Paper - I **Code-5**

Time: 3 Hours **Maximum Marks: 210**

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

INSTRUCTIONS

A. General:

1. This booklet is your Question Paper. Do not break the seals of this booklet before being instructed to do so by the invigilators.
2. The **question paper CODE** is printed on the right hand top corner of this sheet and also on the back page (page no. 28) of this booklet.
3. Blank spaces and blank pages are provided in this booklet for your rough work. No additional sheets will be provided for rough work.
4. Blank papers, clipboards, log tables, slide rules, calculators, cellular phones, pagers and electronic gadgets are NOT allowed inside the examination hall.
5. Answers to the questions and personal details are to be filled on a two-part carbon-less paper, which is provided separately. You should not separate these parts. The invigilator will separate them at the end of examination. The upper sheet is a machine-gradable Objective Response Sheet (ORS) which will be taken back by the invigilator. You will be allowed to take away the bottom sheet at the end of the examination.
6. **Using a black ball point pen, darken the bubbles on the upper original sheet.** Apply sufficient pressure so that the impression is created on the bottom sheet.
7. DO NOT TAMPER WITH/MUTILATE THE **ORS** OR THIS BOOKLET.
8. On breaking the seals of the booklet check that it contains 28 pages and all the 60 questions and corresponding answer choices are legible. Read carefully the instructions printed at the beginning of each section.

B. Filling the Right Part of the ORS :

9. The ORS also has **CODES** printed on its Left and Right parts.
10. Check that the same CODE is printed on the ORS and on this booklet. IF IT IS NOT THEN ASK FOR A CHANGE OF THE BOOKLET. Sign at the place provided on the ORS affirming that you have verified that all the codes are same.
11. Write your Name, Registration No. and the name of examination centre and sign **with pen** in the boxes provided on the right part of the ORS. **Do not write any of this information anywhere else.** Darken the appropriate bubble **UNDER** each digit of your Registration Number in such a way that the impression is created on the bottom sheet. Also darken the paper CODE given on the right side of ORS (R4).

C. Question paper format

The question paper consists of **3 parts** (Physics, Chemistry and Mathematics). Each part consists of three sections.

12. In **Section I** contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.
13. In **Section II** contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE are correct**.
14. In **Section III** contains **5 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive)

D. Marking Scheme

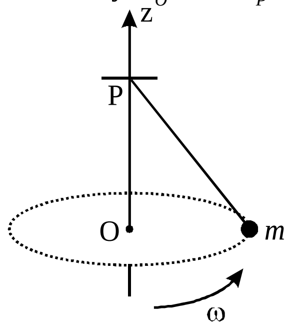
15. For each question in **Section I,** you will be awarded **3 marks** if you darken the bubble corresponding to the correct answer **ONLY** and **zero marks** if no bubbles are darkened. In all other cases, **minus one (–1) mark** will be awarded in this section.
16. For each question in **Section II,** you will be awarded **4 marks** if you darken **ALL** the bubble(s) corresponding to the correct answer(s) **ONLY.** In all other cases **zero (0) marks** will be awarded. **No negative marks** will be awarded for incorrect answers in this section.
17. For each question in **Section III,** you will be awarded **4 marks** if you darken the bubble corresponding to the correct answer **ONLY.** In all other cases **zero (0) marks** will be awarded. **No negative marks** will be awarded for incorrect answers in this section.

PART I : PHYSICS

SECTION- I : <u>Single Correct Answer Type</u>

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct:

1. A small mass m is attached to a massless string whose other end is fixed at P as shown in the figure. The mass is undergoing circular motion is the x-y plane with centre at O and constant angular speed ω. If the angular momentum of the system, calculated about O and P are denoted by $\vec{L}_O$ and $\vec{L}_P$ respectively, then



(A) $\vec{L}_O$ and $\vec{L}_P$ do not vary with time

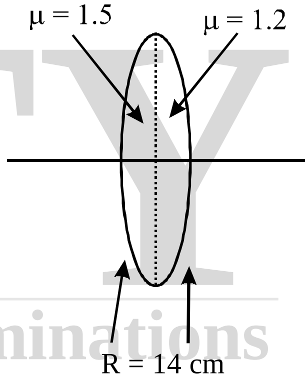
(B) $\vec{L}_O$ varies with time while $\vec{L}_P$ remains constant

(C) $\vec{L}_O$ remains constant while $\vec{L}_P$ varies with time

(D) $\vec{L}_O$ and $\vec{L}_P$ both vary with time.

Sol: [C] $\vec{L}_0$ is along z-axis while $\vec{L}_P$ is perpendicular to line joining mass to point P.

2. A bi-convex lens is formed with two thin plano-convex lenses as shown in the figure. Refractive index n of the first lens is 1.5 and that of the second lens is 1.2. Both the curved surfaces are of the same radius of curvature R = 14 cm. For this bi-convex lens, for an object distance of 40 cm, the image distance will be



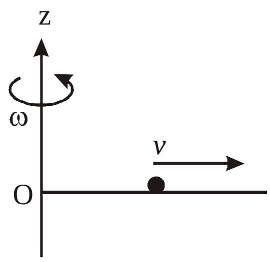
(A) – 280.0 cm (B) 40.0 cm

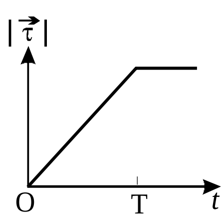
(C) 21.5 cm (D) 13.3 cm

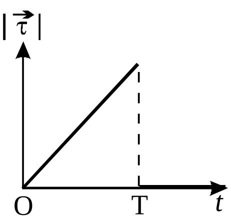
Sol: [B] $\dfrac{1}{F} = \left(\dfrac{1.5}{1} - 1\right)\left(\dfrac{1}{14} - \dfrac{1}{\infty}\right) + \left(\dfrac{1.2}{1} - 1\right)\left(0 - \dfrac{1}{-14}\right) = \dfrac{1}{20} \Rightarrow F = 20$ cm

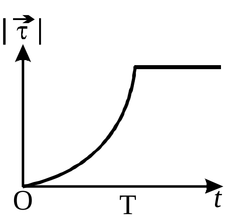
Object is placed at $2F \Rightarrow$ image distance = 40 cm

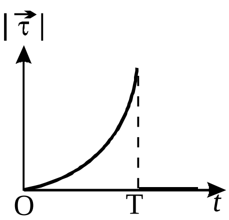
3. The thin uniform rod, pivoted at O, is rotating in the horizontal plane with constant angular speed ω, as shown in the figure. At time $t = 0$, a small insect starts from O and moves with constant speed v with respect to the rod towards the other end. It reaches the end of the rod at t = T and stops. The angular speed of the system remains ω throughout. The magnitude of the torque $(|\vec{\tau}|)$ on the system about O, as a function of time is best represented by which plot?



(A)


(B)


(C)


(D)


Sol: [B] Velocity of insect w.r.t. rod = $\left(\frac{l}{T}\right)$ where l is length of rod

$\Rightarrow$ Angular momentum at time t

$$L = \left(I_{\text{rod}} + m\left(\frac{l}{T}t\right)^2\right)\omega = \frac{dL}{dt} = \left(0 + m \times 2 \times \frac{l}{T}\right)\omega,$$

which is linear.

4. A mixture of 2 moles of helium gas (atomic mass = 4 amu) and 1 mole of argon gas (atomic mass = 40 amu) is kept at 300 K in a container. The ratio of the rms speeds $\left(\frac{v_{rms}(\text{helium})}{v_{rms}(\text{argon})}\right)$ is

(A) 0.32 (B) 0.45 (C) 2.24 (D) 3.16

Sol: [D] $v_{\text{rms}} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_{\text{rms}}(\text{helium})}{v_{\text{rms}}(\text{argon})} = \sqrt{\frac{40}{4}} = 3.16$

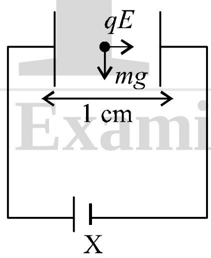
5. Two large vertical and parallel metal plates having a separation of 1 cm are connected to a DC voltage source of potential difference X. A proton is released at rest midway between the two plates. It is found to move at 45° to the vertical JUST after release. Then X is nearly

(A) 1×10^{-5} V (B) 1×10^{-7} V (C) 1×10^{-9} V (D) 1×10^{-10} V

Sol: [C] $qE = mg$

$$e.\frac{X}{d} = mg$$

$$X = \frac{mgd}{e} = \frac{1.6\times10^{-27}\times10\times10^{-2}}{1.6\times10^{-19}} = \left(10^{-9}\right)\text{ volt}$$



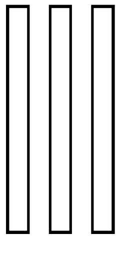
6. Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity. The first and third plates are maintained at temperatures 2T and 3T respectively. The temperature of the middle (i.e. second) plate under steady state condition is

(A) $\left(\frac{65}{2}\right)^{1/4}T$ (B) $\left(\frac{97}{4}\right)^{1/4}T$ (C) $\left(\frac{97}{2}\right)^{1/4}T$ (D) $(97)^{1/4}T$

Sol: [C] Let area of one side of plate = A

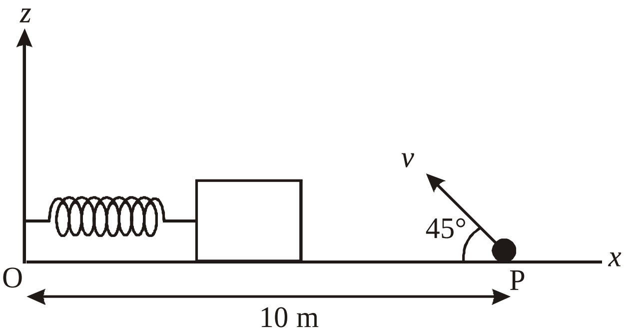
$\Rightarrow \quad \sigma A(3T)^4 + \sigma A(2T)^4 = \sigma \times 2A\, T_1^4$

$\Rightarrow \quad T_1 = \left(\frac{97}{2}\right)^{1/4} T$



7. A small block is connected to one end of a massless spring to un-stretched length 4.9 m. The other end of the spring (see the figure) is fixed. The system lies on a horizontal frictionless surface. The block is stretched by 0.2 m and released from rest at $t = 0$. It then executes simple harmonic motion with angular frequency $\omega = \frac{\pi}{3}$ rad/s. Simultaneously at $t = 0$, a small pebble is projected with speed v from point P at an angle of 45° as shown in the figure.

Point P is at a horizontal distance of 10 m from O. If the pebble hits the block at t =1s, the value of v is (take g = 10 m/s^2)



(A) $\sqrt{50}$ m/s (B) $\sqrt{51}$ m/s

(C) $\sqrt{52}$ m/s (D) $\sqrt{53}$ m/s

Sol: **[A]** Time of flight of pebble, $t = \frac{2v\sin 45^\circ}{g} \Rightarrow 1 = \frac{2v \times \frac{1}{\sqrt{2}}}{10}$

$v = 5\sqrt{2} = \sqrt{50}$ m/sec.

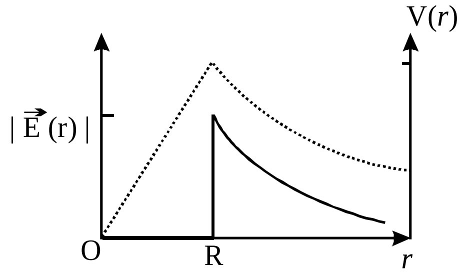
8. Young's double slit experiment is carried out by using green, red and blue light, one colour at a time. The fringe widths recorded are β_G, β_R and β_B, respectively. Then,

(A) $\beta_G > \beta_B > \beta_R$ (B) $\beta_B > \beta_G > \beta_R$ (C) $\beta_R > \beta_B > \beta_G$ (D) $\beta_R > \beta_G > \beta_B$

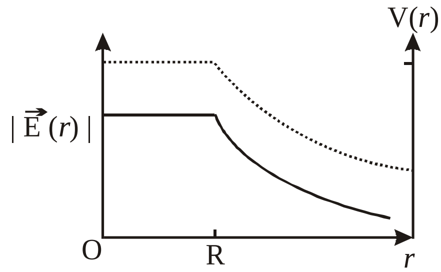
Sol: **[D]** $\beta \propto \lambda \Rightarrow \beta_R > \beta_G > \beta_B$

9. Consider a thin spherical shell of radius R with its centre at the origin, carrying uniform positive surface charge density. The variation of the magnitude of the electric field $|\vec{E}(r)|$ and the electric potential V(r) with the distance r from the centre, is best represented by which graph?

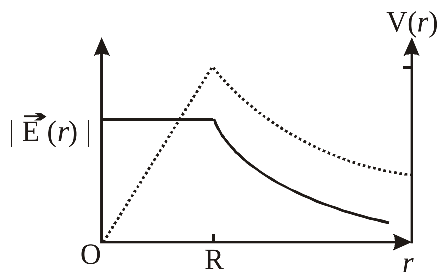
(A)



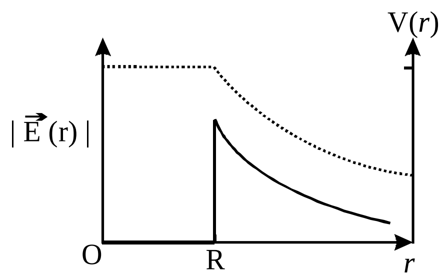
(B)



(C)



(D)



Sol: **[D]** Factual

10. In the determination of Young's modulus $\left(Y = \frac{4MLg}{\pi l d^2}\right)$ by using Searle's method, a wire of length L = 2 m and diameter d = 0.5 mm is used. For a load M = 2.5 kg, an extension l = 0.25 mm in the length of the wire is observed. Quantities d and l are measured using a screw gauge and a micrometer, respectively. They have the same pitch of 0.5 mm. The number of divisions on their circular scale is 100. The contributions to the maximum probable error of the Y measurement

(A) due to the errors in the measurement of d and l are the same

(B) due to the error in the measurement of d is twice that due to the error in the measurement of l.

(C) due to the error in the measurement of l is twice that due to the error in the measurement of d.

(D) due to the error in the measurement of d is four times that due to the error in the measurement of l.

Sol: [B] $\frac{\Delta Y}{Y} = \pm\left(\frac{\Delta l}{l} + 2\frac{\Delta d}{d}\right) \Rightarrow$ error in d causes more error in Y.

SECTION- II: <u>Multiple Correct Answers Type</u>

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** are correct.

11. Consider the motion of a positive point charge in a region where there are simultaneous uniform electric and magnetic fields $\vec{E} = E_o\hat{j}$ and $\vec{B} = B_o\hat{j}$. At time t = 0, this charge has velocity $\vec{v}$ in the x - y plane, making and angle θ with the x-axis. Which of the following option (s) is(are) correct for time t > 0?

(A) If θ = 0°, the charge moves in a circular path in the x–z plane

(B) If θ = 0°, the charge undergoes helical motion with constant pitch along the y-axis.

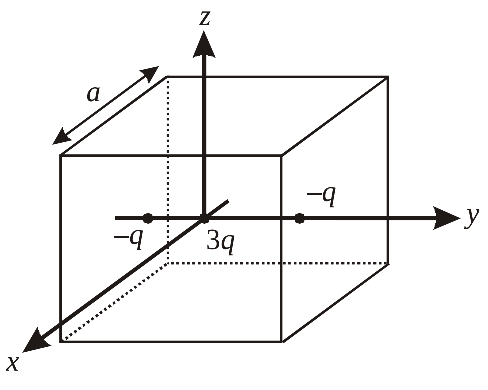
(C) If θ = 10°, the charge undergoes helical motion with its pitch increasing with time, along the y-axis.

(D) If θ = 90°, the charge undergoes linear but accelerated motion along the y-axis.

Sol: [C,D] For 0 ≤ θ < 90

Path is helical, but for θ = 90º, there is no magnetic force and under E it will move along y-axis.

12. A cubical region of side a has its centre at the origin. It encloses three fixed point charges, $-q$ at (0, – a/4, 0) +3q at (0, 0, 0) and $-q$ at (0, + a/4, 0). Choose the correct option (s).



(A) The net electric flux crossing the plane x = + a/2 is equal to the net electric flux crossing the plane x = – a/2.

(B) The net electric flux crossing the plane y = + a/2 is more than the net electric flux crossing the plane y = – a/2.

(C) The net electric flux crossing the entire region is q/ϵ_0

(D) The net electric flux crossing the plane z = + a/2 is equal to the net electric flux crossing the plane x = +a/2

Sol: [A,C,D] Plane $x = \pm\frac{a}{2}$, $y = \pm\frac{a}{2}$ and $z = \pm\frac{a}{2}$ are symmetric w.r.t. charge distributions.

13. A person blows into open end of a long pipe. As a result, a high-pressure pulse of air travels down the pipe. When this pulse reaches the other end of the pipe.

(A) a high-pressure pulse starts travelling up the pipe, if the other end of the pipe is open

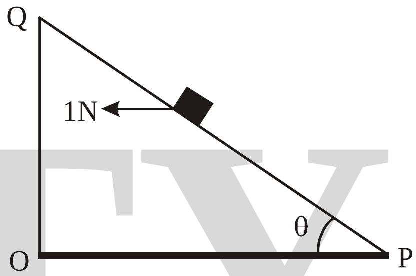
(B) a low-pressure pulse starts travelling up the pipe, if the other end of the pipe is open

(C) a low-pressure pulse starts travelling up the pipe, if the other end of the pipe is closed

(D) a high-pressure pulse starts travelling up the pipe, if the other end of the pipe is closed

Sol: [B,D] Open end acts as fixed end while closed end as free end for purpose of reflection of pressure of the medium.

14. A small block of mass of 0.1 kg lies on a fixed inclined plane PQ which makes an angle θ with the horizontal. A horizontal force of 1 N acts on the block through its centre of mass as shown in the figure. The block remains stationary if (take g = 10 m/s^2)



(A) θ = 45°

(B) θ > 45° and a frictional force acts on the block towards P

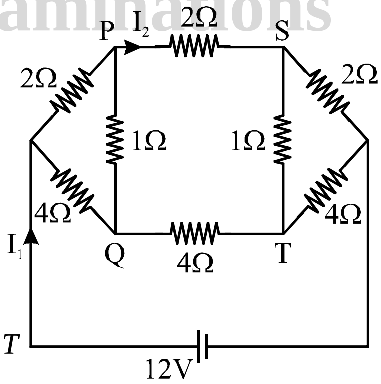
(C) θ > 45° and a frictional force acts on the block towards Q

(D) θ < 45° and a frictional force acts on the block towards Q

Sol: [A,C] For, 1 × cos θ = 0.1 × 10 sin θ i.e., θ = 45º

Net force on block is zero in the absence of friction. For θ > 45º, block has tendency to move downward and for θ < 45º, it has tendency to move upwards.

15. For the resistance network shown in the figure, choose the correct option (s)



(A) The current through PQ is zero

(B) I_1 = 3A

(C) The potential as S is less than the at Q

(D) I_2 = 2A

Sol: [A,B,C,D] In the absence of resistance between *P* and *Q* & *S* and *T*

$V_P = V_Q$ and $V_S = V_T$

⇒ There is no effect on current distribution when resistance of 1 Ω each are connected across P and Q & S and T.

$$R_e = \frac{6\times 12}{18} = 4\Omega$$

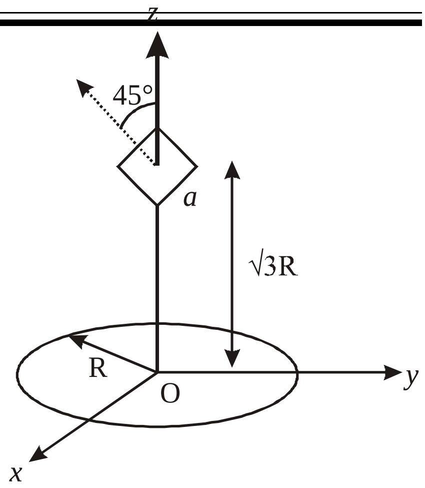
$$I_1 = \frac{12}{4} = 3A$$

$$I_2 = \frac{12}{18}\times 3 = 2A$$

SECTION- III : Integer Answer Type

This Section contains **five questions.** The answer to each question is a **single digit integer,** ranging form 0 to 9 (both inclusive).

16. A circular wire loop of radius R is placed in the x-y plane centered at the origin O. A square loop of side $a(a << R)$ having two turns is placed with its centre at $z = \sqrt{3}R$ along the axis of the circular wire loop, as shown in figure. The plane of the square loop makes an angle of 45° with respect to the z-axis. If the mutual inductance between the loops is given by $\frac{\mu_o a^2}{2^{p/2} R}$, then the value of p is



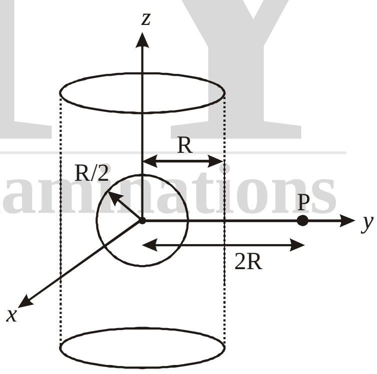
Sol. [7] B on square loop = $\frac{\mu_0 i R^2}{2(R^2+3R^2)^{3/2}} = \frac{\mu_0 i}{16R}$

Flux associated with square loop, $\phi = 2\times\frac{\mu_0 i}{16R}\times a^2\cos 45^o = \left(\frac{\mu_0 i a^2}{8\sqrt{2}R}\right)$

$\Rightarrow\ M = \frac{\phi}{i} = \frac{\mu_0 \times a^2}{8\sqrt{2}R}$

Comparing $2^{P/2} = 2^{7/2}$ $\Rightarrow$ $\boldsymbol{p = 7}$

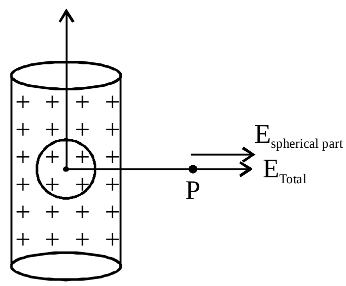
17. An infinitely long solid cylinder of radius R has a uniform volume charge density ρ. It has a spherical cavity of radius R/2 with its centre on the axis of the cylinder, as shown in the figure. The magnitude of the electric field at the point P, which is at a distance 2R from the axis of the cylinder, is given by the expression $\frac{23\rho R}{16k\varepsilon_o}$. The value of k is



Sol. [6] Electric field at

$P = \vec{E}_{\text{Total}} - \vec{E}_{\text{Spherical part}} = \frac{\rho R^2}{2\varepsilon_0\times 2R} - \frac{\rho(R/2)^3}{3\varepsilon_0(2R)^2}$

$= \frac{\rho R}{4\varepsilon_0} - \frac{\rho R}{96\varepsilon_0} = \left(\frac{23\rho R}{96\varepsilon_0}\right)$



Comparing, $\boldsymbol{k = 6}$

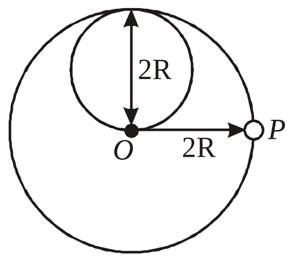
18. A proton is fired from very far away towards a nucleus with charge Q = 120 e, where e is the electronic charge. It makes a closest approach of 10 fm to the nucleus. The de Broglie wavelength (in unit of fm) of the proton at its start is: (take the proton mass, $m_p = (5/3)\times10^{-27}$ kg; $h/e = 4.2\times10^{-15}$ J.s/C; $\frac{1}{4\pi\varepsilon_o} = 9\times10^9$ m/F, 1 fm = 10^{-15} m)

Sol. [7] K.E. of proton = $\dfrac{9\times10^{9}\times120e^{2}}{10\times10^{-15}} = 108e^{2}\times10^{24}$

$$\lambda = \frac{h}{(2m\times108e^{2}\times10^{24})^{1/2}} = \frac{4.2\times10^{-15}}{(2\times\frac{5}{3}\times10^{-27}\times108\times10^{24})^{1/2}}$$

$= 7\times10^{-15}$ m = **7 fm**

19. A lamina is made by removing a small disc of diameter 2R from a bigger disc of uniform mass density and radius 2R, as shown in the figure. The moment of inertia of this lamina about axes passing through O and P is I_O and I_P, respectively. Both these axes are perpendicular to the plane of the lamina. The ratio $\dfrac{I_p}{I_o}$ to the nearest integer is

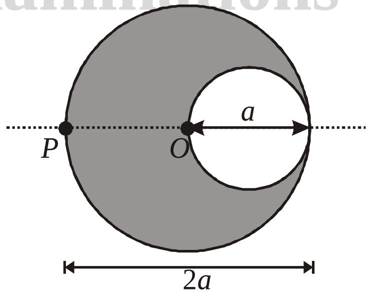


Sol. [3] $I_0 = \dfrac{M(2R)^2}{2} - \left[\dfrac{(M/4)(R^2)}{2} + \dfrac{M}{4}.(R)^2\right] = 2MR^2 - \left[\dfrac{3MR^2}{8}\right] = \dfrac{13MR^2}{8}$

$$I_P = \frac{M(2R)^2}{2} + MR^2 - \left(\frac{M}{4}.\frac{R^2}{2} + \frac{M}{4}(R\sqrt{5})^2\right) = \frac{37MR^2}{8}$$

$$\Rightarrow \frac{I_P}{I_0} = \frac{37}{13} \approx 3$$

20. A cylindrical cavity of diameter *a* exists inside a cylinder of diameter 2*a* as shown in the figure. Both the cylinder and the cavity are infinitely long. A uniform current density J flows along the length. If the magnitude of the magnetic field at the point P is given by $\dfrac{N}{12}\mu_o aJ$, then the value of N is



Sol. [5] $\left|\vec{B}_P\right| = \dfrac{\mu_0 J\times a}{2} - \dfrac{\mu_0 J(a/2)^2}{2\times\frac{3}{2}\times a}$

$$B_P = \left(\frac{5\mu_0 Ja}{12}\right)$$

Comparing, ***N* = 5**

PART II : CHEMISTRY

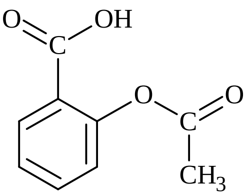
ECTION- I (Single Correct Answer Type)

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**

21. The carboxyl functional group (–COOH) is present in

(A) picric acid (B) barbituric acid (C) ascorbic acid (D) aspirin

Sol: [D] aspirin



acetyl salicylic acid

22. As per IUPAC nomenclature, the name of the complex $[Co(H_2O)_4(NH_3)_2]Cl_3$ is

(A) Tetraaquadiaminecobalt(III)chloride (B) Tetraaquadiamminecobalt(III)chloride

(C) Diaminetetraaquacobalt(III)chloride (D) Diamminetetraaquacobalt(III)chloride

Sol: [D] Diamminetetraaquacobalt(III)chloride

23. In allene (C_3H_4), the type(s) of hybridisation of the carbon atoms is (are)

(A) sp and sp^3 (B) sp and sp^2 (C) only sp^2 (D) sp^2 and sp^3

Sol: [B] $\underset{sp^2}{H_2C}=\underset{sp}{C}=\underset{sp^2}{CH_2}$

24. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius]

(A) $\frac{h^2}{4\pi^2 ma_0^2}$ (B) $\frac{h^2}{16\pi^2 ma_0^2}$ (C) $\frac{h^2}{32\pi^2 ma_0^2}$ (D) $\frac{h^2}{64\pi^2 ma_0^2}$

Sol: [C] $\text{K.E.} = \frac{1}{2}\frac{Ze^2}{r}$ and $r = \frac{n^2h^2}{4\pi^2 mze^2}$

$$\Rightarrow e^2 = \frac{n^2h^2}{4\pi^2 mzr}$$

$$\text{So K.E.} = \frac{1}{2} \times \frac{z}{r} \times \frac{n^2h^2}{4\pi^2 mzr}$$

$$= \frac{n^2h^2}{8\pi^2 mr^2}$$

Here n = 2 and $r = a_0 \times n^2$

$$\Rightarrow \text{K.E.} = \frac{2^2h^2}{8\pi^2 m(a_0 \times 4)^2} = \frac{h^2}{32\pi^2 ma_0^2}$$

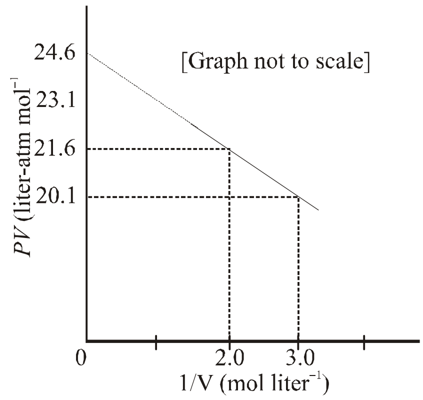
25. Which ordering of compounds is according to the decreasing order of the oxidation state of nitrogen?

(A) HNO_3, NO, NH_4Cl, N_2 (B) HNO_3, NO, N_2, NH_4Cl

(C) HNO_3, NH_4Cl, NO, N_2 (D) NO, HNO_3, NH_4Cl, N_2

Sol: [B] $H\overset{+5}{N}O_3 > \overset{+2}{N}O > \overset{+0}{N}_2 > \overset{-3}{N}H_4Cl$

26. For one mole of a van der Waals gas when $b = 0$ and $T = 300$K, then PV vs. 1/V plot is shown below. The value of the van der Waals constant a (atm. liter^2 mol^{-2}) is



(A) 1.0 (B) 4.5

(C) 1.5 (D) 3.0

Sol: [C] $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$

$\left(P + \frac{a}{V^2}\right)(V - b) = RT$, $PV + \frac{a}{V} = RT$

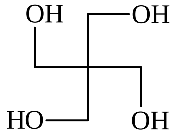
$PV = RT - \frac{a}{V}$

slope = a

$\frac{24.6 - 20.1}{3.0 - 0} = a$, $\frac{4.5}{3} = a$

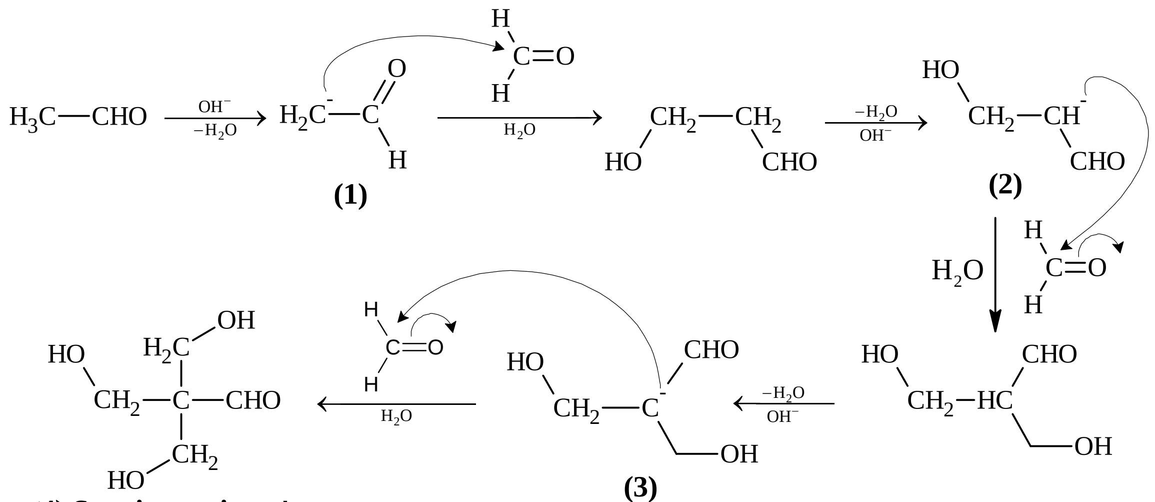
a = 1.5

27. The number of aldol reaction(s) that occurs in the given transformation is

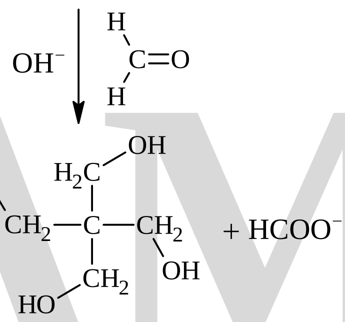
$CH_3CHO + 4HCHO \xrightarrow{\text{conc. aq. NaOH}}$ 

(A) 1 (B) 2 (C) 3 (D) 4

Sol: [C]



(4) Step is cannizaro's reaction

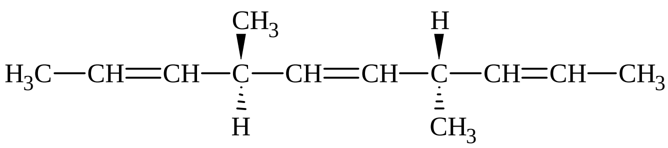


28. The colour of light absorbed by an aqueous solution of $CuSO_4$ is

(A) orange-red (B) blue-green (C) yellow (D) violet

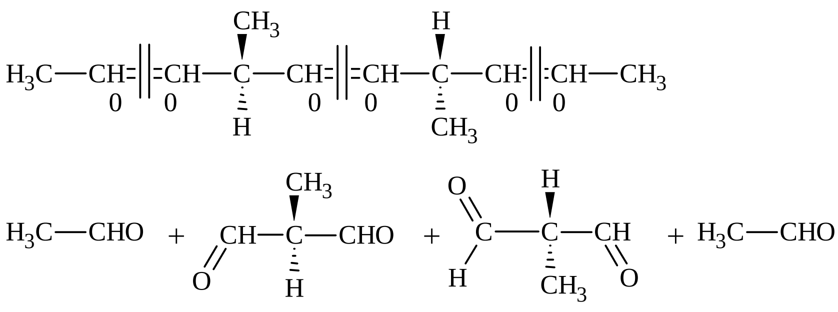
Sol: [A] Complementary colour of blue green is orange red.

29. The number of optically active products obtained from the **complete** ozonolysis of the given compound is

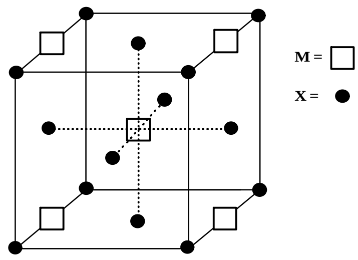


(A) 0 (B) 1 (C) 2 (D) 4

Sol: [A]



30. A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is



(A) MX (B) MX_2

(C) M_2X (D) M_5X_{14}

Sol: [B] Number of X = 4

Number of M = M present in body centre = 1

M present in edge centre $4\times\frac{1}{4}=1$

$M_2X_4 = MX_2$

SECTION- II: (Multiple Correct Answer Type)

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

31. Which of the following hydrogen halides react(s) with $AgNO_3$ (aq) to give a precipitate that dissolves in $Na_2S_2O_3$ (aq)?

(A) HCl (B) HF (C) HBr (D) HI

Sol: [A, C, D]

AgF = soluble
AgCl = white ppt.
AgBr = yellow ppt.
AgI = dark yellow ppt.

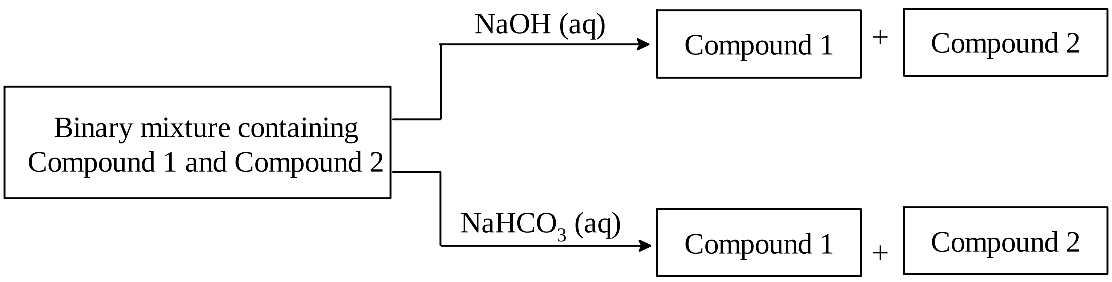
$\xrightarrow{Na_2S_2O_3}$

$AgCl \xrightarrow{Na_2S_2O_3} Na_3[Ag(S_2O_3)_2] + NaCl$

$AgBr \xrightarrow{Na_2S_2O_3} Na_3[Ag(S_2O_3)_2] + NaBr$

$AgI \xrightarrow{Na_2S_2O_3} Na_3[Ag(S_2O_3)_2] + NaI$

32. Identify the binary mixture(s) that can be separated into individual compounds by differential extraction, as shown in the given scheme.



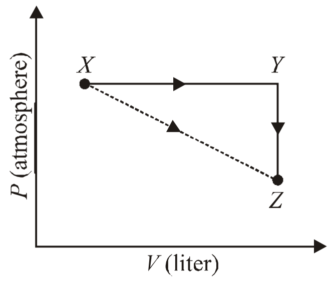
(A) C_6H_5OH and C_6H_5COOH (B) C_6H_5COOH and $C_6H_5CH_2OH$

(C) $C_6H_5CH_2OH$ and C_6H_5OH (D) $C_6H_5CH_2OH$ and $C_6H_5CH_2COOH$

3ol: [B, D] (B) C_6H_5COOH reacts with $NaOH_{(aq)}$ while $C_6H_5CH_2OH$ does not react with $NaOH_{(aq)}$.

(D) $C_6H_5CH_2COOH$ reacts with $NaHCO_3$ while $C_6H_5CH_2OH$ does not react with $NaHCO_3$ (aq).

33. For an ideal gas, consider only P-V work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is(are) correct? [take ΔS change in entropy and w as work done]



(A) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$

(B) $w_{x\to z} = w_{x\to y} + w_{y\to z}$

(C) $w_{x\to y\to z} = w_{x\to y}$

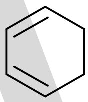
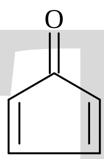
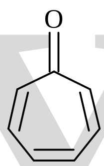
(D) $\Delta S_{x\to y\to z} = \Delta S_{x\to y}$

Sol: [A, C] ΔS is state function

work done is path function

$w_{y-z} = 0$ (volume constant)

34. Which of the following molecules, in pure form, is (are) **unstable** at room temperature?

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

Sol: [B, C] Both are antiaromatic and hence unstable.

A is non-aromatic, D is aromatic

35. Choose the correct reason(s) for the stability of the **lyophobic** colloidal particles.

(A) Preferential adsorption of ions on their surface from the solution

(B) Preferential adsorption of solvent on their surface from the solution

(C) Attraction between different particles having opposite charges on their surface

(D) Potential difference between the fixed layer and the diffused layer of opposite charges around the colloidal particles.

Sol: [A, D] Self explanatory

SECTION- III: (Integer Answer Type)

This Section contains **5 questions.** The answer to each of the question is a **single digit integer,** ranging from 0 to 9 (both inclusive)

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36. 29.2% (w/w) HCl stock solution has a density of 1.25 g mL^{-1}. The molecular weight of HCl is 36.5 g mol^{-1}. The volume (mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is

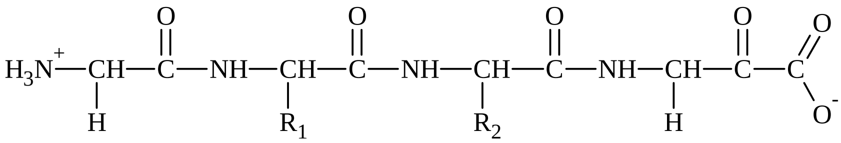
Sol. [8] Molarity of 29.2% w/W HCl solution (density 1.25 g/cc) is 10 M

$M_1V_1 = M_2V_2$

$10 \times V = 200 \times 0.4$

$V = 8$ ml

37. The substituents $\mathbf{R_1}$ and $\mathbf{R_2}$ for nine peptides are listed in the table given below. How many of these peptides are positively charged at pH = 7.0?



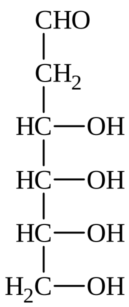
Peptide	$\mathbf{R_1}$	$\mathbf{R_2}$
I	H	H
II	H	CH_3
III	CH_2COOH	H
IV	CH_2CONH_2	$(CH_2)_4NH_2$
V	CH_2CONH_2	CH_2CONH_2
VI	$(CH_2)_4NH_2$	$(CH_2)_4NH_2$
VII	CH_2COOH	CH_2CONH_2
VIII	CH_2OH	$(CH_2)_4NH_2$
IX	$(CH_2)_4NH_2$	CH_3

Sol. [4] Peptide IV, VI, VIII and IX gives positive charge peptide at pH = 7.

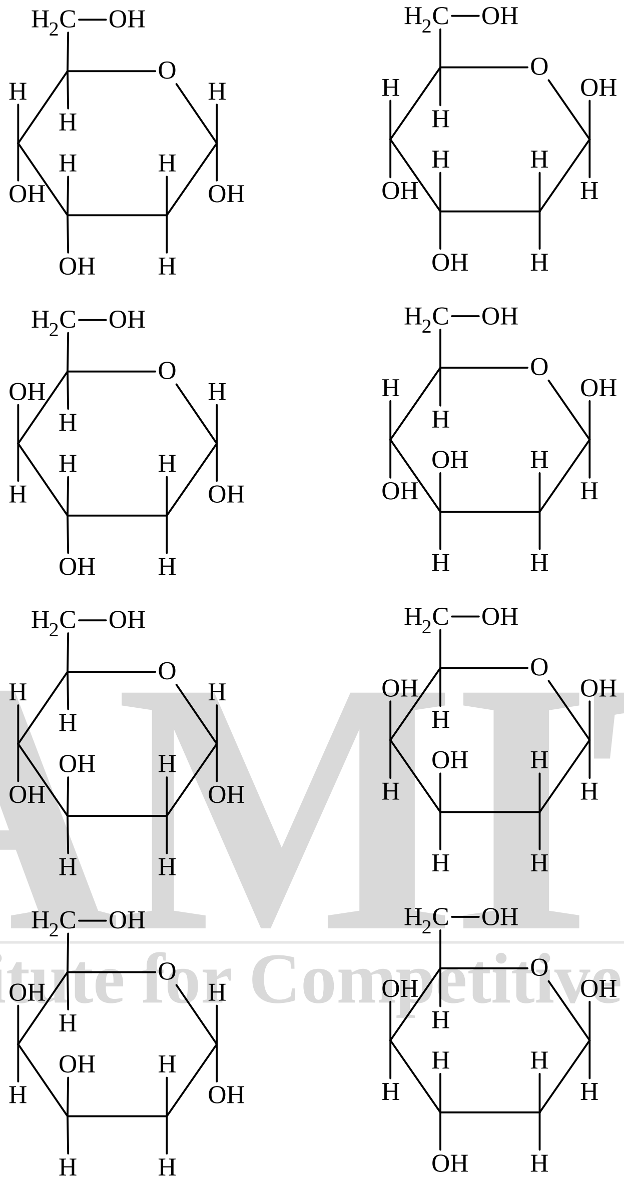
38. An organic compound undergoes first-order decomposition. The time taken for its decomposition to 1/8 and 1/10 of its initial concentration are $t_{1/8}$ and $t_{1/10}$ respectively. What is the value of $\frac{[t_{1/8}]}{[t_{1/10}]} \times 10$? (take $\log_{10}2 = 0.3$)

Sol. [9] $\frac{t_{1/8}}{t_{1/10}} \times 10 = \frac{\log 8}{\log 10} \times 10 = 9 \approx 9$

39. When the following aldohexose exists in its **D-**configuration, the total number of stereoisomers in its pyranose from is



Sol. [8] Total number of stereoisomers is equal to 8.



40. The periodic table consists of 18 groups. An isotope of copper, on bombardment with protons, undergoes a nuclear reaction yielding element **X** as shown below. To which group , element **X** belongs in the periodic table?

$${}^{63}_{29}Cu + {}^{1}_{1}H \longrightarrow 6\,{}^{1}_{0}n + \alpha + 2\,{}^{1}_{1}H + \mathbf{X}$$

Sol. [8] $${}^{63}_{29}Cu + {}^{1}_{1}H \longrightarrow 6\,{}^{1}_{0}n + {}^{4}_{2}He + 2\,{}^{1}_{1}H + {}^{32}_{26}X$$

X is Fe and belongs to 8 group of periodic table.

PART III : MATHEMATICS

SECTION- I : Single Correct Answer Type

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

41. Let $P = [a_{ij}]$ be a 3×3 matrix and let $Q = [b_{ij}]$, where $b_{ij} = 2^{i+j}a_{ij}$ for $1 \le i, j \le 3$. If the determinant of P is 2, then the determinant of the matrix Q is

(A) 2^{10} (B) 2^{11} (C) 2^{12} (D) 2^{13}

Sol: [D] $b_{ij} = 2^{i+j} a_{ij}$

$|P| = 2, |Q|$

$$P = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}, |Q| = \begin{vmatrix} 2^2 a_{11} & 2^3 a_{12} & 2^4 a_{13} \\ 2^3 a_{21} & 2^4 a_{22} & 2^5 a_{23} \\ 2^4 a_{31} & 2^5 a_{32} & 2^6 a_{33} \end{vmatrix}$$

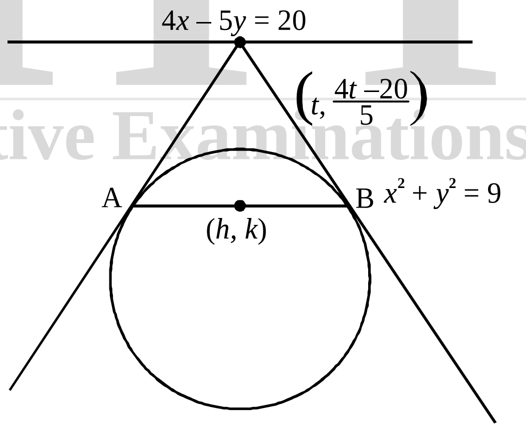
$= 2^9 \times 2^1 \times 2^2 = 2^{13}$

42. The locus of the mid-point of the chord of contact of tangents drawn from point lying on the straight line $4x - 5y = 20$ to the circle $x^2 + y^2 = 9$ is

(A) $20(x^2 + y^2) - 36x + 45y = 0$ (B) $20(x^2 + y^2) + 36x - 45y = 0$

(C) $36(x^2 + y^2) - 20x + 45y = 0$ (D) $36(x^2 + y^2) + 20x - 45y = 0$

Sol: [A] T = 0



$$xt + y\left(\frac{4t-20}{5}\right) = 9$$

$5tx + 4ty - 20y = 45$ ...(i)

$xh + hk - 9 = h^2 + k^2 - 9$ ....(ii)

$$\frac{5t}{h} = \frac{4t-20}{k} = \frac{45}{h^2+k^2}$$

$$t = \frac{9h}{h^2+k^2}$$

$$t = \frac{45k}{4(h^2+k^2)} + \frac{20}{4}$$

$$\frac{9h}{h^2+k^2} = \frac{45k}{4(h^2+k^2)} + 5$$

$36h - 45k = 20(h^2 + k^2)$, $20(x^2 + y^2) + 45y - 36x = 0$

43. The total number of ways in which 5 balls of different colours can be distributed among 3 persons so that each person gets at least one ball is

(A) 75 (B) 150 (C) 210 (D) 243

Sol: [B] $= 3^5 - 3C_1.2^5 + 3C_2.\ 1^5$

$= 243 - 96 + 3 = 246 - 96 = 150$

44. The integral $\int \frac{\sec^2 x}{(\sec x + \tan x)^{9/2}} dx$ equals (for some arbitrary constant K)

(A) $-\frac{1}{(\sec x - \tan x)^{11/2}}\left\{\frac{1}{11} - \frac{1}{7}(\sec x + \tan x)^2\right\} + K$

(B) $\frac{1}{(\sec x + \tan x)^{11/2}}\left\{\frac{1}{11} - \frac{1}{7}(\sec x + \tan x)^2\right\} + K$

(C) $-\frac{1}{(\sec x + \tan x)^{11/2}}\left\{\frac{1}{11} + \frac{1}{7}(\sec x + \tan x)^2\right\} + K$

(D) $\frac{1}{(\sec x + \tan x)^{11/2}}\left\{\frac{1}{11} + \frac{1}{7}(\sec x + \tan x)^2\right\} + K$

Sol: [D] Let $\sec x + \tan x = t$

$\sec x (\sec x + \tan x)\, dx = dt \Rightarrow \sec x\, dx = \frac{dt}{t}$

Again $\tan^2 x = t^2 + \sec^2 x - 2t \sec x$

$\sec x = \frac{t^2 + 1}{2t}$

$$\int \frac{(t^2+1)dt}{2t^2.t^{9/2}} = \int \frac{1}{2} t^{-9/2} dt + \frac{1}{2}\int t^{-13/2} dt$$

$$= -\frac{1}{7t^{7/2}} - \frac{1}{11t^{11/2}} = -\frac{1}{t^{11/2}}\left\{\frac{1}{11} + \frac{1}{7}t^2\right\} + K$$

$$= -\frac{1}{(\sec x + \tan x)^{11/2}}\left\{\frac{1}{11} + \frac{1}{7}(\sec x + \tan x)^2\right\} + K$$

45. The point P is the intersection of the straight line joining the point $Q(2, 3, 5)$ and $R(1, -1, 4)$ with the plane $5x - 4y - z = 1$. If S is the foot of the perpendicular drawn from the point $T(2, 1, 4)$ to QR, then the length of the line segment PS is

(A) $\frac{1}{\sqrt{2}}$ (B) $\sqrt{2}$ (C) 2 (D) $2\sqrt{2}$

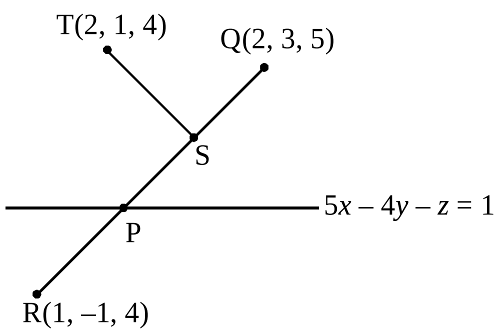
Sol: [A] Equation of line OR is $\frac{x-2}{1} = \frac{y-3}{4} = \frac{z-5}{1} = \lambda$

then $x + \lambda + 2$, $y = 4\lambda + 3$, $z = \lambda + 5$

for point P : $5(\lambda + 2) - 4(4\lambda + 4) - (\lambda + 5) = 1$

$-12\lambda = 8$ $\lambda = -\frac{2}{3}$

$P \equiv \left(\frac{4}{3}, \frac{1}{3}, \frac{13}{3}\right)$



for point S : $(\lambda + 2 - 2) \times 1 + (4\lambda + 3 - 1) \times 4 + (\lambda + 5 - 4) \times 1 = 0$

$$\lambda + 16\lambda + 8 + \lambda + 1 = 0$$

$$18\lambda = -9$$

$$\lambda = -\frac{1}{2}$$

$$S \equiv \left(\frac{3}{2}, 1, \frac{9}{2}\right)$$

$$PS = \frac{1}{\sqrt{2}}$$

46. Let $f(x) = \begin{cases} x^2\left|\cos\frac{\pi}{x}\right|, & x \neq 0 \\ 0, & x = 0 \end{cases}$, $x \in$ IR, then f is

(A) differentiable both at $x = 0$ and at $x = 2$

(B) differentiable at $x = 0$ but not differentiable at $x = 2$

(C) not differentiable at $x = 0$ but not differentiable at $x = 2$

(D) differentiable neither at $x = 0$ nor at $x = 2$

Sol: [B] $f'(0^+) = f'(0^-) = 0$

and $f'(2^+) = \pi$ and $f'(2^-) = -\pi$

47. Let z be a complex number such that the imaginary part of z is nonzero and $a = z^2 + z + 1$ is real. Then a **cannot** take the value

(A) –1 (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{3}{4}$

Sol: [D] $a = z^2 + z + 1$

$\Rightarrow (x^2 - y^2 + x + 1) = a$ and $2xy + y = 0 \Rightarrow x = -\frac{1}{2}$

$\Rightarrow a = \frac{3}{4} - y^2$

48. The ellipse $E_1 : \frac{x^2}{9} + \frac{y^2}{4} = 1$ is inscribed in a rectangle R whose sides are parallel to the coordinate axes. Another ellipse E_2 passing through the point (0, 4) circumscribes the rectangle R. The ecentricity of the ellipse E_2 is

(A) $\frac{\sqrt{2}}{2}$ (B) $\frac{\sqrt{3}}{2}$ (C) $\frac{1}{2}$ (D) $\frac{3}{4}$

Sol: [C] Let ellipse be $\frac{x^2}{b^2}+\frac{y^2}{16}=1$

$\Rightarrow \quad \frac{9}{b^2}+\frac{4}{16}=1 \Rightarrow b^2 = 12$

$\Rightarrow \quad e = \frac{1}{2}$

49. The function $f : [0, 3] \rightarrow [1, 29]$, defined by $f(x) = 2x^3 - 15x^2 + 36x + 1$, is

(A) one-one and onto (B) onto but one-one

(C) one-one but not onto (D) neither one-one nor onto

Sol: [B] $f(0) = 1$

$f(3) = 54 - 135 + 108 + 1 = 28$

$f'(x) = 6(x-2)(x-3)$

50. If $\lim_{x\to\infty}\left(\frac{x^2+x+1}{x+1}-ax-b\right)=4$, then

(A) $a = 1, b = 4$ (B) $a = 1, b = -4$ (C) $a = 2, b = -3$ (D) $a = 2, b = 3$

Sol: [B] $\lim_{x\to\infty}\frac{(1-a)x^2+(1-a-b)x+(1-b)}{x+1}=4$

$\Rightarrow a = 1$ and $b = -4$

SECTION- II : Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

51. Tangents are drawn to the hyperbola $\frac{x^2}{9}-\frac{y^2}{4}=1$, parallel to the straight line $2x - y = 1$, The points of contact of the tangents on the hyperbola are

(A) $\left(\frac{9}{2\sqrt{2}},\frac{1}{\sqrt{2}}\right)$ (B) $\left(-\frac{9}{2\sqrt{2}},-\frac{1}{\sqrt{2}}\right)$ (C) $\left(3\sqrt{3},-2\sqrt{2}\right)$ (D) $\left(-3\sqrt{3},2\sqrt{2}\right)$

Sol: [A,B] The equations of tangents are $y = 2x \pm 4\sqrt{2}$

and point of intersections are (A) and (B)

52. Let $\theta,\varphi\in[0,2\pi]$ be such that $2\cos\theta(1-\sin\varphi)=\sin^2\theta\left(\tan\frac{\theta}{2}+\cot\frac{\theta}{2}\right)\cos\varphi-1$, $\tan(2\pi-\theta)>0$ and $-1<\sin\theta<-\frac{\sqrt{3}}{2}$. Then φ **cannot** satisfy

(A) $0<\varphi<\frac{\pi}{2}$ (B) $\frac{\pi}{2}<\varphi<\frac{4\pi}{3}$ (C) $\frac{4\pi}{3}<\varphi<\frac{3\pi}{2}$ (D) $\frac{3\pi}{2}<\varphi<2\pi$

Sol: [A,C,D] $2\cos\theta\,(1 - \sin\phi) = \sin^2\theta \left(\dfrac{1}{\sin\theta/2\cos\theta/2}\right)\cos\phi - 1$

$2\cos\theta - 2\cos\theta\sin\phi = 2\sin\theta\cos\phi - 1$

$\dfrac{1+2\cos\theta}{2} = \sin(\theta+\phi)$

$-1 < \sin\theta < \dfrac{-\sqrt{3}}{2} \Rightarrow \dfrac{4\pi}{3} < \theta < \dfrac{5\pi}{3}$ ....(i)

$\Rightarrow \quad 0 < 2\pi - \theta < \dfrac{\pi}{2}$ or $\pi < 2\pi - \theta < \dfrac{3\pi}{2}$

$\Rightarrow \quad \dfrac{3\pi}{2} < \theta < 2\pi$ or $\dfrac{\pi}{2} < \theta < \dfrac{3\pi}{2}$

$\Rightarrow \quad \dfrac{3\pi}{2} < \theta < 2\pi$ or $\dfrac{\pi}{2} < \theta < \pi$ ....(ii)

$\Rightarrow \quad \dfrac{3\pi}{2} < \theta < \dfrac{5\pi}{3}$

Again $\dfrac{1}{2} < \sin(\theta+\phi) < 1$

$\Rightarrow \quad \dfrac{\pi}{6} < (\theta+\phi) < \dfrac{5\pi}{6}$ or $\dfrac{13\pi}{6} < \theta+\phi < \dfrac{17\pi}{6}$

$\dfrac{\pi}{2} < \phi < \dfrac{4\pi}{3}$

53. If $y(x)$ satisfies the differential equation $y' - y\tan x = 2x\sec x$ and $y(0) = 0$, then

(A) $y\left(\dfrac{\pi}{4}\right) = \dfrac{\pi^2}{8\sqrt{2}}$

(B) $y'\left(\dfrac{\pi}{4}\right) = \dfrac{\pi^3}{18}$

(C) $y\left(\dfrac{\pi}{3}\right) = \dfrac{\pi^2}{9}$

(D) $y'\left(\dfrac{\pi}{3}\right) = \dfrac{4\pi}{3} + \dfrac{2\pi^2}{3\sqrt{3}}$

Sol: [A,D] $\dfrac{dy}{dx} - y\tan x = 2x\sec x$

I.F. = $e^{\int -\tan x\,dx} = e^{-\log\sec x} = \cos x$

$y\cos x = \int 2x\,dx + C$

$\Rightarrow y\cos x = x^2 + C \Rightarrow C = 0$

$y = x^2\sec x \quad y\left(\dfrac{\pi}{4}\right) = \dfrac{\pi^2}{8\sqrt{2}}, \; y'\left(\dfrac{\pi}{3}\right) = \dfrac{4\pi}{3} + \dfrac{2\pi^2}{3\sqrt{3}}$

54. A ship is fitted with three engines E_1, E_2 and E_3. The engines function independently of each other with respective probabilities $\frac{1}{2}, \frac{1}{4}$ and $\frac{1}{4}$. For the ship to be operational at least two of its engines must function. Let X denote the event that the ship is operational and let X_1, X_2 and X_3 denote respectively the events that the engines E_1, E_2 and E_3 are functioning. Which of the following is (are) true ?

(A) $P\left[X_1^c \mid X\right] = \frac{3}{16}$

(B) P[Exactly two engines of the ship are functioning | X] = $\frac{7}{8}$

(C) $P\left[X \mid X_2\right] = \frac{5}{16}$

(D) $P\left[X \mid X_1\right] = \frac{7}{16}$

Sol: [B,D] P(X) $= \frac{1}{2}\times\frac{1}{4}\times\frac{1}{4}+\frac{1}{2}\times\frac{1}{4}\times\frac{1}{4}+\frac{1}{2}\times\left(1-\frac{1}{4}\right)\times\frac{1}{4}+\frac{1}{2}\times\frac{1}{4}\times\left(1-\frac{1}{4}\right)=\frac{1}{4}$

$$P\left(\frac{X_1^C}{X}\right) = 1 - P\left(\frac{X_1}{X}\right) = 1 - \frac{P(X_1 \cap X)}{P(X)}$$

$$= 1 - \frac{\left(\frac{1}{32}+\frac{3}{32}+\frac{3}{32}\right)}{\frac{1}{4}} = 1 - \frac{7}{8} = \frac{1}{8}$$

$$P\left(\frac{\text{exactly two ships}}{X}\right) = \frac{7/32}{1/4} = \frac{7}{8}$$

$$P\left(\frac{X}{X_2}\right) = \frac{5/32}{1/4} = \frac{5}{8}$$

$$P\left(\frac{X}{X_1}\right) = \frac{7/32}{1/2} = \frac{7}{16}$$

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

(A) $S \geq \frac{1}{e}$

(B) $S \geq 1 - \frac{1}{e}$

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

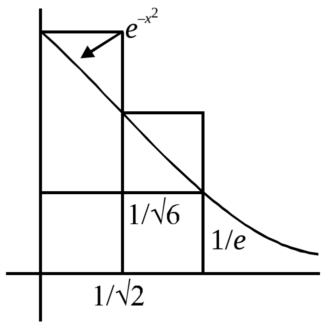
(D) $S \leq \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{e}}\left(1-\frac{1}{\sqrt{2}}\right)$

Sol: [A,B,C] Clarly S $\geq \frac{1}{e}\times 1$

$$S \leq \frac{1}{\sqrt{2}}\times 1 + \frac{1}{\sqrt{e}}\left(1-\frac{1}{\sqrt{2}}\right)$$

and $e^{-x} \leq e^{-x^2}$

$$\int_0^1 e^{-x}dx \leq \int_0^1 e^{-x^2}dx \quad \left(1-\frac{1}{e}\right) \leq S$$



SECTION- III : Integer Answer Type

This Section contains **5 questions.** The answer to each of the question is a **single digit integer,** ranging from 0 to 9 (*both inclusive*).

56. If $\vec{a}, \vec{b}$ and $\vec{c}$ are unit vectors satisfying $\left|\vec{a}-\vec{b}\right|^2+\left|\vec{b}-\vec{c}\right|^2+\left|\vec{c}-\vec{a}\right|^2=9$, then $\left|2\vec{a}+5\vec{b}+5\vec{c}\right|$ is

Sol. [3] $|\because|2\bar{a}+5b+5c|^2 = 54+20\bar{a}.\bar{b}+20\bar{a}.\bar{c}+50\bar{b}.\bar{c} = 54-\dfrac{90}{2}=9$

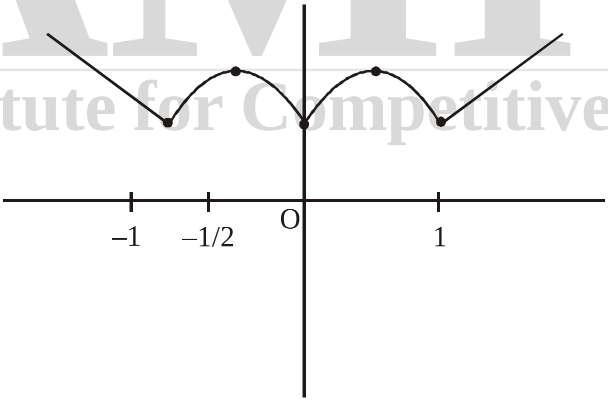
So $|2\bar{a}+5\bar{b}+5\bar{c}|=3$

57. Let f : IR $\to$ IR be defined as $f(x) = |x|+|x^2-1|$. The total number of points at which f attains either a local maximum or a local minimum is

Sol. [5] $f(x) = |x| + |x^2 - 1|$

$f(x) = |x| + |x - 1| + |x + 1|$

$$= \begin{cases} -x+(x-1)(x+1) & x \le -1 \quad = x^2-x-1 \\ -x-(x-1)(x+1) & -1 \le x \le 0 \quad = -x^2-x+1 \\ x-(x-1)(x+1) & 0 \le x \le 1 \quad = -x^2+1+x \\ x+(x-1)(x+1) & x \ge 1 \quad = x^2+x-1 \end{cases}$$



The given curve is symmetric about y-axis

number of points = 5

58. Let S be the focus of the parabola $y^2 = 8x$ and let PQ be the common chord of the circle $x^2 + y^2 - 2x - 4y = 0$ and the given parabola. The area of the triangle PQS is

Sol. [4] S is (2, 0). Let general point be $(2t^2, 4t)$

pulting it in $x^2 + y^2 - 2x - 4y = 0$

$4t^4 + 16t^2 - 4t^2 - 16t = 0$

$4t(t^3 + 3t - 4) = 0$

$t = 0,\ t = 1$

$\Rightarrow\ t = 0,\ t = 1$

P(0, 0), Q(2, 4), S(2, 0)

Hence Area = 4

59. Let $p(x)$ be a real polynomial of least degree which has a local maximum at $x = 1$ and a local minimum at $x = 3$. If $p(1) = 6$ and $p(3) = 2$, then $p'(0)$ is

Sol. [9] Let $P'(x) = K(x-1)(x-3)$

$P'(x) = K(x^2 - 4x + 3)$

$$P(x) = K\left(\frac{x^3}{3} - 2x^2 + 3x\right) + C$$

$$P(1) = 6 \Rightarrow K\left(\frac{1}{3} - 2 + 3\right) + C = 6$$

$$K\left(\frac{1}{3} + 1\right) + C = 6$$

$$K\left(\frac{4}{3}\right) + C = 6 \qquad \text{....(i)}$$

$P(3) = 2 \Rightarrow K(9 - 18 + 9) + \mathrm{C} = 2$

$C = 2$

$$K\left(\frac{4}{3}\right) = 4$$

$K = 3$

$P'(x) = 3(x^2 - 4x + 3)$

$P'(0) = 9$

60. The value of $6 + \log_{\frac{3}{2}}\left(\frac{1}{3\sqrt{2}}\sqrt{4 - \frac{1}{3\sqrt{2}}\sqrt{4 - \frac{1}{3\sqrt{2}}\sqrt{4 - \frac{1}{3\sqrt{2}}\ldots}}}\right)$ is

Sol. [4] Let $y = \sqrt{4 - \frac{1}{3\sqrt{2}}\sqrt{4 - \frac{1}{3\sqrt{2}}\ldots\ldots}}$

$$\Rightarrow\ y^2 4 - \frac{1}{3\sqrt{2}}y$$

$$\Rightarrow\ 3\sqrt{2}y^2 + y - 12\sqrt{2}$$

$$\Rightarrow\ \left(y + \frac{3}{\sqrt{2}}\right)\left(y - \frac{8}{3\sqrt{2}}\right)$$

$\Rightarrow \left(y = -\frac{3}{\sqrt{2}}\right)$ (rejected) or $\left(y = \frac{8}{3\sqrt{2}}\right)$ (selected)

Now $6 + \log_{\frac{3}{2}}\left[\frac{1}{3\sqrt{2}} \times \frac{8}{3\sqrt{2}}\right]$

$= 6 + \log_{\frac{3}{2}}\left[\frac{8}{9 \times 2}\right]$

$= 6 + \log_{\frac{3}{2}}\left[\frac{4}{9}\right]$

$= 6 - 2$

$= 4.$

Answers

Physics

1.	[C]	2.	[B]	3.	[B]	4.	[D]	5.	[C]
6.	[C]	7.	[A]	8.	[D]	9.	[D]	10.	[B]
11.	[C,D]	12.	[A,C,D]	13.	[B,D]	14.	[A,C]	15.	[A,B,C,D]
16.	[7]	17.	[6]	18.	[7]	19.	[3]	20.	[5]

Chemistry

21.	[D]	22.	[D]	23.	[B]	24.	[C]	25.	[B]
26.	[C]	27.	[D]	28.	[A]	29.	[A]	30.	[B]
31.	[A,C,D]	32.	[B,D]	33.	[A,C]	34.	[B,C]	35.	[A,D]
36.	[8]	37.	[4]	38.	[9]	39.	[8]	40.	[8]

Mathematics

41.	[D]	42.	[A]	43.	[B]	44.	[D]	45.	[A]
46.	[B]	47.	[D]	48.	[C]	49.	[B]	50.	[B]
51.	[A,B]	52.	[A,C,D]	53.	[A,D]	54.	[B,D]	55.	[A,B,C]
56.	[3]	57.	[5]	58.	[4]	59.	[9]	60.	[4]