Question Paper

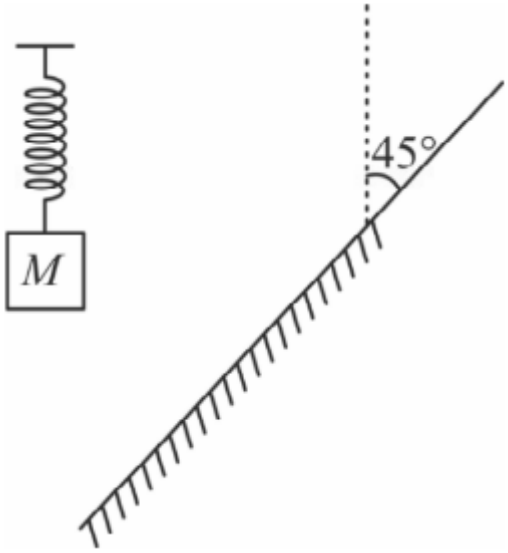
Physics Single Correct (Maximum Marks: 15)

Question No. 1

Only One Option Correct Type

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

An insect of negligible mass is sitting on a block of mass M, tied with a spring of force constant K. The block performs simple harmonic motion with amplitude A infront of a plane mirror placed as shown. The maximum speed of insect relative to its image will be:



A. $A\sqrt{\frac{K}{M}}$

B. $\frac{A}{\sqrt{2}}\sqrt{\frac{K}{M}}$

C. $A\sqrt{2}\sqrt{\frac{K}{M}}$

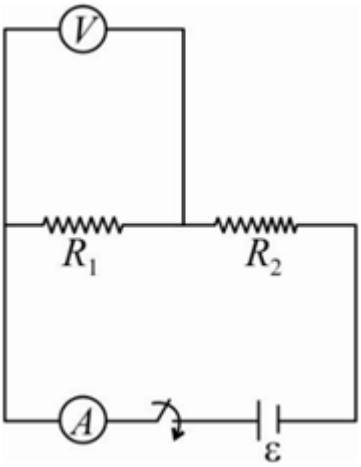
D. $A\sqrt{\frac{M}{K}}$

Question No. 2

Only One Option Correct Type

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

In the given circuit, if the resistance of the voltmeter is considered :



A. voltmeter reading is lesser than $\frac{\varepsilon R_1}{R_1+R_2}$
B. ammeter reading is lesser than $\frac{\varepsilon}{R_1+R_2}$
C. voltmeter reading is equal to $\frac{\varepsilon R_1}{R_1+R_2}$
D. ammeter reading is equal to $\frac{\varepsilon}{R_1+R_2}$

Question No. 3

Only One Option Correct Type

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

When a 4 kg mass is hung vertically on a light spring that obeys Hooke's law, the spring stretches by 2 cm. The work required to be done by an external agent in stretching this spring by 5 cm will be ($g = 9.8$ m s^{-2})

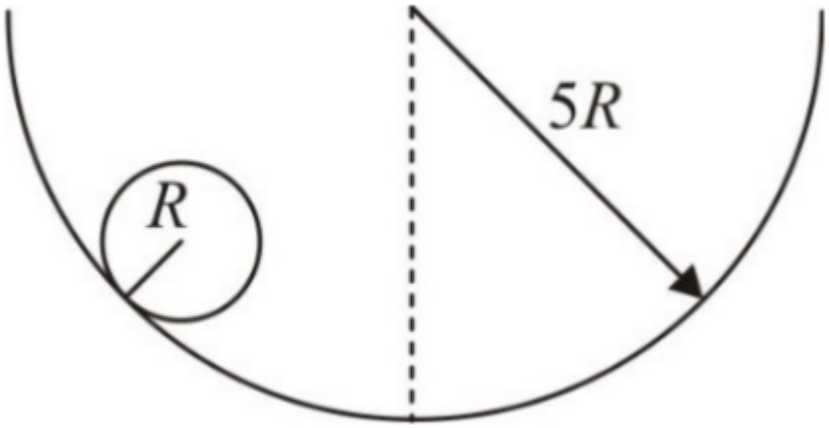
A. $4.900J$
B. $2.450J$
C. $0.495J$
D. $0.245J$

Question No. 4

Only One Option Correct Type

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

A ring of mass m and radius R rolls without slipping on a fixed cylindrical surface of radius $5R$ as shown in the figure. The time period of small oscillation of ring is :



A. $2\pi\sqrt{\frac{2R}{g}}$

B. $2\pi\sqrt{\frac{8R}{g}}$

C. $\pi\sqrt{\frac{2R}{g}}$

D. None of these

Question No. 5

Only One Option Correct Type

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

In the ideal double slit experiment, when a glass plate (refractive index μ) of thickness t is introduced in the path of one of the interacting beams (wavelength λ) the intensity of the position where central maximum occurred previously becomes 50% of the previous intensity. The minimum thickness of the glass slab is :

A. $\frac{\lambda}{6(\mu-1)}$

B. $\frac{\lambda}{4(\mu-1)}$

C. $\frac{\lambda}{2(\mu-1)}$

D. $\frac{\lambda}{(\mu-1)}$

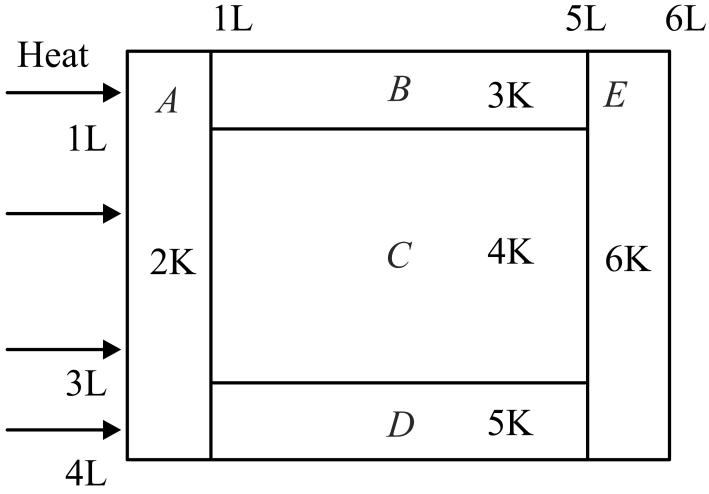
Physics Multiple Correct (Maximum Marks: 28)

Question No. 1

One or More Options Correct Type

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

A composite block is made of slabs A,B,C,D and E of different thermal conductivities (given in terms of a constant K) and size (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat Q flows only from left to right through the blocks. Then in steady state



A. Heat flow through A and E slabs are same
B. Heat flow through slab E is maximum
C. Temperature difference across slab E is smallest
D. Heat flow through C = heat flow through B + heat flow through 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 vernier callipers has 1 mm marks on the main scale. It has 20 equal divisions on the vernier scale which match with 16 main scale divisions. For this vernier calipers, the least count is

A. 0.02 mm
B. 0.05 mm
C. 0.1 mm
D. 0.2 mm

Question No. 3

One or More Options Correct Type

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

Imagine an atom made up of a proton and a hypothetical particle of double the mass of the electron but having the same charge as that of the electron. Apply the Bohr atom model and consider all possible transitions of this hypothetical particle to the first excited level. The longest wavelength photon that will be emitted has wavelength λ, (given in terms of Rydberg constant R for hydrogen atom) equal to

A. $\frac{9}{5R}$

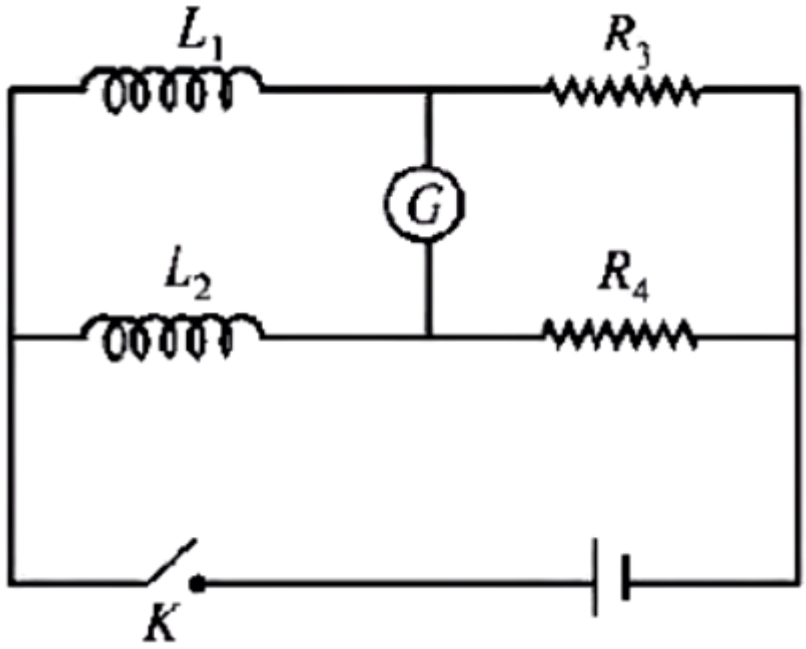
B. $\frac{36}{5R}$
C. $\frac{18}{5R}$
D. $\frac{4}{R}$

Question No. 4

One or More Options Correct Type

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

Two inductors of self-inductances L_1 and L_2 and of resistances R_1 and R_2 (not shown here) respectively, are connected in the circuit as shown in figure. At the instant $t = 0$, key K is closed. Choose the correct options for which the galvanometer will show zero deflection at all times after the key is closed.



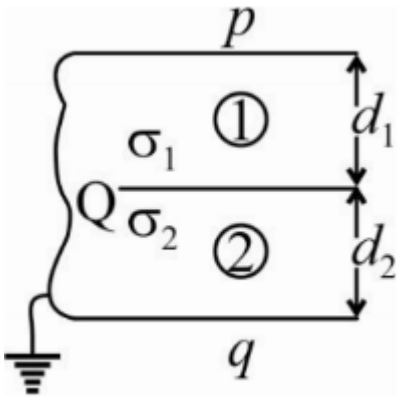
A. $\frac{L_1}{L_2} = \frac{R_3}{R_4}$
B. $\frac{L_1}{L_2} = \frac{R_1}{R_2}$
C. $\frac{R_1}{R_2} = \frac{R_3}{R_4}$
D. None of these

Question No. 5

One or More Options Correct Type

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

Three conducting plates each of area A form the energy storage device. Then, (Q = charge of the middle plate) p and q are the outer surfaces:



A. $\sigma_p = \sigma_q = 0$(σ = surface charge density)
B. $\frac{\sigma_1}{\sigma_2} = \frac{d_2}{d_1}$
C. the net force acting on the middle conductor is $\frac{Q^2(d_2-d_1)}{2\epsilon_0 A(d_1+d_2)}$
D. the ratio of energy stored in the regions 1 and 2 is $\frac{d_1}{d_2}$

Question No. 6

One or More Options Correct Type

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

A mass of 3M moving at a speed v collides with a mass of M moving directly towards it, also with a speed v. If the collision is completely elastic, the total kinetic energy after the collision is K_e. If the masses stick together, the total kinetic energy after the collision is K_s. What is the ratio $\frac{K_e}{K_s}$?

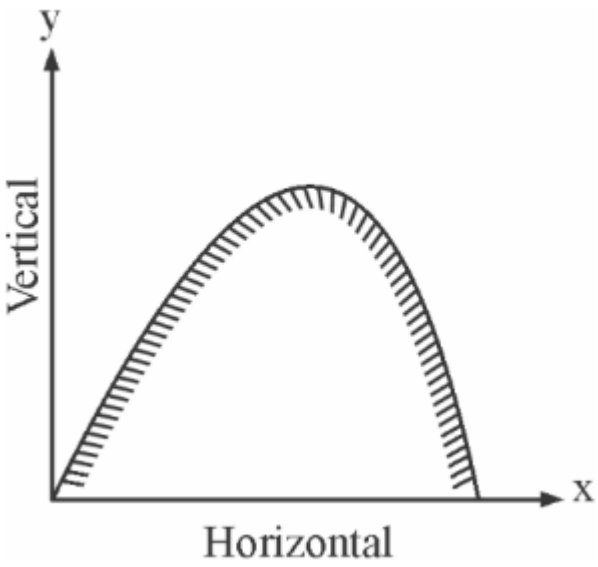
A. $\frac{1}{4}$
B. 4
C. $\frac{1}{2}$
D. 2

Question No. 7

One or More Options Correct Type

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

A reflecting surface is represented by the equation $y = \frac{2L}{\pi} \sin(\frac{\pi X}{L}), 0 \leq x \leq L$. A ray travelling horizontally becomes vertical after reflection. The co-ordinates of points where this ray incident is :



A. $(\frac{L}{4}, \frac{\sqrt{2}L}{\pi})$

B. $(\frac{L}{3}, \frac{\sqrt{3}L}{\pi})$

C. $(\frac{3L}{4}, \frac{\sqrt{2}L}{\pi})$

D. $(\frac{2L}{3}, \frac{\sqrt{3}L}{\pi})$

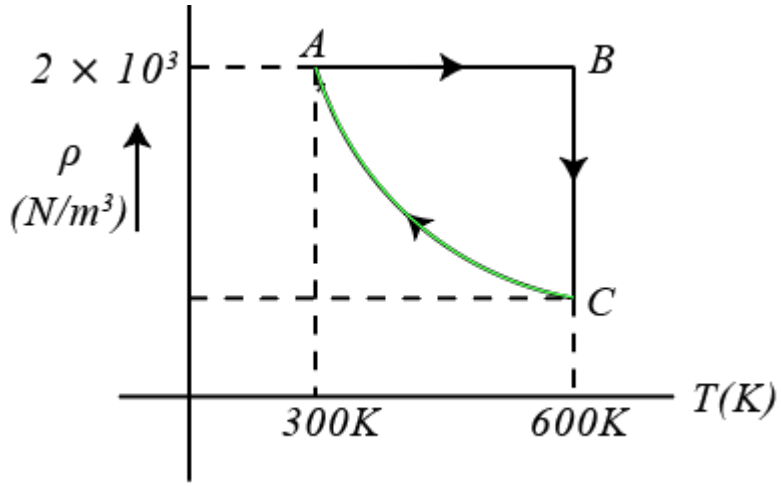
Physics Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

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

Two moles of a monoatomic ideal gas is taken through a cyclic process shown in p-T diagram. The process CA is represented as pT = constant. If efficiency of cycle is $1 - \frac{3x}{12 \ln 2 + 15}$, then find the value of x

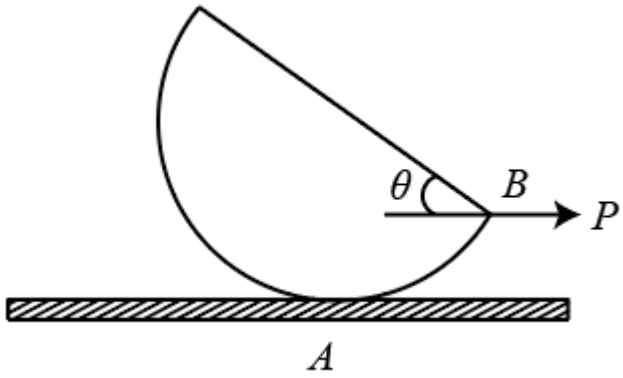


Question No. 2

Numerical Type

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

A short semi-circular right cylinder of radius r and weight w put on a horizontal surface and is pulled by a horizontal force P applied at the point B of the front edge. The flat face make angle θ with the horizontal plane just before sliding begins and coefficient of friction at the line of contact with surface is μ. Find the value of $7 \sin\theta$, if μ is $1/\pi$.

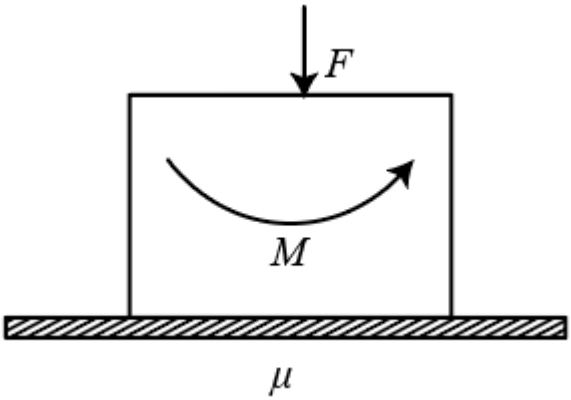


Question No. 3

Numerical Type

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

A shaft of diameter D is resting on a support as shown in the figure. The shaft exerts a total axial force F. Assuming the coefficient of friction is μ, the twisting moment M necessary to cause rotary motion to impend is μ FD/N. Find the value of N .



Question No. 4

Numerical Type

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

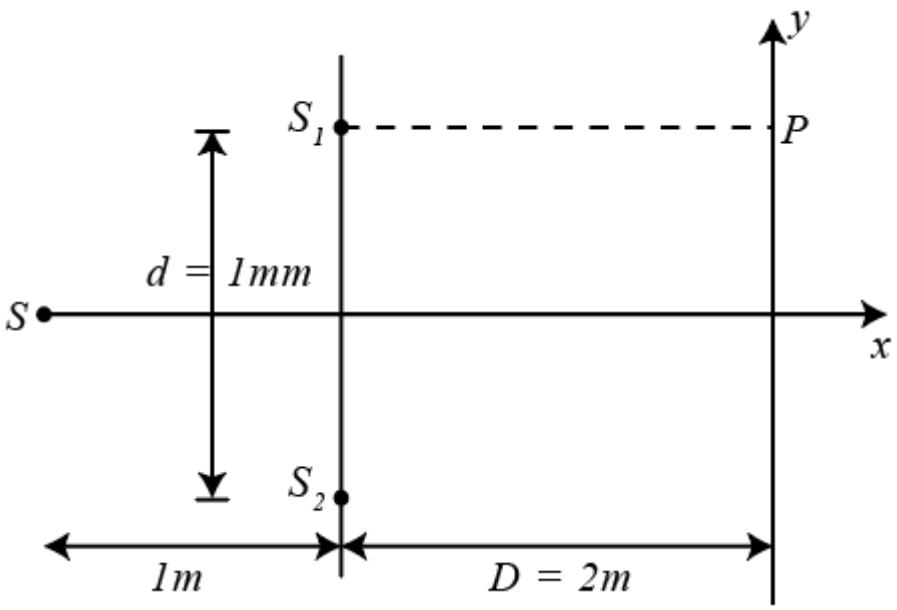
A photoelectric plate is initially exposed to a spectrum of hydrogen gas excited to second energy level. Later when the same photoelectric plate is exposed to radiation from some unknown hydrogen like gas, excited to second energy level, it is found that the de-Broglie wavelength of the photoelectrons, now ejected has decreased $\sqrt{6.1}$ times. For this new gas difference of energies of first Lyman series and Balmer series limit is found to be two times, the ionisation potential of the hydrogen atom. Find the value of Z for unknown gas.

Question No. 5

Numerical Type

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

In a modified YDSE, the source S of wavelength 5000Å oscillates about vertical axis of set up according to the equation, $y = 0.5\sin(\frac{\pi}{6})t$, where y is in millimetre and t in second. At what time t will the intensity at P, a point exactly in front of slit S_1, be maximum for the first time?

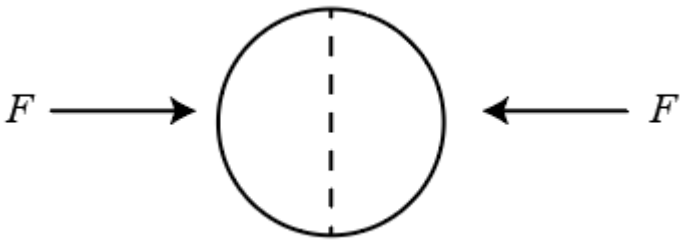


Question No. 6

Numerical Type

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

A uniformly charged thin spherical shell of radius R carries uniform surface charge density σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F. The value of F will be (Take, $\pi\sigma^2R^2 = 4\varepsilon_0$)



Chemistry Single Correct (Maximum Marks: 15)

Question No. 1

Only One Option Correct Type

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

Which of the following pairs of precipitate are red and black in colour respectively and both are soluble in excess of KI solution?

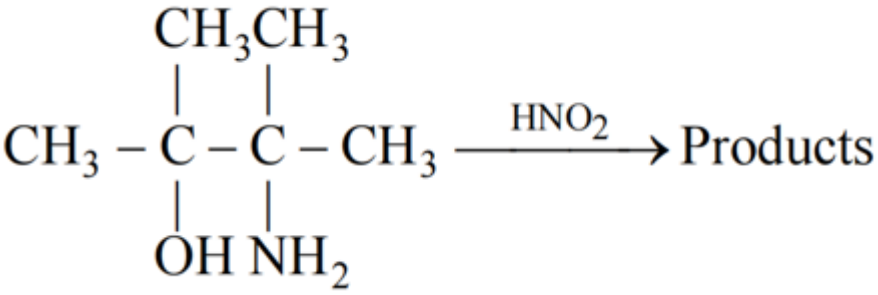
A. HgI_2, Hg_2I_2
B. Cu_2I_2, AgI
C. CdI_2, PbI_2
D. HgI_2, BiI_3

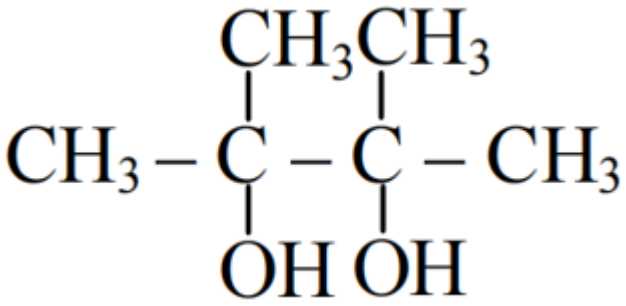
Question No. 2

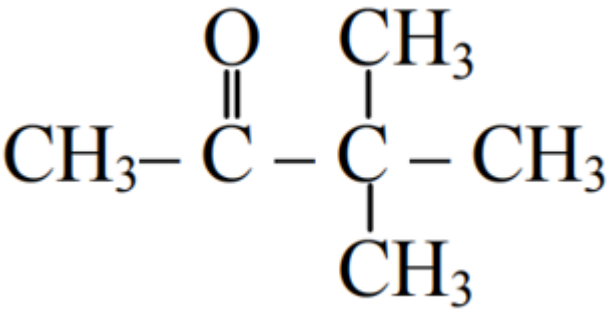
Only One Option Correct Type

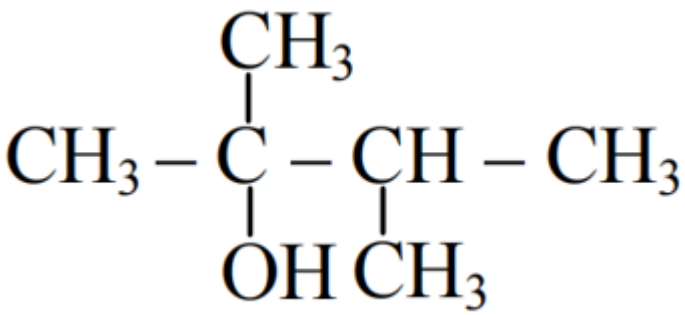
Each question has multiple options out of which ONLY ONE is correct.

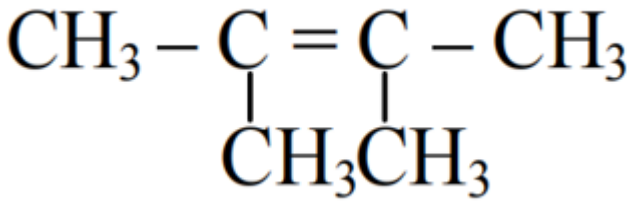
The product of the given reaction is:



A. 

B. 

C. 

D. 

Question No. 3

Only One Option Correct Type

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

An ideal gas expands according to the law $P^2 V =$ constant. on expansion, the temperature

A. decreases
B. increases
C. remains constant
D. none of these

Question No. 4

Only One Option Correct Type

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

1 mole of an ideal gas is expanded reversibly and isothermally at temperature 300 K to double its volume. Calculate ΔG during this process. (Take $2.303 \times R \times \log 2 = 5.76$)

A. 1728 J
B. 0
C. -1728 J
D. -750 J

Question No. 5

Only One Option Correct Type

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

In self reduction the reducing species is .....

Select the correct option for blank.

A. Cu^+
B. O^{-2}
C. S^{-2}
D. SiO_2

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 is/are correct regarding the active nitrogen?

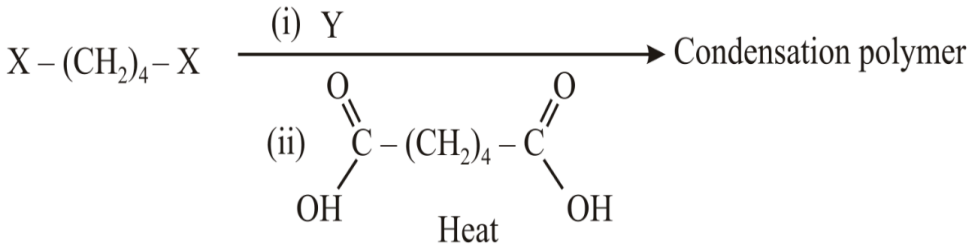
A. It is produced by the passage of electric discharge through the molecular nitrogen
B. It reacts with hydrocarbon to produce HCN
C. It reacts with H_2S to give blue solid
D. When electric discharge is stopped it produces a yellow afterglow due to recombination of atomic nitrogen

Question No. 2

One or More Options Correct Type

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

The correct functional group, X, and the reagent/reaction conditions, Y, in the following scheme are:



A. $X = COOCH_3$, $Y = H_2/Ni/heat$
B. $X = CONH_2$, $Y = H_2/Ni/heat$
C. $X = CONH_2$, $Y = Br_2/NaOH$
D. $X = CN$, $Y = H_2/Ni/heat$

Question No. 3

One or More Options Correct Type

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

If K_{a_1}, K_{a_2} and K_{a_3} be the first, second, and third ionization constant of H_3PO_4 and $K_{a_1} \gg K_{a_2} \gg K_{a_3}$ which is/are correct?

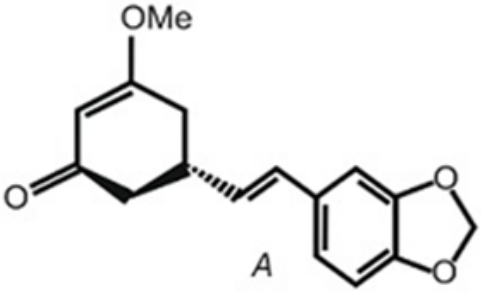
A. $[H^+] \simeq [HPO_4^{2-}]$
B. $K_{a_2} \simeq [HPO_4^{2-}]$
C. $[HPO_4^{2-}] = [PO_4^{3-}]$
D. $[H^+] \simeq \sqrt{K_{a_1}[H_3PO_4]}$

Question No. 4

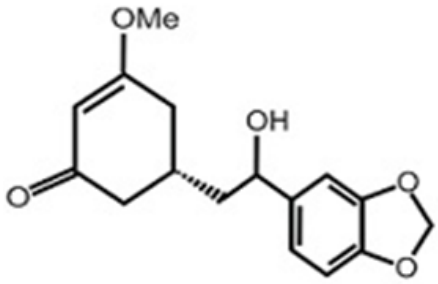
One or More Options Correct Type

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

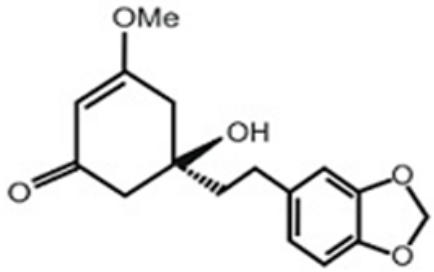
Which of the following alcohol will give the compound "A" the fastest upon treatment with H_3PO_4?



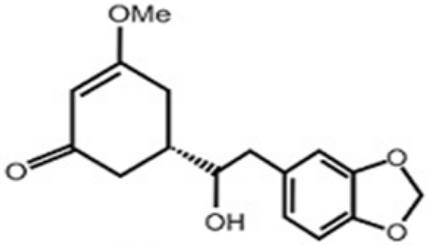
A.



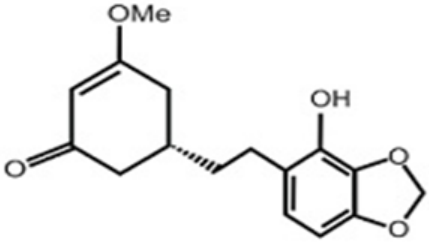
B.



C.



D.



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 polymers is formed by only one type of monomeric units?

A. Bakelite

B. Terylene
C. Teflon
D. PHBV

Question No. 6

One or More Options Correct Type

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

If NaCl crystal has two 'F' centres per unit cell. Then the possible formula per unit cell is

A. $Na_4Cl_{3.75}$
B. Na_4Cl_3
C. NaCl
D. All of these

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 is/are correct?

A. Metallic hydrides are deficient in electrons.
B. Metallic hydrides conduct heat and electricity as molten salts.
C. Ionic hydrides do not conduct electricity in solid state.
D. Ionic hydrides are very good conductors of electricity in solid state.

Chemistry Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

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

Many aromatic compounds can be drawn with molecular formula $C_8H_8O_2$. Find out the no. of aromatic compounds which can be drawn with this molecular formula and which also contains an $-O-$ (non cyclic ether) linkage.

Question No. 2

Numerical Type

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

The number of correct orders wrt the property mentioned along with is:

(i) HF > HCl > HBr > HI > (Boiling point)

(ii) $H_2S < H_2Se < H_2Te$ (Acidic strength)

(iii) $Cl_2 > F_2$ (Bond energy)

(iv) $NH_3 > PH_3 > AsH_3 > SbH_3$ (Proton affinity)

(v) $H_3BO_3 > H_2CO_3$ (Acidic strength)

(vi) $HOCl > HClO_3$ (Acidic strength)

(vii) $H_2O(s)$ $D_2O(s)$ (Density)

(viii) $CH_3CH_2OH < CH_3CHO < CH_3COOH$ (Boiling point)

(ix) H_2O_2 > H_2O (Strength of H-bonding)

Question No. 3

Numerical Type

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

A compound (A) with molecular formula $C_7H_{17}O_5N_3$ is reacted with excess of acetyl chloride to give a compound with molar mass 433 . Calculate the number of moles of acetyl chloride used for 1 mole of compound (A).

Question No. 4

Numerical Type

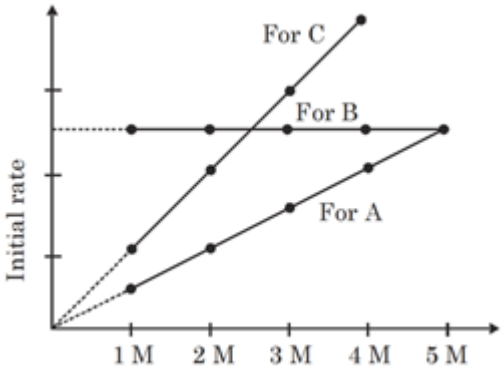
The answer has to be filled into the input box provided below.

A compound having molecular formula $C_5H_{10}O_5$ was reacted with excess of CH_3COCl to give compound having molecular weight 318 gm. Predict the number of hydroxy groups present into the unknown compound.

Question No. 5

Numerical Type

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



Initial conc in various exp.

If three reactions :

$A \longrightarrow$ Products Rate $= K_1[A]^X$

$B \longrightarrow$ Products Rate $= K_2[B]^Y$

$C \longrightarrow$ Products Rate $= K_3[C]^Z$

Value of $\left(\frac{X+Y}{4Z}\right)$ is?

Question No. 6

Numerical Type

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

Calculate molarity of H_2SO_4 solution whose V litres ($V < 5$) require 1 litre of 3MNaOH for complete neutralisation. If above H_2SO_4 solution sample is diluted upto 5 litre then again ' V ' litre of diluted solution requires 0.2 litres of above NaOH solution for neutralisation.

Mathematics Single Correct (Maximum Marks: 15)

Question No. 1

Only One Option Correct Type

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

$\lim_{x \to 0} \frac{\sin x^4 - x^4 \cos x^4 + x^{20}}{x^4(e^{2x^4} - 1 - 2x^4)}$ is equal to

A. 0

B. $-\frac{1}{6}$

C. $\frac{1}{6}$

D. does not exist

Question No. 2

Only One Option Correct Type

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

The number of positive integer solutions of $a + b + c = 60$, where a is a factor of b and c, is

A. 184
B. 200
C. 144
D. 270

Question No. 3

Only One Option Correct Type

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

Let the curve $y = f(x)$ passes through origin and satisfies the differential equation $\frac{dy}{dx} + \int_0^5 ydx = 27$. If a and b are chosen randomly from the set $S = \{1, 2, 3, 4\}$ with replacement. The probability that the above curve passes through (a, b) is :

A. $\frac{1}{2}$
B. $\frac{1}{6}$
C. $\frac{1}{8}$
D. $\frac{1}{12}$

Question No. 4

Only One Option Correct Type

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

$\int \cos(2\theta)\ln(\frac{\cos\theta+\sin\theta}{\cos\theta-\sin\theta})d\theta$

A. $\frac{1}{2}(\sin2\theta)\ln(\frac{\cos\theta+\sin\theta}{\cos\theta-\sin\theta}) - \frac{1}{2}\ln(\sec2\theta) + c$
B. $\frac{\sin(2\theta)}{2}\ln\left|\frac{\cos\theta-\sin\theta}{\cos\theta+\sin\theta}\right| - \frac{1}{2}\ln(\sec 2\theta) + c$
C. $\frac{\sin(2\theta)}{2}\ln\left|\frac{\cos\theta+\sin\theta}{\cos\theta-\sin\theta}\right| + \frac{1}{2}\ln(\sec 2\theta) + c$
D. $\frac{\sin(2\theta)}{2}\ln\left|\frac{\cos\theta-\sin\theta}{\cos\theta+\sin\theta}\right| + \frac{1}{2}\ln(\sec 2\theta) + c$

Question No. 5

Only One Option Correct Type

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

A ray of light is incident on x-axis at $A \equiv (-2, 0)$ and after reflection it intersect the curve $y^2 = 4x$ in P and Q if $\frac{1}{AP} + \frac{1}{AQ} = \frac{1}{4}$

(P, Q are in Ist quadrant), then equation of incident ray is

A. $y - x - 2\sqrt{3} = 0$
B. $y - x\sqrt{3} + 2\sqrt{3} = 0$
C. $y + x\sqrt{3} + 2\sqrt{3} = 0$
D. $y + x + 2\sqrt{3} = 0$

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.

The equation of largest circle passing through the points $(1, 1)$ and $(2, 2)$ and for all (x, y) on the circle $x \geq 0, y \geq 0$ is/are :

A. $x^2 + y^2 - 4x - 2y + 4 = 0$
B. $x^2 + y^2 - 2x - 4y + 4 = 0$
C. $x^2 + y^2 - 3x - 3y + 4 = 0$
D. None of these

Question No. 2

One or More Options Correct Type

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

Let $P(x) = a_0 + a_1 x + \ldots . + a_n x^n, a_n \neq 0$ be such that $P(x^2) = P(x)^2$, then :

A. $a_0 = 1$
B. $a_0 = a_1 = \ldots = a_{n-1} = 0$
C. $a_n = 1$
D. $a_n = -1$

Question No. 3

One or More Options Correct Type

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

Let $f(x) = \int_{-x}^{x} (t \sin at + bt + c)dt$ where a, b, c are non zero real numbers, then $\text{Lim}_{x \to 0} \frac{f(x)}{x}$ is :

A. Independent of a

B. Independent of a and b and has the value equals to c
C. Independent of a, b and c
D. dependent only on c

Question No. 4

One or More Options Correct Type

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

If $f : R \to R, f(x)$ is a differentiable bijective function, then which of the following may be true ?

A. $(f(x) - x)f''(x) < 0 \forall x \in R$
B. $(f(x) - x)f''(x) > 0 \forall x \in R$
C. If $(f(x) - x)f''(x) > 0$, then $f(x) = f^{-1}(x)$ has no solution
D. If $(f(x) - x)f''(x) > 0$, then $f(x) = f^{-1}(x)$ has at least a real solution

Question No. 5

One or More Options Correct Type

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

Let $\vec{x}, \vec{y}, \vec{z}$ are unit vectors such that $\vec{x} + \vec{y} + \vec{z} = \vec{a}, \vec{x} \times (\vec{y} \times \vec{z}) = \vec{b}, (\vec{x} \times \vec{y}) \times \vec{z} = \vec{c}, \vec{a} \cdot \vec{x} = \frac{3}{2}, \vec{a} \cdot \vec{y} = \frac{7}{4}$ and $|\vec{a}| = 2$, then :

A. $\vec{x} = \frac{3\vec{a}+4\vec{b}+8\vec{c}}{3}$
B. $\vec{y} = 4\vec{c}$
C. $\vec{z} = (\vec{b} - \vec{c})$
D. $\vec{y} = -4\vec{c}$

Question No. 6

One or More Options Correct Type

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

If the tangent at a point P_1 (other than $(0, 0)$ on the curve $ax^3 - y + b = 0$ meets the curve again at P_2. The tangent at P_2 meets the curve at P_3 and so on. If the abscissae of $P_1, P_2, P_3, \ldots\ldots, P_n$ form a G.P. then (a, b) may be :

A. $(1, 0)$
B. $(2, 7)$
C. $(3, 5)$
D. $(4, 9)$

Question No. 7

One or More Options Correct Type

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

Let $A = \begin{bmatrix} a & b & c \\ b & c & a \\ c & a & b \end{bmatrix}$ and $B = \begin{bmatrix} bc - a^2 & ca - b^2 & ab - c^2 \\ ca - b^2 & ab - c^2 & bc - a^2 \\ ab - c^2 & bc - a^2 & ac - b^2 \end{bmatrix}$ be two non-singular matrices such that $(A^2 - 2I)B = O$ where $a > b > c > 0$, then which of the following statement(s) is(are) correct?

[Note: I is an identity matrix of order 3 and Tr. (P) and det. (P) denote trace and value of the determinant of square matrix P respectively.

A. Tr $\cdot(AB) = 6\sqrt{2}$
B. Tr $\cdot(AB) = -6\sqrt{2}$
C. det. $(A - \sqrt{2}B) = 54\sqrt{2}$
D. det. $(A - \sqrt{2}B) = -54\sqrt{2}$

Mathematics Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

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

If $\lim_{n\to\infty} \frac{1}{n} \sum_{k=1}^{n} \ln\left(\frac{n^2+(k-1)^2}{n^2+k^2}\right)$ exists and is equal to L. The absolute value of [L] is (where [.] denotes greatest integer function)

Question No. 2

Numerical Type

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

If A, B, C are the angles of an acute angled triangle ABC and $D = \begin{vmatrix} (\tan B + \tan C)^2 & \tan^2 A & \tan^2 A \\ \tan^2 B & (\tan A + \tan C)^2 & \tan^2 B \\ \tan^2 C & \tan^2 C & (\tan A + \tan B)^2 \end{vmatrix}$, then the least integer greater then or equal to $\frac{D}{1000}$ is equal to

Question No. 3

Numerical Type

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

Let two parallel lines L_1 and L_2 with positive slope are tangent to the circle $C_1 : x^2 + y^2 - 2x - 16y + 64 = 0$

If L_1 is also tangent to the circle $C_2 : x^2 + y^2 - 2x + 2y - 2 = 0$ and equation of L_2 is $a\sqrt{a}x - by + c - a\sqrt{a} = 0$ where $a, b, c \in N$, then find the value of $(a + b + c) - 10$

Question No. 4

Numerical Type

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

The number of 12 digit numbers whose all digits are prime and sum of any two consecutive digits is also prime is 2^r then r is

Question No. 5

Numerical Type

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

If $S_n = (\ln 2)^n \sum_{k=0}^{n} \frac{1}{(n-k)!k!}$ then $S_0 + S_1 + S_2 + \ldots\ldots$ upto ∞ is equal to

Question No. 6

Numerical Type

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

If the curves $C_1 : y = \frac{\ln x}{x}$ and $C_2 : y = \lambda x^2$ (where λ is constant) touch each other, then the reciprocal of the area bonded by curves C_1, C_2 and x-axis is (ab is two digit natural number) then $a + b$ is