

Question Paper

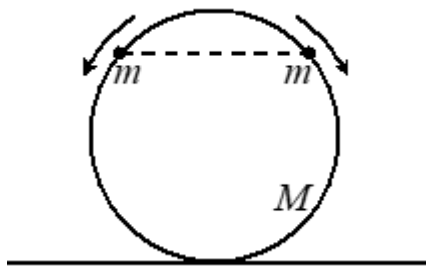
Physics Single Correct (Maximum Marks: 15)

Question No. 1

**Only One Option Correct Type**

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

Two beads of mass  $m$  each are positioned at the top of a frictionless hoop of mass  $M$  and radius  $R$ , which stands vertically on the ground. The beads are given tiny kicks, and they slide down the hoop, one to the right and other-one to the left, as shown. The smallest value of  $m/M$  for which the hoop will rise up off the ground at some time during the motion, is



- A.  $\frac{2}{3}$
- B.  $\frac{3}{4}$
- C.  $\frac{3}{2}$
- D. 1

Question No. 2

**Only One Option Correct Type**

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

In a screw gauge, there are 100 divisions in circular scale and each main scale division is of 1 mm. When there is no gap between the jaws, 97<sup>th</sup> divisions coincides with the main scale zero and zero of main scale is not visible. While measuring the diameter of a ball, the circular scale is between 3 mm mark and 4 mm mark such that the 76<sup>th</sup> division of circular scale coincides with the reference line. Select the correct alternative

- A. the least count of the micrometer is 0.01 cm
- B. the zero error is  $-0.04$  mm
- C. the diameter of the ball is 3.79 cm
- D. the main scale reading is 4 mm

Question No. 3

**Only One Option Correct Type**

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

A vertical capillary tube of glass is brought in contact with pure water surface, what amount of heat is liberated while the water rises along the capillary? The wetting is assumed to be complete and the surface tension is  $S$ . Density of water is  $\rho$

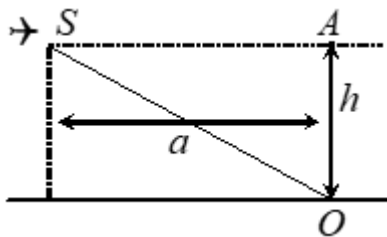
- A.  $\frac{2\pi S^2}{\rho g}$
- B.  $\frac{\pi S^2}{\rho g}$
- C. zero
- D.  $\frac{4\pi S^2}{\rho g}$

Question No. 4

**Only One Option Correct Type**

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

An airplane is in supersonic flight at an altitude  $h$  at  $t = 0$ . At what smallest distance  $a$  (along the horizontal) from the observer on the ground is there a point from which the sound emitted by the airplane motors travels to the observer before the sound emitted by the airplane when it is directly above the observer



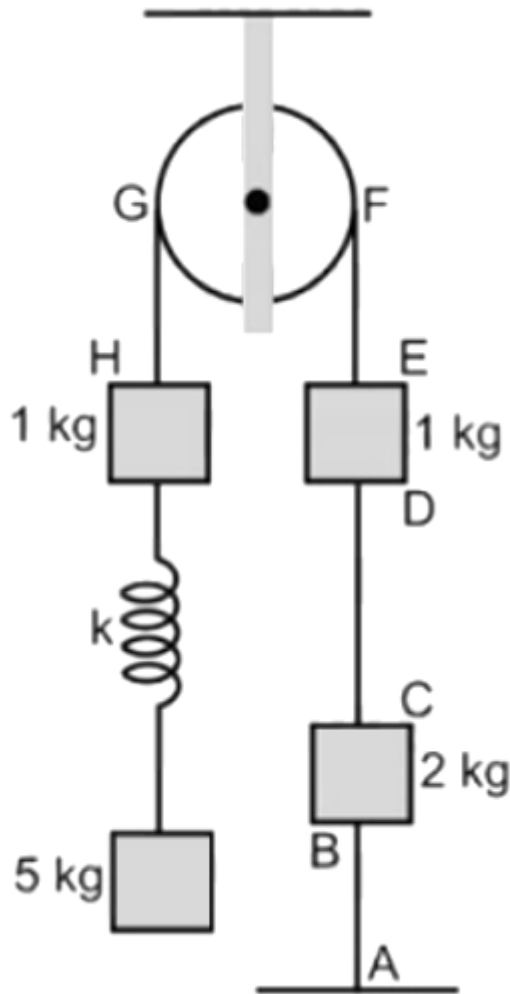
- A.  $a < \frac{2(\frac{v_p}{v_s})}{(\frac{v_p}{v_s})^2 - 1} h$
- B.  $a < \frac{(\frac{v_p}{v_s})}{(\frac{v_p}{v_s})^2 - 1} h$
- C. not possible for any real value of  $a$
- D.  $a > \frac{2(\frac{v_p}{v_s})}{(\frac{v_p}{v_s})^2 - 1} h v_p \rightarrow$  velocity of airplane  $v_s \rightarrow$  velocity of sound.

Question No. 5

**Only One Option Correct Type**

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

In the situation shown in the diagram, the system is in equilibrium. All the strings, spring and pulley are light. Just after cutting the string  $AB$ ,



- A. The tension in the string  $GH$  is  $6g$
- B. The tension in the string  $GH$  is zero
- C. The tension in string  $GH$  is  $\frac{21g}{4}$
- D. The 2 kg block remains in equilibrium

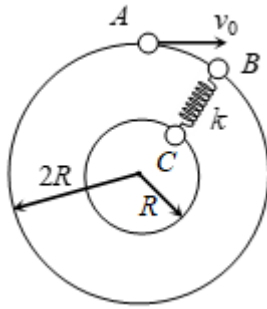
Physics Multiple Correct (Maximum Marks: 28)

Question No. 1

**One or More Options Correct Type**

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

Three particles each of mass  $m$ , can slide on fixed frictionless circular tracks in the same horizontal plane as shown. Particle  $A$  moves with velocity  $v_0$  and hits particle  $B$  elastically. Assuming that  $B$  and  $C$  are initially at rest and lie along a radial line and the spring is initially relaxed before impact, then



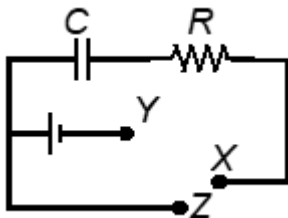
- A. the velocity of  $B$  immediately after impact is  $v_0$
- B. the velocity of  $C$  when the stretch in the spring is maximum is  $\frac{2v_0}{5}$
- C. the velocity of  $B$  when the stretch in the spring is maximum is  $\frac{4v_0}{5}$
- D. the maximum stretch in the spring in the spring is  $\sqrt{\frac{m}{5k}} v_0$

Question No. 2

**One or More Options Correct Type**

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

The capacitor  $C$  is initially without charge.  $X$  is now joined to  $Y$  for a long time, during which  $H_1$  heat is produced in the resistance  $R$ .  $X$  is now joined to  $Z$  for a long time, during which  $H_2$  heat is produced in  $R$ . Now,



- A.  $H_1 = H_2$
- B.  $H_1 = \frac{H_2}{2}$
- C.  $H_1 = 2H_2$
- D. the maximum energy stored in  $C$  at any time is  $H_1$

Question No. 3

**One or More Options Correct Type**

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

During a positive beta decay

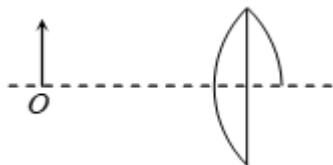
- A. the atomic number of the atom decreases by one
- B. sometimes a neutrino may also come along with it
- C. a proton gets converted into a neutron
- D. the binding energy of the remaining nucleus increases

Question No. 4

**One or More Options Correct Type**

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

One fourth part of an equiconvex lens of focal length 100 cm is removed as shown in the figure. An object of height 1 cm is placed in front of the lens. It is observed that all the images are of equal height. Then



- A. Object is at a distance of  $\frac{400}{3}$  cm from the lens.
- B. The magnitude of magnification produced by upper and lower part is equal.
- C. The no. of images formed is two.
- D. The product of magnification of both the lenses is negative.

Question No. 5

**One or More Options Correct Type**

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

In a Young's double slit experiment

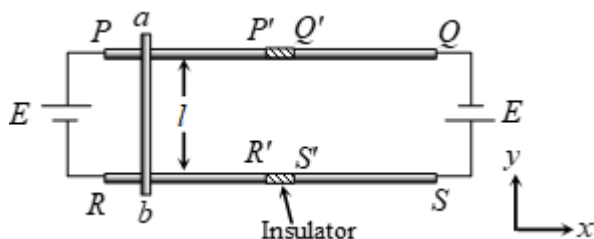
- if a point source is placed symmetrically from both the slits then
- A. interference will be observed on the screen
- if a point source is placed un-symmetrically from both the slits then
- B. interference will be observed on the screen
- if two slits are illuminated by two independent sources then the interference
- C. will be observed on the screen.
- D. intensity of light at two slits should be same for better interference

Question No. 6

**One or More Options Correct Type**

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

System shows a slidable conductor  $ab$  of mass  $m$  which can move over frictionless and resistanceless rails  $PP'Q'Q$  and  $RR'S'S$  in horizontal plane.  $PP'$ ,  $QQ'$  and  $RR'$ ,  $S'S$  are separated by a very small insulator as shown in the figure. At  $t = 0$  a magnetic field  $-\hat{B}\hat{k}$  Tesla is applied everywhere and conductor  $ab$  is released from rest. Choose the correct statement (s). Neglecting back emf in the conductor  $ab$ .



A. Motion of conductor  $ab$  is S.H.M.

Time taken by conductor  $ab$  to reach back the initial position must be

B.  $\sqrt{\frac{32ymR}{BE}}$ , where  $R$  is resistance of conductor  $ab$  and  $PP' = QQ' = y$ .

If the battery on the right hand side is removed and a conductor identical to  $ab$  is kept on the rails near the end  $Q$  and  $S$  and  $ab$  is released from the position shown the new conductor will tend to move in the direction

C. opposite to the motion of  $ab$  due to electromagnetic induction.

To keep the new conductor at its position the minimum coefficient of

D. friction between rails and new conductor must be  $\mu = \frac{BEI}{m^2g}$ .

Question No. 7

**One or More Options Correct Type**

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

A particle of mass  $m$  moves on the  $x$ -axis as follows: It starts from rest at  $t = 0$  from the point  $x = 0$ , and comes to rest at  $t = 1$  at the point  $x = 1$ . No other information is available about its motion at intermediate times ( $0 < t < 1$ ). If  $\alpha$  denotes the instantaneous acceleration of the particle, then:

A.  $\alpha$  cannot remain positive for all  $t$  in the interval  $0 \leq t \leq 1$

B.  $|\alpha|$  cannot exceed 2 at any point in its path

C.  $|\alpha|$  must be  $\geq 4$  at some point of points in its path

$\alpha$  must change sign during the motion, but no other assertion can be made

D. with the information given

## Physics Numerical (Maximum Marks: 24)

Question No. 1

**Numerical Type**

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

A thin copper rod rotates about an axis passing through its end and perpendicular to its length with an angular speed  $\omega_0$ . The temperature of the copper rod is increased by  $100^\circ\text{C}$ . If the coefficient of linear expansion of copper is  $2 \times 10^{-5} / ^\circ\text{C}$ , the percentage change in the angular speed of the rod is  $K$ , find  $-10 K$ . (roundoff to nearest integer)

Question No. 2

**Numerical Type**

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

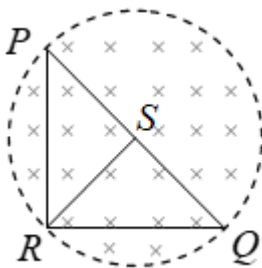
One mole of an ideal monatomic gas is kept in a rigid vessel whose outer surface is maintained at a constant temperature  $100^{\circ}\text{C}$ . The thickness and surface area of the vessel are  $5\text{ mm}$  and  $400\text{ cm}^2$  respectively. Initial temperature of the gas in the vessel is  $16^{\circ}\text{C}$ . The conductivity of the material of the walls is  $0.01\text{ W m}^{-1}\text{ K}^{-1}$ . A sound signal move with a velocity  $320 + n$  in the gas contained in the vessel after 250 seconds if initially its speed in the gas is  $290\text{ m/s}$ . Find the value of  $n$ . (nearest integer)  
 Given  $e^{1.6} = 4.94$ , gas constant  $R = \frac{25}{3}\text{ J mol}^{-1}\text{ K}^{-1}$ . (Neglect the heat capacity of the vessel.)

Question No. 3

**Numerical Type**

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

$PQR$  is a triangular frame made of a uniform metallic wire.  $RS$  is a median of the triangular frame joining the vertex  $R$  to the mid point  $S$  of the wire  $PQ$ . (Wire  $RS$  is also made of the same metallic wire). It is given that  $PR = 6\text{ cm}$ ,  $RQ = 8\text{ cm}$  and  $PQ = 10\text{ cm}$ . The cross sectional area of the wire is  $1\text{ mm}^2$  and its resistivity is  $24 \times 10^{-9}\text{ }\Omega\text{ m}$ . The triangle  $PQR$  lies in a cylindrical region of magnetic field such that the intersection of the surface of the cylinder with the plane containing the frame forms the circum circle of triangle  $PQR$ . The magnetic field in the region decreases at the rate of  $0.526\text{ T/s}$ . The magnitude of the induced current in  $\text{mA}$  in the median  $RS$  of the frame is  $5n$ . Find  $n$ .



Question No. 4

**Numerical Type**

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

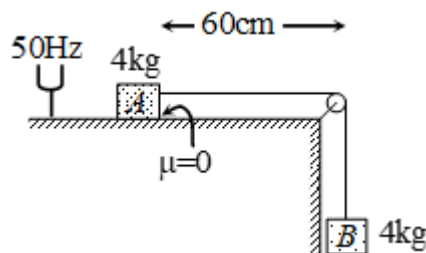
A radionuclide with disintegration constant  $\lambda$  is produced in a reactor at a constant rate  $\alpha (= 2\lambda)$  nuclei per second. At  $t = 0$ , there are no nuclei present in the reactor. During each decay energy  $E_0$  is released. 20% of this energy is utilized in increasing the temperature of water. The increase in temperature of  $m$  mass of water in time  $t = T_{1/2}$  if specific heat of water is  $s$  is  $772n\text{ K}$ . Assume that there is no loss of energy through water surface. (Given  $E_0 = 100$  times the energy required to raise the temperature of mass  $m$  of water from  $0^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ ) Find the value of  $n$ . (nearest integer)

Question No. 5

**Numerical Type**

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

In the system shown, the wire connecting two masses has linear mass density of  $\frac{1}{20}$  kg/m . A tuning fork of 50 Hz is found to be in resonance with the horizontal part of wire between pulley and block A . (Assuming nodes at block A and pulley). Now at  $t = 0$  system is released from rest. The ratio of time gap between successive resonance with the same tuning fork starting from  $t = 0$  is  $\underline{1} : \underline{K}$ , find  $(K + 1)^2$  . (take  $g = 10 \text{ m/s}^2$ )

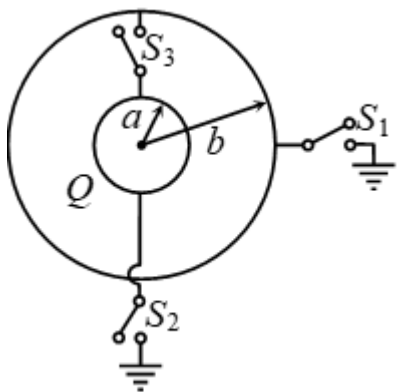


Question No. 6

**Numerical Type**

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

The figure shows a conducting sphere 'A' of radius 'a' which is surrounded by a neutral conducting spherical shell B of radius 'b' ( $b > a$ ) . Initially switches  $S_1, S_2$  and  $S_3$  are open and sphere 'A' carries a charge  $Q$ . First the switch ' $S_1$ ' is closed to connect the shell B with the ground and then opened. Now the switch ' $S_2$ ' is closed so that the sphere 'A' is grounded and then  $S_2$  is opened. Finally, the switch ' $S_3$ ' is closed to connect the spheres together. If the heat (in mJ ) which is produced after closing the switch  $S_3$  is  $x$ , then find  $\frac{x}{9}$  . [Consider  $b = 4 \text{ cm}, a = 2 \text{ cm}$  and  $Q = 0.8\mu\text{C}$ ]



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.



Let  $\phi_x^C$  and  $\phi_z^C$  denote the wavefunctions of the  $2p_x$  and  $2p_z$  orbitals of carbon, respectively, and  $\phi_x^O$  and  $\phi_z^O$  represent the wavefunctions of the  $2p_x$  and  $2p_z$  orbitals of oxygen, respectively. If  $c_1$  and  $c_2$  are constants used in linear combinations and the CO molecule is oriented along the z axis, then, according to molecular orbital theory, the  $\pi$ -bonding molecular orbital has a wavefunction given by

- A.  $c_1\phi_z^C + c_2\phi_x^O$
- B.  $c_1\phi_z^C + c_2\phi_z^O$
- C.  $c_1\phi_z^C + c_2\phi_z^O$
- D.  $c_1\phi_x^C + c_2\phi_x^O$

Question No. 2

**Only One Option Correct Type**

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

Out of the following the incorrect statement(s) is

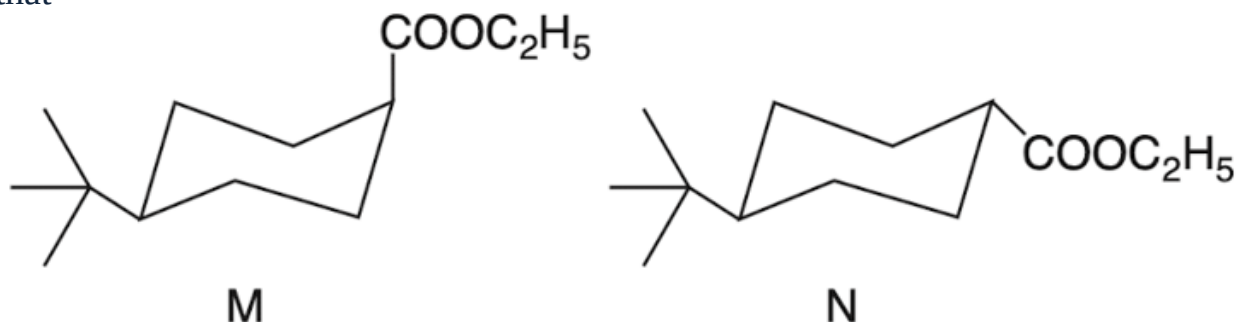
- A. the structure of diamond and corundum is same  
a mixture of 5 – 10%CO<sub>2</sub> and O<sub>2</sub> is known as carbogen which is used for
- B. artificial respiration in pneumonia patient
- C. SnCl<sub>2</sub> is a strong oxidising agent
- D. PbO is a yellow orange coloured powder commonly known as litharge

Question No. 3

**Only One Option Correct Type**

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

Regarding the saponification of M and N shown below, the correct statement is that



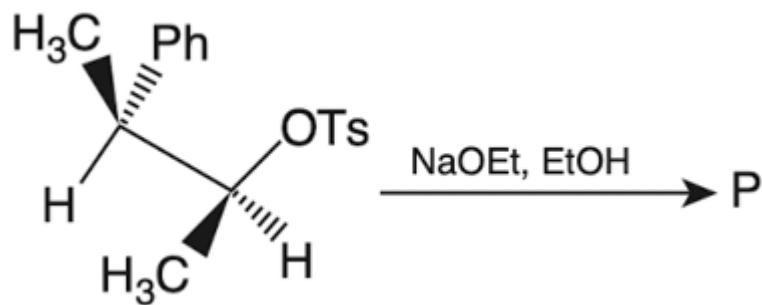
- M reacts faster than N because the transition state is less crowded for M
- A. than for N.
- M reacts slower than N because the transition state is more crowded for M
- B. than for N.
- N and M react at the same rate because of formation of tetrahedral
- C. intermediate in both cases.
- D. N reacts slower than M because of its greater thermodynamics stability.

Question No. 4

**Only One Option Correct Type**

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

The major product P formed in the given reaction



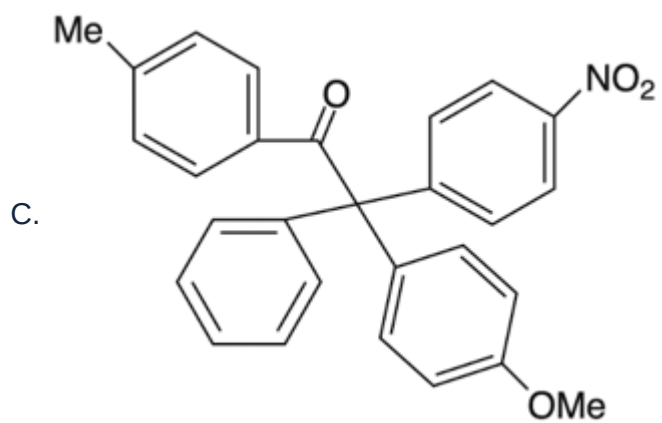
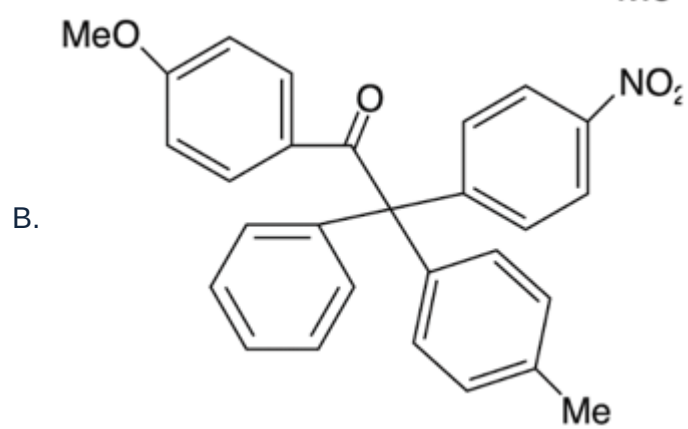
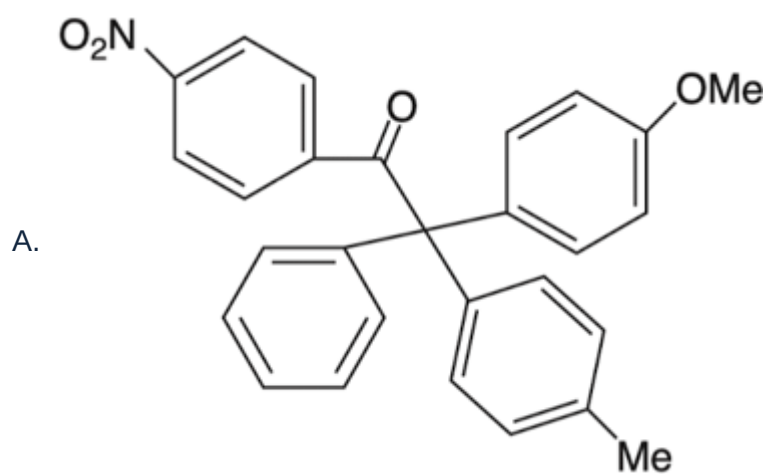
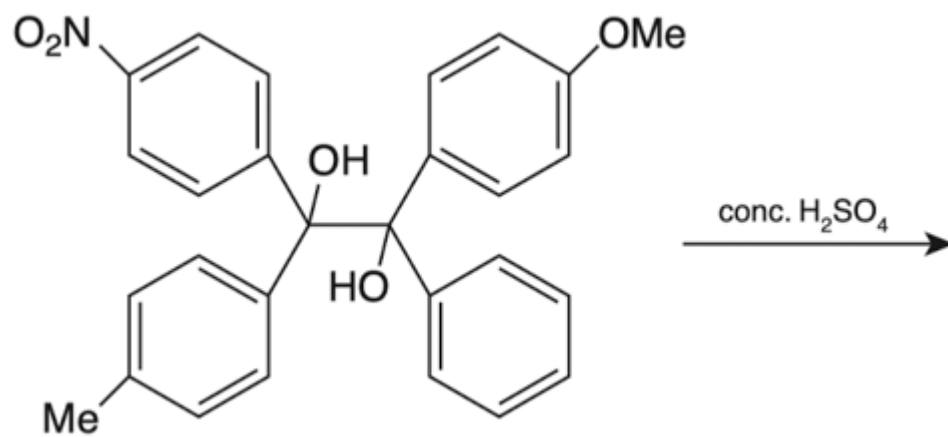
- A.
- B.
- C.
- D.

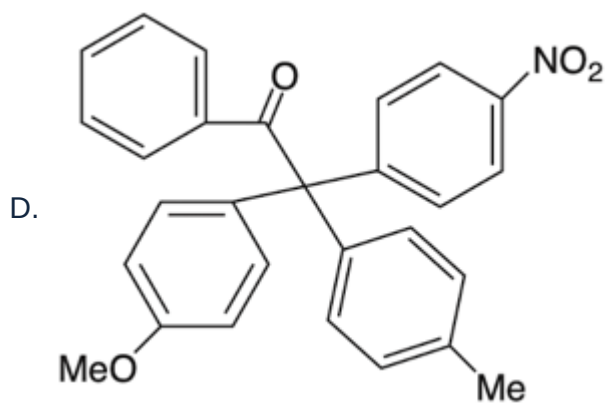
Question No. 5

**Only One Option Correct Type**

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

The major product formed in the reaction given below is





## 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.

A carbonyl compound (A) of molecular weight 100 does not reduce Tollen's reagent but shows haloform reaction. On careful oxidation, (A) gives (B) an acid as one of the product with equivalent mass of 102. (B) when heated with sodalime yields 2-methylpropane. Which of the following is correct regarding structure of (A) and (B)?

- A. (A) :  $(\text{CH}_3)_3\text{CCOCH}_3$
- B. (A) :  $(\text{CH}_3)_2\text{CHCH}_2\text{COCH}_3$
- C. (B) :  $(\text{CH}_3)_3\text{CCOOH}$
- D. (B) :  $(\text{CH}_3)_2\text{CHCH}_2\text{COOH}$

Question No. 2

### 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  $\text{CO}_2$
- C. Ammonium nitrate is heated
- D. Zinc oxide is treated with NaOH

Question No. 3

### One or More Options Correct Type

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

Two moles of a monoatomic perfect gas initially at 4.0 bar and  $47^\circ\text{C}$  undergoes reversible expansion in an insulated container. The temperature at which the pressure reduces to 3.0 bar is

- A. 200 K

- B. 285 K
- C. 310 K
- D. 320 K

Question No. 4

**One or More Options Correct Type**

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

Consider the electrochemical cell  $M(s)|MI_2(s)|MI_2(aq) || M(s)$  where 'M' is a metal. At 298 K, the standard reduction potentials are

$$E_{M^{2+}(aq)/M(s)}^{\circ} = -0.12 \text{ V}, E_{MI_2(s)/M(s)}^{\circ} = -0.36 \text{ V} \quad \text{and the temperature}$$

coefficient is  $\left(\frac{\partial E_{\text{cell}}^{\circ}}{\partial T}\right)_p = 1.5 \times 10^{-4} \text{ V K}^{-1}$ . At this temperature the standard

enthalpy change for the overall cell reaction,  $\Delta_r H^{\circ}$ , is \_\_\_\_\_  $\text{kJmol}^{-1}$ .  
(Faraday constant  $F = 96500 \text{ Cmol}^{-1}$ )

- A.  $> -40$
- B.  $< -35$
- C.  $< -25$
- D.  $> -25$

Question No. 5

**One or More Options Correct Type**

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

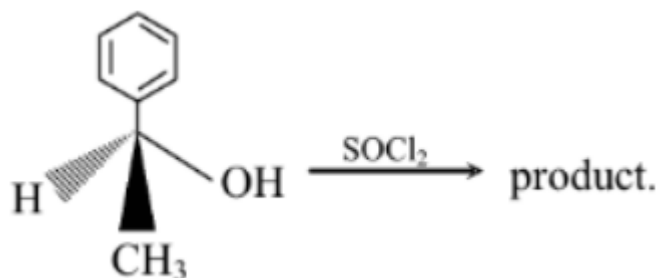
An ideal solution is formed by mixing two volatile liquids A & B.  $X_A$  and  $X_B$  are the mole fractions of A & B respectively in the solution and  $Y_A$  and  $Y_B$  are the mole fractions of A and B respectively in the gas phase. A plot of  $\frac{1}{Y_A}$  along y-axis vs  $\frac{1}{X_A}$  along x-axis gives a straight line. What is the slope of the straight line?

- A.  $\frac{P_B^{\circ}}{P_A^{\circ}}$
- B.  $\frac{P_A^{\circ}}{P_B^{\circ}}$
- C.  $P_B^{\circ} - P_A^{\circ}$
- D.  $P_A^{\circ} - P_B^{\circ}$

Question No. 6

**One or More Options Correct Type**

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



Which is/are incorrect statement/s regarding the above reaction?

- A. Kinetically, the reaction is unimolecular.
  - B. Stereochemically, the configuration is retained.
  - C. Stereochemically, Walden inversion takes place.
  - D. inversion.
- Addition of pyridine drives the configuration from retention to Walden

Question No. 7

**One or More Options Correct Type**

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

In Freundlich isotherm, a linear relationship is obtained in the plot of ( $\theta$  = surface coverage and  $p$  = partial pressure of the gas)

- A.  $\theta$  vs  $p$ .
- B.  $\ln(\theta)$  vs  $\ln(p)$ .
- C.  $\ln(\theta)$  vs  $p$ .
- D.  $\theta$  vs  $\ln(p)$ .

**Chemistry Numerical (Maximum Marks: 24)**

Question No. 1

**Numerical Type**

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

The number of p-orbitals involved in hybridization state of central atom in  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  are \_\_\_\_\_.

Question No. 2

**Numerical Type**

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

2.2 g of  $\text{KClO}_3$  is dissolved in conc.  $\text{HCl}$  and the solution was boiled. Chlorine gas evolved in the reaction was then passed through a solution of  $\text{KI}$  and liberated iodine was titrated with 100 mL of 1N hypo solution. 12.3 mL of same hypo solution required 24.6 mL of 0.5 N iodine for complete neutralization. Calculate the percentage impurity of  $\text{KClO}_3$  sample. (Atomic weight:  $\text{K} = 39, \text{Cl} = 36, \text{O} = 16$  ).

Question No. 3

**Numerical Type**

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

Calculate the value of '  $n$  ' if  $6 \times 10^{-3}$  mole of  $K_2Cr_2O_7$  reacts completely with  $9 \times 10^{-3}$  mole of an unknown metal  $M$  with oxidation state '  $n$  ' to give  $MO_3^-$  and  $Cr^{+3}$  ?

Question No. 4

**Numerical Type**

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

Consider the following reaction,  $[Ag(CN)_2]^- \rightleftharpoons Ag^+ + 2CN^-$ , the  $K_C$  at  $25^\circ C$  is  $4 \times 10^{-19}$ . The concentration of  $Ag^+$  is  $x \times 10^{-18}$  M in solution which was originally 0.1M in  $KCN^-$  and 0.03M in  $AgNO_3$ . The value of  $x$  is ..... .

Question No. 5

**Numerical Type**

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

A gas originally at 1.10 atm and 298 K, underwent a reversible adiabatic expansion to 1.00 atm and 287 K. What is the molar heat capacity of the gas at constant pressure? (use  $\log 287 = 2.45$ ,  $\log 298 = 2.47$  and  $\log 110 = 2.04139$  )

Question No. 6

**Numerical Type**

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

The  $pK_a$  values of  $H_3PO_4$  are 2.12, 7.21 and 12.67. The pH of a phosphate buffer containing 0.2M  $NaH_2PO_4$  and 0.1M  $Na_2HPO_4$  is \_\_\_\_\_.

**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.

Let  $P(r)$  represents the number of points  $(x, y)$ , (where  $x, y \in I$ ) which lie inside or on the boundary of the region enclosed by the curves whose joint equation is  $|xy| - r(|x| + |y|) + r^2 = 0, r \in N$  and if

$$\lim_{n \rightarrow \infty} \frac{\sum_{r=1}^n P(r) - \lambda n^3}{an^2 + bn + c} = \frac{1}{2}, \text{ then } a + 3\lambda \text{ equals}$$

- A. 14
- B. 13
- C. 12
- D. 17

Question No. 2

**Only One Option Correct Type**

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

If  $\alpha$  and  $\beta$  are roots of equation

$$\frac{27}{4} \sin\left(\frac{\theta}{9}\right) = \sin^3 \theta + 3\sin^3\left(\frac{\theta}{3}\right) + 9\sin^3\left(\frac{\theta}{9}\right) + \frac{1}{4\sqrt{2}} \quad \text{for } 0 < \theta < \frac{\pi}{2}, \text{ then}$$

$\tan \alpha + \tan \beta$  is equal to

- A.  $2 + \sqrt{3}$
- B.  $3 + \sqrt{3}$
- C.  $3 - \sqrt{3}$
- D.  $2 - \sqrt{3}$

Question No. 3

**Only One Option Correct Type**

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

The number 916238457 is an example of nine digit number which contains each of the digit 1 to 9 exactly once. It also has the property that the digits 1 to 5 occur in their natural order, while the digits 1 to 6 do not. Number of such numbers are :

- A. 2268
- B. 2520
- C. 2975
- D. 1560

Question No. 4

**Only One Option Correct Type**

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

Given three non zero, non coplanar vectors  $\vec{a}, \vec{b}$  and  $\vec{c}$ , and given two vectors  $\vec{r}_1 = p\vec{a} + q\vec{b} + \vec{c}$  and  $\vec{r}_2 = \vec{a} + p\vec{b} + q\vec{c}$ . If the vectors  $\vec{r}_1 + 2\vec{r}_2$  and  $2\vec{r}_1 + \vec{r}_2$  are collinear, then  $(p, q)$  is



- A. (0, 0)
- B. (1, -1)
- C. (-1, 1)
- D. (1, 1)

Question No. 5

**Only One Option Correct Type**

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

Let line  $x + 2y = 3$  intersects a circle  $S = 0$  at  $A$  and  $B$ . Let point of intersection of tangents to circle at  $A$  and  $B$  meet at  $P(3, 5)$ . If  $S = 0$  passes through origin then radius of circle  $S = 0$  is

- A.  $\frac{\sqrt{83}}{8}$
- B.  $\frac{\sqrt{85}}{8}$
- C.  $\frac{\sqrt{79}}{8}$
- D.  $\frac{\sqrt{87}}{8}$

### Mathematics Multiple Correct (Maximum Marks: 28)

Question No. 1

**One or More Options Correct Type**

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

Let  $\int (2x^2 + 2x + 1)e^{x^2} dx = f(x) + C$  where  $C$  is integration constant and  $f(0) = 1$ , then-

- A.  $2 \int f(x)e^{-x^2} dx = (x + 1)^2 + C$
- B.  $f(1) = 2e$
- C.  $\lim_{x \rightarrow 0} (f(x))^{\frac{1}{x}} = e^2$
- D.  $\lim_{x \rightarrow 0} (f(x))^{1/x} = e$

Question No. 2

**One or More Options Correct Type**

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

Let  $\alpha, \beta$  are real numbers for which the system of linear equations

$$2\alpha x + y + z = 0$$

$$\alpha x + y + 2z = 1$$

$$\beta^2 x + y - 3\alpha z = -2$$

never posses unique solution then point  $P(\alpha, \beta)$  lies on a conic whose-

- A. center is  $(-\frac{1}{2}, 0)$
- B. eccentricity is less than 3
- C. one vertex is origin
- D.  $(-1, 0)$  lies on it

Question No. 3

**One or More Options Correct Type**

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

There is 30% chance that it rains on any particular day. Then in a period of 7 days

- The probability that there is at least one rainy day within a period of 7 days
- A. is  $1 - (\frac{7}{10})^6$

- The probability that there is at least one rainy day within a period of 7 days
- B. is  $1 - (\frac{7}{10})^7$

- Given that there is at least one rainy day, what is the probability that there
- C. are at least two rainy days is  $\frac{1 - (\frac{7}{10})^7 - 7(\frac{3}{10})(\frac{7}{10})^6}{1 - (\frac{7}{10})^7}$

- Given that there is at least one rainy day, what is the probability that there
- D. are at least two rainy days is  $\frac{1 - (\frac{7}{10})^7 - 7(\frac{3}{10})(\frac{7}{10})^6}{1 - (\frac{7}{10})^7}$

Question No. 4

**One or More Options Correct Type**

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

$f(x)$  and  $g(x)$  are two functions which satisfy the differential equation

$\frac{d^2x}{dy^2} \cdot \frac{d^2y}{dx^2} + \frac{dx}{dy} = 0$ , where  $f(0) = g(0) = 2$  and  $f'(0) = g'(0) = 1$ , then

- A. Both  $f(x)$  and  $g(x)$  are decreasing functions
- B. Both  $f(x)$  and  $g(x)$  are monotonic functions
- Area bounded by the curves  $y = f(x), y = g(x)$  and  $x = \ln 2$  is
- C.  $(\frac{3}{2} + \ln 4)$  sq. units.
- Area bounded by the curves  $y = f(x), y = g(x)$  and  $x = \ln 2$  is
- D.  $(\frac{3}{2} - \ln 4)$  sq. units.

Question No. 5

**One or More Options Correct Type**

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

Consider three distinct lines

$$x + \lambda y + 6 = 0$$

$$2x + y - 3 = 0$$

$$\lambda x + 2y + 5 = 0$$

let  $m$  denotes number of possible values of  $\lambda$  for which given lines are concurrent and  $n$  denotes number of possible values of  $\lambda$  for which given lines do not form a triangle, then

A.  $m = 2$

B.  $m = 3$

C.  $n = 6$

D.  $n = 7$

Question No. 6

**One or More Options Correct Type**

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

Consider a sequence  $\{a_n\}$  with  $a_1 = 2$  &  $a_n = \frac{a_{n-1}^2}{a_{n-2}}$  for all  $n \geq 3$ , terms of the sequence being distinct. If  $a_2$  &  $a_5$  are +ve integers and  $a_5 \leq 162$ , then the possible value (s) of  $a_5$  can be

A. 162

B. 64

C. 32

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.

If the equation  $\left( 2^{\left( \frac{1}{\cos^{-1} x} \right)} \right)^{2\pi} - \left( a + \frac{1}{2} \right) \left( 2^{\left( \frac{1}{\cos^{-1} x} \right)} \right)^{\pi} - a^2 = 0$  has only one real solution then subsets of values of 'a' are

A.  $(-3, 1)$

B.  $(-\infty, -3]$

C.  $[1, \infty)$

D.  $[-3, \infty)$

Mathematics Numerical (Maximum Marks: 24)

Question No. 1

**Numerical Type**

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

If  $[\vec{a} \ \vec{b} \ \vec{c}] = 2$  and  $(\vec{a} \cdot \vec{b}) = 2, (\vec{c} \cdot \vec{a}) = 5$ , then  $\vec{a}$  is equal to  $x\vec{b} + y\vec{c} + z(\vec{b} \times \vec{c})$  (where  $\vec{b}$  &  $\vec{c}$  are orthogonal unit vectors) then  $(x + y - z) =$  ?

Question No. 2

**Numerical Type**

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

Area of trapezium whose vertices lie on the parabola  $y^2 = 4x$  and its diagonals pass through  $(1, 0)$  and having length  $\frac{25}{4}$  unit each, is  $\frac{75}{\lambda}$ . Then  $\lambda$  is

Question No. 3

**Numerical Type**

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

Consider the cubic polynomial  $P(x) = x^3 - ax^2 + bx + c$ . If the equation  $P(x) = 0$  has integral roots such that  $P(6) = 3$  then sum of all possible values of  $a$  is \_\_\_\_\_.

Question No. 4

**Numerical Type**

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

If  $T_n = (n^2 + 1)n!$  &  $S_n = T_1 + T_2 + T_3 + \dots + T_n$ . Let  $\frac{T_{10}}{S_{10}} = \frac{a}{b}$ , where  $a, b$  are relatively prime natural numbers, then the value of  $(b - a)$  is

Question No. 5

**Numerical Type**

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

Let a complex number  $z = x + iy$  satisfies equation  $|z|^4 - 16|z|^2 - 3z^2 - 3\bar{z}^2 + 9 = 0$ . If  $a$  and  $b$  are the maximum and minimum value of  $|z|$  then  $ab$  is equal to \_\_\_\_\_.

Question No. 6

**Numerical Type**

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

If the set of values of parameter  $\alpha$  so that point  $P(\alpha, \frac{1}{1+\alpha^2})$  does not lie outside the triangle formed by lines  $L_1 : 15y = x + 1, L_2 : 78y = 118 - 23x$  and  $L_3 : y + 2 = 0$  is  $[a, b]$  Then  $a + b =$