Question Paper

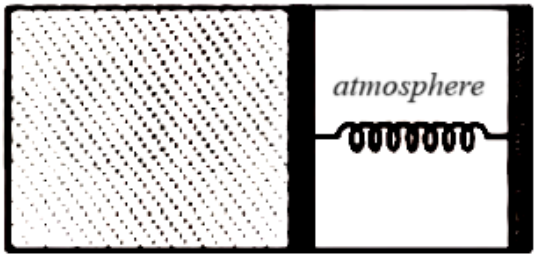
Physics Multiple Correct (Maximum Marks: 32)

Question No. 1

One or More Options Correct Type

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

An ideal monoatomic gas is confined in a horizontal cylinder by a spring-loaded piston (as shown in the figure). Initially, the gas is at temperature T_1, pressure p_1 and volume v_1 and the spring is in its relaxed state. The gas is the heated very slowly to temperature T_2, pressure p_2 and volume v_2. During this process, the piston moves out by a distance x. Ignoring the friction between the piston and the cylinder, then choose the correct statements.



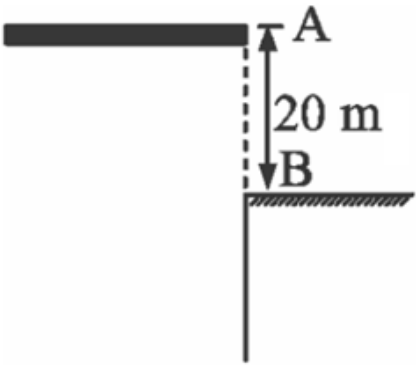
A. If $V_2 = 2V_1$ and $T_2 = 3T_1$, then the energy stored in the spring is $1/4(p_1V_1)$.
B. If $V_2 = 2V_1$ and $T_2 = 3T_1$, then the change in internal energy is $3p_1V_1$
C. If $V_2 = 3V_1$ and $T_2 = 4T_1$, then the work done by the gas is $\frac{7}{3}\,p_1V_1$
D. If $V_2 = 3V_1$ and $T_2 = 4T_1$, then the heat supplied to the gas is $\frac{1}{4}\,(p_1v_1)$

Question No. 2

One or More Options Correct Type

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

A horizontal rigid rod of length 1m is dropped from height $h = 20$ m, as shown in figure. The end of the rod collides with the table. If collision is perfectly elastic.



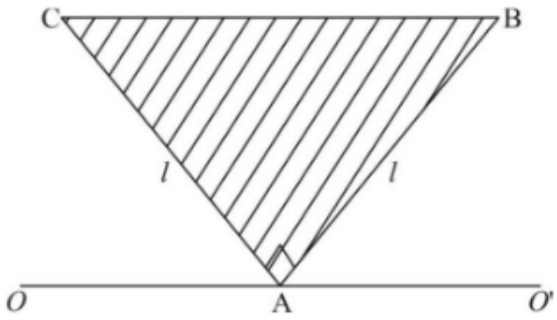
A. Angular velocity of rod after collision is 60rad/sec
B. Angular velocity of rod after collision is 30rad/sec
C. Velocity of midpoint of rod just after collision is 15 m/s downward
D. Velocity of midpoint of rod just after collision is 10 m/s downward

Question No. 3

One or More Options Correct Type

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

In the adjacent figure, ABC is a uniform isosceles triangular lamina of mass m and $AB = AC = l$. The lamina is free to rotate about a fixed horizontal axis OAO' which is in the plane of the lamina. Initially the lamina is in static equilibrium with maximum gravitational potential energy. Due to slight disturbance, lamina starts rotating. Now choose the correct option(s)



A. The maximum angular speed acquired by the lamina is $4\sqrt{\frac{\sqrt{2}g}{3l}}$

B. The maximum vertical force on the axis by the lamina is $\frac{41mg}{9}$

C. Angular speed of the lamina about OAO' is conserved

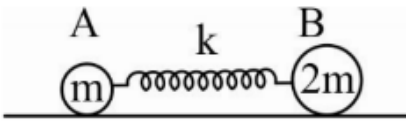
D. The maximum vertical force on the axis by the lamina is $\frac{40mg}{9}$

Question No. 4

One or More Options Correct Type

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

Two particles A and B of mass m and $2m$ are interconnected by a light spring of stiffness k. Particles are pulled along the line of spring upto elongation in spring is x_0 and then released. Choose the correct options :



A. Both particles will execute the SHM with same time-period $T = 2\pi\sqrt{\frac{2m}{3K}}$

B. Both particles will execute SHM, A with time-period $T_A = 2\pi\sqrt{\frac{m}{K}}$ and B with $T_B = 2\pi\sqrt{\frac{2m}{K}}$

C. Amplitude of SHM of A is $\frac{x_0}{3}$ and of B is $\frac{2x_0}{3}$

D. Amplitude of SHM of both A and B are same and equal to $\frac{x_0}{2}$.

Question No. 5

One or More Options Correct Type

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

A point sound source is situated in a medium of bulk modulus 1.6×10^5 N/m^2 . An observer standing at a distance 10 m from the source writes down the equation of the wave as $y = a\sin(15\pi x - 6000\pi t)$. Here y and x are in meters and t is in second. The maximum pressure amplitude received by the observer's ear is 24πPa , then :

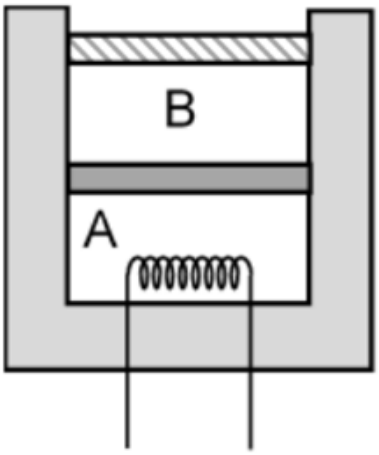
A. The density of the medium is $1\ \text{kg/m}^3$
B. The displacement amplitude A of the waves received by the observer is $10\mu\text{m}$.
C. Power of the sound source is $288\pi^3$ watt.
D. Power of the sound source is $188\pi^3$ watt.

Question No. 6

One or More Options Correct Type

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

Cylinder has 2 pistons and each can move without friction. Bottom piston is conducting but the above piston is perfectly insulating. Lower portion carries 2 moles of monoatomic gas and upper carries 4 moles diatomic gas. Through a heater system is slowly heated and a total heat of 190R is given:



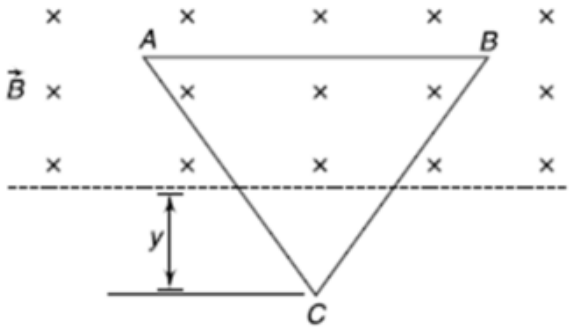
A. The increase in temperature of both the gasses is 10 K.
B. Work done by gas in chamber B is 40R joules
C. Work done by gas in chamber A is 40R joules
D. Both the gasses will suffer equal change in volume.

Question No. 7

One or More Options Correct Type

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

A current carrying loop is in the shape of an equilateral triangle of side length a. Its mass is M and it is in vertical plane. There exists a uniform horizontal magnetic field B in the region shown. The loop is in equilibrium for $y = \frac{\sqrt{3}}{4}a$. Neglect emf induced in the loop.



A. The current in the loop is $\frac{2Mg}{aB}$

B. If the loop is displaced slightly in its plane perpendicular to its side AB and released it the loop performs SHM.

C. If the loop is displaced slightly in its plane perpendicular to its side AB and released its period of oscillation is $\pi\sqrt{\frac{\sqrt{3}a}{2g}}$

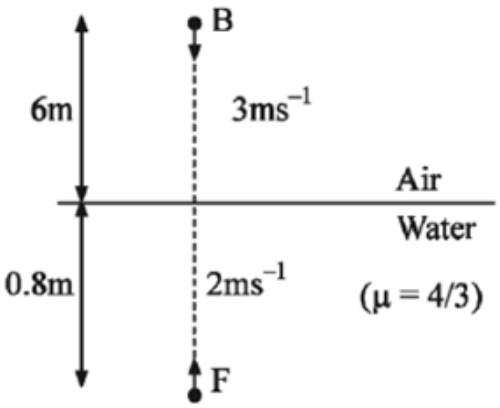
D. If the current in the loop is changed to $\frac{\sqrt{3}Mg}{2aB}$ equilibrium shifts to $y = a$.

Question No. 8

One or More Options Correct Type

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

A fish, F in the pond, is at a depth of $0.8m$ from water surface and is moving vertically upwards with velocity $2\ ms^{-1}$. At the same instant, a bird B is at a height of $6m$ from water surface and is moving downwards with velocity $3\ ms^{-1}$. At this instant both are on the same vertical lines as shown in the figure. Which of the following statement(s) is(are) correct?



A. Height of B, observed by F (from itself) is equal to 8.00 m

B. Depth of F, observed by B (from itself) is equal to 6.60 m

C. Velocity of B, observed by F (relative to itself) is equal to $5.00\ ms^{-1}$

D. Velocity of F, observed by B (relative to itself) if equal to $4.50\ ms^{-1}$

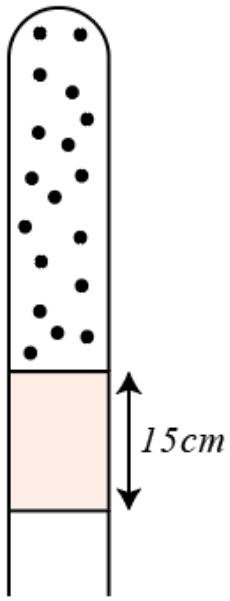
Physics Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

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

A certain amount of air at 300 K is trapped in a glass tube between its closed end and a 15 cm long mercury column as shown in figure. Other end of tube is open to atmosphere. Tube is now inverted isothermally due to which volume of air decreases. If the air column is heated to the temperature (T in K) so that it regains its original volume, find value of $\frac{T}{10}$. (Atmospheric pressure = 75 cm of Hg)



Question No. 2

Numerical Type

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

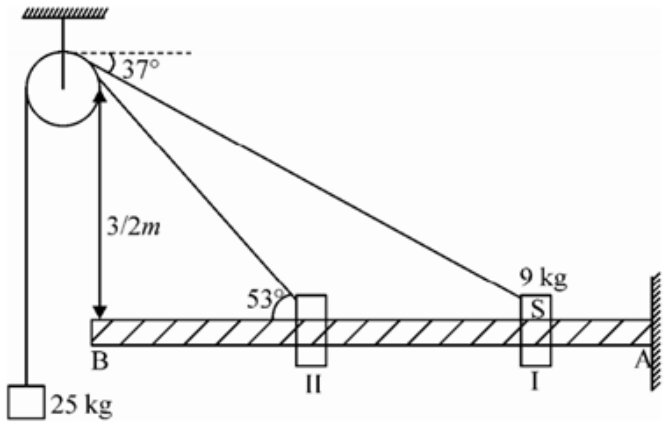
A body cools from 50˚C to 40˚C in 5 min. The surrounding temperature is 20˚C. By how many ˚C does the temperature decreases in the next 5 min ? (Round off your answer to nearest integer)

Question No. 3

Numerical Type

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

In the adjacent figure, AB is a fixed horizontal rod. A sleeve S of mass $m = 9$ kg is free to move along the rod. One end of a light and inextensible string which is passing over a fixed pulley is connected to the sleeve. A block of mass $M = 25$ kg is attached to the other end which keeps the other part vertical. The system is set free from rest with the sleeve in position I. Calculate the speed of sleeve in the nearest integer value when it reaches the position II. Ignore any friction.



Question No. 4

Numerical Type

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

A sample of monatomic hydrogen gas contains 100 atoms and all the atoms are in nth excited state. As the atoms come down to the ground state following various transitions, they released a total energy of $\frac{4800}{49}$ Rch. (where, 1 Rch = 13.6eV)

Find the value of N, where theoretically maximum possible number of electronic transitions in the process is $N \times 100$.

Question No. 5

Numerical Type

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

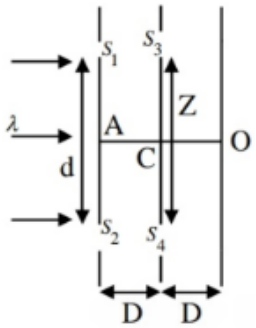
Consider a nuclear fusion reaction $A + B \rightarrow C$. Nucleus A is moving with $KE = 5\text{MeV}$ and collides with nucleus B moving with $KE = 3\text{MeV}$ and forms nucleus C in excited state. Find the KE (in MeV) of C nucleus just after its formation given that its excitation energy is 10.3MeV. Take masses of nuclei of A, B and C as $25.0, 10.0, 34.99$ amu respectively. [Take : $1\text{amu} = 930\text{MeV}$]

Question No. 6

Numerical Type

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

In arrangement shown in figure, plane wave front of monochromatic light of wavelength λ is incident on identical slits S_1 and S_2. There is another pair of identical slits S_3 and S_4 which are having separation $Z = \frac{\lambda D}{2d}$ point O is on the screen at the common perpendicular bisector of S_1S_2 and S_3S_4 . I_1 is the intensity at point O. Now the board having slits S_3S_4 is moved upward parallel to itself and perpendicular to line AO till slit S_4 is on line AO and it is observed that now intensity at point O is I_2 then $\frac{I_2}{I_1}$ is



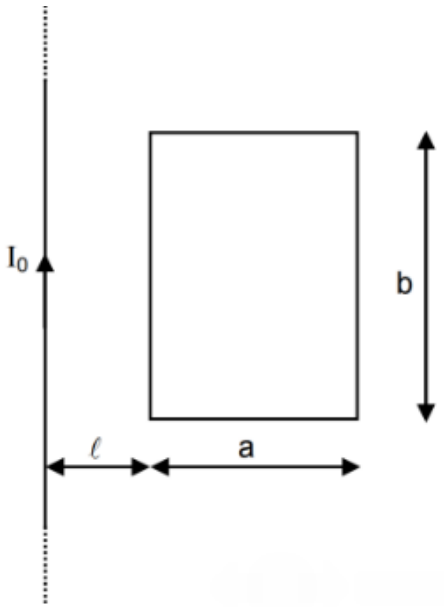
Physics Paragraph Type (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

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

Consider a rectangular loop of wire with dimensions a and *b*. One side of which is parallel to another long straight wire carrying current I_0, at a distance ℓ, (as shown in the figure). The resistance of the loop is R and inductance is negligible.



At a certain moment of time, the current in the long wire is switched off. What is the net charge Q flowing through a fixed cross-section of the wire of the loop?

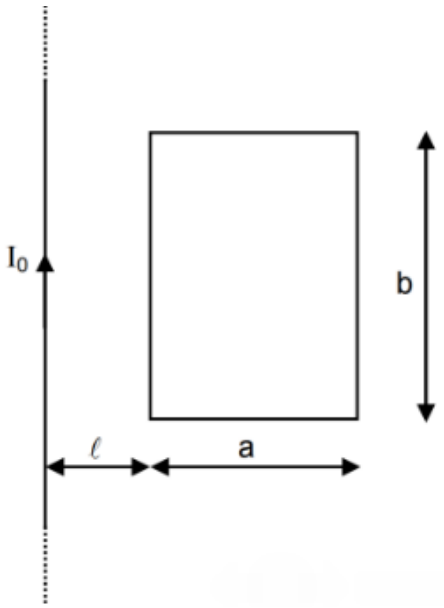
A. $\frac{b\mu_0 I_0}{2\pi R}\left(\frac{a+\ell}{\ell}\right)$
B. $\frac{b\mu_0 I_0}{2\pi R}\ln\frac{a+\ell}{\ell}$
C. $\frac{\mu_0 I_0}{2\pi R}\ln\frac{a+\ell}{\ell}$
D. $\frac{b\mu_0 I_0}{2\pi R}$

Question No. 2

Only One Option Correct Type

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

Consider a rectangular loop of wire with dimensions a and *b*. One side of which is parallel to another long straight wire carrying current I_0, at a distance ℓ, (as shown in the figure). The resistance of the loop is R and inductance is negligible.



The net momentum p given to the loop during the switch-off the current is.

A. $\frac{a(b\mu_0 I_0)^2}{2\pi^2 R\ell(\ell+a)} \ln\frac{a+\ell}{\ell}$

B. $\frac{a(b\mu_0 I_0)^2}{4\pi^2 R\ell(\ell+a)} \ln\frac{a+\ell}{\ell}$

C. $\frac{a(b\mu_0 I_0)^2}{8\pi^2 R\ell(\ell+a)} \ln\frac{a+\ell}{\ell}$

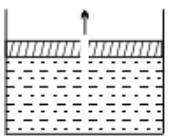
D. None of these

Question No. 3

Only One Option Correct Type

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

In the figure shown water is filled in the cylindrical tank of cross-sectional area 100 cm^2 up to a height of 10 cm. The mass of the thin, tight fitting and frictionless piston is 100 kg. The small hole in the piston has area $2\sqrt{2}$ mm^2. Due to weight of the piston water spurts upwards in a jet from the hole. If velocity of efflux initially is $N\sqrt{2}$(m/s). Find value of N. (Assume that spurted water does not fall back on piston)



A. 10

B. 8

C. 6

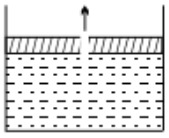
D. None of these

Question No. 4

Only One Option Correct Type

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

In the figure shown water is filled in the cylindrical tank of cross-sectional area $100\ cm^2$ up to a height of $10\ cm$. The mass of the thin, tight fitting and frictionless piston is $100\ kg$. The small hole in the piston has area $2\sqrt{2}\ mm^2$. Due to weight of the piston water spurts upwards in a jet from the hole. Find the time in which the tank becomes empty. If your answer is n fill value of n/25 . (Assume that spurted water does not fall back on piston)



A. 2
B. 1.5
C. 1
D. 4

Chemistry Multiple Correct (Maximum Marks: 32)

Question No. 1

One or More Options Correct Type

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

A mixture of liquids A and B in molar ratio $1:2$ forms a maximum boiling azeotrope. Identify the incorrect statement(s), if 'A' is more volatile. Molar masses of A \& B are 200 and 100 g/mole respectively.

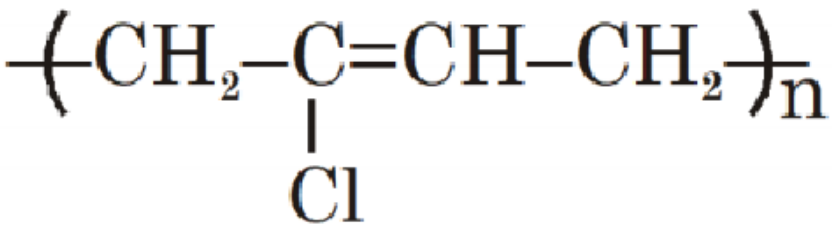
A. A liquid solution of ' A ' and ' B ' having mass % of A = 50 will have vapours having mass % of A = 50 .
B. A liquid solution of ' A ' and ' B ' having mass % of A > 50 will have vapours having mass % of A > 50 .
C. A mixture of ' A ' and ' B ' in the mass ratio $1:2$ can be separated into azeotropic mixture and pure 'A'
D. A mixture of ' A ' and ' B ' in the molar ratio $2:1$ can be separated into zeotropic mixture and pure 'A'

Question No. 2

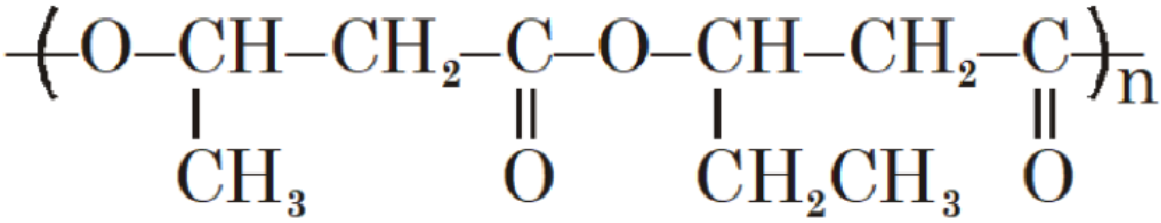
One or More Options Correct Type

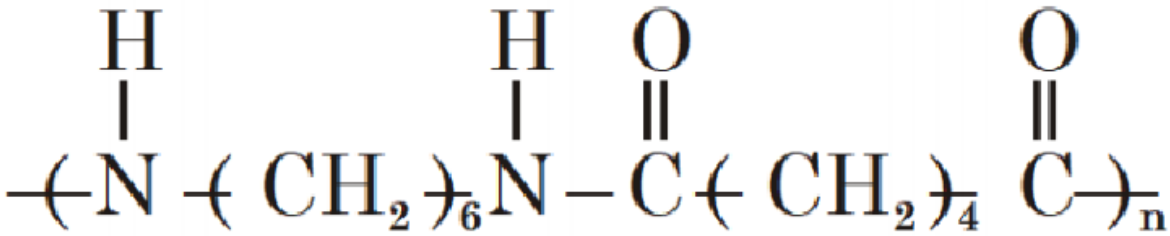
The question has multiple options out of which ONE or MORE is/are correct.

Which of the following polymer is/are Biodegradable?

A. 

B. 

C. 

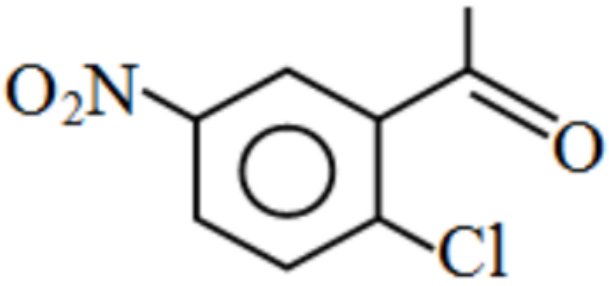
D. 

Question No. 3

One or More Options Correct Type

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

An oxime of compound

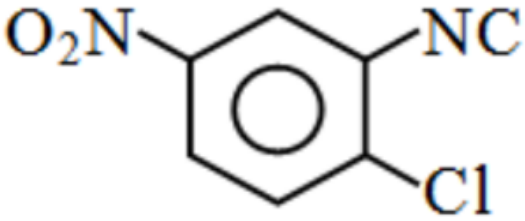


(which can substitute $-Cl$ intramolecularly in alkaline

condition) whenever treated with H_2SO_4/Δ gives a compound (P) which on hydrolysis produce (Q) and (R). If (Q) is primary amine, then choose the correct option(s)?

A. (P) and (R) are soluble in hot aq. NaOH .
B. (R) gives brisk effervence of CO_2 with aqueous $NaHCO_3$.

Q can give foul smelling compound



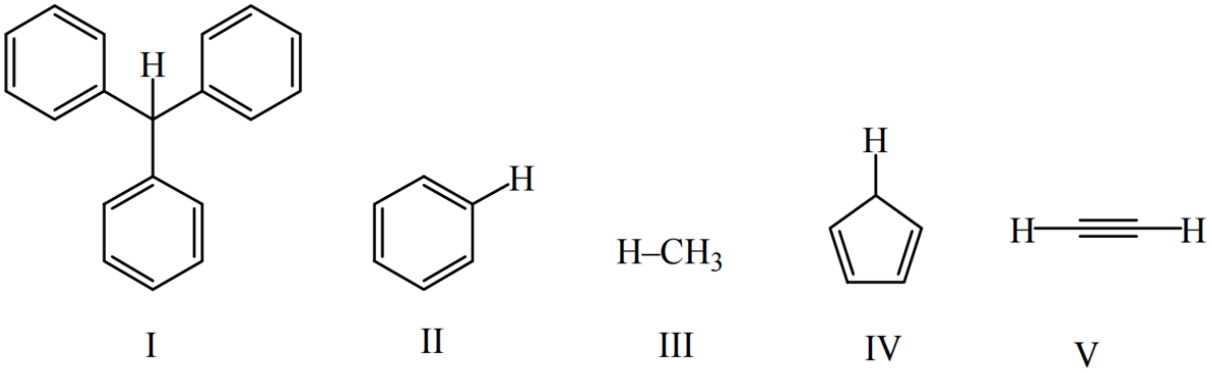
C. with $CHCl_3/NaOH$.
D. Q on Hofmann exhaustive methylation gives a product which is soluble in water.

Question No. 4

One or More Options Correct Type

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

With respect to the compounds I-V, choose the correct statement(s).



A. The acidity of compound I is due to delocalization in the conjugate base.
B. The conjugate base of compound IV is aromatic.
C. Compound II becomes more acidic, when it has a $-NO_2$ substituent.
D. The acidity of compounds follows the order I > IV > **V** > II > III.

Question No. 5

One or More Options Correct Type

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

An excess of aqueous ammonia is added to three different flasks ($\mathbf{F}_1, \mathbf{F}_2$ and $\mathbf{F}_3$) containing aqueous solutions of $CuSO_4$, $Al_2(SO_4)_3$ and $NiSO_4$ respectively. Which of the following is (are)correct about this addition?

A. A precipitate will be formed in all three flasks.
B. Ammonia acts as a base as well as a ligand exchange reagent in $\mathbf{F}_1$ and $\mathbf{F}_3$.
C. A soluble complex of NH_3 and the metal ion is formed in $\mathbf{F}_1$ and $\mathbf{F}_3$.
D. A precipitate will be formed only in $\mathbf{F}_2$.

Question No. 6

One or More Options Correct Type

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

In the given wave function, $\psi = \frac{1}{81}\left(\frac{2}{\pi}\right)^{\frac{1}{2}}\left(\frac{1}{a_0}\right)^{\frac{3}{2}}\left(6\frac{r}{a_0} - \frac{r^2}{a_0^2}\right)e^{-\frac{r}{3a_0}}\cos\theta$

Identify the correct choice(s).

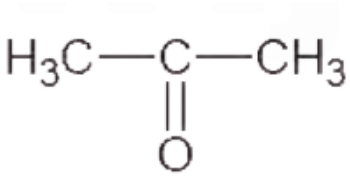
A. The given orbital is $3p_z$.
B. The given orbital is $3\,d_{z^2}$.
C. The nodal surface is at a radical distance of $6a_0$ from the nucleus.
D. The number of angular nodes in the given orbital are 2 .

Question No. 7

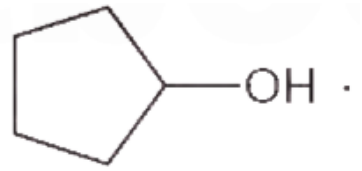
One or More Options Correct Type

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

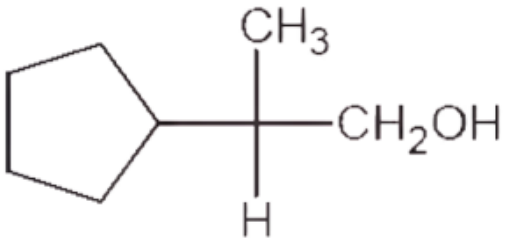
An optically active alcohol $A(C_8H_{16}O)$ on oxidation gives B. A on acidic heating gives $C(C_8H_{14})$ as major product. C on ozonolysis produces $D(C_5H_8O)$ and

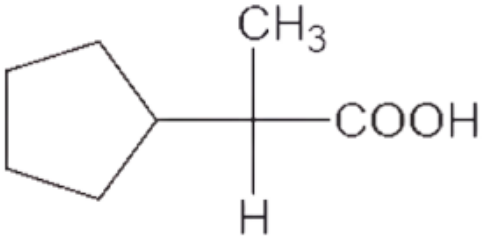


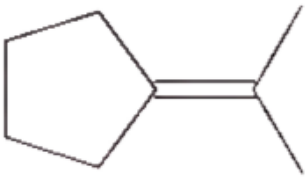
D on reduction with $LiAlH_4$ gave

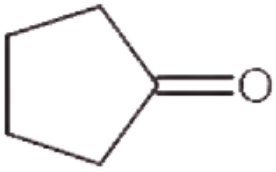


Identify correct answer:

A. A is 

B. B is 

C. C is 

D. D is 

Question No. 8

One or More Options Correct Type

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

Which among the following statement(s) is(are) true for the extraction of aluminium from bauxite?

A. Hydrated Al_2O_3 precipitates, when CO_2 is bubbled through a solution of sodium aluminate.
B. Addition of Na_3AlF_6 lowers the melting point of alumina.
C. CO_2 is evolved at the anode during electrolysis.
D. The cathode is a steel vessel with a lining of carbon.

Chemistry Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

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

For the first order reaction $A(g) \rightarrow 2\,B(g) + C(g)$ the half life for decomposition of A is 3 minute at 300 K. Calculate the time (in minute) in which partial pressure of $A(g)$ will drop from 2 bar to 0.5 bar at 400 K. Given activation energy of reaction is 840R. (Take $\ln 2 = 0.7$)

Question No. 2

Numerical Type

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

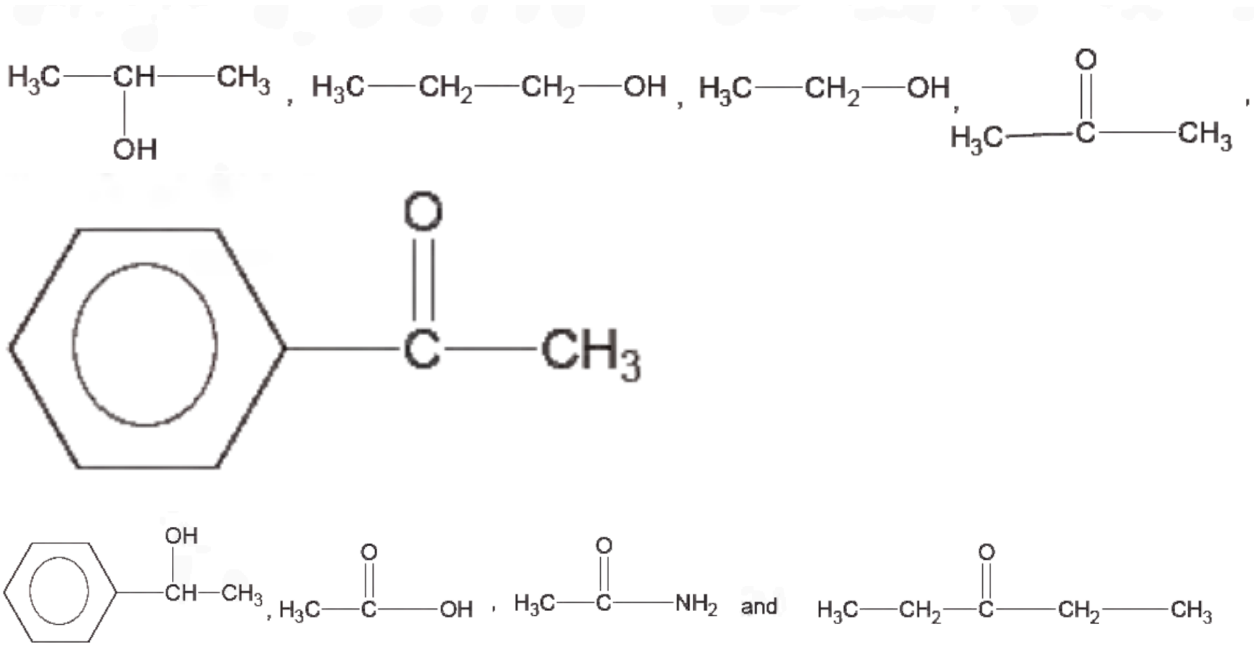
K_{sp} of $PbBr_2$ (Molar mass = 367) is 3.2×10^{-5} . If the salt is 80% dissociated in solution, calculate the solubility of salt in gram per litre. (in litre-1)

Question No. 3

Numerical Type

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

Among the following the total number of compound which give positive iodoform test is:



Question No. 4

Numerical Type

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

Consider the following 3 d series ions: Sc^{3+} , Ti^{3+} , V^{3+} , Cr^{3+} , Mn^{3+} , Fe^{3+} , Co^{3+} , Ni^{3+} .

Find total number of ions for which all octahedral complexes are paramagnetic, irrespective of ligand.

Question No. 5

Numerical Type

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

How many of the following contain peroxide linkage?

(a) $[FeO_4]^{2-}$

(b) Mn_2O_7

(c) HSO_5^-

(d) CrO_5

(e) PbO_3^{2-}

(f) HNO_4

(g) $Na_2B_4O_7$

(h) MnO_2

(i) $S_4O_6^{2-}$

Question No. 6

Numerical Type

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

A magnesium ribbon, when burnt in air, left an ash containing MgO and Mg_3N_2. The ash was found to consume $0.6\ mol$ of HCl according to the reactions :

$$MgO + 2HCl \longrightarrow MgCl_2 + H_2O$$
$$Mg_3N_2 + 8HCl \longrightarrow 3MgCl_2 + 2NH_4Cl.$$

The solution so obtained is treated with excess of $NaOH$, then $0.1\ mol$ of NH_3 is evolved ($NaOH + NH_4Cl \rightarrow NH_3 + H_2O + NaCl$). The mass (in g) of magnesium burnt is.

Chemistry Paragraph Type (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

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

Paragraph:

Concrete is produced from a mixture of cement, water, sand and small stones. It consists primarily of calcium silicates and calcium aluminates formed by heating and grinding of clay and limestone. In later steps of cement production a small amount of gypsum, $CaSO_4 \cdot 2H_2O$ is added to improve subsequent hardening of concrete. The use of elevated temperatures during the final production may lead to formation of unwanted hemihydrate, $CaSO_4 \cdot 1/2H_2O$. Consider the following reaction:

$$CaSO_4 \cdot 2H_2O(s) \longrightarrow CaSO_4 \cdot \tfrac{1}{2}H_2O(s) + \tfrac{3}{2}H_2O(g)$$

The following thermodynamic data apply at 25°C, standard pressure: 1bar

Compound	$\Delta H^o_{f(kJ/mol)}$	$S^o(JK^{-1}\ mol^{-1})$
$CaSO_4.2H_2O(s)$	- 2021.0	194.0
$CaSO_4.\frac{1}{2}H_2O(s)$	- 1575.0	130.5
$H_2O(g)$	- 241.8	188.6

$R = 8.314\ JK^{-1}\ mol^{-1}$

Question:

ΔH° for the formation of $1.00\ kg$ of $CaSO_4 \cdot \frac{1}{2}H_2O(s)$ from $CaSO_4 \cdot 2H_2O(s)$ is

A. $+446\ kJ$
B. $570.5\ kJ$
C. $-446\ kJ$
D. $-484\ kJ$

Question No. 2

Only One Option Correct Type

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

Paragraph:

Concrete is produced from a mixture of cement, water, sand and small stones. It consists primarily of calcium silicates and calcium aluminates formed by heating and grinding of clay and limestone. In later steps of cement production a small amount of gypsum, $CaSO_4 \cdot 2H_2O$ is added to improve subsequent hardening of concrete. The use of elevated temperatures during the final production may lead to formation of unwanted hemihydrate, $CaSO_4 \cdot 1/2H_2O$. Consider the following reaction:

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$H_2O(g)$	- 241.8	188.6

$R = 8.314\ JK^{-1}\ mol^{-1}$

Question:

Equilibrium pressure (in bar) of water vapour in closed vessel containing $CaSO_4 \cdot 2H_2O(s)$, $CaSO_4 \cdot \frac{1}{2} H_2O(s), H_2O(g)$ at 25˚C

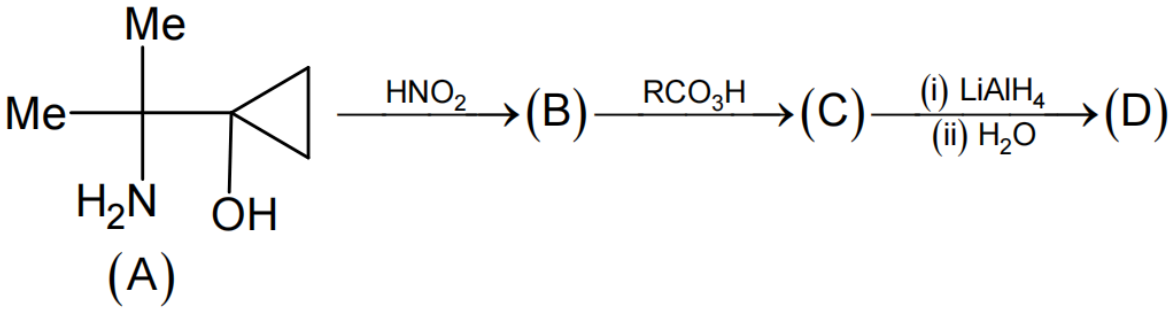
A. 17.35×10^{-4} bar
B. 2.15×10^{-4} bar
C. 8.10×10^{-3} bar
D. 7.00×10^{-4} bar

Question No. 3

Only One Option Correct Type

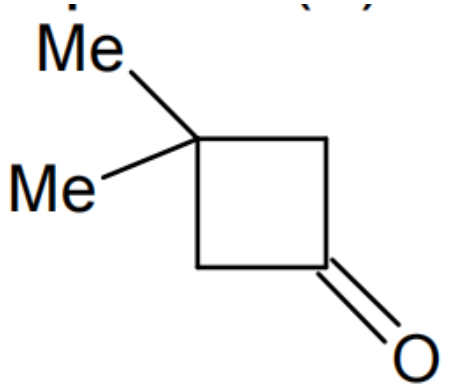
Each question has multiple options out of which ONLY ONE is correct.

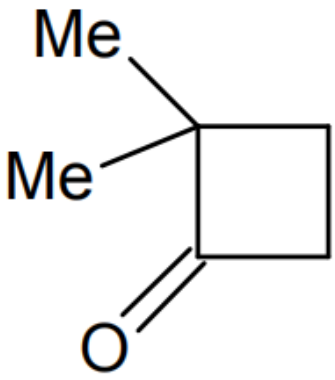
Paragraph:

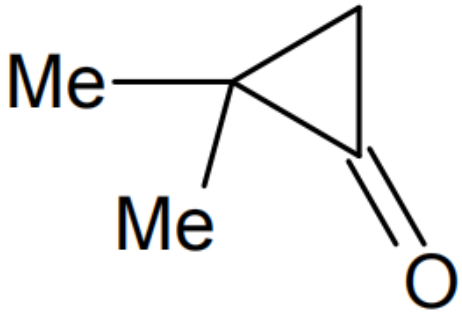


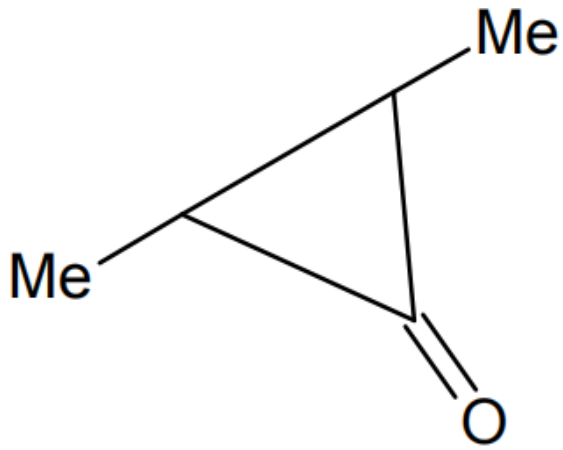
Question:

The compound (*B*) is

A. 

B. 

C. 

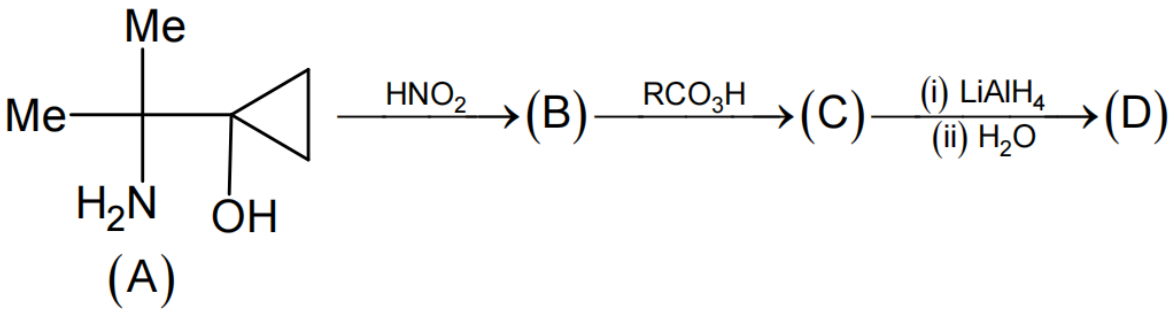
D. 

Question No. 4

Only One Option Correct Type

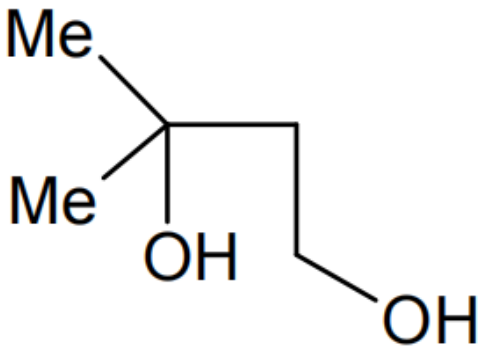
Each question has multiple options out of which ONLY ONE is correct.

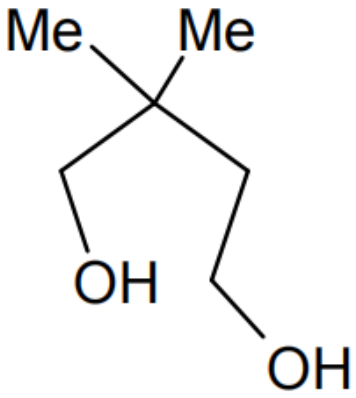
Paragraph:

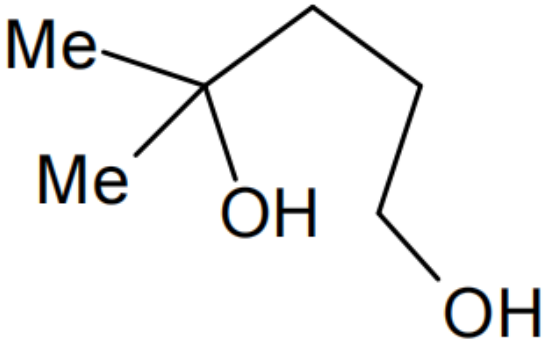


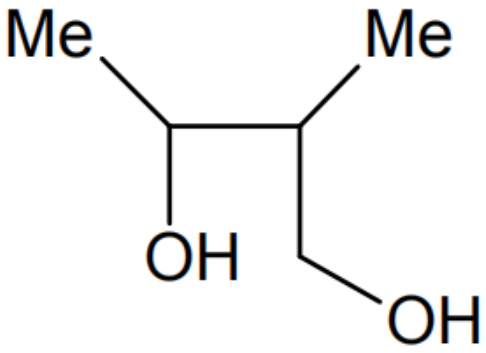
Question:

The combound (D) is

A. 

B. 

C. 

D. 

Mathematics Multiple Correct (Maximum Marks: 32)

Question No. 1

One or More Options Correct Type

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

Let N be the number of ordered pairs of non-empty sets A and B. If A and B satisfy

(i) $A \cup B = \{1, 2, 3, \ldots .12\}$

(ii) $A \cap B = \phi$

(iii) (number of elements of A) $\notin A$

(iv) (number of elements of B) $\notin B$ then choose correct options

A. N is a 3-digits number
B. Sum of the digits of N is 11
C. When N is divided by 10 , remainder is 2
D. N is an odd number

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 variable tangent of the circle $x^2 + y^2 = 1$ intersect the ellipse $x^2 + 2y^2 = 4$ at the points P and Q. If locus of point of intersection of tangents at P and Q is a conic C. Then which of the following is are true

A. C is hyperbola
B. C is ellipse
C. eccentricity of C is $\frac{\sqrt{3}}{2}$
D. eccentricity of C is 1

Question No. 3

One or More Options Correct Type

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

Assume that $A_i (i = 1, 2, \ldots, n)$ are the vertices of a regular polygon inscribed in a circle of radius unity. The value of $\frac{|A_1A_2|^2 + |A_1A_3|^2 + \ldots + |A_1A_n|^2}{n}$ is:

A. > 1.5
B. 1
C. 2
D. < 1.5

Question No. 4

One or More Options Correct Type

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

Let \mathrm{b}b be a nonzero real number. Suppose f: \mathbb{R} \rightarrow \mathbb{R} is a differentiable function such that f(0)=1. If the derivative f^{\prime} of f satisfies the equation \mathrm{f}^{\prime}(\mathrm{x})=\frac{\mathrm{f}(\mathrm{x})}{\mathrm{b}^2+\mathrm{x}^2} for all \mathrm{x} \in \mathbb{R}, then which of the following statements is/are TRUE ?

A. If $\mathrm{b}>0$, then f is an increasing function
B. If $\mathrm{b} < 0$, then f is a decreasing function
C. $f(\mathrm{x}) f(-\mathrm{x})=1$ for all $\mathrm{x} \in \mathbb{R}$
D. $f(\mathrm{x})-f(-\mathrm{x})=0$ for all $\mathrm{x} \in \mathbb{R}$

Question No. 5

One or More Options Correct Type

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

$\int \frac{\sin 2 x d x}{(\sin x+\cos x)^2}$ is equal to (where $\mathrm{C}_1, \mathrm{C}_2, \mathrm{C}_3, \mathrm{C}_4$ are constant of integration)

A. $\mathrm{x}+\frac{1}{2} \cot \left(\mathrm{x}+\frac{\pi}{4}\right)+\mathrm{C}_1$
B. $\mathrm{x}+\frac{1}{2} \tan \left(\frac{\pi}{4}-\mathrm{x}\right)+\mathrm{C}_2$
C. $x-\frac{\tan 2 x}{2}+\frac{\sec 2 x}{2}+\mathrm{C}_3$
D. $\mathrm{x}+\frac{1}{1+\tan \mathrm{x}}+\mathrm{C}_4$

Question No. 6

One or More Options Correct Type

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

A straight line $\mathrm{y}=\mathrm{m}(\mathrm{x}-\mathrm{a}), \mathrm{m} \neq 0$ meets a parabola $\mathrm{y}^2=4 \mathrm{ax}$ at two points A and B. Then which of the following option(s) is/are correct

A. Length $\mathrm{AB}=4 \mathrm{a}$ when $m=1$
B. Length $\mathrm{AB}=8 \mathrm{a}$ when $\mathrm{m}=1$
C. Angle between normals drawn at A and B is 45° when $\mathrm{m}=1$
D. Angle between normals drawn at A and B is 90° when $\mathrm{m}=2$

Question No. 7

One or More Options Correct Type

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

Let $f:[-1,1] \rightarrow[-1,1], f(x)=\sin \left(2 \sin ^{-1} x\right) \&$ let $g(x)=\frac{\mathrm{f}(\mathrm{x})}{\sqrt{1-\mathrm{x}^2}}$, then -

A. $f(\mathrm{x})$ is one-one function
B. $f(\mathrm{x})$ is odd function
C. $\mathrm{g}(\mathrm{x})$ is continuous in $(-1,1)$
D. $f(\mathrm{x})$ is continuous for all $\mathrm{x} \in[-1,1]$

Question No. 8

One or More Options Correct Type

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

If OABC is a tetrahedron (where O is origin and points $\mathrm{A}, \mathrm{B}, \mathrm{C}$ lies on $\mathrm{x}, \mathrm{y}, \mathrm{z}$ axes respectively). Let $\mathrm{A}^{\prime}$ is point on $\mathrm{OA}(\vec{a}), \mathrm{B}^{\prime}$ is point on $\mathrm{OB}(\vec{b})$ ~\&~ $\mathrm{C}^{\prime}$ is point on $\mathrm{OC}(\vec{c})$ such that $\mathrm{A}^{\prime} \mathrm{B}^{\prime} \mathrm{C}^{\prime}$ plane is parallel to ABC and volume of tetrahedron $\mathrm{OA}^{\prime} \mathrm{B}^{\prime} \mathrm{C}^{\prime}$ is half the volume of tetrahedron OABC, then -

A. equation of plane through three points $\mathrm{A}^{\prime}, \mathrm{B}^{\prime}, \mathrm{C}^{\prime}$ is $\frac{\mathrm{x}}{|\overrightarrow{\mathrm{a}}|}+\frac{\mathrm{y}}{|\overrightarrow{\mathrm{b}}|}+\frac{\mathrm{z}}{|\overrightarrow{\mathrm{c}}|}=\frac{1}{2}$
B. equation of plane through three points $A^{\prime}, B^{\prime}, C^{\prime}$ is $\frac{x}{|\vec{a}|}+\frac{y}{|\vec{b}|}+\frac{z}{|\vec{c}|}=\frac{1}{2^{1 / 3}}$
C. $\frac{\text { area of }(\triangle \mathrm{ABC})}{\text { area of }\left(\triangle \mathrm{A}^{\prime} \mathrm{B}^{\prime} \mathrm{C}^{\prime}\right)}=2^{1 / 3}$
D. $\frac{\text { area of }(\Delta \mathrm{ABC})}{\text { area of }\left(\Delta \mathrm{A}^{\prime} \mathrm{B}^{\prime} \mathrm{C}^{\prime}\right)}=2^{2 / 3}$

Mathematics Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

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

Total number of points where the function $y=f(x)$ defined parametrically is non-differentiable is, where $x=2 t-|t-1|$ and $y=2 t^2+t|t|$

Question No. 2

Numerical Type

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

Let B be a skew symmetric matrix of order 3×3 with real entries.

Given $I-B$ and $I+B$ are non-singular matrices.

If $A=(I+B)(I-B)^{-1}$ where $\operatorname{det}(\mathrm{A})>0$, then the value of $\operatorname{det}(2 \mathrm{~A})-\operatorname{det}(\operatorname{adj} \mathrm{A})$ is

[here det (P) denotes determinant of square matrix P and $\operatorname{det}(\operatorname{adj} \mathrm{P})$ denotes determinant of adjoint of square matrix P respectively]

Question No. 3

Numerical Type

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

The equation $x^3-6 x^2+9 x+\lambda=0$ have exactly one root in $(1,3)$ then find the number of integral values of $\lambda+1$.

Question No. 4

Numerical Type

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

A bag contains 3 red, 2 white and 2 black balls. Two balls are drawn at random and none of them is found to be a white ball. The probability that both balls are red is $\frac{\mathrm{a}}{\mathrm{b}}$ (where a, b are coprime) then $\mathrm{b}-\mathrm{a}$ is equal to

Question No. 5

Numerical Type

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

$\text { Number of solutions of equation } \frac{\sum_{\mathrm{r}=0}^4{ }^4 \mathrm{C}_{\mathrm{r}} \sin 2 \mathrm{rx}}{\sum_{\mathrm{r}=0}^4{ }^4 \mathrm{C}_{\mathrm{r}} \cos 2 \mathrm{rx}}=0 \text { in }[0,4 \pi) \text { is/are equal to }$

Question No. 6

Numerical Type

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

Let $\mathrm{N}=5^3 11^3 13^3 19^3$. If total number of divisors of N in the form of $8 \lambda+1$ (λ is positive integer) are 'a', then $\frac{a}{5}$ is equal to

Mathematics Paragraph Type (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

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

Paragraph:

Given two fixed points \(A\) and \(B\) in a plane and a positive real number \(k\) not equal to unity. Introduce a rectangular Cartesian co-ordinate system by choosing mid-point of \(A B\) as origin and the positive direction of \(x\) - axis is chosen from \(A\) to \(B\). The locus of points \(M\) for which the equation \(\frac{M A}{M B}=k\) holds is a circle \(C_k\).

Question:

If the circles \(C_{k_1}\) and \(C_{k_2}\left(0 < k_1 \neq 1,0 < k_2 \neq 1\right)\), are symmetric to each other with respect to the perpendicular bisector of segment \(\mathrm{AB}\), then

A. \(\mathrm{k}_1=\mathrm{k}_2\)
B. \(k_1 k_2 < 1\)
C. \(k_1 k_2 > 1\)
D. \(k_1 k_2=1\)

Question No. 2

Only One Option Correct Type

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

Paragraph:

Given two fixed points A and B in a plane and a positive real number k not equal to unity. Introduce a rectangular Cartesian co-ordinate system by choosing mid-point of $A B$ as origin and the positive direction of x - axis is chosen from A to B. The locus of points M for which the equation $\frac{M A}{M B}=k$ holds is a circle C_k.

Question:

An arbitrary circle passes through points A and B intersects the circle C_k at an angle

A. $\frac{\pi}{4}$
B. nothing can be said
C. $\frac{\pi}{2}$
D. π

Question No. 3

Only One Option Correct Type

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

Paragraph:

Let $f(x)$ is defined as $f(x)=\left|\begin{array}{lll}\sin (x+\alpha) & \sin (x+\beta) & \sin (x+\gamma) \\ \cos (x+\alpha) & \cos (x+\beta) & \cos (x+\gamma) \\ \cos (\beta-\gamma) & \cos (\gamma-\alpha) & \cos (\alpha-\beta)\end{array}\right|$ and $f(9)=\lambda \neq 0$ and $P=\left[\begin{array}{cc}\cos (\pi / 9) & \sin (\pi / 9) \\ -\sin (\pi / 9) & \cos (\pi / 9)\end{array}\right]$, where α, β and γ be non-zero numbers such that $\left(\alpha P^{6}+\beta P^{3}+\gamma I\right)$ is the zero matrix and where I is an identity matrix of order 2 .
\(\begin{array}{ll}

\text{ List-I } & \text{ List-II } \\

\text{ (I) The value of } \frac{\sum_{k=1}^{9} f(k)}{f(9)} \text{ equals } & \text{ (P) 1 } \\

\text{ (II) The absolute value of } \frac{\alpha}{\beta} \text{ is equal to } & \text{ (Q) 2 } \\

\text{ (III) The value of } \left(\alpha^{2}+\beta^{2}+\gamma^{2}\right)^{(\alpha-\beta)(\beta-\gamma)(\gamma-\alpha)},\text{ is } & \text{ (R) 5 } \\

\text{ (IV) The absolute value of } \frac{2 \beta}{\gamma} \text{ is equal to } & \text{ (S) 7 } \\

& \text{ (T) 9 } \\

\end{array}\)

Question:

Which of the following options has the correct combination considering List-I and List-II?

A. (IV) (P)
B. (III) (Q)
C. (II) (R)
D. (I) (T)

Question No. 4

Only One Option Correct Type

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

Paragraph:

Let $f(x)$ is defined as $f(x)=\left|\begin{array}{lll}\sin (x+\alpha) & \sin (x+\beta) & \sin (x+\gamma) \\ \cos (x+\alpha) & \cos (x+\beta) & \cos (x+\gamma) \\ \cos (\beta-\gamma) & \cos (\gamma-\alpha) & \cos (\alpha-\beta)\end{array}\right|$ and $f(9)=\lambda \neq 0$ and $P=\left[\begin{array}{cc}\cos (\pi / 9) & \sin (\pi / 9) \\ -\sin (\pi / 9) & \cos (\pi / 9)\end{array}\right]$, where α, β and γ be non-zero numbers such that $\left(\alpha P^{6}+\beta P^{3}+\gamma I\right)$ is the zero matrix and where I is an identity matrix of order 2 .
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\text{ (III) The value of } \left(\alpha^{2}+\beta^{2}+\gamma^{2}\right)^{(\alpha-\beta)(\beta-\gamma)(\gamma-\alpha)},\text{ is } & \text{ (R) 5 } \\

\text{ (IV) The absolute value of } \frac{2 \beta}{\gamma} \text{ is equal to } & \text{ (S) 7 } \\

& \text{ (T) 9 } \\

\end{array}\)

Question:

Which of the following options has the incorrect combination considering List-I and List-II?

A. (II) P
B. (I) R
C. (III) P
D. $(\mathrm{IV}) \mathrm{Q}$