

**JEE (Main)-2025 (Online) Session-2**  
**Memory Based Question with & Solutions**  
**(Physics, Chemistry and Mathematics)**  
**3rd April 2025 (Shift-1)**

**Time: 3 hrs.**

**M.M.: 300**

**IMPORTANT INSTRUCTIONS:**

- (1) The test is of 3 hours duration.
- (2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.
- (3) This question paper contains Three Parts. Part-A is Physics, Part-B is Chemistry and Part-C is Mathematics. Each part has only two sections: Section-A and Section-B.
- (4) Section - A : Attempt all questions.
- (5) Section - B : Attempt all questions.
- (6) Section - A (01 - 20) contains 20 multiple choice questions which have only one correct answer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.
- (7) Section - B (21 - 25) contains 5 Numerical value based questions. The answer to each question should be rounded off to the nearest integer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.

# **MEMORY BASED QUESTIONS JEE-MAIN EXAMINATION – APRIL, 2025**

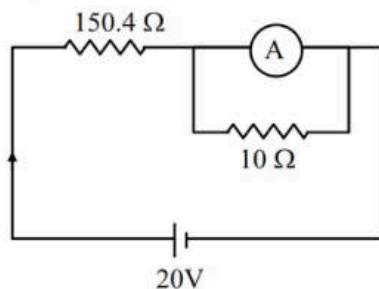
**(Held On Thursday 3<sup>rd</sup> April, 2025)**

**TIME : 9 : 00 AM to 12 : 00 PM**

## **PHYSICS**

### **SECTION-A**

1. An ammeter having resistance  $240\Omega$  is connected in the given circuit as shown. Find current through the ammeter.



- (1) 2 mA                      (2) 5 mA  
(3) 8 mA                      (4) 9 mA

**Ans. (2)**

**Sol.** 
$$I_1 = I_0 \times \frac{10}{250}$$
$$= \frac{20}{150.4 + 9.6} \times \frac{10}{250}$$
$$= \frac{20}{160} \times \frac{10}{250} = 5\text{mA}$$

2. A particle is released from height 'h' above the surface of the earth. At certain height it's K.E is 3 times of PE. The height from the surface of the earth and the speed of the Particle at the instant are respectively.

- (1)  $\frac{h}{2}, \sqrt{\frac{3gh}{2}}$                       (2)  $\frac{h}{4}, \sqrt{\frac{3gh}{2}}$   
(3)  $\frac{h}{2}, \sqrt{\frac{3gh}{4}}$                       (4)  $\frac{h}{4}, \sqrt{\frac{3gh}{4}}$

**Ans. (2)**

**Sol.**  $mgh = KE + PE$   
 $mgh = 4mgh'$

$$h' = \frac{h}{4}$$

$$\frac{1}{2}mv^2 = 3 \times mg \frac{h}{4}$$

$$v = \sqrt{\frac{3}{2}gh}$$

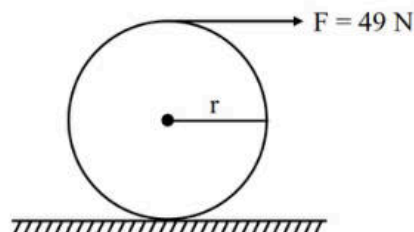
3. The work function of a metal 3 eV. The colour of the visible light that is required to cause emission of photo electrons is :-

- (1) Violet                      (2) Red  
(3) Yellow                      (4) Green

**Ans. (1)**

**Sol.** 
$$\phi_0 = E = \frac{hc}{\lambda} = \frac{1240}{\lambda}$$
$$\lambda = \frac{1240}{3} = 413.3 \text{ nm}$$

4. A force of 49 N acts tangentially at the highest point of a sphere (solid sphere of mass 20 kg) kept on a rough horizontal plane. If the sphere rolls without slipping, then the acceleration of the center of the sphere is :-



- (1)  $2.5 \text{ m/s}^2$                       (2)  $3.5 \text{ m/s}^2$   
(3)  $0.35 \text{ m/s}^2$                       (4)  $0.45 \text{ m/s}^2$

**Ans. (2)**

**Sol.**  $F + f = ma$

$$(F - f)R = \frac{2}{5}mR^2 \frac{a}{R}$$

$$2F = \frac{7}{5}ma$$

$$a = \frac{10}{7} \times \frac{F}{m} = \frac{10}{7} \times \frac{49}{20} = 3.5 \text{ m/s}^2$$

5. The electrostatic potential on the surface of uniformly charged spherical shell of radius  $R = 10 \text{ cm}$  is 120 V. The potential at the centre of shell, at a distance 5 cm from centre and a distance 15 cm from the centre of the shells are :-

- (1) 0V, 120 V, 40 V                      (2) 40 V, 40 V, 80 V  
(3) 120 V, 120 V, 80 V                      (4) 0 V, 0 V, 80 V

**Ans. (3)**

**Sol.**  $v_{\text{surface}} = \frac{KQ}{R} = 120 = (V_{\text{in}})_{\text{surface}}$

$v_c = 120\text{V}$

$v_{5\text{cm}} = 120\text{V}$

$v_{15} = \frac{kQ}{r} = 120 \times \frac{10}{15} = 80$

6. In a biconvex lens  $R_1$ ,  $R_2$  and  $f$  are 15 cm, 10 cm and 12 cm respectively find refractive index of lens.

(1) 2 (2)  $\frac{3}{4}$

(3)  $\frac{4}{3}$  (4)  $\frac{3}{2}$

**Ans.** (4)

**Sol.**  $\frac{1}{f} = (\mu - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right)$

$\frac{1}{12} = (\mu - 1) \left( \frac{1}{15} + \frac{1}{10} \right)$

$\frac{1}{12} = (\mu - 1) \frac{1}{5} \left( \frac{5}{6} \right)$

$\frac{1}{2} + 1 = \mu$

7. Power of point source is 450 watt. Radiation pressure on a perfectly Reflecting surface at a distance of 2 m is

(1)  $2 \times 10^{-8}$  (2)  $4 \times 10^{-8}$

(3)  $6 \times 10^{-8}$  (4)  $8 \times 10^{-8}$

**Ans.** (3)

**Sol.**  $\frac{2I}{C} = \frac{2}{C} \left( \frac{P}{4\pi r^2} \right)$

$= \frac{2 \times 450}{3 \times 10^8 \times 4\pi \times 2^2} = \frac{300}{16\pi} 10^{-8}$

8. When block of ice melts

(1) Internal energy decreases

(2) Internal energy constant

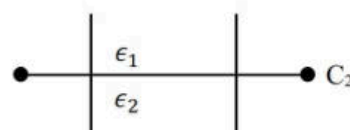
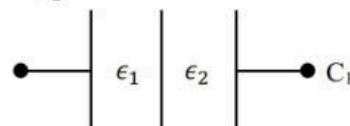
(3) Work done by atmosphere is positive

(4) Work done by atmosphere is negative

**Ans.** (3)

**Sol.** Work done by atmosphere is positive.

9. Two dielectric of dielectric constants  $\epsilon_1$  &  $\epsilon_2$  are inserted between the plates of two identical parallel plate capacitors as shown in the figure. The ratio of their capacitances  $C_2/C_1$  is (Given  $\frac{\epsilon_1}{\epsilon_2} = 2$ ) :-



(1)  $\frac{9}{8}$  (2)  $\frac{7}{8}$  (3)  $\frac{8}{7}$  (4)  $\frac{8}{9}$

**Ans.** (1)

**Sol.**  $C_1^{**} = \frac{2k \frac{A}{2} \epsilon_0}{d} = C_0 \text{ (Let)}$

$C_2^{**} = \frac{2 \frac{A}{2} \epsilon_0}{d} = \frac{C_0}{2}$

$C_2 = \frac{3C_0}{2}$

$C_1^* = \frac{2KA\epsilon_0}{\frac{d}{2}}$

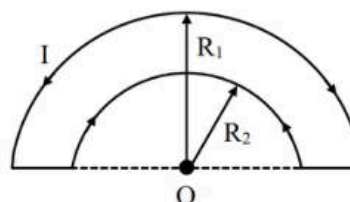
$C_1^* = 4C_0$

$C_2^* = \frac{KA\epsilon_0}{\frac{d}{2}} = 2C_0$

$C_{\text{effc}} = \frac{4C_0 + 2C_0}{2} = \frac{6C_0}{2} = 3C_0$

$C_{\text{effc}} = \frac{4}{3} C_0$

10. A current carrying wire is bent as shown in the figure. Find magnetic field at centre O of the semi-circles. (Take  $R_1 = 4\pi$  and  $R_2 = 6\pi$ ) :-



(1)  $8.3 I \times 10^{-9} \text{ T}$  (2)  $8.3 I \times 10^{-6} \text{ T}$

(3)  $6 I \times 10^{-8} \text{ T}$  (4)  $4 I \times 10^{-6} \text{ T}$

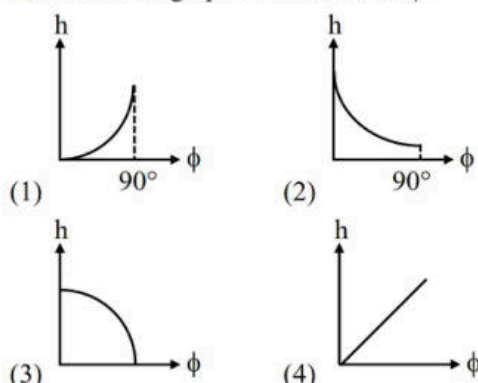
**Ans.** (1)

**Sol.**  $B_{\text{net}} = B_1 - B_2$

$$= \frac{\mu_0}{4} = \frac{I}{R} - \frac{\mu_0}{4} \frac{I}{r_2} = \frac{\mu_0 I}{4} \left( \frac{1}{4\pi} - \frac{1}{6\pi} \right)$$

$$= \frac{\mu_0}{4\pi} \frac{I}{2} \left( \frac{1}{2} - \frac{1}{3} \right) = 8.3 \times 10^{(-9)} \text{ T}$$

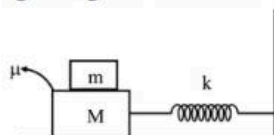
- 11.** If a particle is thrown at an angle  $\phi$  with vertical then mark the graph between  $h$  and  $\phi$ .



**Ans.**  
**Sol.**

$$H = \frac{u^2 \sin^2 \theta}{2g} \Rightarrow H = \frac{u^2 \cos^2 \theta}{2g}$$

- 12.** The figure below shows an oscillating system of two blocks and a spring. The horizontal surface is smooth and the contact between the blocks is rough with coefficient of static friction  $\mu$ . Considering that the blocks of mass  $m$  is always stationary relative to  $M$ , choose the correct option regarding the statement below :



smooth

- (A) Maximum frictional force between blocks is  $\mu mg$   
 (B) Time period of oscillation is  $2\pi \sqrt{\frac{m+M}{k}}$   
 (C) Friction between the blocks at any instant is  $\mu Mg$   
 (1) Only A & B are correct  
 (2) Only A is correct  
 (3) Only B is correct  
 (4) None of these

**Ans.** (3)

**Sol.**  $f_{\text{max.}} = ma_{\text{max.}}$

$$= m\omega^2 A$$

$$f = ma$$

$$= m\omega^2 x$$

- 13.** Choose the correct option.

- a. Gravitational potential (i)  $M^{-1}L^3T^{-2}$   
 b. Gravitational constant (ii)  $ML^2T^{-2}$   
 c. Acceleration due to gravity (iii)  $M^0L^2T^{-2}$   
 d. Potential energy (iv)  $M^0LT^{-2}$   
 (1) a(iii), b(i), c(iv), d(ii)  
 (2) a(iii), b(ii), c(iv), d(i)  
 (3) a(ii), b(i), c(iv), d(iii)  
 (4) a(ii), b(iv), c(i), d(iii)

**Ans.** (1)

**Sol.** Gravitational potential

$$v = \frac{-GM}{R} = M^0L^2T^{-2}$$

$$\text{Gravitational constant } F = \frac{GM_1M_2}{R^2} = M^{-1}L^3T^{-2}$$

$$g = \frac{GM}{R^2} = M^0LT^{-2}$$

$$U = \frac{GM_1M_2}{R} = ML^2T^{-2}$$

- 14.** A thin uniform wire of length 25 m and area of cross-section  $5 \text{ mm}^2$  has resistivity  $2 \times 10^{-6} \Omega\text{-m}$ . If the wire is bent to form a circle, the resistance across diametrically opposite points is

- (1)  $12.5 \Omega$  (2)  $5 \Omega$   
 (3)  $10 \Omega$  (4)  $2.5 \Omega$

**Ans.** (4)

**Sol.**  $R = \frac{\rho \ell}{A}$

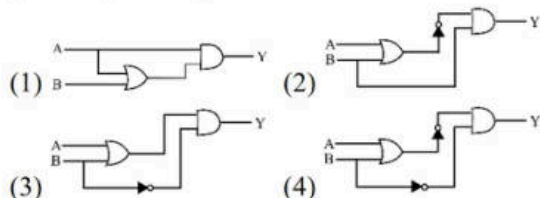
$$R_{\text{net}} = \frac{R}{4}$$

$$= \frac{\rho \ell}{4A}$$

$$= \frac{\rho \ell}{4A} = \frac{2 \times 10^{-6} \times 25}{5 \times 10^{-6} \times 4} = \frac{10}{4} = 2.5 \Omega$$

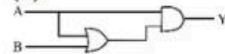
15. For given truth table, which option is correct

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |



Ans. (1)

Sol.



Option 1 is correct because it follows the given truth table

16. Which of the following is correct when deviation is minimum regarding an equilateral prism of angle A :

- (1)  $i = e$
- (2) Ray inside prism becomes parallel to base of prism.
- (3) More is 'A', smaller is deviation.
- (4) All of these

Ans. (4)

Sol.

From condition of minimum deviation

$$i = e$$

Ray inside prism becomes parallel to base of prism.

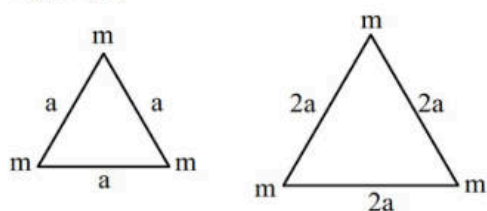
$$\delta = (i + e) - A$$

$$\delta = 2i - A$$

So, More is 'A', smaller is deviation.

### SECTION-B

1. Three particles in figure (a) collide at centroid in 4 sec. In how much time will they collide in figure (b)



Ans. (8)

Sol.

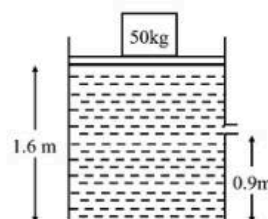
$$v_{rel} = \frac{3v}{2}$$

$$t' = 8s$$

$$t = \frac{2d}{3v} = 4$$

2.

In the shown diagram a block of 50 kg is kept on a light plate of area  $1 \text{ m}^2$  covering the surface of a water tank in which a hole is pierced at a height of 0.9 m from the bottom. Given the height of water is 1.6 m. If the velocity of efflux is  $v$  (in SI unit), then find  $10v^2$  :



Ans. (150)

Sol.

$$P_0 + \frac{50 \times 10}{1} + 1000 \times 10 \times 0.7$$

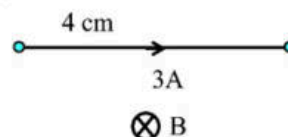
$$= P_0 + \frac{1}{2} \rho v^2$$

$$2 \left( \frac{500 \times 7000}{1000} \right) = v^2 = 15$$

$$10v^2 = 150$$

3.

If a rod of length 4 cm is placed in magnetic field 0.15 T perpendicularly having current 3 amp. The magnitude of force on Rod is  $2x \times 10^{-3}$ . Find  $x$  :-



Ans. ( $x = 9$ )

Sol.

$$\vec{F} = i(\vec{\ell} \times \vec{B})$$

$$F = i \ell B$$

$$3 \times 4 \times 10^{-2} \times 0.15$$

$$= 12 \times 10^{-2} \times 0.15$$

$$F = 180 \times 10^{-4} \text{ N}$$

$$= 18 \times 10^{-3} \text{ N}$$

$$2x = 18$$

$$x = 9 \text{ s}$$

## CHEMISTRY

### SECTION-A

1. Which of the following has highest atomic number

(1) Po (2) Pt  
(3) Pr (4) Pb

Ans. (1)

Sol.  ${}_{84}\text{Po} \rightarrow$  p-block  
 ${}_{78}\text{Pt} \rightarrow$  d-block  
 ${}_{59}\text{Pr} \rightarrow$  f-block  
 ${}_{82}\text{Pb} \rightarrow$  p-block

2. Which of the following ion shows spin only magnetic of 4.9 B.M.

(1)  $\text{Mn}^{2+}$  (2)  $\text{Cr}^{2+}$   
(3)  $\text{Fe}^{3+}$  (4)  $\text{Co}^{2+}$

Ans. (2)

Sol.  $\mu = \sqrt{n(n+2)}$  B.M., where n = no. of unpaired e<sup>-</sup> if  $\mu = 4.9$  B.M. then n = 4

$\text{Cr}^{2+} \Rightarrow 3d^4$ 

|   |   |   |   |  |
|---|---|---|---|--|
| 1 | 1 | 1 | 1 |  |
|---|---|---|---|--|

 n=4

3. An ideal gas with an adiabatic exponent 1.5, initially at 27°C is compressed adiabatically from 800 cc to 200 cc. The final temperature of the gas is

(1) 600 K (2) 300 K  
(3) 450 K (4) 273 K

Ans. (1)

Sol.  $PV^x = \text{constant}$

$$\frac{T_1}{T_2} = \left( \frac{V_2}{V_1} \right)^{x-1}$$

$$\frac{300}{T_2} = \left( \frac{200}{800} \right)^{\frac{3}{2}-1}$$

$$T_2 = 600\text{K}$$

4. 2 moles each of ethylene glycol and glucose are mixed with 500 g of water. Find the boiling point of solution.

Given :  $K_b = 0.52 \text{ K kg mol}^{-1}$

(1) 377.16 K (2) 368.84 K  
(3) 376.16 K (4) 369.84 K

Ans. (1)

Sol.  $\Delta T_b = i k_b m$

$$\Delta T_b = k_b \times \frac{4 \times 1000}{500} \quad (i = 1)$$

$$= 0.52 \times 8$$

$$= 4.16$$

$$(T_b)_{\text{solution}} - T_b = 4.16$$

$$(T_b)_{\text{solution}} = 373 + 4.16$$

$$= 377.16$$

5. Match the column.

| List-I |                            | List-II |                                  |
|--------|----------------------------|---------|----------------------------------|
| (a)    | $\text{PF}_5$              | (i)     | Tetrahedral and $sp^3$           |
| (b)    | $\text{SF}_6$              | (ii)    | Square planar and $dsp^2$        |
| (c)    | $[\text{Ni}(\text{CO})_4]$ | (iii)   | Octahedral and $sp^3d^2$         |
| (d)    | $[\text{PtCl}_4]^{2-}$     | (iv)    | Trigonal bipyramidal and $sp^3d$ |

(1) a  $\rightarrow$  (iv), b  $\rightarrow$  (iii), c  $\rightarrow$  (i), d  $\rightarrow$  (ii)

(2) a  $\rightarrow$  (ii), b  $\rightarrow$  (i), c  $\rightarrow$  (iv), d  $\rightarrow$  (iii)

(3) a  $\rightarrow$  (iii), b  $\rightarrow$  (ii), c  $\rightarrow$  (i), d  $\rightarrow$  (iv)

(4) a  $\rightarrow$  (ii), b  $\rightarrow$  (iv), c  $\rightarrow$  (i), d  $\rightarrow$  (iii)

Ans. (1)

Sol. (a)  $\text{PF}_5 \rightarrow sp^3d$  (Trigonal bipyramidal)  
 (b)  $\text{SF}_6 \rightarrow sp^3d^2$  (Octahedral)  
 (c)  $\text{Ni}(\text{CO})_4 \rightarrow sp^3$  (Tetrahedral)  
 (d)  $[\text{PtCl}_4]^{2-} \rightarrow dsp^2$  (Square Planar)

6. Arrange the following cations in increasing order of limiting molar conductivities of at 298 K

$\text{H}^+$ ,  $\text{Ca}^{+2}$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{+2}$ .

(1)  $\text{K}^+ > \text{Na}^+ > \text{H}^+ > \text{Ca}^{+2} > \text{Mg}^{+2}$

(2)  $\text{H}^+ > \text{Ca}^{+2} > \text{Mg}^{+2} > \text{K}^+ > \text{Na}^+$

(3)  $\text{H}^+ > \text{Ca}^{+2} > \text{K}^+ > \text{Mg}^{+2} > \text{Na}^+$

(4)  $\text{H}^+ > \text{Ca}^{+2} > \text{Mg}^{+2} > \text{Na}^+ > \text{K}^+$

Ans. (2)

Sol. Reference NCERT table

Limiting Molar Conductivity for some Ions in Water at 298 K

| Ion              | $\lambda^0 / (\text{S cm}^2 \text{mol}^{-1})$ |
|------------------|-----------------------------------------------|
| $\text{H}^+$     | 349.6                                         |
| $\text{Na}^+$    | 50.1                                          |
| $\text{K}^+$     | 73.5                                          |
| $\text{Ca}^{2+}$ | 119.0                                         |
| $\text{Mg}^{2+}$ | 106.0                                         |

Molar conductivity  $\propto$  charge

$\propto$  Mobility

Limiting Molar Conductivity :

$\text{H}^+ > \text{Ca}^{+2} > \text{Mg}^{+2} > \text{K}^+ > \text{Na}^+$

7. Which is **correct** :
- (1)  $A + e^- \rightarrow A^-$  is always exothermic.
  - (2)  $A \rightarrow A^+ + e^-$  is always endothermic.
  - (3)  $IE_1$  of (Be) <  $IE_1$  (B).
  - (4) Lithium is most electropositive in its group.

**Ans.** (2)

- Sol.** (1)  $A + e^- \rightarrow A^-$   
If A = inert gas, Be, Mg & N then it will be endothermic.
- (2)  $A \rightarrow A^+ + e^-$   
Ionisation energy is always endothermic
- (3) Be > B ionisation energy (due to  $2s^2$  configuration)
- (4) Li is not most electropositive in its group  
Cs is more electropositive

8. Which of the following property shows irregular trend in group 16?

- (1) Electronegativity
- (2) Atomic radius
- (3) Electron affinity
- (4) Ionisation enthalpy

**Ans.** (3)

**Sol.** Electron affinity  
 $S > Se > Te > Po > O$

9. Consider the following statements

**Statement I:** N–N has less bond strength than P–P

**Statement II:** All group-15 elements in +3 oxidation state undergo disproportionation.

In the above statements, choose the correct option.

- (1) Both Statement are correct.
- (2) Statement I is correct but Statement II is incorrect.
- (3) Statement I is incorrect but Statement II is correct.
- (4) Both Statement are incorrect.

**Ans.** (2)

**Sol.**  $\ddot{N}-\ddot{N} < \ddot{P}-\ddot{P}$   
(due to Lone pair. – Lone pair repulsion)

10. Consider the following complex ions

- (a)  $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (b)  $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$
- (c)  $[\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+}$
- (d)  $[\text{Co}(\text{CN})_6]^{3-}$

Choose the correct order of wavelength absorbed by complex ions

- (1)  $b > a > c > d$
- (2)  $a > b > c > d$
- (3)  $b > c > a > d$
- (4)  $d > c > b > a$

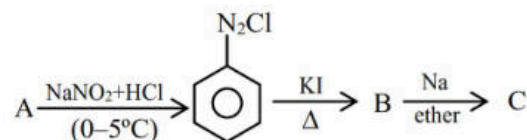
**Ans.** (3)

**Sol.**  $\Delta \propto \frac{1}{\lambda_{\text{obs}}}$

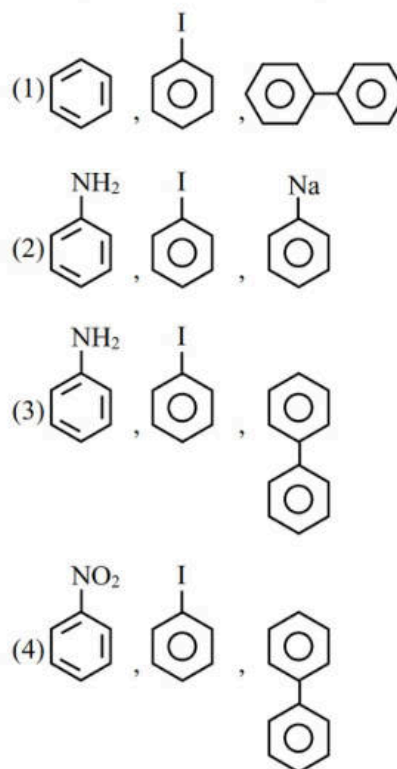
$\Delta : d > a > c > b$

$\lambda_{\text{obs}} : b > c > a > d$

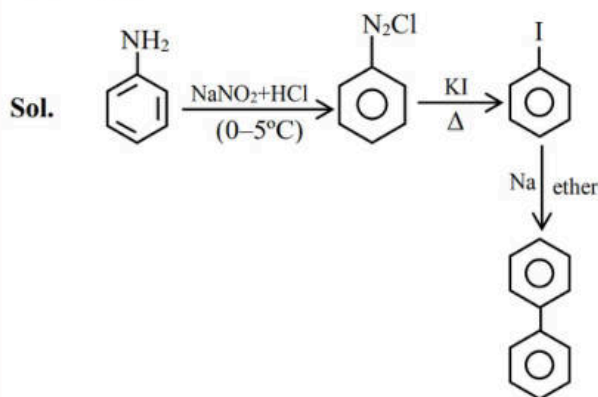
11.



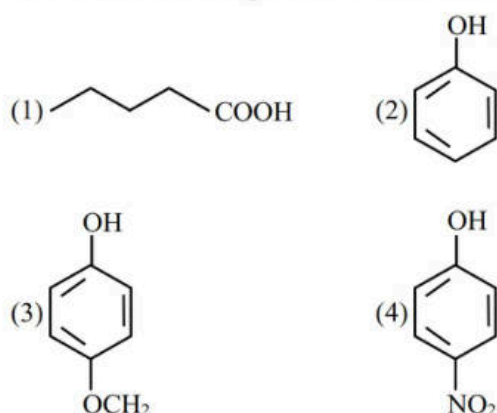
Identify A, B, C respectively



**Ans.** (3)



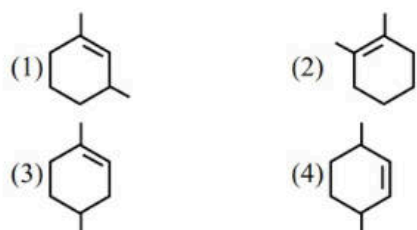
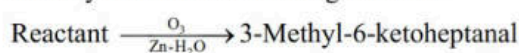
12. Which of the following is more acidic than others?



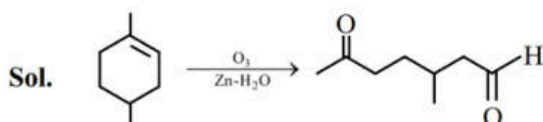
Ans. (1)

Sol.  $pK_a(\text{p-nitrophenol})$  is around 7.15  
 $pK_a(\text{pentanoic acid})$  is around 4.82  
 $pK_a(\text{phenol})$  is around 10.00  
 $pK_a(\text{p-methoxy phenol})$  is around 10.2  
 So, pentanoic acid has highest acidic nature among all

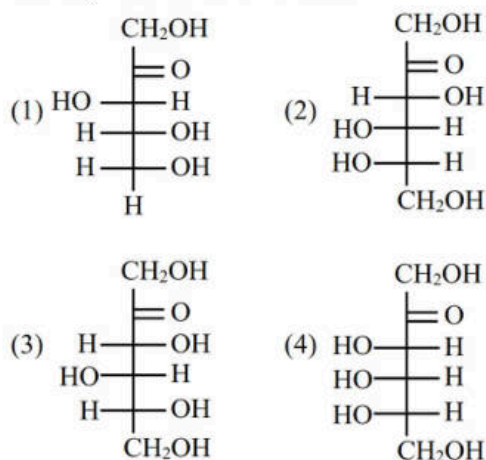
13. Identify reactant of following reaction



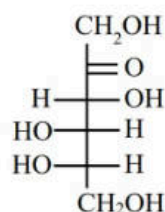
Ans. (3)



14. Identify structure of L-Fructose



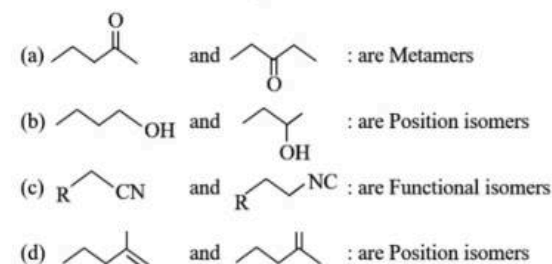
Ans. (2)



Sol.

(L-Fructose)

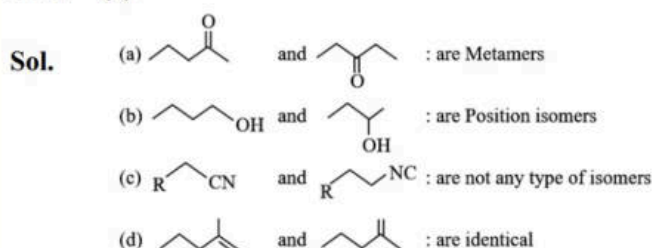
15. Which of the following is/are correct



(1) (a), (b), (c) (2) (a), (b), (d)

(3) (a), (b) (4) (a), (b), (c), (d)

Ans. (3)



16. The given reaction is at equilibrium starting with only  $\text{PCl}_5$



When addition of Xe gas takes place at constant pressure, then which of the following is correct?

- (1) Conc. of  $\text{PCl}_3$  will become more than  $\text{Cl}_2$   
 (2)  $\text{PCl}_3$  and  $\text{Cl}_2$  will have same concentration at new equilibrium.  
 (3) Conc. of  $\text{Cl}_2$  will become more than  $\text{PCl}_3$ .  
 (4)  $\text{PCl}_3$  will be 30% and  $\text{Cl}_2$  will be 70% at the new equilibrium

Ans. (2)

Sol.  $PV = nRT$

$(V) \uparrow \propto (n) \uparrow$

Reaction will be shift at that direction where no. of gases mole more.

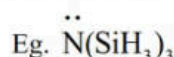
17. Which of the following statement(s) is/are **INCORRECT**

I.  $\text{NO}_2$  dimerises easily  
 II.  $\text{NF}_5$  does not exist but  $\text{PF}_5$  exists  
 III. The oxides  $\text{N}_2\text{O}_5$  and  $\text{P}_2\text{O}_5$  are purely acidic but  $\text{As}_2\text{O}_5$  and  $\text{Sb}_2\text{O}_5$  are basic  
 IV. Nitrogen cannot form  $p\pi-d\pi$  bond as the heavier elements

(1) Only I, II and IV (2) Only III  
 (3) Only III and IV (4) Only I and II

**Ans. (3)**

**Sol.** I.  $\text{NO}_2$  dimerises easily to form  $\text{N}_2\text{O}_4$  due to presence of unpaired electron.  
 II. N does not have any d-orbital so it cannot increase its valency to 5 to form  $\text{NF}_5$   
 III.  $\text{N}_2\text{O}_5$ ,  $\text{P}_2\text{O}_5$ ,  $\text{As}_2\text{O}_5$ ,  $\text{Sb}_2\text{O}_5$  = Acidic oxides  
 IV. Nitrogen can form  $p\pi-d\pi$  bond



18. Correct set of four Quantum numbers for last electron of  $\text{Cr}^{3+}$  on is:

(1)  $n = 4, l = 1, m = 0, s = +\frac{1}{2}$   
 (2)  $n = 4, l = 2, m = 0, s = +\frac{1}{2}$   
 (3)  $n = 3, l = 2, m = 0, s = +\frac{1}{2}$   
 (4)  $n = 3, l = 2, m = -1, s = 0$

**Ans. (3)**

**Sol.**  $\text{Cr}^{+3} = [\text{Ar}]3d^3$

$n = 3, l = 2, m = 0, s = +\frac{1}{2}$

19. Given below are two statements about X-ray spectra of elements:

**Statement I:** A plot of  $\sqrt{\nu}$  ( $\nu$  = frequency of X-rays emitted) vs atomic mass is a straight line.

**Statement II:** A plot of  $\nu$  ( $\nu$  = frequency of X-rays emitted) vs atomic number is a straight line.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement are correct.  
 (2) Statement I is correct but Statement II is incorrect.  
 (3) Statement I is incorrect but Statement II is correct.  
 (4) Both Statement are incorrect.

**Ans. (4)**

**Sol.**  $\sqrt{\nu} = a(z - b)$

$\sqrt{\nu} \propto Z$

$\sqrt{\nu}$  vs  $Z$  graph is a straight line

## SECTION-B

20. There are two solutions of compounds A & B. The initial concentration of B is 8 times initial concentration of A. If half life of A & B are 40 and 10 min. then find the time when concentration of both A & B are same.

(Assume first order reaction)

**Ans. (40)**

**Sol.**

|       |                                                                                      |                                     |
|-------|--------------------------------------------------------------------------------------|-------------------------------------|
|       | $\text{A} \longrightarrow \text{P}$                                                  | $\text{B} \longrightarrow \text{P}$ |
| $t=0$ | $a$                                                                                  | $8a$                                |
| $t=t$ | $C_A$                                                                                | $C_B$                               |
|       | $C_A = a \cdot e^{-k_A t}$                                                           | $C_B = 8a \times e^{-k_B t}$        |
|       | $k_A = \frac{\ln 2}{40}$                                                             | $k_B = \frac{\ln 2}{10}$            |
|       | $a \times e^{-\frac{\ln 2}{40} \times t} = 8a \times e^{-\frac{\ln 2}{10} \times t}$ |                                     |
|       | $\frac{t}{10} - \frac{t}{40} = 3$                                                    |                                     |
|       | $t = 40 \text{ min}$                                                                 |                                     |

21.  $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 + 4\text{H}_2\text{O}_2 \rightarrow \text{A} + \text{K}_2\text{SO}_4 + 5\text{H}_2\text{SO}_4$ .

Find the number of oxygen atom in product A.

**Ans. (5)**

**Sol.**  $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 + 4\text{H}_2\text{O}_2 \rightarrow \text{CrO}_5 + \text{K}_2\text{SO}_4 + 5\text{H}_2\text{SO}_4$ .

Number of 'O' atom in A = 5

22.  $\text{FeCl}_3 + \text{KOH} + \text{H}_2\text{C}_2\text{O}_4 \longrightarrow \text{A}$

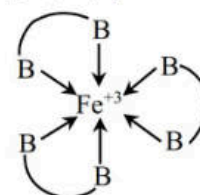
'A' is a complex, find the number of optical isomer of product A.

**Ans. (2)**

**Sol.**  $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3] = \text{A}$

$\text{C}_2\text{O}_4^{2-} \rightarrow$  Symmetrical bidentate ligand

$[\text{Fe}(\text{BB})_3]^{3-}$

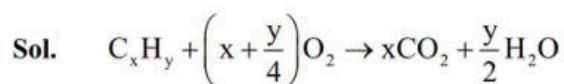


POS  $\times$

Optically active

23. 0.5 g of a hydrocarbon gives 1.46 g  $\text{CO}_2$  and 0.9 g  $\text{H}_2\text{O}$  on combustion. What is the percentage of carbon in hydrocarbon. (Nearest integer)

**Ans. (80)**

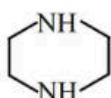


$$\%C = \frac{12}{44} \times \frac{\text{wt. of } CO_2}{\text{wt. of Hydrocarbon}} \times 100$$

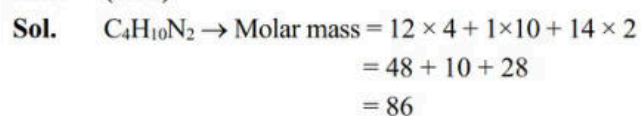
$$\%C = \frac{12}{44} \times \frac{1.46}{0.5} \times 100$$

$$\%C = 79.63 \approx 80\%$$

- 24.** Calculate the mass of nitrogen present in 1.6 g of following compound



**Ans. (0.52)**



$$86 \text{ g m o.c} \rightarrow 28\text{g nitrogen}$$

$$1.6 \text{ gm o.c} \rightarrow \frac{28}{86} \times 1.6$$

$$= 0.52 \text{ g}$$

# MATHEMATICS

1. Let A be  $3 \times 3$  matrix such that  $\det(A) = 5$ .  
If  $\det(3\text{adj}(2A\text{adj}(2A))) = 2^\alpha \cdot 3^\beta \cdot 5^\gamma$ , then  
( $\alpha + \beta + \gamma$ ) is equal to  
(1) 25 (2) 26 (3) 27 (4) 28

Ans. (4)

Sol.  $|3\text{adj}(2A\text{adj}(2A))| = 3^3 |\text{adj}(2A\text{adj}(2A))|$   
 $= 3^3 |2A\text{adj}(2A)|^2$   
 $= 3^3 \|2A\|_{I_3}^2$   
 $= 3^3 (|2A|^3)^2$   
 $= 3^3 \times (2^9 \cdot |A|^3)^2$   
 $= 3^3 \times 2^{18} \times 5^6$

2. The sum of all rational terms in  $(2 + \sqrt{3})^8$  is  
(1) 18117 (2) 18817  
(3) 17280 (4) 1800

Ans. (2)

Sol.  $T_{r+1} = {}^8C_r \times 2^{8-r} \times (\sqrt{3})^r$   
 Sum of all rational terms  
 $= {}^8C_0 \times 2^8 + {}^8C_2 \times 2^6 \times 3 + {}^8C_4 \times 2^4 \times 3^2$   
 $+ {}^8C_6 \times 2^2 \times 3^3 + 3^4$   
 $= 256 + 28 \times 64 \times 3 + 70 \times 16 \times 9 + 28 \times 4 \times 27 + 81$   
 $= 256 + 5376 + 10080 + 3024 + 81$   
 $= 18817$

3. If the sum  $\sum_{r=1}^9 \left(\frac{r+3}{2^r}\right) \cdot {}^9C_r = \alpha \cdot \left(\frac{3}{2}\right)^9 - \beta$ ,  
then the value of  $(\alpha + \beta)^2$  is equal to  
(1) 9 (2) 81  
(3) 27 (4) 36

Ans. (2)

Sol.  $\sum_{r=1}^9 r \cdot \frac{9}{r} \cdot {}^8C_{r-1} \cdot \frac{1}{2^r} + \sum_{r=1}^9 \frac{3}{2^r} \cdot {}^9C_r$   
 $= \frac{9}{2} \left(1 + \frac{1}{2}\right)^8 + 3 \left\{ \left(1 + \frac{1}{2}\right)^9 - 1 \right\}$   
 $= \frac{9}{2} \cdot \left(\frac{3}{2}\right)^8 + 3 \cdot \left(\frac{3}{2}\right)^9 - 3$   
 $= 6 \cdot \left(\frac{3}{2}\right)^9 - 3 = \alpha \left(\frac{3}{2}\right)^9 - \beta$   
 $\therefore \alpha = 6, \beta = 3$   
 $\therefore (\alpha + \beta)^2 = 81$

4. Let  $S_n = 1 + 3 + 11 + 25 + 45 + \dots$  Then sum  
upto 20<sup>th</sup> term equals to  
(1) 6200 (2) 7200  
(3) 7240 (4) 6240

Ans. (3)

Sol. Using method of difference

$$S_n = 1 + 3 + 11 + 25 + 45 + \dots$$

$$\begin{array}{ccccccc} & & \vee & & \vee & & \vee \\ & & 2 & & 8 & & 14 & & 20 \end{array}$$

$$T_1 = 1$$

$$T_2 = 1 + 2$$

$$T_3 = 1 + 2 + 8$$

$$T_4 = 1 + 2 + 8 + 14$$

$$T_n = \underbrace{1 + 2 + 8 + 14 + 20 + \dots}_{\text{upto } n \text{ terms}}$$

$$T_n = 1 + \frac{n-1}{2} [2 \times 2 + (n-2) \times 6] = 3n^2 - 7n + 5$$

$$S_{20} = \sum_{n=1}^{20} T_n = 3 \sum_{n=1}^{20} n^2 - 7 \sum_{n=1}^{20} n + 5 \sum_{n=1}^{20} 1$$

$$= 3 \times \frac{20 \times 21 \times 41}{6} - \frac{7 \times 20 \times 21}{2} + 5 \times 20$$

$$= 7240$$

5. Let  $f(x) = \int x^3 \sqrt{3-x^2} dx$ . If  $5f(\sqrt{2}) = -4$ , then  $f(1)$  is equal to

(1)  $-\frac{2\sqrt{2}}{5}$  (2)  $-\frac{6\sqrt{2}}{5}$   
 (3)  $-\frac{4\sqrt{3}}{5}$  (4)  $-\frac{8\sqrt{2}}{5}$

Ans. (2)

Sol. Let  $3-x^2 = y^2$

$$\therefore -x dx = y dy$$

$$\therefore x dx = -y dy$$

$$\int (3-y^2)(-y dy) = \int -(3y^2 - y^4) dy$$

$$= -3\left(y^3 - \frac{y^5}{5}\right) + c$$

$$= -\frac{y^3}{5}(5-y^2) + c$$

$$= -\frac{(3-x^2)^{3/2}}{5}(5-3+x^2) + c$$

$$f(x) = -\frac{(3-x^2)^{3/2}}{5}(2+x^2) + c$$

$$f(\sqrt{2}) = -\frac{4}{5} \therefore -\frac{4}{5} = -\frac{1}{5}(2+2) + c \therefore c = 0$$

$$\therefore f(1) = -\frac{(2)^{3/2}}{5}(3) = -\frac{6\sqrt{2}}{5}$$

6. A relation

$R = \{(x, y) : x, y \in A = \{-3, -2, -1, 0, 1, 2, 3\}\}$  such that  $x^2 + 2y \leq 4$ . Then, the number of ordered pairs in relation R be r and number of ordered pairs required to add in R so that it becomes reflexive relations is m, then  $r + m$  is equal to

(1) 26 (2) 28  
 (3) 24 (4) 23

Ans. (2)

Sol.  $A = \{-3, -2, -1, 0, 1, 2, 3\}$

No of ordered pairs in relation R

$$2y \leq 4 - x^2 \therefore y \leq \frac{4-x^2}{2}$$

Now put:

(1)  $x = \pm 3, y \leq \frac{4-9}{2} \Rightarrow y \leq \frac{-5}{2} \Rightarrow y = -3$   
 $(\pm 3, -3) \rightarrow 2$  pairs

(2)  $x = \pm 2, y \leq \frac{4-4}{2} \Rightarrow y \leq 0$

$$\Rightarrow y = -3, -2, -1, 0$$

$$(\pm 2, -3), (\pm 2, -2), (\pm 2, -1), (\pm 2, 0)$$

8 pairs.

(3)  $x = \pm 1, y \leq \frac{3}{2} \Rightarrow y = -3, -2, -1, 0, 1$

No of ordered pairs = 10

(4)  $x = 0, y \leq 2$

$$\Rightarrow y = -3, -2, -1, 0, 1, 2$$

6 pairs.

$\therefore$  total order pair

$$\therefore r = 26$$

For reflexive  $m = 2$

$$\therefore r + m = 28.$$

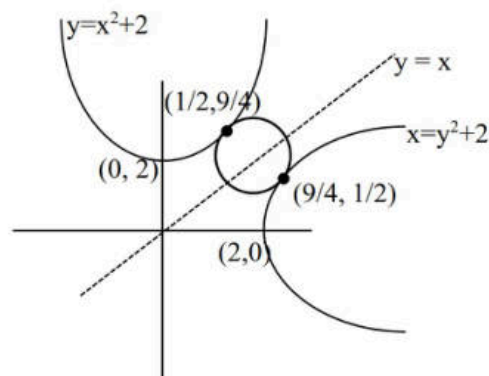
7. The radius of circle touching both parabolas  $y = x^2 + 2$  and  $x = y^2 + 2$  is

(1)  $\frac{7\sqrt{2}}{8}$  (2)  $\frac{7\sqrt{2}}{2}$

(3)  $\frac{7\sqrt{2}}{4}$  (4)  $\frac{7\sqrt{2}}{6}$

Ans. (1)

Sol.



For  $y = x^2 + 2$

$$\frac{dy}{dx} = 2x = 1$$

$$\text{at } x = \frac{1}{2} \quad \text{and} \quad y = \frac{9}{4}$$

For  $x = y^2 + 2$

$$1 = 2y \frac{dy}{dx} \Rightarrow \frac{1}{2y} = 1$$

$$\text{at } y = \frac{1}{2} \quad \text{and} \quad x = \frac{9}{4}$$

$$\Rightarrow 2R = \sqrt{2 \times \left(\frac{9}{4} - \frac{1}{2}\right)^2} = \sqrt{2 \times \left(\frac{7}{4}\right)^2} = \sqrt{2} \times \frac{7}{4}$$

$$\Rightarrow R = \frac{7\sqrt{2}}{8}$$

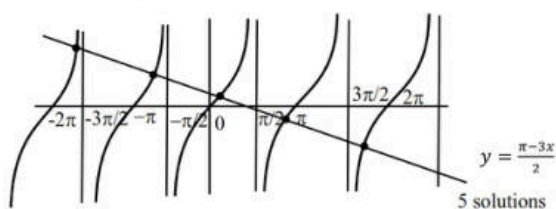
8. If  $3x + 2 \tan x = \pi$ ,  $x \in [-2\pi, 2\pi] - \left\{\pm \frac{\pi}{2}, \pm \frac{3\pi}{2}\right\}$ . Then number of values of  $x$  that satisfies the above equation is

- (1) 7 (2) 5  
(3) 4 (4) 6

Ans. (2)

Sol.  $3x + 2 \tan x = \pi$ ,  $x \in [-2\pi, 2\pi] - \left\{\pm \frac{\pi}{2}, \pm \frac{3\pi}{2}\right\}$

$$\tan x = \frac{\pi - 3x}{2}$$



9. Let  $\int_0^x g(t) dt = x - \int_0^x t g(t) dt$ ,  $x \geq 0$  and  $\frac{dy}{dx} - y \tan x = 2(x+1) \sec x$  satisfying the condition  $y(0) = 0$ . Then  $y\left(\frac{\pi}{3}\right)$  is

- (1)  $\pi$  (2)  $2\pi$   
(3)  $\frac{2\pi}{3}$  (4)  $\frac{4\pi}{3}$

Ans. (4)

Sol.  $\int_0^x g(t) dt = x - \int_0^x t g(t) dt \quad x \geq 0$

$$g(x) = 1 - xg(x)$$

$$\Rightarrow g(x) = \frac{1}{1+x}$$

$$\frac{dy}{dx} - y \tan x = 2(x+1) \sec x g(x)$$

$$\frac{dy}{dx} - y \tan x = 2 \sec x$$

$$\cos x \cdot y = 2x + c$$

$$y = \frac{2x}{\cos x}$$

$$y\left(\frac{\pi}{3}\right) = \frac{2 \cdot \frac{\pi}{3}}{\frac{1}{2}} = \frac{4\pi}{3}$$

10. If  $f(x) = \begin{vmatrix} \sin x & \cos x & \sin x + \cos x + 1 \\ 27 & 28 & 27 \\ 1 & 1 & 1 \end{vmatrix}$ , then

the value of  $f''(x) + f(x)$  is

- (1) -1 (2) 28  
(3) 27 (4) 1

Ans. (1)

Sol.  $f(x) = \begin{vmatrix} \sin x & \cos x & \sin x + \cos x + 1 \\ 27 & 28 & 27 \\ 1 & 1 & 1 \end{vmatrix}$

$$f'(x) = \begin{vmatrix} \cos x & -\sin x & \cos x - \sin x \\ 27 & 28 & 27 \\ 1 & 1 & 1 \end{vmatrix}$$

$$f''(x) = \begin{vmatrix} -\sin x & -\cos x & -\sin x - \cos x \\ 27 & 28 & 27 \\ 1 & 1 & 1 \end{vmatrix}$$

$$f''(x) + f(x) = \begin{vmatrix} 0 & 0 & 1 \\ 27 & 28 & 27 \\ 1 & 1 & 1 \end{vmatrix}$$

$$= 27 - 28$$

$$= -1$$

11. The number of seven digit numbers whose sum of digits is 7, is \_\_\_\_.

Ans. (924)

Sol. Let the seven digit number be  $a_0, a_1, a_2, a_3, a_4, a_5, a_6$  where  $a_0, a_1, a_2, a_3, a_4, a_5, a_6$  are digits from 0 to 7 &  $a_0 \neq 0$

$$\therefore \text{When } a_0 = 1, a_1 + a_2 + a_3 + a_4 + a_5 + a_6 = 6$$

$$\therefore \text{No. of ways} = {}^{6+6-1}C_{6-1} = {}^{11}C_5$$

$$\therefore \text{When } a_0 = 2, a_1 + a_2 + a_3 + a_4 + a_5 + a_6 = 5$$

$$\therefore \text{No. of ways} = {}^{5+6-1}C_{6-1} = {}^{10}C_5$$

$\vdots$

$$\therefore \text{When } a_0 = 7, a_1 + a_2 + a_3 + a_4 + a_5 + a_6 = 0$$

$$\therefore \text{No. of ways} = {}^{0+6-1}C_{6-1} = {}^5C_5$$

$\therefore$  Total number of nos.

$$= {}^5C_5 + {}^6C_5 + {}^7C_5 + \dots + {}^{11}C_5$$

$$= {}^{12}C_6 = \frac{12 \cdot 11 \cdot 10 \cdot 9 \cdot 8 \cdot 7}{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1} = 924$$

12. Let  $\alpha, \beta$  be the roots of the equation  $x^2 + \sqrt{3}x - 16 = 0$  and  $\gamma, \delta$  are the roots of the equation  $x^2 + 3x - 1 = 0$ .

If  $Q_n = \alpha^n + \beta^n \forall n \in \mathbb{N}$  then the value of  $\frac{Q_{25} + \sqrt{3}Q_{24}}{2Q_{23}} + \left(\frac{P_{25} - P_{23}}{P_{24}}\right)$  is

- (1) 5 (2) 6  
(3) 7 (4) 8

Ans. (1)  
Sol.

$$x^2 + \sqrt{3}x - 16 = 0 \begin{cases} \alpha \\ \beta \end{cases}, Q_n = \alpha^n + \beta^n$$

so, it will satisfy  $Q_{n+2} + \sqrt{3}Q_{n+1} - 16Q_n = 0$

$$x^2 + 3x - 1 = 0 \begin{cases} \gamma \\ \delta \end{cases}, P_n = \gamma^n + \delta^n$$

so, it will satisfy  $P_{n+2} + 3P_{n+1} - P_n = 0$

So, the value of  $\left(\frac{Q_{25} + \sqrt{3}Q_{24}}{2Q_{23}}\right) + \left(\frac{P_{25} - P_{23}}{P_{24}}\right)$

$$\therefore \frac{Q_{25} + \sqrt{3}Q_{24}}{2Q_{23}} = 8 \text{ and } \frac{P_{25} - P_{23}}{P_{24}} = -3$$

$\Rightarrow$  the required value  $= 8 - 3 = 5$

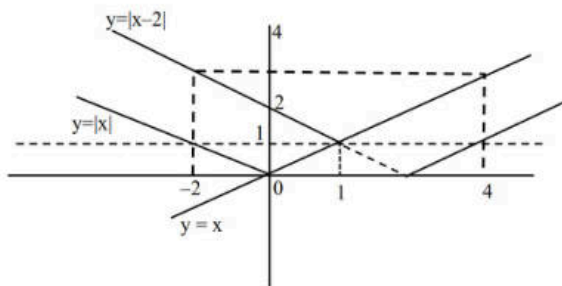
13. If  $y = \max\{|x|, x, |x - 2|\}$ , then the area under the curve from  $x = -2$  to  $x = 4$  is

(in square units)

- (1) 15 (2) 20  
(3) 12 (4) 8

Ans. (1)

Sol.  $\therefore \text{Area} = \frac{1}{2} \times 3 \times 3 + 3 \times 1 + 3 \times 1 + \frac{1}{2} \times 3 \times 3$   
 $= 15$



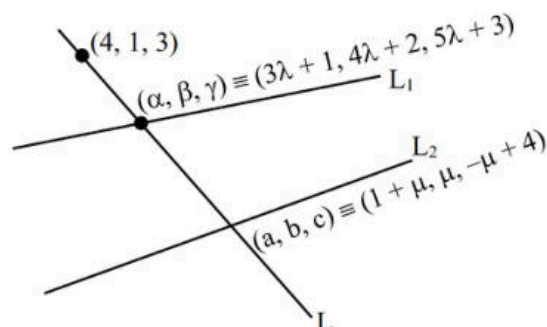
14. Let a line passing through  $(4, 1, 3)$  intersects the lines  $l_1: \frac{x-1}{3} - \frac{y-2}{4} = \frac{z-3}{5}$  at  $(\alpha, \beta, \gamma)$  and

$l_2: x - 1 = y = -z + 4$  at  $(a, b, c)$ , then find

$$\begin{vmatrix} 63 & 21 & -21 \\ \alpha & \beta & \gamma \\ a & b & c \end{vmatrix} \text{ is equal to}$$

- (1) 102 (2) 204  
(3) 63 (4) 21

Ans. (2)  
Sol.



$$\frac{3\lambda + 1 - 4}{1 + \mu - 4} = \frac{4\lambda + 2 - 1}{\mu - 1} = \frac{5\lambda + 3 - 3}{-\mu + 4 - 3}$$

$$\frac{3\lambda - 3}{\mu - 3} = \frac{4\lambda + 1}{\mu - 1} = \frac{5\lambda}{-\mu + 1} = \frac{9\lambda + 1}{0}$$

$$\Rightarrow \lambda = \frac{-1}{9}, \mu = \frac{9}{7}$$

$$\begin{vmatrix} 63 & 21 & -21 \\ 3\lambda + 1 & 4\lambda + 2 & 5\lambda + 3 \\ \mu + 1 & \mu & -\mu + 4 \end{vmatrix}$$

Using  $C_2 \rightarrow C_2 + C_3$

$$\begin{vmatrix} 63 & 0 & -21 \\ 3\lambda + 1 & 9\lambda + 5 (=4) & 5\lambda + 3 \\ \mu + 1 & 4 & -\mu + 4 \end{vmatrix}$$

Using  $R_2 \rightarrow R_2 - R_3$

$$\begin{vmatrix} 63 & 0 & -21 \\ 3\lambda - \mu & 0 & 5\lambda + \mu - 1 \\ \mu + 1 & 4 & -\mu + 4 \end{vmatrix}$$

$$= -4[63(5\lambda + \mu - 1) + 21(3\lambda - \mu)]$$

$$= -4 \times 21[15\lambda + 3\mu - 3 + 3\lambda - \mu]$$

$$= -84[18\lambda + 2\mu - 3]$$

$$= -84\left[-2 + \frac{18}{7} - 3\right]$$

$$= -84\left[-5 + \frac{18}{7}\right] = -12[-35 + 18]$$

$$= 12 \times 17$$

$$= 204$$

15. Let  $a_1, a_2, a_3, \dots$  be the terms of an increasing G.P. such that  $a_3 \cdot a_5 = 729$  and  $a_2 + a_4 = \frac{111}{4}$ , then  $24(a_1 + a_2 + a_3)$  is equal to

- (1) 139 (2) 129  
(3) 125 (4) 119

Ans. (2)

Sol. Let the first term of the increasing G.P. be  $a$  and common ratio be  $r$  then as per the question  $a_3 \cdot a_5 = ar^2 \cdot ar^4 = 729 \Rightarrow ar^3 = 27$

$$a_2 + a_4 = \frac{111}{4} \Rightarrow ar + ar^3 = \frac{111}{4}$$

$$\Rightarrow ar = \frac{111}{4} - 27 = \frac{3}{4}$$

$$\text{So, } r^2 = \frac{27}{3/4} = 36 \Rightarrow r = 6$$

$$\text{So, } a = \frac{3}{4 \times 6} = \frac{1}{8}$$

$$\text{Hence, } 24(a_1 + a_2 + a_3) = 24(a + ar + ar^2)$$

$$= 24 \times a(1 + r + r^2)$$

$$= 24 \times \frac{1}{8}(1 + 6 + 6^2) = 129$$

16. Let  $z \in \mathbb{C}$  such that  $\frac{z^2 + 3i}{z - 2 + i} = 2 + 3i$  then sum of all possible values of  $z^2$  is

- (1)  $-19 - 2i$  (2)  $19 + 2i$   
(3)  $-19 + 2i$  (4)  $19 - 2i$

Ans. (1)

Sol.  $\frac{z^2 + 3i}{z - 2 + i} = 2 + 3i$

$$\Rightarrow z^2 + 3i = (2 + 3i)(z - 2 + i)$$

$$\Rightarrow z^2 + 3i = 2z - 4 + 2i + 3iz - 6i - 3$$

$$\Rightarrow z^2 + 3i = 2z - 4i - 7 + 3iz$$

$$\Rightarrow z^2 - z(2 + 3i) + 7(1 + i) = 0$$

Which has roots as  $\alpha$  and  $\beta$  sum of whose squares will be given as

$$\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$$

$$= (2 + 3i)^2 - 2 \times 7(1 + i)$$

$$= (4 - 9 + 12i) - 14 - 14i$$

$$= -19 - 2i$$

17. Let  $f(x) = \begin{cases} (1 + ax)^{\frac{1}{x}} & , x < 0 \\ 1 + b & , x = 0 \\ \frac{(x+4)^{\frac{1}{2}} - 2}{(x+c)^{\frac{1}{3}} - 2} & , x > 0 \end{cases}$  be

continuous

at  $x = 0$  then  $e^a bc$  is equal to

- (1) 64 (2) 48  
(3) 72 (4) 36

Ans. (2)

Sol.  $f(x) = \begin{cases} (1 + ax)^{\frac{1}{x}} & , x < 0 \\ 1 + b & , x = 0 \\ \frac{(x+4)^{\frac{1}{2}} - 2}{(x+c)^{\frac{1}{3}} - 2} & , x > 0 \end{cases}$

$$\Rightarrow \frac{2-2}{c^{\frac{1}{3}} - 2} \Rightarrow \text{finite}$$

$$c^{\frac{1}{3}} = 2$$

$$c = 8$$

$$\frac{1}{e^x} \times ax = 1 + b \Rightarrow e^a = b + 1$$

$$\frac{\frac{1}{2}(x+4)^{\left(\frac{-1}{2}\right)}}{\frac{1}{3}(x+c)^{\frac{-2}{3}}} \Rightarrow \frac{\frac{1}{2} \times \frac{1}{2}}{\frac{1}{3} \times c^{\frac{-2}{3}}}$$

$$= \frac{3}{4} c^{\frac{2}{3}} = \frac{3}{4} \times 4 = 3$$

$$b + 1 = 3 \Rightarrow b = 2$$

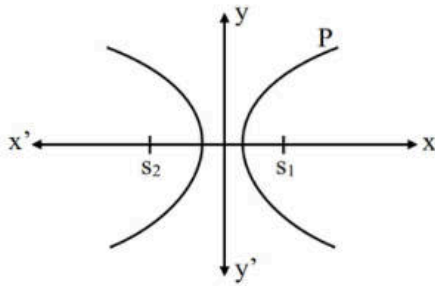
$$e^a \times bc = (b + 1)bc$$

$$= 3 \times 2 \times 8 = 48$$

18. Let the product of the focal distances of the point  $P(4, 2\sqrt{3})$  on the hyperbola  $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$  be 32. The length of conjugate axis be  $p$  and the length of its latus rectum be  $q$ . Then  $p^2 + q^2$  is equal to \_\_\_\_.

Ans. (120)

**Sol.**  $P \ 4, 2\sqrt{3} \equiv P(x_1, y_1)$



$$PS_1 = e \left| x_1 - \frac{a}{e} \right| = ex_1 - a$$

$$PS_2 = e \left| x_1 + \frac{a}{e} \right| = ex_1 + a$$

$$PS_1 \times PS_2 = 32$$

$$\Rightarrow e^2 x_1^2 - a^2 = 32$$

$$\Rightarrow \left( 1 + \frac{b^2}{a^2} \right) \times 16 - a^2 = 32$$

$$\Rightarrow 16 \frac{b^2}{a^2} - a^2 = 16 \quad \dots(i)$$

$$\frac{16}{a^2} - \frac{12}{b^2} = 1 \quad \dots(ii)$$

$$\Rightarrow 16 \frac{b^2}{a^2} - 12 = b^2$$

$$\Rightarrow 16 + a^2 - 12 = b^2$$

$$\Rightarrow b^2 = a^2 + 4 \quad \dots(iii)$$

Solving (ii) & (iii)

$$\frac{16}{a^2} - \frac{12}{a^2 + 4} = 1$$

$$\Rightarrow 16a^2 + 64 - 12a^2 = a^4 + 4a^2$$

$$\Rightarrow a^4 = 64$$

$$\therefore a^2 = 8$$

$$b^2 = 12$$

$$p = 2b \text{ \& } q = \frac{2b^2}{a}$$

$$p^2 + q^2 = 4b^2 + \frac{4b^4}{a^2}$$

$$= 4 \times 12 + 4 \times \frac{144}{8}$$

$$= 48 + 72 = 120$$

**19.**  $\frac{2x-3}{5+4x} - 1 \frac{3x+4}{2-x}$  If domain of  $f(x)$  is  $[\alpha, \beta)$ , then find the value of  $\alpha^2 + 4\beta$ .

**Ans.** (4)

**Sol.**  $\frac{2x-3}{5+4x} > 0 \Rightarrow x \in \left( -\infty, -\frac{5}{4} \right) \cup \left( \frac{3}{2}, \infty \right)$

$$-1 \leq \frac{3x+4}{2-x} \leq 1 \Rightarrow -1 \leq \frac{3x+4}{2-x} \text{ and } \frac{3x+4}{2-x} < 1$$

$$\frac{3x+4}{2-x} + 1 \geq 0 \text{ and } \frac{3x+4}{2-x} - 1 < 0$$

$$\Rightarrow x \in [-3, 2) \text{ and } x \in \left( -\infty, -\frac{1}{2} \right] \cup (2, \infty)$$

$$\text{So, Domain is } x \in \left[ -3, -\frac{5}{4} \right)$$

$$\alpha = -3 \text{ \& } \beta = -\frac{5}{4}$$

$$\text{So, } \alpha^2 + 4\beta$$

$$= 9 - 5 = 4.$$