

Question Paper

Physics Numerical (Maximum Marks: 28)

Question No. 1

**Numerical Type**

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

A visitor to a medieval castle measures the depth of a well by dropping a stone and timing its fall. She finds that the time to fall is  $t = (3.0 \pm 0.5)\text{sec}$  and calculates the depth as  $d = 0.5gt^2$ . What is the relative error in calculation of '  $d$  ' if she takes  $g = 9.80 \text{ m/s}^2$  with negligible uncertainty?

Question No. 2

**Numerical Type**

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

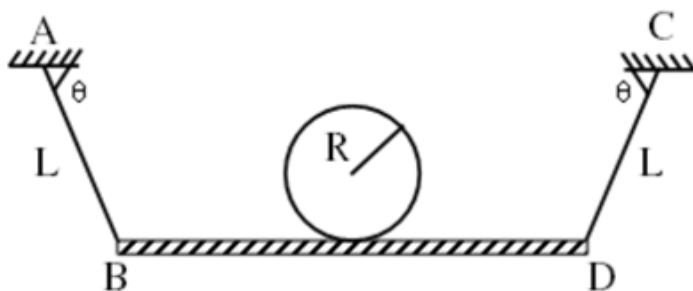
A satellite of mass  $m$  is orbiting around the earth (mass  $M$ , radius  $R$ ) in a circular orbit of radius  $4R$ . It starts losing energy slowly at constant rate  $-\frac{dE}{dt} = \eta$  due to friction. The time  $t$  in which the satellite will spiral down to the surface of the earth is given by,  $t = \frac{3GMm}{x\eta R}$ . Find  $x$ .

Question No. 3

**Numerical Type**

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

A metal cylinder of radius  $R$  is placed on a wooden plank  $BD$ . The plank is kept horizontally suspended with the help of two identical string  $AB$  and  $CD$  each of length  $L$ . The temperature coefficient of linear expansion of the cylinder and the strings are  $\alpha_1$  and  $\alpha_2$  respectively. Angle  $\theta$  shown in the figure is  $30^\circ$ . It was found that with change in temperature the centre of the cylinder did not move. Find the ratio  $\frac{\alpha_1}{\alpha_2}$ , if it is known that  $L = 4R$ . Assume that change in value of  $\theta$  is negligible for small temperature changes.

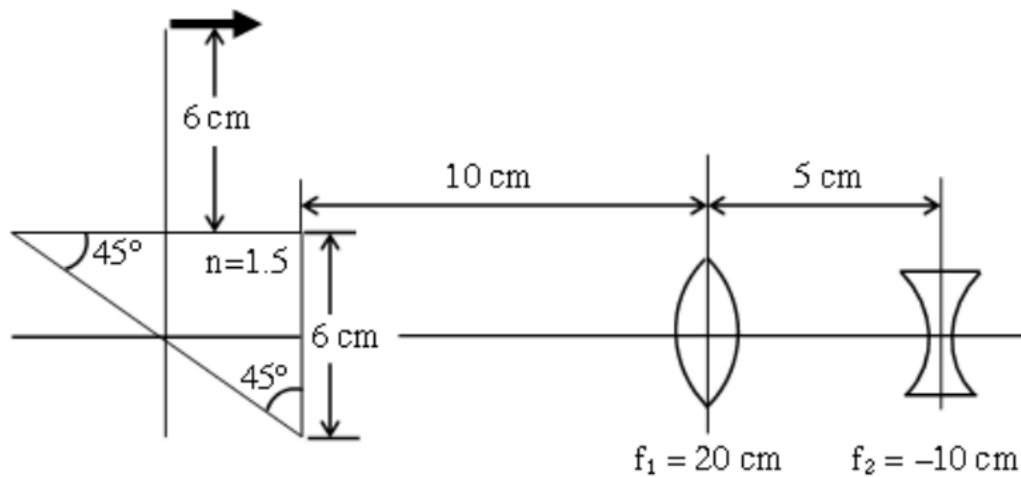


Question No. 4

**Numerical Type**

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

For the combination of one prism and 2 lenses shown. Find the size (in cm ) of final image when the object whose length is 1 cm is located as shown in figure.



Question No. 5

#### Numerical Type

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

A police car B is chasing a culprit's car A. Car A and B are moving at constant speed  $V_1 = 108$  km/hr and  $V_2 = 90$  km/hr respectively along a straight line. The police decide to open fire and a policeman starts firing with his machine gun directly aiming at car A. The bullet has a velocity  $u = 305$  m/s relative to the gun. The policeman keep firing for an interval of  $T_0 = 20$  s . The Culprit experiences that the time gap between the first and the last hitting his car is  $\Delta t$  is



Question No. 6

#### Numerical Type

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

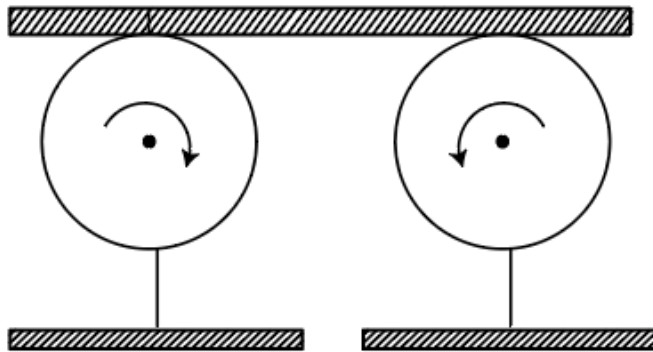
A point source S is placed at a distance of 15 cm from a converging lens of focal length 10 cm on its principal axis. The diverging mirror of focal length 12 cm is placed at a certain distance ( $< 30$  cm) from lens such that a real image is formed on the source itself. Find the distance.

Question No. 7

#### Numerical Type

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

A uniform rod is placed on two spinning wheels as shown in figure. The axes of the wheels are separated by a distance  $\ell = \frac{50}{\pi^2}$  m, the coefficient of friction between the rod and the wheels is  $\mu = 0.1$ . The rod performs harmonic oscillations. The period of these oscillations is  $10x$  sec. Find the value of  $x$ .



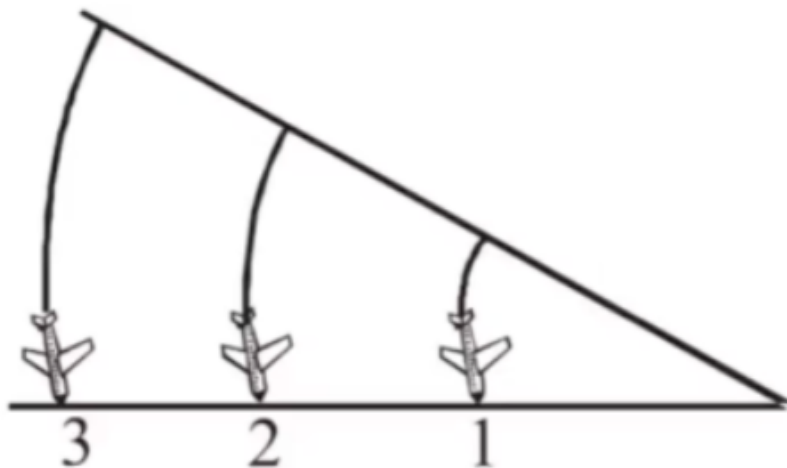
### Physics Multiple Correct (Maximum Marks: 28)

Question No. 1

#### One or More Options Correct Type

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

Three aircraft make a turn in the horizontal plane at uniform speed, moving along concentric circular trajectories that are shown in figure. The aircraft move such that they are at constant distance of 600 m from each other at any time. The aircraft closest to the center moves in a circle of radius  $R = 600$  m. The aircraft 2 is moving at a speed of  $v_2 = 720$  km/h. Find the acceleration of third aircraft (in  $\text{m/s}^2$ ).



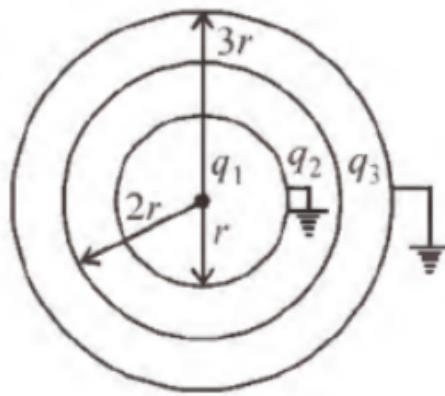
- A.  $< 25$
- B.  $> 25$
- C.  $< 60$
- D.  $> 60$

Question No. 2

#### One or More Options Correct Type

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

Three concentric conducting spherical shells have radii  $r$ ,  $2r$  and  $3r$  and charge  $q_1$ ,  $q_2$  and  $q_3$  respectively as shown in the figure. Select the correct alternatives



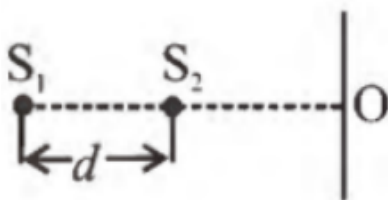
- A.  $q_1 + q_3 = -q_2$
- B.  $q_1 = -\frac{q_2}{4}$
- C.  $\frac{q_3}{q_1} = 3$
- D.  $\frac{q_3}{q_2} = -\frac{1}{3}$

Question No. 3

**One or More Options Correct Type**

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

Two point monochromatic and coherent sources of light of wavelength  $\lambda$  are placed on the dotted line in front of an infinite screen. The source emit waves in phase with each other. The distance between  $S_1$  and  $S_2$  is  $d$  while their distance from the screen is much larger. Then



- A. If  $d$  is  $\frac{3\lambda}{2}$ , at  $O$  minima will be observed
- B. if  $d$  is  $\frac{11\lambda}{6}$ , then intensity at  $O$  will be  $\frac{3}{4}$  of maximum intensity
- C. if  $d$  is  $3\lambda$ ,  $O$  will be a maxima
- D. if  $d$  is  $\frac{7\lambda}{6}$ , the intensity at  $O$  will be  $\frac{3}{4}$  of maximum intensity

Question No. 4

**One or More Options Correct Type**

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

A metal sphere of radius  $R$  and specific heat  $C$  is rotated about an axis passing through its centre at a speed  $n$  rotation/second. It is suddenly stopped and 50% of its energy is used in increasing its temperature, then choose the correct statement(s) from the following?

- A. Kinetic energy used to raise the temperature of the sphere is  $\frac{2\pi^2 n^2}{5} MR^2$
- B. Kinetic energy used to raise the temperature of the sphere is  $\frac{5\pi^2 n}{3} MR$
- C. The rise in the temperature of the sphere is  $\frac{4\pi^2 n^2 R^2}{7C}$

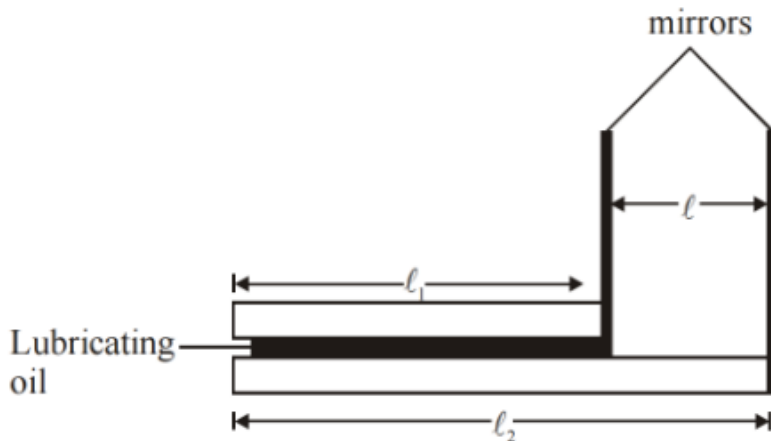
D. The rise in the temperature of the sphere is  $\frac{2\pi^2 n^2 R^2}{5C}$

Question No. 5

**One or More Options Correct Type**

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

An optical engineering firm needs to ensure that the separation between two mirrors is unaffected by temperature changes. The mirrors are attached to the ends of two bars of different materials that are welded together at one end as shown in figure. The surfaces of the bars in contact are lubricated. The distance  $\ell$  does not change with temperature change.  $\ell_1$  and  $\ell_2$  are the length of the bars  $\alpha_1$  and  $\alpha_2$  are the respective thermal coefficients of temperature. Which of the following options is/are correct :



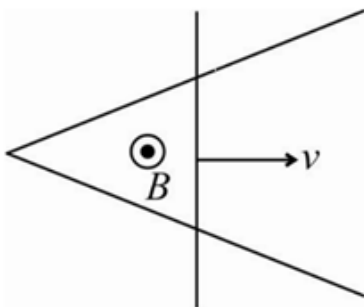
- A.  $\ell_1 = \frac{\ell \alpha_2}{\alpha_1 - \alpha_2}$
- B.  $\ell_2 = \frac{\ell \alpha_1}{\alpha_2 - \alpha_1}$
- C.  $\alpha_1 \ell_1 = \alpha_2 \ell_2$
- D.  $\alpha_1 \ell_2 = \alpha_2 \ell_1$

Question No. 6

**One or More Options Correct Type**

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

A rod of length  $L$  and resistance  $R$  is pulled with a constant velocity  $v$  on the conducting rail of negligible resistance in the outward magnetic field. Then :



- A. a clockwise current will flow in the loop
- B. the rod will experience a constant force
- C. the current in the loop will be uniform
- D. the anticlockwise decreasing current will flow in the loop

Question No. 7

**One or More Options Correct Type**

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

In an X-ray tube, electrons emitted from a filament (cathode) carrying current  $I$  hit a target (anode) at a distance  $d$  from the cathode. The target is kept at a potential  $V$  higher than the cathode resulting in emission of continuous and characteristic X-rays. If the filament current  $I$  is decreased to  $\frac{I}{2}$ , the potential difference  $V$  is increased to  $2V$ , and the separation distance  $d$  is reduced to  $\frac{d}{2}$ , then

- the cut-off wavelength will reduce to half, and the wavelengths of the characteristic X-
- A. rays will remain the same
- the cut-off wavelength as well as the wavelengths of the characteristic X-rays will
- B. remain the same
- the cut-off wavelength will reduce to half, and the intensities of all the X-rays will
- C. decrease
- the cut-off wavelength will become two times larger, and the intensity of all the X-rays
- D. will decrease

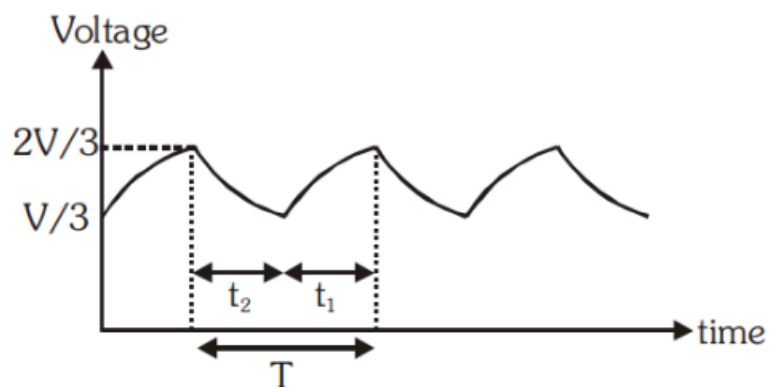
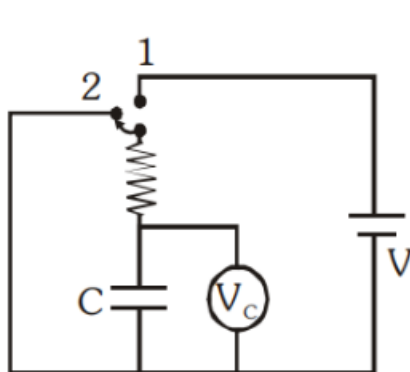
**Physics Single Correct (Maximum Marks: 12)**

Question No. 1

**Only One Option Correct Type**

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

The switch in circuit shifts from 1 to 2 when  $V_C > \frac{2V}{3}$  and goes back to 1 from 2 when  $V_C < \frac{V}{3}$ . The voltmeter reads voltage as plotted. What is the period  $T$  of the wave form in terms of  $R$  and  $C$ ?



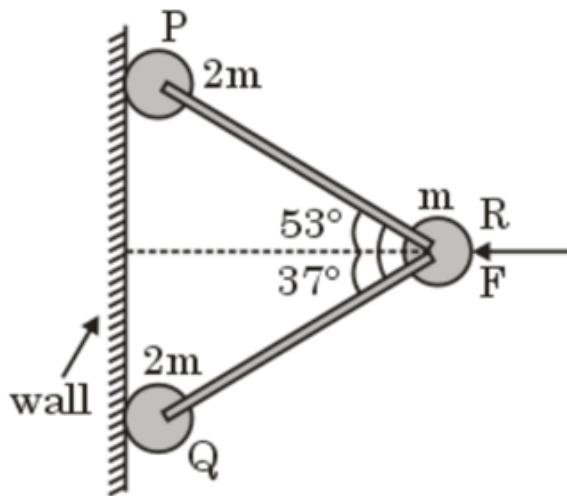
- A.  $RC \ln 3$
- B.  $2RC \ln 2$
- C.  $\frac{RC}{2} \ln 3$
- D.  $\frac{RC}{3} \ln 3$

Question No. 2

**Only One Option Correct Type**

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

Three small discs are connected with two identical massless rods as shown in figure. The rods are pinned to the discs such that angle between them can change freely. The system is placed on a smooth horizontal surface with discs P and Q touching a smooth wall. A force F is applied to the disc R is in direction perpendicular to the wall. Find acceleration of disc P immediately after the force starts to act. Masses of discs are  $m_P = m_Q = 2m$ ,  $m_R = m$  [wall is perpendicular to the plane of the figure]



- A.  $\frac{F}{\sqrt{2}m}$
- B.  $\frac{\sqrt{2}F}{\sqrt{m}}$
- C.  $\frac{2F}{11m}$
- D.  $\frac{11F}{2m}$

Question No. 3

**Only One Option Correct Type**

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

A large insulating thick sheet of thickness  $2d$  carries a uniform charge per unit volume  $\rho$ . A particle of mass  $m$ , carrying a charge  $q$  having a sign opposite to that of the sheet, is released from the surface of the sheet. The sheet does not offer any mechanical resistance to the motion of the particle. Find the oscillation frequency  $\nu$  of the particle inside the sheet.

- A.  $\nu = \frac{1}{2\pi} \sqrt{\frac{q\rho}{m\epsilon_0}}$
- B.  $\nu = \frac{1}{2\pi} \sqrt{\frac{2q\rho}{m\epsilon_0}}$
- C.  $\nu = \frac{1}{4\pi} \sqrt{\frac{q\rho}{m\epsilon_0}}$
- D. None of these

Question No. 4

**Only One Option Correct Type**

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

Electrons with de-Broglie wavelength  $\lambda$  fall on the target in an X-ray tube. The cut off wavelength of the emitted X-ray is :

- A.  $\lambda_0 = \frac{2mc\lambda^2}{h}$
- B.  $\lambda_0 = \frac{2h}{mc}$

$$\text{C. } \lambda_0 = \frac{2m^2 c^2 \lambda^3}{h^2}$$

$$\text{D. } \lambda_0 = \lambda$$

## Chemistry Numerical (Maximum Marks: 28)

Question No. 1

### Numerical Type

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

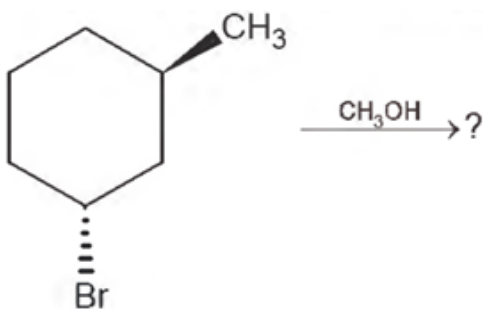
A free movable piston inside a closed cylinder is initially locked so as to divide the cylinder into 2 compartments of length  $L_1 = 10 \text{ cm}$  and  $L_2 = 4.4 \text{ cm}$ , which are filled with air at  $10^\circ\text{C}$  and  $P_1 = 76 \text{ cm Hg}$  and  $P_2 = 4 \text{ cm Hg}$  respectively. The piston is then released and allowed to move reversibly until the pressures are equal. Conditions are adiabatic  $\gamma = 1.4$ . Calculate the final temperature of the air in the larger compartment. (round off to nearest integer & take  $\frac{10}{13.66}^{0.44} = \frac{250}{283}$ )

Question No. 2

### Numerical Type

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

$X$  = total number of substitution and elimination product(s). Find the value of  $X$ .



Question No. 3

### Numerical Type

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

Find number of substance which produce  $\text{H}_2$  gas when react with cold water.

$\text{Ca}$ ,  $\text{CaH}_2$ ,  $\text{Mg}$ ,  $\text{MgCl}_2$ ,  $\text{Ba}$ ,  $\text{BaO}_2$ ,  $\text{NaHCO}_3$ ,  $\text{Ca}_3\text{N}_2$ .

Question No. 4

### Numerical Type

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

Diethyl  $\beta, \beta'$ -dimethyl glutarate (ester) is condensed with diethyl oxalate in presence of sodium ethoxide and ethanol to form a major product ( $P$ ), which on acidic hydrolysis followed by heating gives another product ( $Q$ ). Calculate total number of  $\text{C}=\text{O}$  bonds in ( $P$ ) and ( $Q$ ) compounds?



Question No. 5

**Numerical Type**

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

A  $5.0 \text{ cm}^3$  solution of  $\text{H}_2\text{O}_2$  liberates  $0.508 \text{ g}$  of iodine from an acidified KI solution. Calculate the strength of  $\text{H}_2\text{O}_2$  solution in terms of volume strength at STP. (roundoff answer to two decimal places)

Question No. 6

**Numerical Type**

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

When an electron is removed from every ion of  $1 \text{ mol}$  of  $\text{H}^-$  ions,  $72 \text{ kJ}$  of energy is required. In another experiment, when electrons are removed from  $\frac{1}{2}$  mole of  $\text{H}$  (one electron each) and given them to another  $\frac{1}{2}$  mole of  $\text{H}$  (one electron each),  $619.5 \text{ kJ}$  of energy is found to be required. The ionisation energy (in  $\text{kJ/mol}$ ) of hydrogen is :

Question No. 7

**Numerical Type**

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

In the adsorption experiment, a graph between  $\log \frac{x}{m}$  v/s  $\log P$  was found to be linear with a slope of  $45^\circ$ . The intercept on  $\log \frac{x}{m}$  axis was found to be  $0.3010$ . Calculate the amount of gas adsorbed per gram of charcoal under a pressure of  $0.5$  atmosphere.

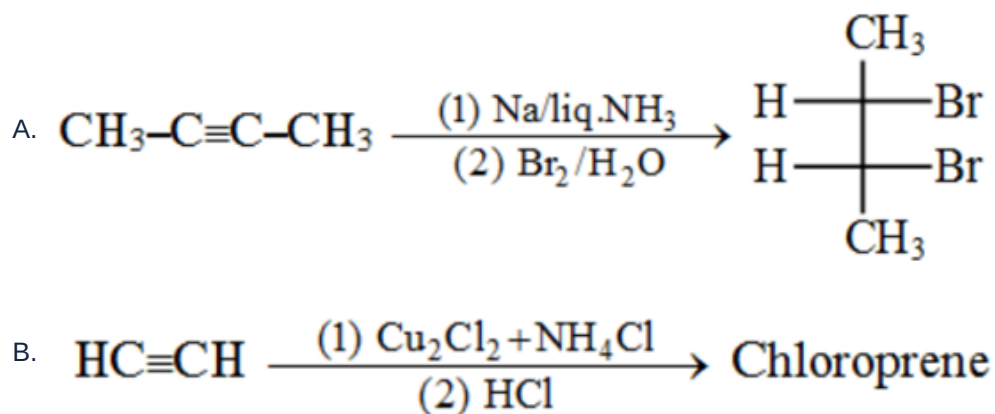
**Chemistry Multiple Correct (Maximum Marks: 28)**

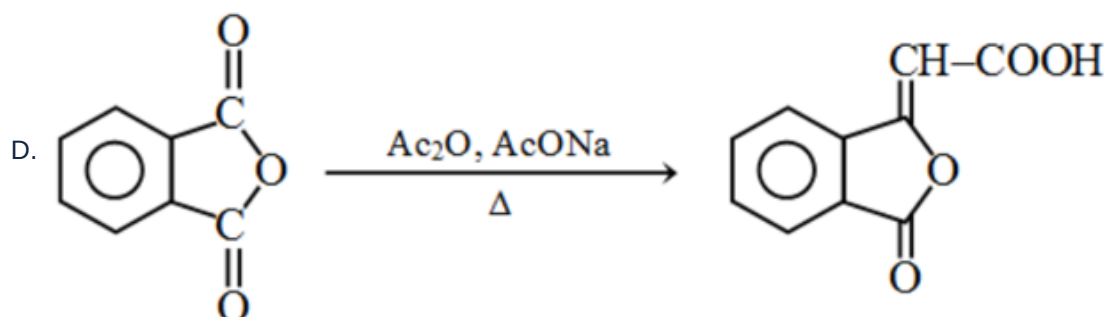
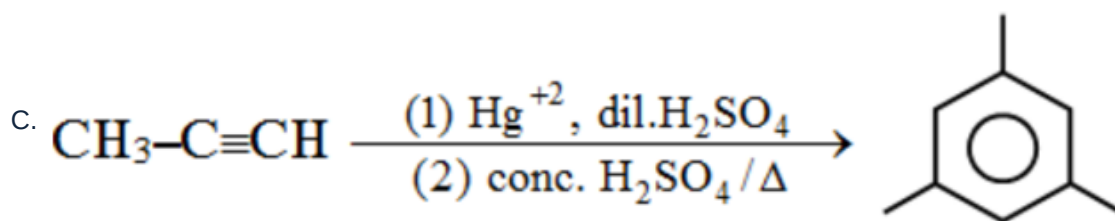
Question No. 1

**One or More Options Correct Type**

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

Which of following reactions represent correct major product?





Question No. 2

**One or More Options Correct Type**

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

Reaction of R-2-butanol with p-toluenesulphonyl chloride in pyridine then LiBr gives:

- A. R-2-butyl bromide
- B. S-2-butyl tosylate
- C. R-2-butyl tosylate
- D. S-2-butyl bromide

Question No. 3

**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 water insoluble but neither black nor white nor blue in colour?

- A.  $\text{Cu}(\text{CN})_2$
- B.  $\text{Cu}(\text{OH})_2$
- C.  $\text{Cu}_2\text{O}$
- D.  $\text{Cu}_3[\text{Fe}(\text{CN})_6]_2$

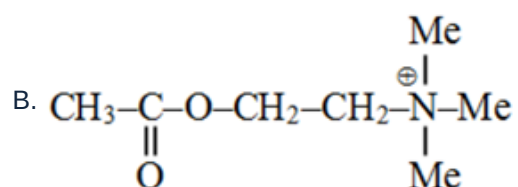
Question No. 4

**One or More Options Correct Type**

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

Which of the following compound(s) has/have gauche form more stable than anti form?

- A.  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{Cl}$  (liquid)

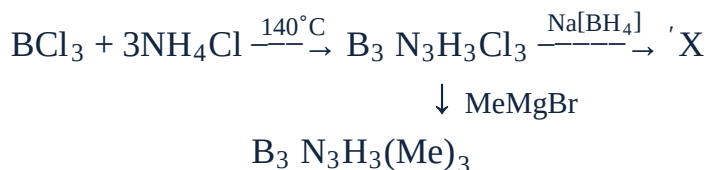


- c.  $\text{Br} - \text{CH}_2 - \text{CH}_2 - \text{Br}$   
 d.  $\text{F} - \text{CH}_2 - \text{CH}_2 - \text{OH}$

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 statements are CORRECT :-

- A. 'X' is known as inorganic graphite  
 B. 'X' on hydrolysis along with heating gives  $\text{NH}_3$ ,  $\text{H}_2$  and  $\text{B(OH)}_3$   
 C. 'X' is known as inorganic benzene  
 D. 'X' has  $2p_\pi - 2p_\pi$  back bonding

Question No. 6

**One or More Options Correct Type**

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

Which of the following pairs have approximately the same atomic radii :

- A. Zr & Hf  
 B. Al, Mg  
 C. Nb, Ta  
 D. Na, Ne

Question No. 7

**One or More Options Correct Type**

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

$E_{\text{cen}}^\ominus = 1.1 \text{ V}$  for Daniell cell. Which of the following expressions are correct description of state of equilibrium in this cell?

- A.  $1.1 = K_c$   
 B.  $\frac{2.303RT}{2F} \log K_c = 1.1$   
 C.  $\log K_c = \frac{2.2}{0.059}$   
 D.  $\log K_c = 1.1$

## Chemistry Single Correct (Maximum Marks: 12)

Question No. 1

**Only One Option Correct Type**

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

What is the magnetic moment of coordination compound formed during brown ring test?

- A. 3.87 BM

- B. 4.92 BM
- C. 5.92 BM
- D. 2.83 BM

Question No. 2

**Only One Option Correct Type**

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

The equilibrium constant  $K$  for the reaction  $2\text{HI}_{(g)} \rightleftharpoons \text{H}_{2(g)} + \text{I}_{2(g)}$ ; at room temperature is 2.85 and that at 698 K is  $1.4 \times 10^{-2}$ . This implies that -

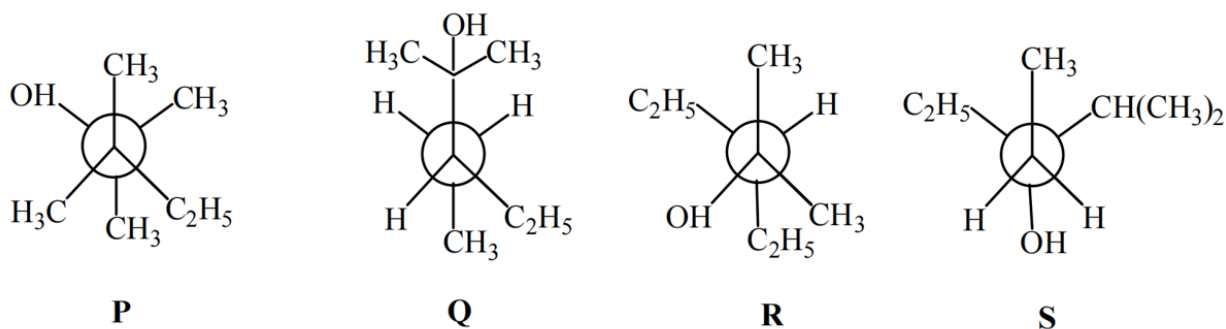
- A. HI is exothermic compound
- B. HI is very stable at room temperature
- C. HI is relatively less stable than  $\text{H}_2$  and  $\text{I}_2$
- D. HI is resonance stabilised

Question No. 3

**Only One Option Correct Type**

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

Newman projections **P**, **Q**, **R** and **S** are shown below :



Which one of the following options represents identical molecules ?

- A. P and Q
- B. Q and S
- C. Q and R
- D. R and S

Question No. 4

**Only One Option Correct Type**

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

Identify how many "Ore names", "Type of Anion", "Metal(s) present in mineral" are correctly related

(i) Magnetite	oxide	Fe
(ii) Cryolite	fluoride	Al
(iii) Copper Pyrite	Sulphide	Fe
(iv) Galena	sulphide	Hg
(v) Asbestos	Silicate	Al
(vi) Lunar Caustic	hydroxide	Ag
(vii) Dolomite	carbonate	Ca
(viii) Dolomite	hydroxide	Mg

- A. 3
- B. 4
- C. 5
- D. 6

### Mathematics Numerical (Maximum Marks: 28)

Question No. 1

#### Numerical Type

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

Let  $f$  is a real valued function defined from  $\mathbb{R}$  to  $\mathbb{R}$  such that  $f(x) + f(-x) = 5 \forall x \in \mathbb{R}$ , then the value of  $\int_{1-x}^{4+x} f^{-1}(t) dt$  is equal to

Question No. 2

#### Numerical Type

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

Let  $D$  is point on line  $\ell_1 : x + y - 2 = 0$  and  $A(3, 3)$  is fixed point.  $\ell_2$  is the line perpendicular to  $DA$  and passing through  $A$ . If  $M$  is another point on line  $\ell_1$  (other than  $D$ ) and locus of point of intersection of  $\ell_2$  and angle bisector of  $\angle MDA$  is  $x^2 + y^2 + 2hxy + 2gx + 2fy + c = 0$ , then  $h + g + f + c$  is equal to

Question No. 3

#### Numerical Type

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

Let  $\omega$  is root of  $h(x) = 0$  where  $h(x) = xf(x^6) + x^2g(x^6)$  and  $\omega = \frac{-1}{2} + \frac{\sqrt{3}}{2}i$  (where  $i^2 = -1$ ). If  $h(x)$  is polynomial of degree 7 with leading coefficient 1 and  $f(x)$  and  $g(x)$  are also polynomial with real coefficients of degree 1 and 0 respectively, then  $f(2)$  is equal to

Question No. 4

#### Numerical Type

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

Let  $A = \begin{bmatrix} 5 & 17 \\ 13 & 29 \end{bmatrix}$  and  $B$  is  $2 \times 2$  matrix whose elements are elements of set

$P\{3, 5, 7, 11, 13, 17, 19, 23, 29\}$ . If all the elements of  $AB$  are multiple of 4, then find the total number of possible matrices  $B$  with distinct elements.

Question No. 5

**Numerical Type**

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

Let  $f(x) = \begin{cases} \ln(x - [x]), & x \notin I \\ 0, & x \in I \end{cases}$ . Area enclosed by the curve  $y = f(x)$ ,  $y = f(|x|)$ ,  $-2 \leq x \leq 0$  and  $y = 0$  is  $k - \log_e p$ , then  $k + p$  is equal to

Question No. 6

**Numerical Type**

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

Let  $f$  be real function defined on  $R$  (the set of real numbers) such that  $f'(x) = 100(x-1)(x-2)^2(x-3)^3 \dots (x-100)^{100}$ , for all  $x \in R$ . If  $g$  is a function defined on  $R$  such that  $\int_a^x e^{f(t)} dt = \int_0^x g(x-t)dt + 2x + 3$ , If sum of the all the values of  $x$  for which  $g(x)$  has a local extremum be  $\lambda$  then find  $\lambda$ .

Question No. 7

**Numerical Type**

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

The value of  $\lim_{n \rightarrow \infty} \sum_{k=0}^n ({}^n C_k)^{-1}$  is

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

Question No. 1

**One or More Options Correct Type**

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

Triangles are formed by joining vertices of a octagon then number of triangles

- A. In which exactly one side common with the side of octagon is 32
- B. In which atmost one side common with the side of polygon is 48
- C. At least one side common with the side polygon 50
- D. Total number of triangle 56

Question No. 2

**One or More Options Correct Type**

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

Let  $f(x) = \int_0^x e^t \sin(x-t) dt$  , then

- A.  $f''(\frac{\pi}{2}) - f'(\frac{\pi}{2}) = -1$
- B.  $f''(0) - f'(0) = 1$
- C.  $(f''(x) - f(x))_{\max} = \sqrt{2}$
- D.  $f''(\frac{\pi}{2}) - f(\frac{\pi}{2}) = 1$

Question No. 3

**One or More Options Correct Type**

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

If  $\vec{a}, \vec{b}, \vec{c}$  are three unit vectors and  $\alpha; \beta; \gamma$  are the angles between the vectors  $\vec{a}, \vec{b}; \vec{b}, \vec{c}; \vec{c}, \vec{a}$  respectively. Further  $\alpha, \beta, \gamma$  are the angles which the unit vector  $\ell\hat{i} + m\hat{j} + n\hat{k}$  makes with the positive x-axis, y-axis and z-axis respectively, then  $|\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}| =$

- A.  $|\ell + m + n - 1|$
- B.  $2(\ell m + mn + n\ell) - 6$
- C.  $\sqrt{2 + 2(\ell m + mn + n\ell) - 2(\ell + m + n)}$
- D.  $2 - (\ell + m + n)$

Question No. 4

**One or More Options Correct Type**

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

If the projection of the line  $\frac{x}{2} = \frac{y-1}{2} = \frac{z-1}{1}$  on a plane  $P$  is  $\frac{x}{1} = \frac{y-1}{1} = \frac{z-1}{-1}$  . Then

- A. Equation of plane  $P$  is  $x + y + 2z - 3 = 0$
- B. Equation of plane  $P$  is  $x + y + 2z + 3 = 0$
- C. Distance of plane  $P$  from origin is  $\sqrt{\frac{3}{2}}$
- D. Distance of plane  $P$  from point  $(1, 1, -1)$  is  $\frac{3}{\sqrt{6}}$

Question No. 5

**One or More Options Correct Type**

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

Let two parabolas be  $S_1 : y^2 = 4ax$  and  $S_2 : y^2 = -4ax$  . From any point  $P$  on  $S_1$ , tangents are drawn to  $S_2$  touching it at  $Q$  and  $R$ , then:

- A. line  $QR$  is tangent to  $S_1$
- B. line  $QR$  neither touches nor intersect  $S_1$
- C. if normal at any point  $A(t)$  on  $S_1$  is tangent to  $S_2$  then  $t^2 = \sqrt{2} - 1$
- D. if normal at any point  $A(t)$  on  $S_1$  is tangent to  $S_2$  then  $t^2 = \sqrt{2} + 1$

Question No. 6

**One or More Options Correct Type**

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

Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  and  $g : \mathbb{R} \rightarrow \mathbb{R}$  be respectively given by  $f(x) = |x| + 1$  and  $g(x) = x^2 + 1$ . Define  $h : \mathbb{R} \Rightarrow \mathbb{R}$  by  $h(x) = \begin{cases} \max. & \{f(x), g(x)\} \\ \min. & \{f(x), g(x)\} \end{cases}$  if  $x \leq 0$ , if  $x > 0$

Then which of the following is/(are) correct

- A.  $h(x)$  is not differentiable at  $x = -1$
- B.  $h(x)$  is not differentiable at  $x = 0$
- C.  $h(x)$  is not differentiable at  $x = 1$
- D.  $h(x)$  is differentiable at  $x = 0$

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 is/are correct

- The number of skew symmetric  $3 \times 3$  matrices than can be formed using elements  $-1, 0, 1$  and  $2$  is  $27$
- The number of skew symmetric  $3 \times 3$  matrices than can be formed using elements  $-1, 0, 1$  and  $2$  is  $64$
- The number of symmetric  $3 \times 3$  matrices than can be formed using elements  $-1, 0, 1$  and  $2$  is  $(12)^3$
- The number of either symmetric or skew symmetric  $3 \times 3$  matrices than can be formed using elements  $-1, 0, 1$  and  $2$  is  $1754$

**Mathematics Single Correct (Maximum Marks: 12)**

Question No. 1

**Only One Option Correct Type**

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

Find the number of all 5 -digit numbers each of which contains the block 15 and is divisible by 15 ? (Example of such number is 31545,34515 etc)

- A. 479
- B. 487
- C. 480
- D. None of these

Question No. 2

**Only One Option Correct Type**

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

Equation of the line of the shortest distance between the lines

$$\frac{x}{2} = \frac{y}{-3} = \frac{z}{1} \quad \& \quad \frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2} \quad \text{is}$$

- A.  $3(x-21) = 3y + 92 = 3z - 32$



- B.  $\frac{x-(62/3)}{1/3} = \frac{y-31}{1/3} = \frac{z+(31/3)}{1/3}$
- C.  $\frac{x-21}{1/3} = \frac{y-(92/3)}{1/3} = \frac{z+(32/3)}{1/3}$
- D.  $\frac{x-2}{1/3} = \frac{y+3}{1/3} = \frac{z-1}{1/3}$

Question No. 3

**Only One Option Correct Type**

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

Let two conics be given by  $P : y^2 = 5x$  and  $H : x^2 - y^2 = 6$ ,  $P$  and  $H$  intersect at points  $A$  and  $B$  in first and fourth quadrant respectively. Tangents to  $P$  and  $H$  at point ' $A$ ' intersect the  $x$ -axis at points  $L$  and  $M$  respectively then ratio of areas of  $\triangle LAB$  and  $\triangle MAB$  is

- A.  $\frac{12}{5}$
- B.  $\frac{5}{12}$
- C.  $\frac{12}{7}$
- D.  $\frac{7}{12}$

Question No. 4

**Only One Option Correct Type**

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

If  $P = (\tan 3^{n+1} \theta - \tan \theta)$  and  $Q = \sum_{r=0}^n \frac{\sin 3^r \theta}{\cos 3^{r+1} \theta}$  then

- A.  $P = 3Q$
- B.  $P = 2Q$
- C.  $2P = Q$
- D.  $3P = Q$