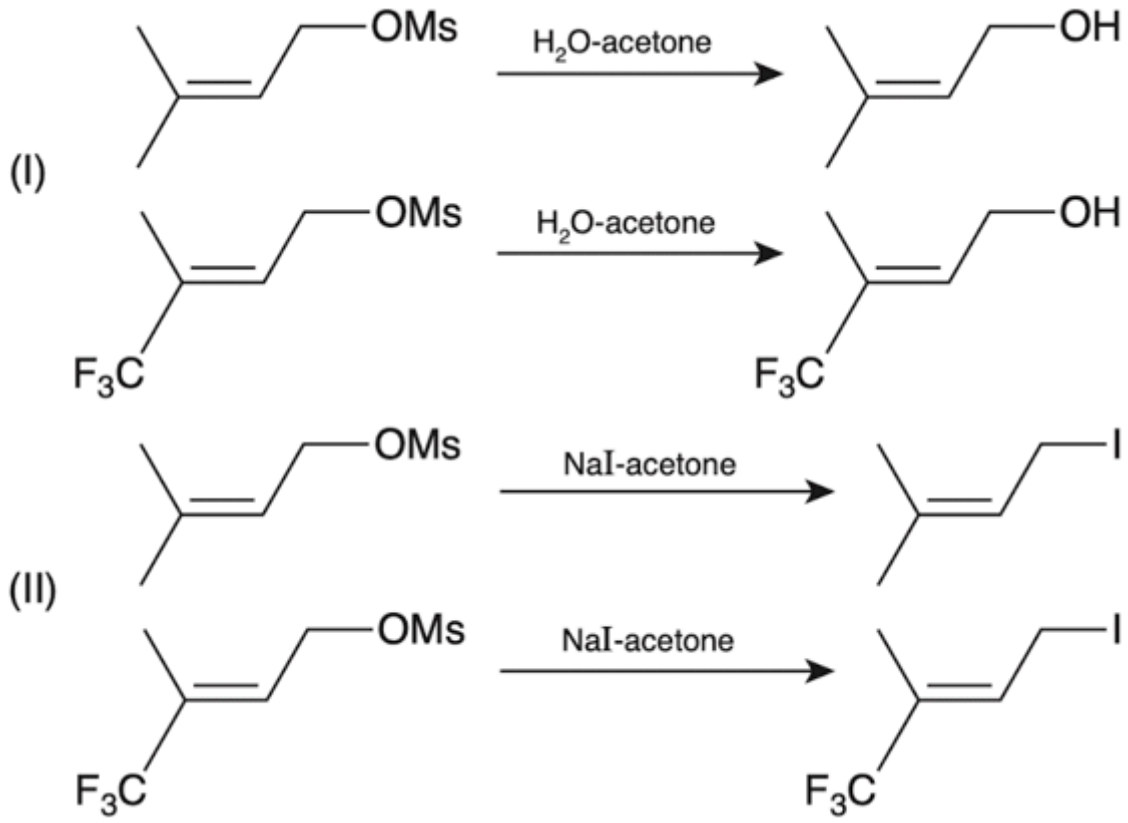
D. (A) is  and (D) is 

Question No. 3

One or More Options Correct Type

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

Statement: Replacement of CH_3 with CF_3 decreases the rate of reaction I, but increases the rate of reaction II.



Reason: Reaction I proceed through S_N1 mechanism and reaction II proceeds through S_N2 mechanism.
Assertion: Being an electron withdrawing group, CF_3 destabilizes the transition state in S_N 1reaction, but stabilizes the transition state in S_N2 reaction.

A. Both Reason and Assertion are correct.
B. Both reason and Assertion are wrong.
C. Reason is correct and Assertion is wrong.
D. Reason is wrong but Assertion is correct.

Question No. 4

One or More Options Correct Type

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

Oxygen is not evolved when

A. Potassium chlorate is heated
B. Sodium peroxide reacts with CO_2
C. Ammonium nitrate is heated
D. Zinc oxide is treated with NaOH

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 statement(s) is/are correct?

A. $ZnSO_4$ dissolves in liquid ammonia to form a tetrahedral complex.

B. Mercurous and cuprous ions are represented respectively as Hg_2^{2+} and Cu_2^{2+}.

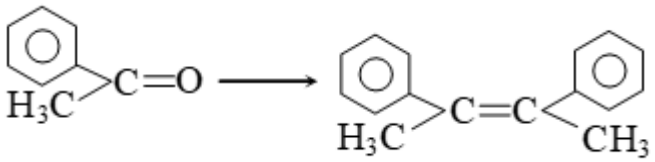
C. ZnS is precipitated from a $ZnSO_4$ solution in the alkaline medium by H_2S.

D. Granulated zinc easily reacts with dilute sulphuric acid, producing hydrogen gas.

Question No. 6

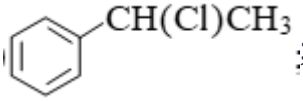
One or More Options Correct Type

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



The above conversion can be done successfully with

A. (I) PCl_5; (II) Zn, CH_3COOH

B. (I) 

; (II) Ph_3P, BuLi ; (III) $PhCOCH_3$

C. (I) PCl_5; (II) Na, ether

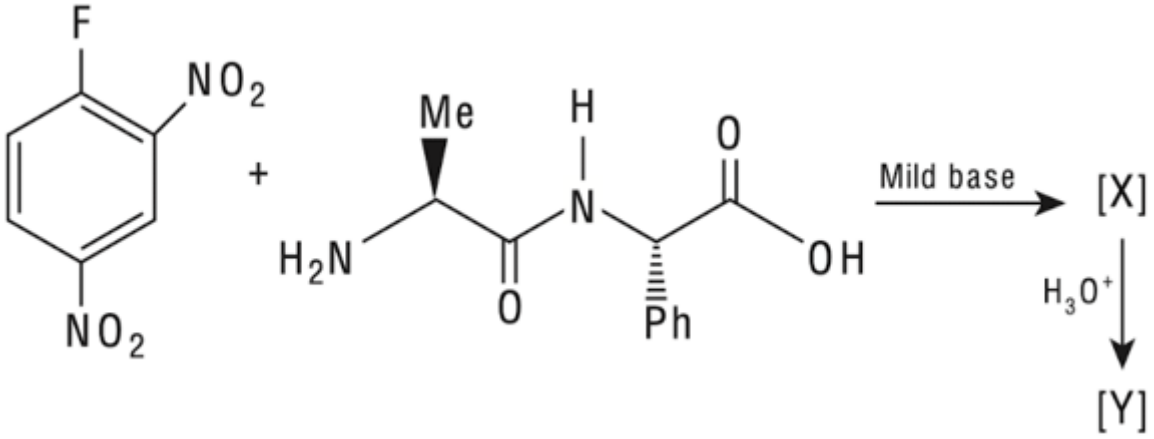
D. (I) $LiAlH_4$; (II) $SOCl_2$; (III) Na, ether

Question No. 7

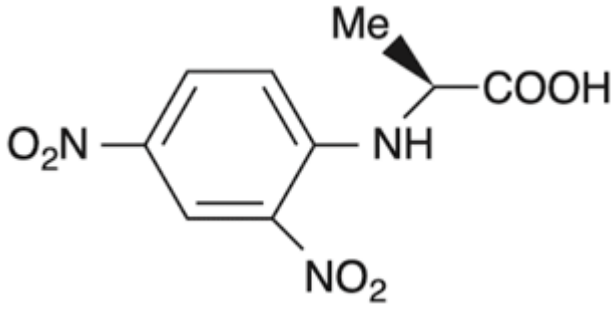
One or More Options Correct Type

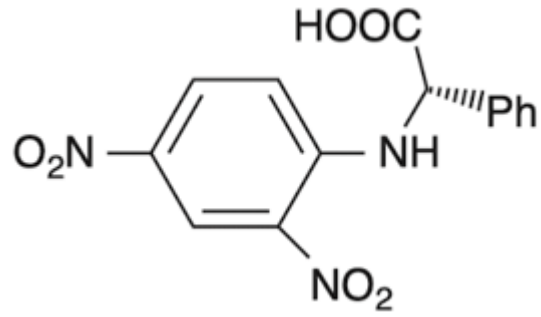
The question has multiple options out of which ONE or MORE is/are correct.

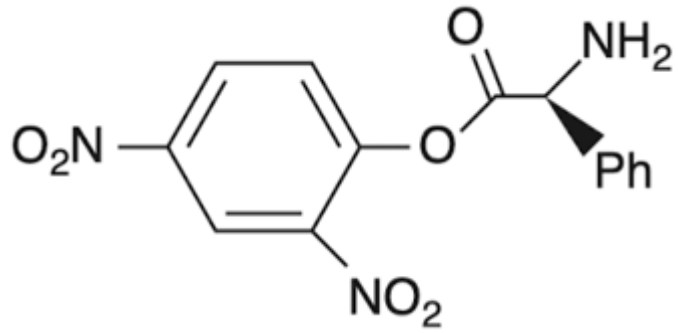
In the two steps reaction sequence

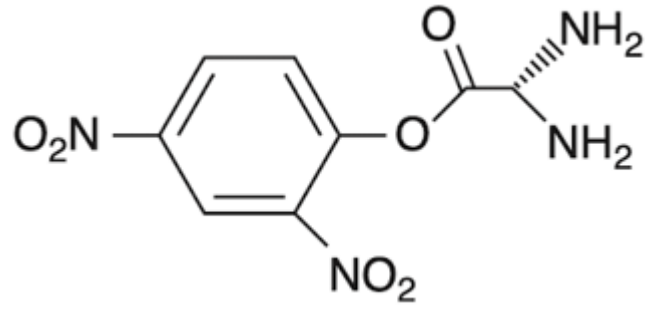


the major product Y is

A. 

B. 

C. 

D. 

Chemistry Question Stem (Maximum Marks: 8)

Question No. 1

Numerical Type

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

Paragraph

The lowering of vapour pressure on adding a non-volatile solute in a pure liquid solvent may be measured by OstwaldWalker method. In this method, dry air is first passed through a series of vessels having the solution, then through a series of vessels having pure solvent and finally through a vessel (normally U-tube) having the absorbent of the solvent. The masses of solution and pure solvent decreases due to removal of vapours of solvent in the flow of air and the mass of absorbent increases due to absorption of the vapour of solvent in order to make the air dry. By measuring the changes in mass, we may determine the lowering of vapour pressure and hence, the composition of solution using Raoult's law.

Question

If the mass of absorbent is increased by $0.24\ \text{g}$ and the mass of pure solvent (water) is decreased by $0.02\ \text{g}$, then the mass percent of solute (glucose) in its aqueous solution is

Question No. 2

Numerical Type

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

Paragraph

The lowering of vapour pressure on adding a non-volatile solute in a pure liquid solvent may be measured by OstwaldWalker method. In this method, dry air is first passed through a series of vessels having the solution, then through a series of vessels having pure solvent and finally through a vessel (normally U-tube) having the absorbent of the solvent. The masses of solution and pure solvent decreases due to removal of vapours of solvent in the flow of air and the mass of absorbent increases due to absorption of the vapour of solvent in order to make the air dry. By measuring the changes in mass, we may determine the lowering of vapour pressure and hence, the composition of solution using Raoult's law.

Question

If the experiment is performed with aqueous $AlCl_3$ solution ($a = 0.8$) prepared by dissolving 1 mole of $AlCl_3$ in 17 mole of water and the decrease in the mass of solution in the experiment is found to be $0.18\ \text{g}$, then the increase in the mass of absorbent should be (mark answer to three decimal places)

Question No. 3

Numerical Type

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

Decomposition of H_2O_2 is a 1st order reaction. A solution of H_2O_2 labelled as 20 volume was left open. H_2O_2 stouts to decompose mildly. To determine the new volume strength after 6hrs, 10ml of this solution was diluted to 100ml.10ml of this solution requires 25ml of 0.025M acidified $KMnO_4$ for complete neutralization. The rate constant for the decomposition of H_2O_2 is (roundoff 10K to two decimal places)

Question No. 4

Numerical Type

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

For the reaction: $2NH_3\ (g) \longrightarrow N_2(g) + 3H_2(g)$
What is the % of NH_3 converted if the mixture effuses twice as fast as that of SO_2 under similar conditions. (roundoff to nearest integer)

Mathematics Numerical (Maximum Marks: 28)

Question No. 1

Numerical Type

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

Suppose a, b, c are such that the curve $y = ax^2 + bx + c$ is tangent to $y = 3x - 3$ at $(1, 0)$ and is also tangent to $y = x + 1$ at $(3, 4)$. Then the value of $(2a - b - 4c)$ equals _____.

Question No. 2

Numerical Type

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

Let $< a_n >$ be an arithmetic sequence such that $\sum_{i=1}^{50} a_{2i-1} = 50$, then $\left|\sum_{j=1}^{50} (-1)^{\frac{j^2+j}{2}} a_{2j-1}\right|$ is equal to

Question No. 3

Numerical Type

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

Let $f : [a, b] \to R$ be a function, continuous on $[a, b]$ and twice differentiable on (a, b). If, $f(a) = f(b)$ and $f'(a) = f'(b)$, then consider the equation $f''(x) - \lambda(f'(x))^2 = 0$. For any real λ the equation has atleast M roots where $3M + 1$ is _____.

Question No. 4

Numerical Type

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

The vertices of a triangle OBC are $0(0,0), B(-3,-1), C(-1,-3)$. Equation of line parallel to BC & intersecting the sides OB & OC whose perpendicular distance from the point $(0,0)$ is $\frac{1}{\sqrt{2}}$, is $ax+by+2=0$, then the value of $\frac{a^4+b^4}{4}$ is

Question No. 5

Numerical Type

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

Coefficient of x^{17} in the expansion of $(1+x^5+x^7)^{20}$ is λ, then $\frac{\lambda}{380}$ is equal to

Question No. 6

Numerical Type

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

Number of integral solutions of the equation
$\log_{\sin x}\sqrt{\sin^2 x}+\log_{\cos x}\sqrt{\cos^2 x}=2$, where $x\in[0,6\pi]$ is _____

Question No. 7

Numerical Type

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

If $f(x)$ be a twice differentiable function from $R\to R$ such that $t^2f(x)-2tf'(x)+f''(x)=0$ has two equal values of $t\forall x\&f(0)=1,f'(0)=2$ then $\lim_{x\to 0}\left(\frac{f(x)-1}{x}-\frac{t}{2}\right)$ is

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.

If variable line $x(3+\lambda)+2y(2-\lambda)-(7-\lambda)=0$ always passes through a fixed point (a,b) where λ is parameter and $I=\lim_{x\to(a-b)}\frac{[(\sin x)-2]+\{\cos x\}}{x-[x]-1}$ where $[y]$ and $\{y\}$ denotes greatest integer $\le y$ and fractional part of y respectively, then:

A. $a+2b=3$
B. $a-b+2I=2$
C. $I=1$

D. I does not exist

Question No. 2

One or More Options Correct Type

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

If a tangent on ellipse at $A(1, 1)$ intersect its directrix at $B(7, -6)$ and S be the focus of ellipse and $C(\alpha, \beta)$ is the circum centre of $\triangle SAB$, then

A. $\alpha + \beta = 1$
B. $\alpha - \beta = 7$
C. $SC^2 = 20.5$
D. $SC^2 = 21.25$

Question No. 3

One or More Options Correct Type

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

Consider a 101 digit number $N = pa_1a_2a_3 \ldots a_{99}a_{106}$ where p is a prime digit and a_1 is any digit. How many numbers N can be formed such that digit 9 is used odd number of times is k, then k is

A. an even number
B. divisible by 27
C. is divisible by 2^{16}
D. not divisible by 2^{32}

Question No. 4

One or More Options Correct Type

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

If $0 < a < b < c$ and the roots, α, β of the equation $ax^2 + bx + c = 0$ are nonreal complex numbers, then

A. $|\alpha| = |\beta|$
B. $|\alpha| > 1$
C. $|\beta| < 1$
D. None of these

Question No. 5

One or More Options Correct Type

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

A plane Π contains the line $L_1 : \frac{y}{b} + \frac{z}{c} = 1, x = 0$ and is parallel to the line $L_2 : \frac{x}{a} - \frac{z}{c} = 1, y = 0$, then-

A. equation of plane Π is $-\frac{x}{a}+\frac{y}{b}+\frac{z}{c}-1=0$

B. equation of plane Π is $\frac{x}{a}+\frac{y}{b}-\frac{z}{c}-1=0$

if shortest distance between line L_1 and line L_2 is $\frac{1}{4}$, then $\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}$ is

C. 64

if shortest distance between line L_1 and line L_2 is $\frac{1}{4}$, then $\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}$ is

D. 192

Question No. 6

One or More Options Correct Type

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

If volume of a parallelepiped determined by the vectors $\bar{a}, \bar{b}$ & $\bar{c}$ is 2, then volume of parallelepiped determined by the vectors

A. $3(\bar{a}+\bar{b}), (\bar{b}+\bar{c})$ and $(\bar{c}+\bar{a})$ is 24

B. $2(\bar{a}\times\bar{b}), 3(\bar{b}\times\bar{c})$ and $(\bar{c}\times\bar{a})$ is 24

C. $(\bar{a}-2\bar{b}), (\bar{b}-2\bar{c})$ and $(\bar{c}-2\bar{a})$ is 14

D. $3(\bar{a}-\bar{b}), (3\bar{b}-\bar{c})$ and $(3\bar{c}-\bar{a})$ is 52

Question No. 7

One or More Options Correct Type

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

Let $f(x)=x+|x-100|-|x+100|$ and $g(x)=|f(x)|-1$, then-

A. $f(x)$ is an odd function

B. $g(x)$ is an even function

C. $f(x)$ is neither even nor odd

D. there are exactly six different values of x satisfying $g(x)=0$

Mathematics Question Stem (Maximum Marks: 8)

Question No. 1

Numerical Type

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

Question Stem

Let $P(x)$ be a polynomial satisfying $\lim_{x\to\infty}\frac{xP(x)}{2016+x^6}=1$ where $P(0)=1, P(2)=9, P(3)=28, P(4)=65$ and $P(6)=217$, then

Question

$\int_{-3}^{9}(P(x)-x^3)dx$ is-

Question No. 2

Numerical Type

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

Question Stem

Let $P(x)$ be a polynomial satisfying $\lim_{x\to\infty} \frac{xP(x)}{2016+x^6} = 1$ where $P(0) = 1, P(2) = 9, P(3) = 28, P(4) = 65$ and $P(6) = 217$, then

Question

If $\int \frac{(x-3)}{(P(x)-x^3-1)}\,dx = \frac{1}{A}\ln\left|\frac{x-6}{x}\right| + \frac{1}{B}\ln\left|\frac{x-2}{x-4}\right| + C$ (where C is an integration constant), then $B^2 - 5A$

Question No. 3

Numerical Type

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

Question Stem

Let $y = f(x)$ is the solution of differential equation $(x\tan(\frac{y}{x}))dx + \sec^2(\frac{y}{x})(xdy - ydx) = 0$, where $f(1) = \frac{\pi}{4}$

Question

If value of $f(\sqrt{3})$ is $\sqrt{3}k\pi$, then $\frac{1}{k}$ is

Question No. 4

Numerical Type

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

Question Stem

Let $y = f(x)$ is the solution of differential equation $(x\tan(\frac{y}{x}))dx + \sec^2(\frac{y}{x})(xdy - ydx) = 0$, where $f(1) = \frac{\pi}{4}$

Question

If $g(x) = f(\frac{1}{x})$, then area bounded by $g(x)$, x -axis and the lines $x = \frac{1}{3}$ and $x = 3$ is (in sq. units) $k\ln 3$, then $[k^2] =$, where [.] represents the greatest integer function.