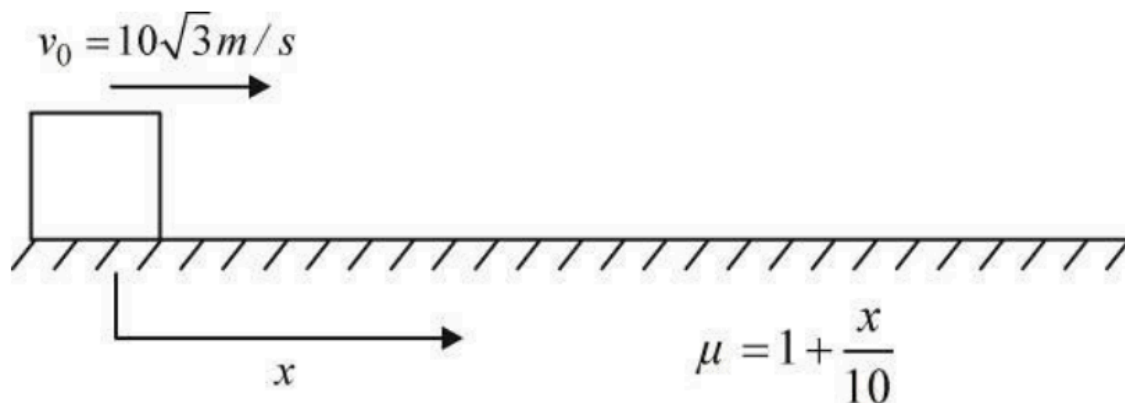## Physics Numerical (Maximum Marks: 28)

Question No. 1
**Numerical Type**
The answer has to be filled into the input box provided below.

A block of mass 1 kg is given horizontal velocity $v_0 = 10\sqrt{3}$ m/s on rough horizontal surface where coefficient of friction is $\mu = \mu_0(1 + \frac{x}{10})$ , where $\mu_0 = 1$. Find the maximum value of power loss (In watts) due to friction.

$$v_0 = 10\sqrt{3}m/s$$



$$\mu = 1 + \frac{x}{10}$$

Question No. 2
**Numerical Type**
The answer has to be filled into the input box provided below.

Two narrow bores of diameters 3.0 mm and 6.0 mm are joined together to form a U-shaped tube open at both ends. If the U-tube contains water, what is the difference in its levels (in mm) in the two limbs of the tube? Surface tension of water at the temperature of the experiment is $7.35 \times 10^{-2}$ N m$^{-1}$ . Take the angle of contact to be zero and density of water to be $1.0 \times 10^3$ kg/m$^3$( g = 9.8 ms$^{-2}$) .

Question No. 3
**Numerical Type**
The answer has to be filled into the input box provided below.

A non-conducting ring of mass m and radius R has charge Q uniformly distributed over its circumference. The ring is placed on a rough horizontal surface such that plane of the ring is parallel to the surface. A vertical magnetic field $B = B_0t^2$ Tesla is switched on. If ring is just about to rotate after $n$ sec from switching the magnetic field find, $n$. ($\mu = \frac{2B_0QR}{mg}$)

Question No. 4
**Numerical Type**
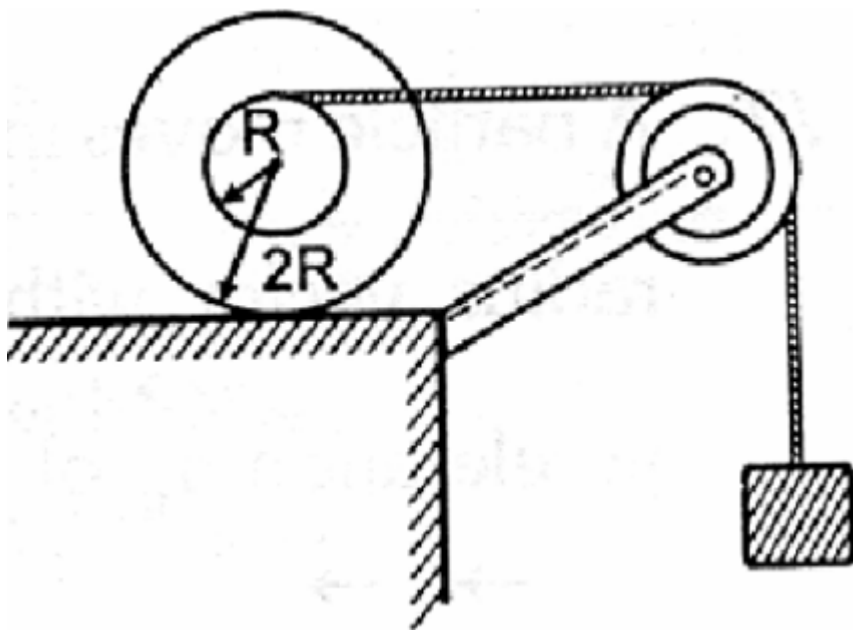The answer has to be filled into the input box provided below.

A galvanometer can be converted into an ammeter as well as voltmeter by using appropriate resistances. We have a galvanometer whose maximum allowable potential drop increases ' $n$ ' times by connecting a 27Ω resistor in series. When we shunt the same galvanometer with a 3Ω resistor, its range of current increases to $n$ times. Find the value of $n$.

Question No. 5
**Numerical Type**
The answer has to be filled into the input box provided below.

In the figure shown mass of both, the spherical body and block is $m$. Moment of inertia of the spherical body about centre of mass is $2mR^2$. The spherical body rolls on the horizontal surface. There is no slipping at any surfaces in contact. The ratio of the kinetic energy of the spherical body to that of block is 2/n . Then find $n$.



Question No. 6
**Numerical Type**
The answer has to be filled into the input box provided below.

In order to find a new approach of calculating the surface tension of any liquid drop placed on a surface, a scientist builds a new equation. He found that the surface tension is dependent on the density of the liquid (d), acceleration due to gravity $(g)$ and length of semi-minor axis $(h)$ of an elliptical drop. The scientist found that surface tension is dependent on $h^n$. Find the value of $n$.

Question No. 7
**Numerical Type**
The answer has to be filled into the input box provided below.

Five identical bricks of uniform density and length $10$ cm each are placed on the top of each other at the edge of a table such that they remain in equilibrium and corner of top most brick is farthest from the edge of the table. Horizontal projection of the distance between the farthest corner of top most brick and edge of the table is (in cm).
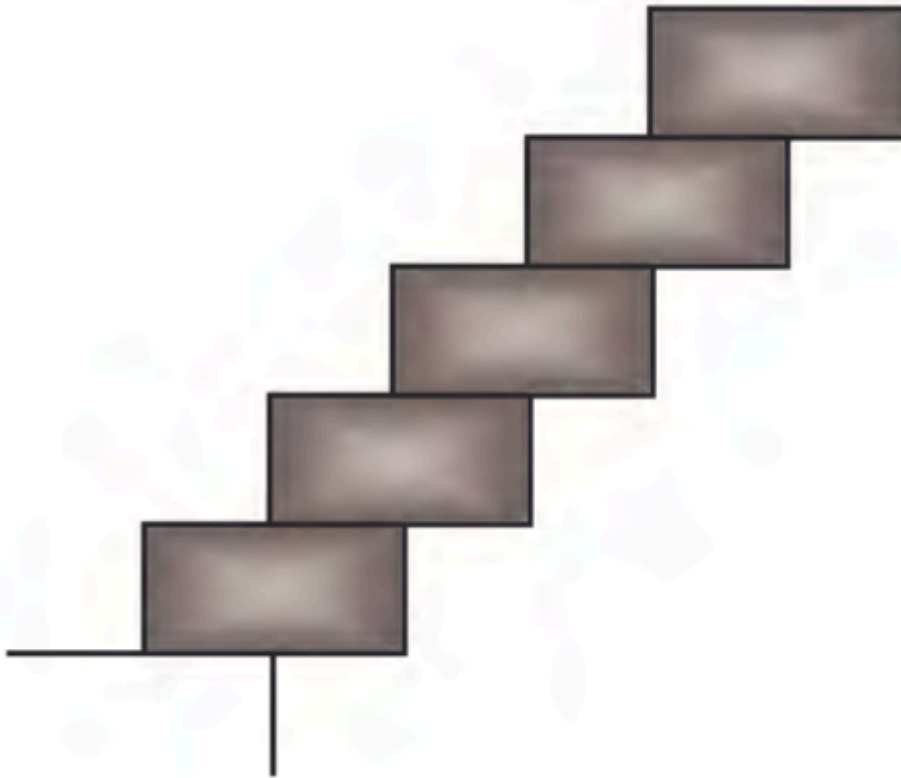


## Physics Multiple Correct (Maximum Marks: 28)

Question No. 1
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

A plano-convex lens is made of material of refractive index $n$. When a small object is placed 20 cm away in front of the curved surface of the lens, a real image of three times the size of the object is produced. Due to reflection from the convex surface of the lens, another faint image is observed at a distance of $60/11$ cm away from the lens. Which of the following statement(s) is(are) true ?

   A. The refractive index of the lens is 2.5
   B. The radius of curvature of the convex surface is 15 cm
   C. The refractive index of the lens is 2.0
   D. The focal length of the lens is 15 cm

## Question No. 2
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

While conducting the Young's double slit experiment, a student replaced the two slits with a large opaque plate in the $x - y$ plane containing two small holes that act as two coherent point sources $(S_1, S_2)$ emitting light of wavelength 600 nm. The student mistakenly placed the screen parallel to the $x - z$ plane (for $z > 0$) at a distance $D = 3$ m from the mid-point of $S_1 S_2$ as shown schematically in the figure. The distance between the sources is $d = 0.6006$ mm. The origin $O$ is at the intersection of the screen and the line joining $S_1 S_2$. Which of the following statement(s) is(are) true about the intensity pattern on the screen?
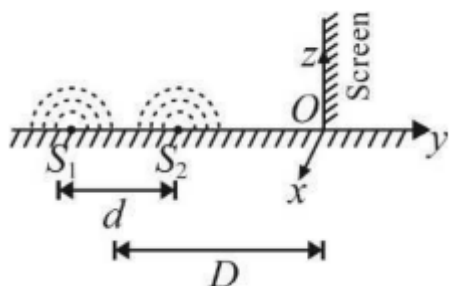


A. The region very close to the point $O$ will be bright
B. The region very close to the point $O$ will be dark
C. The pattern consists of hyperbolic bright and dark bands with foci symmetrically placed about $O$ in the $x$ direction
D. The pattern consists of semi-circular bright and dark bands centred at point $O$

## Question No. 3
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

In an experiment to determine the acceleration due to gravity $g$, the formula used for the time period of a periodic motion is $T = 2\pi\sqrt{\dfrac{7(R-r)}{5g}}$. The value of R and r are measured to be $(60 \pm 1)$mm and $(10 \pm 1)$mm, respectively. In five successive measurements, the time period is found to be 0.52 s, 0.56 s, 0.57 s, 0.54 s and 0.59 s. The least count of the watch used for the measurement of time period is 0.01 s. Which of the following statement(s) is(are) true ?
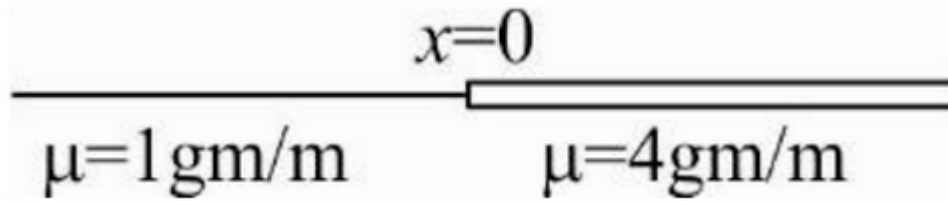
A. The error in the measurement of $r$ is 10%.
B. The error in the measurement of $T$ is 3.57%.
C. The error in the measurement of $R - r$ is 4%.
D. The error in the determined value of $g$ is 11%.

## Question No. 4
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

A wave $y(m, s) = 3( mm) \sin(2\pi x - 200\pi t)$ is propagating on the left string.



$$x=0$$

$\mu=1\,gm/m \qquad \mu=4\,gm/m$

It strikes the boundary $x = 0$ and is reflected partially and transmitted partially. Choose the correct

    A. Tension in the strings is 10 N
    B. The amplitude of transmitted wave is 2 mm
    C. The wave undergoes a phase change of $\pi$ on reflection
    D. The wavelength of transmitted wave is $\frac{1}{2}\,m$

Question No. 5

**One or More Options Correct Type**

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

A ring of radius 1 cm is placed 1 m in front of a spherical glass ball of radius 25 cm with refractive index 1.5. Mark the correct statement $(s)$.

    A. The final magnification of the image is $-3/56$ .
        The final image is formed at a distance $375/7$ cm from the center of the
    B. sphere in front of it.
    C. The final magnification of the image is $-3/7$
        The final image is formed at a distance $200/7$ cm from the center of the
    D. sphere in front of it.

Question No. 6

**One or More Options Correct Type**

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

The figure shows a man of mass $M$ standing on a weighing machine (of negligible mass) placed on a platform of mass $m$. All the pulleys and strings are ideal. Choose the correct statements.
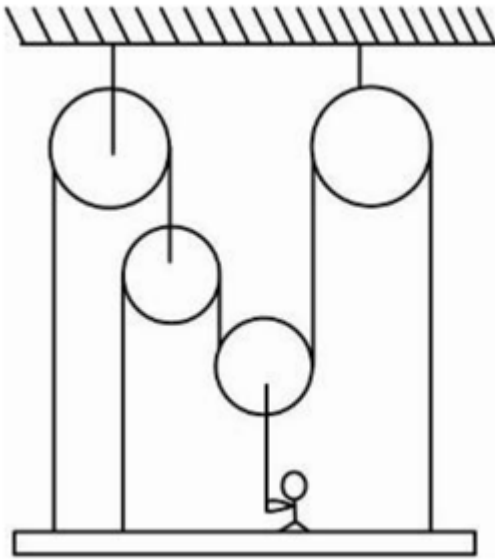


If $m = M = 60$ kg   then the man will have to pull the string with a force of
A. 400 N downwards to stay in equilibrium

If $m = M = 60$ kg   then the man must apply a force of 480 N on the string
B. in order to start moving up with an acceleration of 2 m/s$^2$

If $m = M = 60$ kg   then the man must apply a force of 1200 N on the
C. string in order to reflect his exact weight on the weighting machine

If $m > 2M$ , then weighing machine will never reflect the exact weight of
D. the man

Question No. 7

**One or More Options Correct Type**

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

In the circuit shown in figure $E_1$ and $E_2$ are two ideal sources of unknown emf. Some currents are shown. Potential difference appearing across 6Ω resistance is $V_A - V_B = 10$ V . Choose the correct statement (s) :
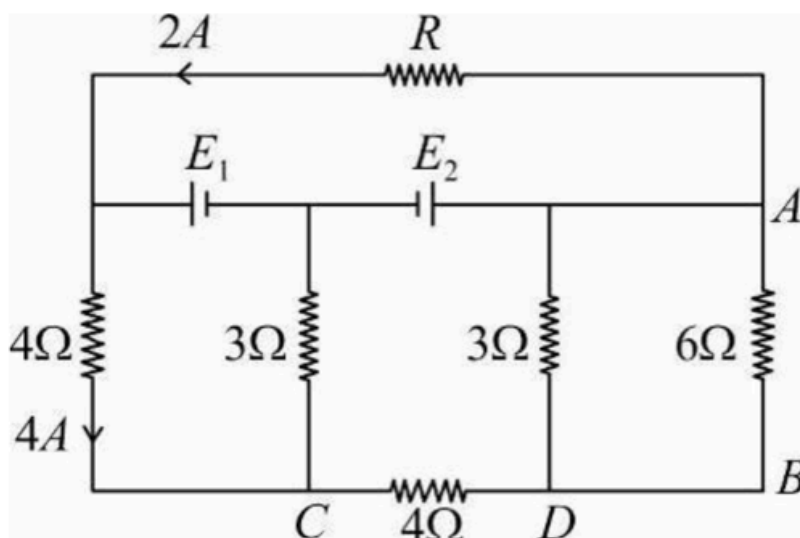
A. the current in $4\Omega$ resistor between $C$ and $D$ is $5A$
B. the unknown emf $E_1$ is $43$ V
C. the unknown emf $E_2$ is $57$ V
D. the resistor $R$ is $7\Omega$

## 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.

A uniform circular disc of mass $m = 12$ kg slides down along a smooth frictionless hill, which ends in a horizontal plane without break. The disc is released from rest at a height of $h = 1.25$ m with zero initial velocity and zero angular velocity and rides on the top of a cart of mass $M = 6$ kg , which can move on a frictionless surface. The coefficient of kinetic friction between the cart and the disc is $\mu = 0.4$ . Find the minimum length of the cart so that the disc begins to roll without slipping before loosing contact with the cart.
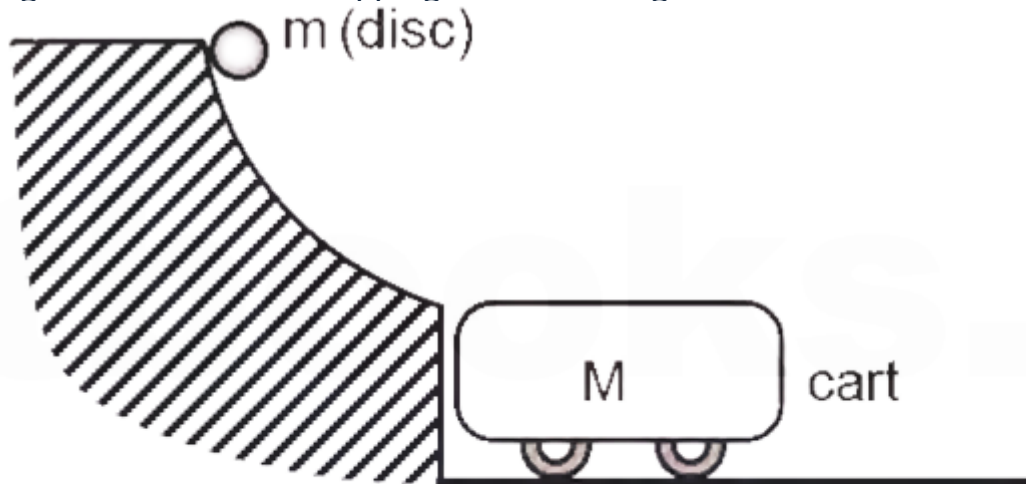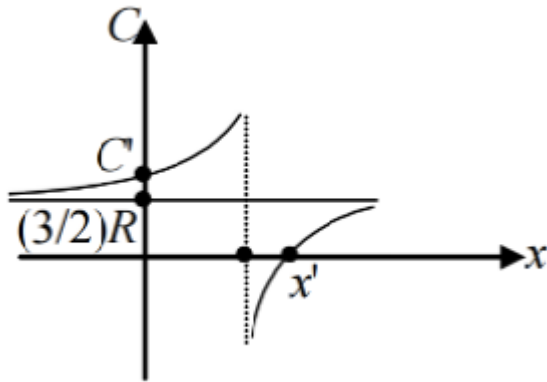


A. $\frac{7}{8}\ m$
B. $\frac{7}{4}\ m$
C. $\frac{21}{4}\ $m
D. $\frac{3}{8}\ $m

Question No. 2

**Only One Option Correct Type**

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

One mole of an ideal monoatomic gas is taken along the process in which $PV^x$ = constant. The graph shown represents the variation of molar heat capacity of such a gas with respect to $x$. The values of $C'$ and $x'$, respectively, are given by :
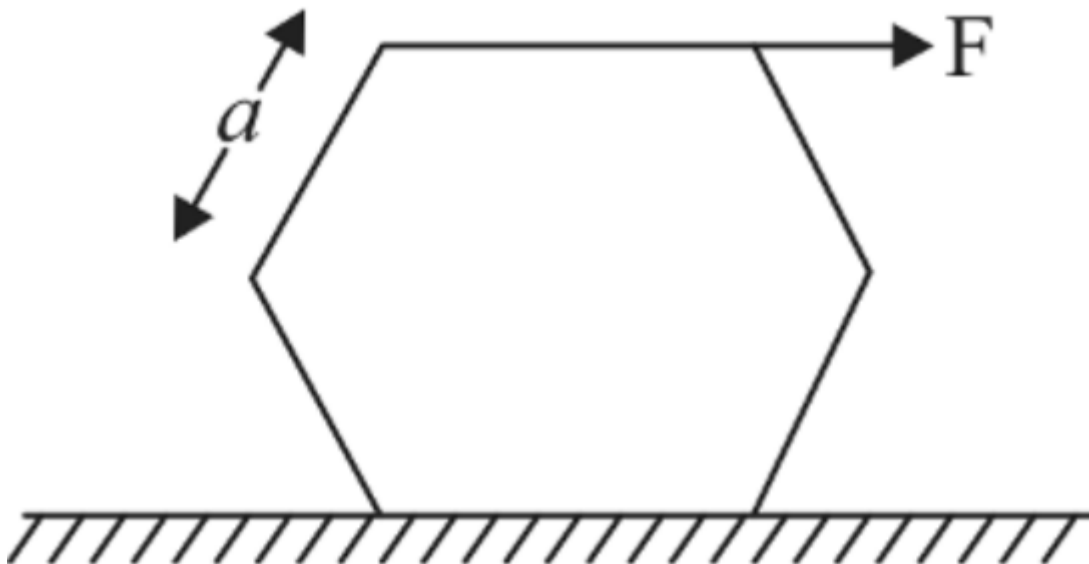


A. $\dfrac{5}{2} R, \dfrac{5}{2}$

B. $\dfrac{5}{2} R, \dfrac{5}{3}$

C. $\dfrac{7}{2} R, \dfrac{7}{2}$

D. $\dfrac{7}{2} R, \dfrac{7}{5}$

Question No. 3

**Only One Option Correct Type**

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

When force F acts on side of hexagonal body for what range of coefficient of friction body will topple before slipping?



A. $\mu > 0.29$

B. $\mu < 0.29$

C. $\mu > 0.21$

D. $\mu < 0.21$

Question No. 4
**Only One Option Correct Type**
Each question has multiple options out of which ONLY ONE is correct.

A parallel beam of uniform monochromatic light of wavelength 546 nm has an intensity of 200 W/m$^2$ . The number of photons in 1 mm$^3$ of this radiation is:

   A. 183
   B. 1831
   C. 18311
   D. 183117

## Chemistry Numerical (Maximum Marks: 28)

Question No. 1
**Numerical Type**
The answer has to be filled into the input box provided below.

When one mole of $K_4[Fe(CN)_6]$ is heated with conc. $H_2SO_4$, the evolved gas during reaction is reacted with excess of $I_2O_5$. find how many moles of $I_2$ will be liberated during the reaction

Question No. 2
**Numerical Type**
The answer has to be filled into the input box provided below.

Consider the following reaction
$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g); \Delta H = -132$ kJ
Also, given are standard molar enthalpies of formation of 1,3-butadiene (g) and butane gas as 115 kJ and $-140$ kJ per mol, respectively. Hence, the magnitude of resonance energy of 1, 3-butadiene (in kJ unit) is :

Question No. 3
**Numerical Type**
The answer has to be filled into the input box provided below.

How many comparison(s) are INCORRECT among given ?
(i) H > Li (ionisation energy)
(ii) Li > Be (size)
(iii) Na > Rb (size)
(iv) O > N (size)
(v) S > P (ionisation energy)
(vi) C > O (size)
(vii) B > Al (size)
(viii) F > Cl (ionisation energy)
(ix) N > O (ionisation energy)

Question No. 4

**Numerical Type**

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

How many number of molecules of formic acid are formed when 1 equivalent fructose react with excess of $HIO_4$ ?

Question No. 5

**Numerical Type**

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

Glucose molecule reacts with $X$ number of molecules of phenylhydrazine to yield osazone.
The value of $X$ is:

Question No. 6

**Numerical Type**

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

How many of the following salts are white and evolves colourless gas or vapours with dil. $H_2SO_4$.
$BaCrO_4, Hg_2CrO_4, ZnS, BaSO_4, BaS_2O_3, CH_3COOAg, AgNO_2$.

Question No. 7

**Numerical Type**

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

An alcohol (A) on treatment with conc. $H_2SO_4/\Delta$ gave an alkene (B). The compound (B), on reacting with $Br_2/CCl_4$ and subsequent didehydrobromination with $NaNH_2$ (2eq.) produced a compound (C). The compound (C) with dil. $H_2SO_4$ in presence of $HgSO_4$ gave a compound 'D'. The compound $D$ can also be obtained by oxidation of $A$ by pcc or from distillation of calcium acetate. If molecular weight of ' $C$ ' is $Y \times 10$ , then write the value of $Y$.

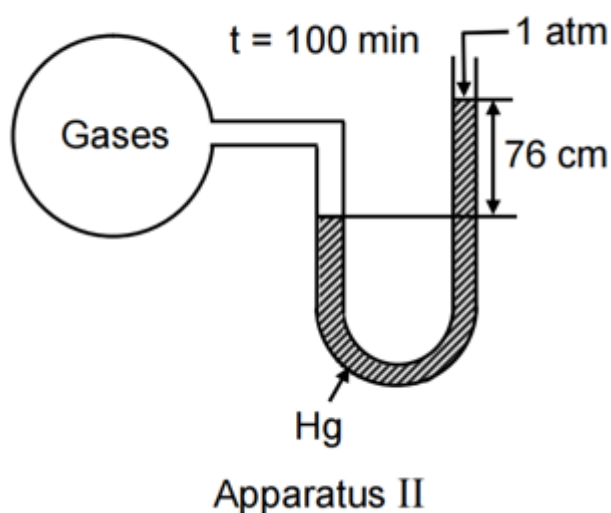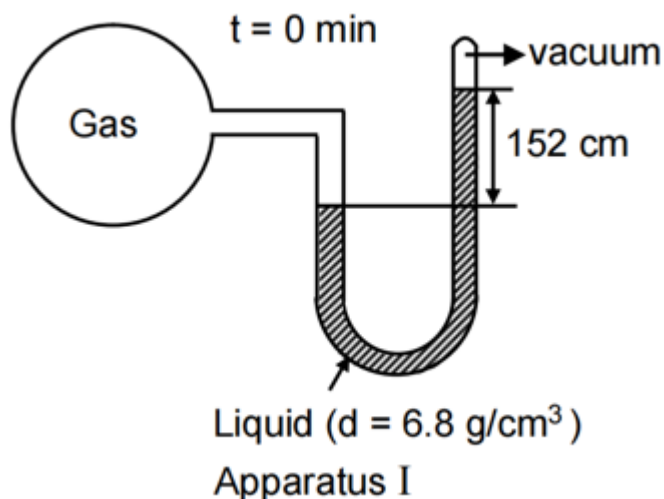## Chemistry Multiple Correct (Maximum Marks: 28)

Question No. 1

**One or More Options Correct Type**

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

Given a first order reaction which takes place as follows :

$A(g) \longrightarrow 2\,B(g) + C(g)$

Total pressure observed is as follows :



t = 0 min

vacuum

Gas

152 cm

Liquid (d = 6.8 g/cm³)

Apparatus I



t = 100 min    1 atm

Gases

76 cm

Hg

Apparatus II

Which is/are correct statement(s) ? [Given $\ell n\,2 = 0.7$ ]

A. Rate constant of appearance of $B$ is equal to $7 \times 10^{-3}\ \text{min}^{-1}$
B. Half life period of reaction is equal to $100$ min.
C. 75% of reaction is completed in 200 min.
D. 87.5% of reaction is completed in 100 min.

Question No. 2
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

In which of the following reactions benzaldehyde will form in final product.
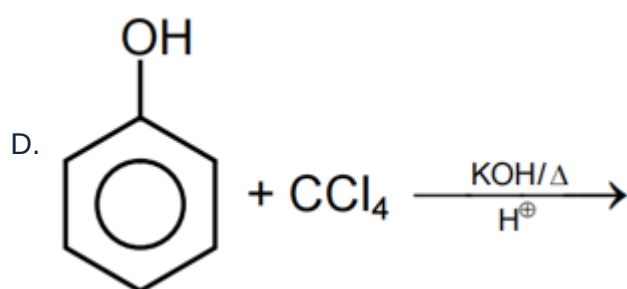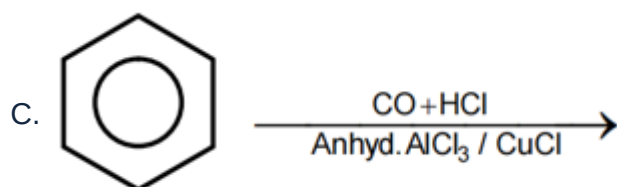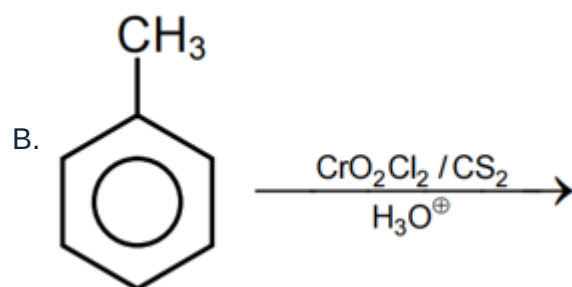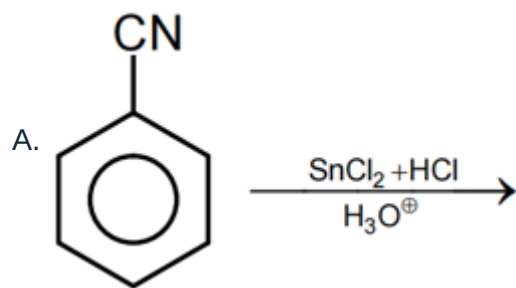
A.

CN

$\xrightarrow[\text{H}_3\text{O}^{\oplus}]{\text{SnCl}_2 + \text{HCl}}$

B.

CH$_3$

$\xrightarrow[\text{H}_3\text{O}^{\oplus}]{\text{CrO}_2\text{Cl}_2 / \text{CS}_2}$

C.

$\xrightarrow[\text{Anhyd. AlCl}_3 / \text{CuCl}]{\text{CO} + \text{HCl}}$

D.

OH

$+ \text{CCl}_4 \xrightarrow[\text{H}^{\oplus}]{\text{KOH}/\Delta}$

Question No. 3

**One or More Options Correct Type**

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

Three electrolytic cell with inert electrodes are connected in series combination as following :
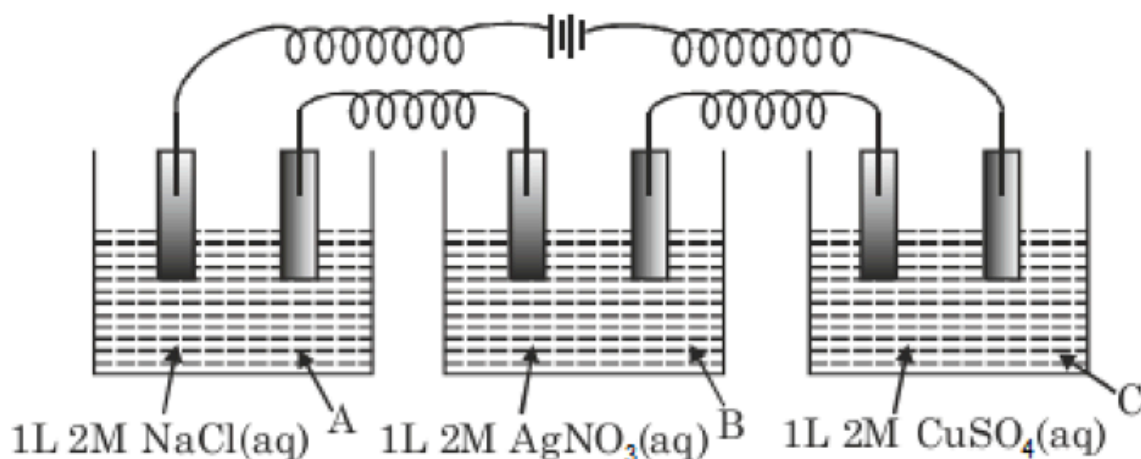If 9.65amp current is passed from external battery for 100 second then which is / are correct statements?
(Assume volume of solution in electrolytic cells remain constant during electrolysis) (Atomic mass of Ag = 108)



1L 2M NaCl(aq) A   1L 2M AgNO₃(aq) B   1L 2M CuSO₄(aq) C

A. pH of electrolytic cell A is 12 after electrolysis.
B. 21.6gm of silver deposits at cathode in electrolytic cell B after electrolysis.
C. Blue colour intensity in the solution of electrolyte cell C, decreases during electrolysis.
D. Electrolytic cell B and electrolytic cell C have equal pH after electrolysis, assuming no hydrolysis of both salts.

Question No. 4

**One or More Options Correct Type**

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

The wave functions of $3s$ and $3p_z$ orbitals are given by

$$\Psi_{3s} = \frac{1}{9\sqrt{3}}\left(\frac{1}{4\pi}\right)^{1/2}\left(\frac{z}{a_0}\right)^{3/2}\left(6 - \frac{4zr}{a_0} + \frac{4}{9}\frac{z^2r^2}{a_0^2}\right)e^{-zr/3a_0}$$

$$\Psi_{3p} = \frac{1}{9\sqrt{3}}\left(\frac{3}{4\pi}\right)^{1/2}\left(\frac{z}{a_0}\right)^{3/2}\left(4 - \frac{2zr}{3a_0}\right)\left(\frac{2zr}{3a_0}\right)e^{-zr/3a_0}\cos\theta$$

From these we can conclude :

A. Number of nodal surface for $3p_z$ & $3s$ orbitals is equal.
B. The angular nodal surface of $3p_z$ orbital has the equation $\theta = \pi/2$ .
C. The radial nodal surfaces of $3s$ orbital and $3p_z$ orbital are at equal distance from the nucleus.
D. 3 s electron have greater penetrating power into the nucleus in comparison to $3p$ electrons.

Question No. 5

**One or More Options Correct Type**

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

Choose correctly matched columns.

| Column-I | Column-II |
|---|---|
| (A) MeOH > EtOH > $Me_2CHOH$ > $Me_3COH$ | Rate of esterification |
| (B) $Me_3COH$ > $Me_2CHOH$ > $MeCH_2OH$ | Rate of dehydration with conc. $H_2SO_4/\Delta$ |
| (C) HCOOH > $MeCO_2H$ > $EtCO_2H$ > $Me_3C - CO_2H$ | Rate of esterification |
| (D) $MeCOCl$ > $(MeCO)_2O$ > $MeCO_2$ Me > $MeCONR_2$ | Rate of reactivity towards $CH_3MgX$ |

A. (A)
B. (B)
C. (C)
D. (D)

Question No. 6

**One or More Options Correct Type**

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

Salt $AB$ undergoes anionic hydrolysis and its 0.1M solution has pOH as 5 then select correct statement(s):

A. $K_h$ is equal to $K_b$ of $B^-$
B. $pK_a$ of HB is 5
C. h is 0.01%
D. pH of 0.1M HB is 3

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 species will be diamagnetic in nature, if Hund's rule is violated while writing their molecular orbital configuration?

A. $O_2$
B. $N_2^{2-}$
C. $He_2^+$
D. $B_2$

## 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.

In the preparation of iron from haematite $(Fe_2O_3)$ by the reduction with carbon
$$Fe_2O_3 + C \rightarrow Fe + CO_2$$
How much 80% pure iron may be produced from 120 kg of 90% pure $Fe_2O_3$ ?

  A. 94.5 kg
  B.   60.48 kg
  C. 116.66 kg
  D. 120 kg

Question No. 2
**Only One Option Correct Type**
Each question has multiple options out of which ONLY ONE is correct.

A mixture of 2 g each of the sulphates of two metals whose equivalent weights are 12 and 32 respectively was dissolved in water. To this solution, an excess of $BaCl_2$ was added, the weight of $BaSO_4$ precipitated is (atomic weight of $O = 16, \ S = 32, Ba = 137$ )

  A. 4 g
  B. 26.7 g
  C. 3.4 g
  D. 6.8 g

Question No. 3
**Only One Option Correct Type**
Each question has multiple options out of which ONLY ONE is correct.

The equilibrium constant for the reaction $N_2$ (g) $+ \ O_2(g) \rightleftharpoons 2NO(g)$ is $4 \times 10^{-4}$ at 200 K. In the presence of a catalyst, the equilibrium is attained 10 times faster. Therefore, the equilibrium constant in the presence of catalyst at 200 K is:

  A. $4 \times 10^{-3}$
  B. $4 \times 10^{-4}$
  C. $4 \times 10^{-5}$
  D. none of these

Question No. 4
**Only One Option Correct Type**
Each question has multiple options out of which ONLY ONE is correct.

Observe the following reaction
$$X \xrightarrow{NH_2OH/HCl} Y \xrightarrow{H_2SO_4} Z \xrightarrow[\text{(ii) } H^+]{\text{(i) NaOH }^{Boil}} H_2 N - CH_2 - CH_2 - CH_2 - COOH$$
If the molar mass of $X$ is $M \times 10$ . Then the value of $M$ is:

A. 7

B. 6.5

C. 8

D. 9

## Mathematics Numerical (Maximum Marks: 28)

Question No. 1

**Numerical Type**

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

The number of tangent(s) which can be drawn to the ellipse $16x^2 + 25y^2 = 400$ , such that sum of perpendicular distance from the foci to the tangent is 8 , is

Question No. 2

**Numerical Type**

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

Find the value of $|a|$ for which the area of the triangle included between the axes and any tangent to the curve $x^a y = \lambda^a$ is constant.

Question No. 3

**Numerical Type**

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

Consider all 6-digit numbers of the form abccba where $b$ is odd. How do you determine the number of all such 6 -digit numbers that are divisible by 7 ?

Question No. 4

**Numerical Type**

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

The value of $\lim\limits_{x \to 0} \dfrac{1 - \cos^5 x \cos^3 2x \cos^3 3x}{x^2}$ is $11k$, where $k$ is ........

Question No. 5

**Numerical Type**

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

Let the functions $f : (-1, 1) \to \mathrm{R}$ and $g : (-1, 1) \to (-1, 1)$ be defined by $f(x) = |2x - 1| + |2x + 1|$ & $g(x) = x - [x]$, where $[x]$ denotes the greatest integer less than or equal to $x$. Let $f \circ g : (-1, 1) \to \mathrm{R}$ be the composite function defined by $(f \circ g)(x) = f(g(x))$. Suppose $c$ is the number of points in the interval $(-1, 1)$ at which $f \circ g$ is not continuous, and suppose $d$ is the number of points in the interval $(-1, 1)$ at which $f \circ g$ is not differentiable. Then the value of $c + d$ is _____

Question No. 6

**Numerical Type**

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

In $\triangle ABC$, the least value of $\pi e^{-\frac{\pi}{3}} \left( \frac{e^A}{A} + \frac{e^B}{B} + \frac{e^C}{C} \right)$ is equal to _____.

Question No. 7

**Numerical Type**

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

If $0 \leq \arg z \leq \frac{\pi}{4}$, find the least value of $\sqrt{2}|z - i|$

## Mathematics Multiple Correct (Maximum Marks: 28)

Question No. 1

**One or More Options Correct Type**

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

The plane containing the line $\frac{x-3}{2} = \frac{y-b}{6} = \frac{z-1}{8}$ passes through the points $(a, 3, 2), (2, 1, 4)$ and $(2, 1, 1)$, then

    A. such a plane is unique
    B. $3a + b = 12$
    C. plane is parallel to $z$ axis
    D. there are infinite such planes

Question No. 2

**One or More Options Correct Type**

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

If $\int \frac{3x\sin^2 x \cos x - 3\sin^3 x}{x^4} dx = f(x) + C$, where $\lim_{x \to 0} f(x) = 1$ and $C$ is the constant of integration, then:

A. the value of $\lim \dfrac{\int_{x\to 0}^{x} tf(t)dt - 2x^2}{1 - \cos x} = -3$

B. the value of $\lim_{x\to 0} \dfrac{(f(x))^{\frac{1}{3}} - x^2}{x^2} = \dfrac{-1}{6}$

C. if $h(x) = x \cdot \sqrt[\beta]{\overline{f(x)}}$ , then $\int_0^{\pi} h^4(x)dx = \dfrac{3\pi}{8}$

D. if $h(x) = x \cdot \sqrt[\beta]{\overline{f(x)}}$ , then $\int_0^{\frac{\pi}{2}} e^{h(x)} (\cos^2 x - \sin x)dx = -1$

Question No. 3
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

Let $S$ be the area of the region enclosed by $y = e^{-x^2}$ ,$y = 0$, $x = 0$ and $x = 1$ .
Then

A. $S \geq \dfrac{1}{e}$

B. $S \geq 1 - \dfrac{1}{e}$

C. $S \leq \dfrac{1}{4}\left(1 + \dfrac{1}{\sqrt e}\right)$

D. $S \leq \dfrac{1}{\sqrt 2} + \dfrac{1}{\sqrt e}\left(1 - \dfrac{1}{\sqrt 2}\right)$

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 solution of the equation $\dfrac{d^2 x}{dt^2} + 4\dfrac{dx}{dt} + 3x = 0$ and for $t = 0, x = 0$ and $\dfrac{dx}{dt} = 12$ is in the form $x = Ae^{-3t} + Be^{-t}$, then :

A. $A + B = 0$
B. $A + B = 12$
C. $|AB| = 36$
D. $|AB| = 49$

Question No. 5
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

If $I = \int \dfrac{5x^8 + 7x^6}{(x^2 + 1 + 2x^7)^2} dx$ , then $I$ is equal to

A. $\dfrac{x^7}{2x^7 + x^2 + 1} + C$

B. $\dfrac{x^5}{x^2 + 1 + 2x^7} + C$

C. $\dfrac{-1}{2x^7 + x^2 + 1} + C$

D. $\frac{p(x)}{q(x)}$ where degree of $p(x) =$ degree of $q(x) = 7$

Question No. 6
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

If $ABC$ is a triangle and $\tan \frac{A}{2}$ , $\tan \frac{B}{2}$ , $\tan \frac{C}{2}$ are in H.P., then the minimum value of $\cot \frac{B}{2}$ is equal to

A. $-\sqrt{3}$
B. $\sqrt{3}$
C. Attains minimum if $A = C$
D. Attains minimum if $2A = C$

Question No. 7
**One or More Options Correct Type**
The question has multiple options out of which ONE or MORE is/are correct.

If $4a^2 - 5b^2 + 6a + 1 = 0$ , where $a, b \in R$ and the line $ax + by + 1 = 0$ touches a fixed circle, then

A. Centre of the circle is $(3, 0)$
B. Radius of the circle is $\sqrt{5}$
C. Circle passes through origin
D. Center of the circle is $(-3, 0)$

## 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.

If $S_{(n)} = 1 + \frac{1}{2} + \frac{1}{3} + \ldots \ldots + \frac{1}{n}, (n \in N)$ , then
$S_{(1)} + S_{(2)} + \ldots \ldots + S_{(n-1)}$ is equal to

A. $nS_{(n)} - n$
B. $nS_{(n)} - 1$
C. $(n-1)S_{(n-1)} - n$
D. none of these

Question No. 2
**Only One Option Correct Type**
Each question has multiple options out of which ONLY ONE is correct.

Let the function $f(x)$ be defined as follows:

$$f(x) = \begin{cases} x^3 + x^2 - 10x & , & -1 \le x < 0 \\ \cos x & , & 0 \le x < \frac{\pi}{2} \\ 1 + \sin x & , & \frac{\pi}{2} \le x \le \pi \end{cases}$$ . Then $f(x)$ has

A. a local minimum at $x = \frac{\pi}{2}$
B. a local maximum at $x = \frac{\pi}{2}$
C. absolute minimum at $x = -1$
D. absolute maximum at $x = \pi$

Question No. 3
**Only One Option Correct Type**
Each question has multiple options out of which ONLY ONE is correct.

A is the $n \times n$ matrix whose elements are all ' 1 ' and B is the $n \times n$ matrix whose diagonal elements are all ' $n$ ' and other elements are ' $n - r$ '. Then, $A^2$ is a scalar multiple of $A$ and then $(B - rI)[B - (n^2 - nr + r)I]$      is

A. I
B. -I
C. 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.

The normals at three points $P, \ Q, \ R$ on a rectangular hyperbola $xy = c^2$ intersect at a point on the curve. Then the centre of the hyperbola is a special point of the triangle $PQR$ , which is

A. Circumcentre
B. Centroid
C. Orthocentre
D. Incentre