



# Aakash

Medical | IIT-JEE | Foundations

08/04/2024

Evening

Corporate Office : Aakash Tower, 8, Pusa Road, New Delhi-110005 | Ph.: 011-47623456

## Memory Based Answers & Solutions

Time : 3 hrs.

for

M.M. : 300

### JEE (Main)-2024 (Online) Phase-2

(Physics, Chemistry and Mathematics)

#### IMPORTANT INSTRUCTIONS:

- (1) The test is of **3 hours** duration.
- (2) This test paper consists of 90 questions. Each subject (PCM) has 30 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 any 05 questions out of 10 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 – 30)** contains 10 **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.

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\*As per student response sheet and NTA answer key.

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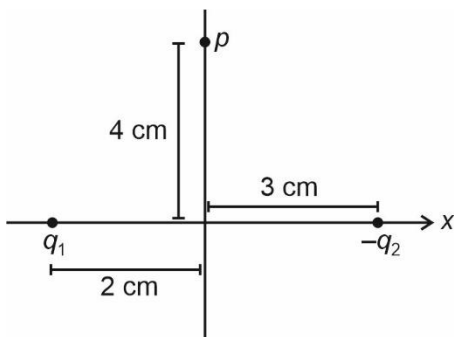
**PHYSICS**

**SECTION - A**

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer:**

1. Figure shows two charges  $q_1$  and  $-q_2$  placed on x-axis as shown. If electric field at  $p$  is along x-direction, find  $\frac{q_1}{q_2}$ .



- (1)  $\frac{4\sqrt{5}}{25}$
- (2)  $\frac{8\sqrt{5}}{25}$
- (3)  $\frac{12}{25}$
- (4)  $\frac{16\sqrt{5}}{25}$

**Answer (2)**

**Sol.**  $E_1 \sin \theta_1 = E_2 \sin \theta_2$

$$\frac{k_{q_1}}{(20)} \times \frac{4}{\sqrt{20}} = \frac{k_{q_2}}{(25)} \frac{4}{5}$$

$$\frac{q_1}{q_2} = \frac{8\sqrt{5}}{25}$$

2. A disk of mass  $M$ , radius  $R$  is rotating about an axis passing through its centre and perpendicular to its plane with angular speed  $\omega$ . If another disk of mass  $\frac{M}{2}$  and radius  $R$  is gently placed over it what will be their common angular velocity after some time?

- (1)  $\frac{\omega}{5}$
- (2)  $\frac{\omega}{2}$
- (3)  $\frac{2\omega}{3}$
- (4)  $\frac{\omega}{4}$

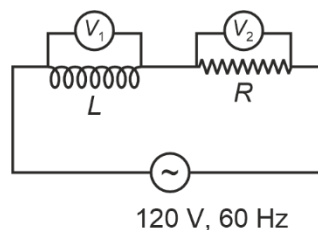
**Answer (3)**

**Sol.**  $I_1\omega = (I_1 + I_2)\omega'$

$$\frac{MR^2}{2}\omega = \frac{3}{2}\left(\frac{MR^2}{2}\right)\omega'$$

$$\omega' = \frac{2\omega}{3}$$

3. In given AC circuit consisting a resistor  $R$  and an inductor  $L$  and source emf, two voltmeter  $V_1$  &  $V_2$  are connected as shown. If  $V_2 = 36$  volts then inductance of inductor is (Resistance  $R$  is  $\sqrt{91}\Omega$ .)



- (1) 0.08 H
- (2) 0.8 H
- (3) 8 H
- (4) 80 H

**Answer (1)**

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Sol.  $i\sqrt{R^2 + X_L^2} = 120$  &  $iR = 36$

$$\Rightarrow \frac{R^2 + X_L^2}{R^2} = \frac{120 \times 120}{36 \times 36} = \frac{100}{9}$$

$$9R^2 + 9X_L^2 = 100R^2$$

$$9X_L^2 = 91R^2$$

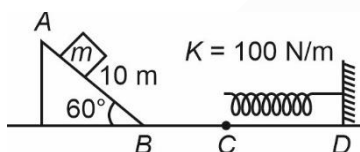
$$X_L = \frac{\sqrt{91}}{3} R$$

$$X_L = \frac{\sqrt{91}}{3} \times \sqrt{91} = \frac{91}{3}$$

$$L_\Omega = \frac{91}{3}$$

$$L = \frac{91}{3 \times 2 \times \pi \times 60}$$

4. A block of mass 5 kg is released as shown in the figure. Surface CD is rough with  $\mu = 0.5$ , rest of all the surfaces are smooth. Find the maximum compression in the spring (initially spring is in its natural length.)



- (1) 1.5 m
- (2) 2.0 m
- (3) 3.5 m
- (4) 2.5 m

**Answer (2)**

Sol.  $|W_f| = E_i - E_f$

$$+(0.5 \times 50) \times x = \frac{50 \times 10}{2} - \frac{1}{2} \times 100 \times x^2$$

$$x = 2.0 \text{ m}$$

5. A physical quantity  $P$  depends on electric field ( $E$ ) and permittivity of free space ( $\epsilon_0$ ) as

$$P \propto E \epsilon_0^2,$$

Find dimension of  $P$

(1)  $[M^1L^{-5}T^5I^3]$

(2)  $[M^{-1}L^{-5}T^5I^3]$

(3)  $[M^2L^{-5}T^5I^2]$

(4)  $[MLTI]$

**Answer (2)**

Sol.  $[P] = [MLT^{-3}I^{-1}][M^{-1}L^{-3}T^4I^2]^2$   
 $= [M^{-1}L^{-5}T^5I^3]$

6. An electron and a proton has same de Broglie wavelength. If  $K_e$  and  $K_p$  are their respective kinetic energies, then

- (1)  $K_p > K_e$
- (2)  $K_e > K_p$
- (3)  $K_e = K_p$
- (4) Nothing can be said

**Answer (2)**

Sol.  $\lambda = \frac{h}{p}$

$$K_e = \frac{p^2}{2m}$$

$$K_e \propto \frac{1}{m}$$

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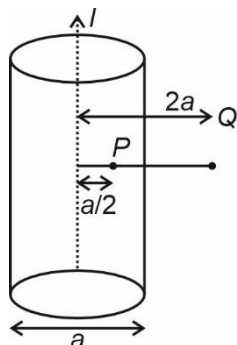
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7. Find ratio of magnetic field at point  $P$  to that at point  $Q$ .

Point  $P$  is inside the solid cylinder and  $Q$  is outside the cylinder. Current is uniform through the cross-section of cylinder.



- (1) 2 : 1                      (2) 1 : 1  
(3) 1 : 2                      (4) 4 : 1

**Answer (2)**

**Sol. For  $P$ :**

$$B_p 2\pi \left(\frac{a}{2}\right) = \mu_0 j \pi \frac{a^2}{4}$$

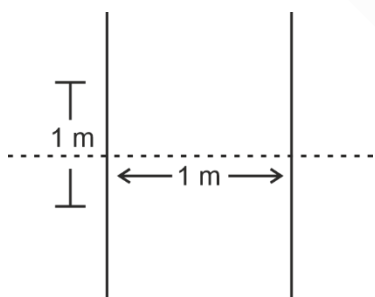
$$B_p = \frac{\mu_0 j a}{4}$$

**For  $Q$ :**

$$B_q 2\pi(2a) = \mu_0 j \pi a^2$$

$$B_q = \frac{\mu_0 j a}{4}$$

8. In a YDSE shown a monochromatic light of wavelength 500 nm is incident. At point  $P$ , 10<sup>th</sup> maxima is formed. Now the two slits are replaced with a single slit of width  $w$  placed at the centre. If first diffraction minima is observed at  $P$ , find  $w$ .



- (1) 0.5 mm  
(2) 1 mm  
(3) 0.1 mm  
(4) 0.2 mm

**Answer (3)**

$$\text{Sol. } 10 \frac{\lambda D}{d} = \frac{\lambda D}{w}$$

$$w = \frac{d}{10} = 0.1 \text{ mm}$$

9. An object is projected such that its horizontal range and maximum height are same, then angle of projection is

- (1)  $\tan^{-1}(2)$   
(2)  $\tan^{-1}(1)$   
(3)  $\tan^{-1}(3)$   
(4)  $\tan^{-1}(4)$

**Answer (4)**

$$\text{Sol. } R = \frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2 \theta}{2g}$$

$$2 \sin \theta \cos \theta = \frac{\sin \theta \sin \theta}{2}$$

$$\tan \theta = 4$$

10. A wave is given by the equation

$$y = A \sin \{ \pi (330t - x) \}, \text{ then frequency of the wave is}$$

- (1) 330 Hz                      (2) 660 Hz  
(3) 165 Hz                      (4)  $\frac{1}{330}$  Hz

**Answer (3)**

$$\text{Sol. } y = A \sin (wt - kn)$$

$$\Rightarrow \omega = 330\pi = 2\pi \nu$$

$$\Rightarrow \nu = 165 \text{ Hz}$$

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11. On two separate inclined plane (one smooth and other rough). Inclination of angle  $\theta$  with horizontal. Two particles (starting from rest) travels same length in time  $t$  and  $nt$  respectively where  $n > 1$ . Friction coefficient for earth surface as

- (1)  $1 - \frac{1}{n^2}$                       (2)  $\left(1 - \frac{1}{n^2}\right) \sin \theta$   
 (3)  $\left(1 - \frac{1}{n^2}\right) \cos \theta$             (4)  $\left(1 - \frac{1}{n^2}\right) \tan \theta$

**Answer (4)**

**Sol.**  $t = \sqrt{\frac{2l}{g \sin \theta}}$

$$nt = \sqrt{\frac{2l}{g(\sin \theta - \mu \cos \theta)}}$$

$$\frac{1}{n^2} = \frac{\sin \theta - \mu \cos \theta}{\sin \theta}$$

$$\frac{1}{n^2} = 1 - \mu \cot \theta$$

$$\mu = \left(1 - \frac{1}{n^2}\right) \tan \theta$$

12. A vernier caliper having least count  $\frac{1}{20N}$  cm and one main scale division is 1 mm, then value of one vernier scale division is

- (1)  $\frac{N+1}{2N}$  mm                      (2)  $\frac{2N+1}{2N}$  mm  
 (3)  $\frac{2N-1}{2N}$  mm                      (4)  $\frac{2N+2}{2N}$  mm

**Answer (3)**

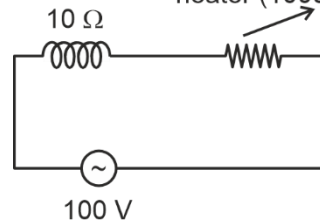
**Sol.** L.C. = 1 MSD - 1 VSD

$$\frac{1}{20N} \text{ cm} = 1 \text{ mm} - 1 \text{ VSD}$$

$$\text{VSD} = 1 \text{ mm} - \frac{1}{2N} \text{ mm}$$

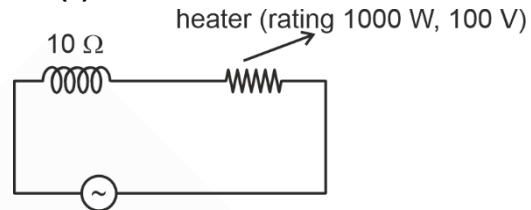
$$= \frac{2N-1}{2N} \text{ mm}$$

13. A heater with rating (1000 W, 100 V) is connected with AC source in series with inductor of reactance of  $10 \Omega$  as shown. Power dissipated in heater is



- (1)  $500\sqrt{2}$  W                      (2)  $250\sqrt{2}$  W  
 (3) 500 W                              (4) 1000 W

**Answer (3)**



**Sol.** 100 V

$$R = \frac{100 \times 100}{1000} = 10 \Omega$$

$$X_L = 10 \Omega$$

$$P = \frac{100 \times 100}{2 \times 10} = 500 \text{ W}$$

14. **Statement-I:** Mean free path is inversely proportional to the diameter of gas molecules, at constant volume, temperature.

**Statement-II :** Energy of  $n$  moles of gas is directly proportional to temperature.

- (1) Both statements I and II are true and statement II is the correct explanation of statement I  
 (2) Both statements I and II are true and statement II is not the correct explanation of statement I  
 (3) Statement I is true but statement II is false  
 (4) Statement I is false but statement II is true

**Answer (2)**

**Sol.** Theoretical

$$\lambda = \frac{KT}{\sqrt{2} \pi d^2 \left(\frac{N}{V}\right)}$$

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15. Find binding energy of nuclei  ${}^{12}_5X$ , if its mass is  $m_o$ ,  $m_p$  is mass of proton and  $m_n$  is mass of neutron.

- (1)  $(12m_p + 5m_n - m_o)C^2$   
 (2)  $(5m_p + 12m_n - m_o)C^2$   
 (3)  $(m_o - 5m_p - 7m_n)C^2$   
 (4)  $(5m_p + 7m_n - m_o)C^2$

**Answer (4)**

**Sol.**  $\Delta m = (5m_p + 7m_n - m_o)$

B.E. =  $(5m_p + 7m_n - m_o)C^2$

16. A screw gauge with a pitch of 1 mm and a circular scale with 100 divisions is used to measure the thickness of aluminium sheet. Negative zero error of 0.05 mm is there.

What is the thickness of the sheet when main scale reading is 4 mm and 60<sup>th</sup> division coincides with the main scale line

- (1) 10.05 mm  
 (2) 10.10 mm  
 (3) 10.15 mm  
 (4) 10.20 mm

**Answer (1)**

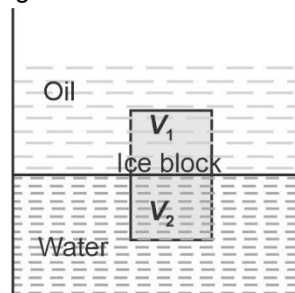
**Sol.** Reading = MSR + CSR × LC – Zero error  
 = 4 mm + 60 × 0.01 mm – (–0.05 mm)  
 = 10.05 mm

17.  
 18.  
 19.  
 20.

**SECTION - B**

**Numerical Value Type Questions:** This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. An ice block of density 0.9 g/cc is sub-merged as shown in figure.



Density of oil = 0.8 g/cc  
 Density of water = 1 g/cc  
 Volume inside water =  $V_2$   
 Volume inside oil =  $V_1$

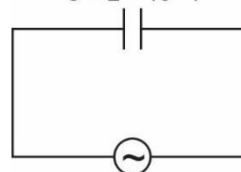
Find ratio  $\frac{V_1}{V_2}$ .

**Answer (1)**

**Sol.**  $mg = \rho_{oil}V_1g + \rho_{water}V_2g$   
 $(V_1 + V_2)\rho_{ice} = (\rho_{oil})V_1 + \rho_{water}V_2$   
 $(V_1 + V_2) \cdot 0.9 = 0.8V_1 + V_2$   
 $9V_1 + 9V_2 = 8V_1 + 10V_2$   
 $V_1 = V_2$   
 $\frac{V_1}{V_2} = 1$

22. A capacitive AC circuit is given. The rms value of current is  $k$  mA. Find the value of  $k$ .

$C = 2 \times 10^{-6} \text{ F}$



$V = 110\sqrt{2} \sin(100t)$

**Answer (22)**

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Sol.  $i_{rms} = \frac{V_0}{\sqrt{2}X_C}$

$i_{rms} = \frac{V_0\omega C}{\sqrt{2}} = 22 \text{ mA}$

$k = 22$

23. At certain instant, kinetic energy and potential energy for particle executing SHM are 0.4 J and 0.5 J respectively. Find amplitude of SHM, if frequency of oscillations is  $\frac{25}{\pi}$  Hz and mass of particle is 0.2 kg, in cm.

**Answer (6)**

Sol.  $\frac{1}{2} m 4\pi^2 f^2 A^2 = 0.9 \text{ J}$

$\frac{1}{2} 0.2 \times 4\pi^2 \times \frac{625}{\pi^2} A^2 = 0.9$

$A = \frac{3}{2 \times 25} = 6 \text{ cm}$

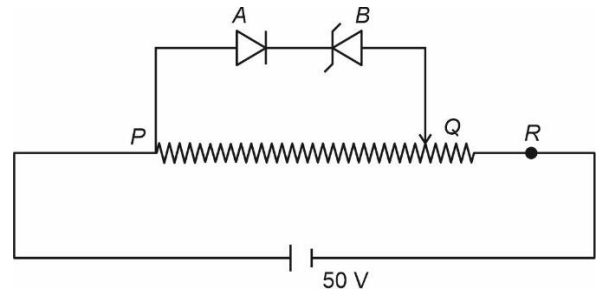
24. A planet is revolving in a circular orbit of radius  $R$  around sun with speed  $v$ . If another planet is revolving in circular orbit of radius  $\frac{R}{4}$ , its velocity is  $nv$ , find  $n$ .

**Answer (2)**

Sol.  $v = \sqrt{\frac{GM}{R}}$

$v_2 = 2v$

25. A  $p$ - $n$  junction diode ( $A$ ) of potential barrier 3.8 V is connected with zener diode ( $B$ ) of potential barrier 1.2 V as shown in figure. The length  $PR$  is 20 cm, then the maximum value of  $PQ$  (in cm) for which their is no current flow through diode\_\_\_\_\_ cm.

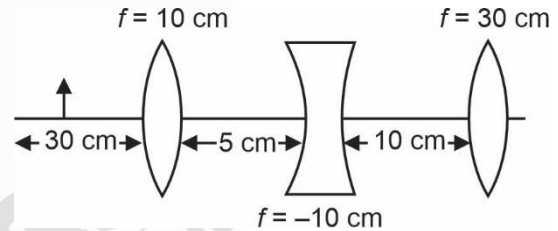


**Answer (2)**

Sol.  $(V)_{PQ}^{max} = 5 \text{ V}$

So,  $PQ = \frac{20}{50} \times 5$   
 $= 2 \text{ cm}$

26. Find the distance (in cm) of image from rightmost lens.



**Answer (30)**

Sol.  $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-30} = \frac{1}{10}$

$\frac{1}{v} = \frac{1}{10} - \frac{1}{30} = \frac{3-1}{30}$

$v = 15 \text{ cm}$

27.  
28.  
29.  
30.

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**CHEMISTRY**

**SECTION - A**

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

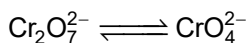
**Choose the correct answer :**

- Molecular orbital  $\sigma^*$  is represented by  
 (1)  $\psi_A + \psi_B$                       (2)  $\psi_A - \psi_B$   
 (3)  $\psi_A - 2\psi_B$                       (4)  $\psi_A + 2\psi_B$

**Answer (2)**

**Sol.**  $\sigma^*$  is antibonding molecular orbital which is represented by  $(\psi_A - \psi_B)$

- Consider the given reaction :



Above reaction shifts in forward direction in

- Acidic medium
- Basic medium
- Neutral medium
- Slightly acidic medium

**Answer (2)**

**Sol.**  $\text{H}_2\text{O} + \text{Cr}_2\text{O}_7^{2-} \rightleftharpoons 2\text{CrO}_4^{2-} + 2\text{H}^+$

As per Le-Chatelier's principle, reaction will shift in forward direction in basic medium.

- Select the correct options

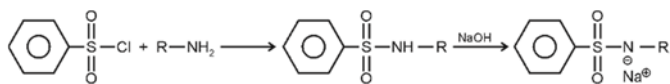
**Statement 1 :** Benzene sulphonyl chloride reacts with  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  amines

**Statement 2 :** All products of the reaction above are soluble in NaOH

- Statement 1 is true, statement 2 is false
- Statement 1 is false, statement 2 is true
- Statement 1 and statement 2 both are true
- Statement 1 and statement 2 both are false

**Answer (4)**

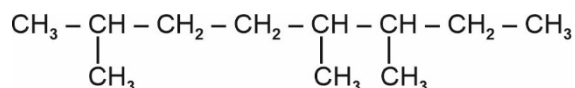
**Sol.**



$1^\circ$  and  $2^\circ$  amines reacts with benzene sulphonyl chloride.

Product of  $1^\circ$  amine only is soluble in NaOH

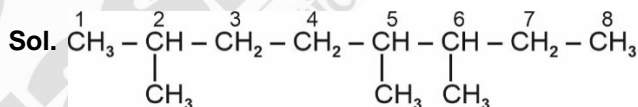
- Consider the following compound :



What is IUPAC nomenclature of above compound?

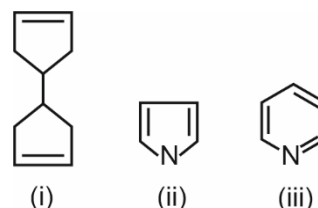
- 2, 5, 6-trimethyloctane
- 3, 4, 7-trimethyloctane
- 2, 4-ethyl, 3-methyloctane
- isopropyl hexane

**Answer (1)**



2, 5, 6-trimethyloctane

- Which of the following are aromatic compounds?



- Only (i) and (ii)
- Only (ii) and (iii)
- Only (i) and (iii)
- All are aromatic

**Answer (2)**

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**Sol.** (ii) and (iii) are aromatic because they have  $4n + 2$   $\pi$  electrons in cyclic resonance or say follow Huckel's rule while in case of (i) resonance is absent.

(ii) and (iii) both are having 6  $\pi$  electrons in cyclic resonance.

6. If de-Broglie wavelength of electron is equal to de-Broglie of proton. What is the relation between their kinetic energy?

- (1)  $KE_e > KE_p$
- (2)  $KE_p > KE_e$
- (3)  $KE_e = KE_p$
- (4)  $2KE_e = KE_p$

**Answer (1)**

**Sol.**  $\lambda_e = \lambda_p$

$$\Rightarrow (m \cdot KE)_e = (m \cdot KE)_p$$

$$\Rightarrow m_e < m_p$$

$$(KE)_e > (KE)_p$$

7. 1 mole of ethylene glycol is dissolved in 9 mol of water. Calculate the mass percentage of ethylene glycol in the resulting solution.

- (1) 27.67%
- (2) 38.27%
- (3) 22.3%
- (4) 31.2%

**Answer (1)**

**Sol.** Mass of ethylene glycol =  $1 \times 62 = 62$  g

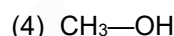
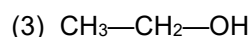
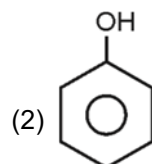
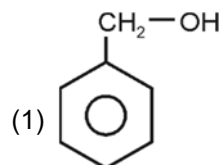
Mass of water =  $9 \times 18 = 162$  g

Therefore, % by mass of ethylene glycol

$$= \frac{62}{62 + 162} \times 100$$

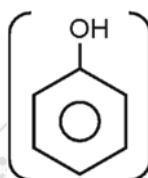
$$= 27.67\%$$

8. Which of the following reacts with NaOH with maximum rate?



**Answer (2)**

**Sol.** More the acidic molecule, faster will be reaction

with NaOH. Phenol  is most acidic in the given options

9. Which of the following is correct?

- (1) Non-metals are generally more electronegative than metals
- (2) Non-metallic oxides are generally basic
- (3) Metallic oxides are generally acidic or neutral
- (4) Non-metallic have always lower ionisation enthalpy than metals

**Answer (1)**

**Sol.** EN order:

(Non-metals) > metals

Non-metallic oxides are generally acidic

Metallic oxides are generally basic

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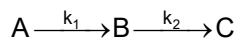


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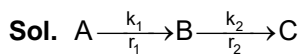
10. Consider the following reaction sequence involving first order reactions :



If net rate of formation of B is zero, what would be concentration of B in terms of concentration of A?

- (1)  $k_1 k_2 [A]$
- (2)  $\frac{k_1}{k_2} [A]$
- (3)  $(k_1 + k_2) [A]$
- (4)  $\frac{k_2}{k_1} [A]$

**Answer (2)**



Net rate of formation of B,  $\frac{d[B]}{dt} = r_1 - r_2$

$$\frac{d[B]}{dt} = k_1[A] - k_2[B] = 0$$

$$\Rightarrow [B] = \frac{k_1[A]}{k_2}$$

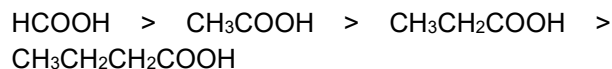
11. What is the correct acidic strength order of the following acids?

HCOOH, CH<sub>3</sub>COOH, CH<sub>3</sub>CH<sub>2</sub>COOH,  
CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH

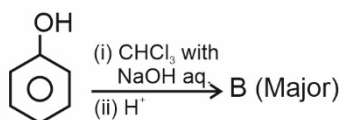
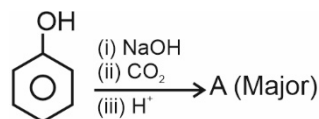
- (1) HCOOH < CH<sub>3</sub>COOH < CH<sub>3</sub>CH<sub>2</sub>COOH < CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH
- (2) HCOOH > CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH > CH<sub>3</sub>COOH > CH<sub>3</sub>CH<sub>2</sub>COOH
- (3) HCOOH > CH<sub>3</sub>COOH > CH<sub>3</sub>CH<sub>2</sub>COOH > CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH
- (4) CH<sub>3</sub>COOH > HCOOH > CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH > CH<sub>3</sub>CH<sub>2</sub>COOH

**Answer (3)**

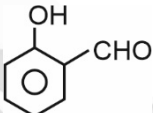
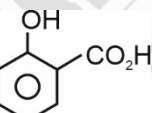
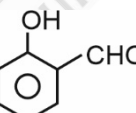
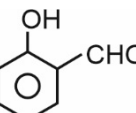
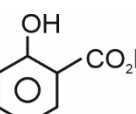
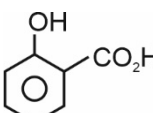
**Sol.** Acidic strength of carboxylic acids decreases as the +I effect of the alkyl group attached to carboxylic group increases. Therefore, the correct order of acidic strength of the given acids is



12. Consider the following two reactions



A and B are

- (1) Both are 
- (2) A is  B is 
- (3) A is  B is 
- (4) Both are 

**Answer (2)**

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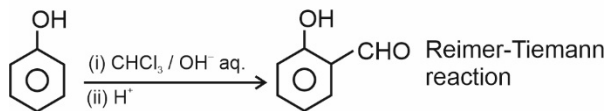
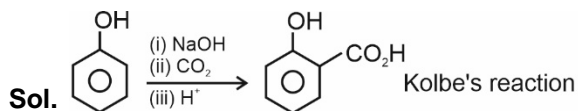


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13. **Assertion:** Kjeldahl method is not used for pyridine.

**Reason:** Nitrogen of pyridine does not change to ammonium sulphate under these conditions.

- (1) Both Assertion and Reason are true and Reason is a correct explanation for assertion  
 (2) Both Assertion and reason are true but Reason is not a correct explanation for assertion  
 (3) Assertion is true but Reason is false  
 (4) Assertion is false but Reason is true

**Answer (1)**

**Sol.** (Reference NCERT Page 358)

Kjeldahl method is not applicable to compounds containing nitrogen in the ring (pyridine) as nitrogen of these compounds does not change to ammonium sulphate under these conditions

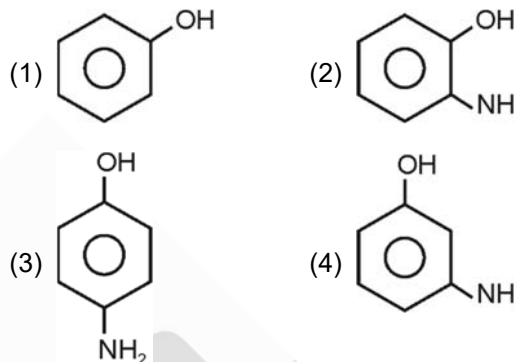
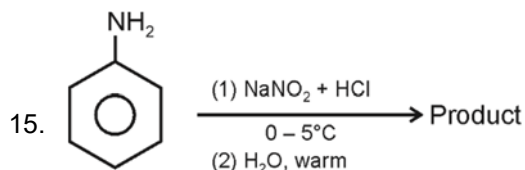
14. Statement-1 :  $S_N2$  reaction is stereospecific reaction.

Statement-2 : In  $S_N1$  reaction, racemic mixture is obtained.

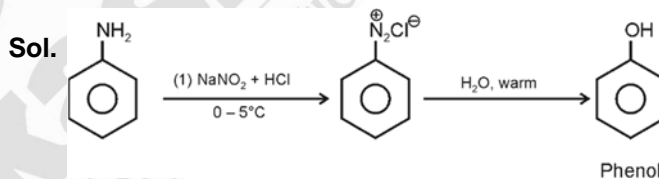
- (1) Statement-1 is true but Statement-2 is false  
 (2) Statement-1 is false but Statement-2 is true  
 (3) Both Statement-1 and Statement-2 is true  
 (4) Both Statement-1 and Statement-2 are false

**Answer (3)**

**Sol.** Both statements are true as in  $S_N2$  only one product is obtained by inversion and in  $S_N1$  due to carbocation formation, racemic mixture is obtained.



**Answer (1)**



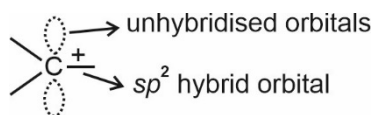
16. What is the structure of a carbocation?

- (1) Triangular planar (2) Tetrahedral  
 (3) Trigonal bipyramid (4) Triangular pyramid

**Answer (1)**

**Sol.** The hybridisation of carbocation is  $sp^2$ .

Therefore, its structure is triangular planar



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17. **S-I:** Blood is a buffer solution, whose pH is maintained at 7.4 by an acidic buffer.

**S-II:** pH is maintained by  $[\text{HCO}_3^-]$  and  $[\text{H}_2\text{CO}_3]$

- (1) S-I and S-II both are correct
- (2) S-I and S-II both in correct
- (3) S-I is correct and S-II are incorrect
- (4) S-I is incorrect and S-II is correct

**Answer (1)**

**Sol.**  $\text{H}_2\text{CO}_3/\text{HCO}_3^-$  buffer system helps to maintain pH of blood between 7.26 to 7.42.

(Refer NCERT p-block group-14)

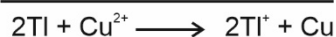
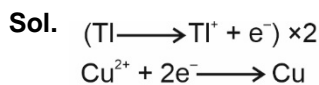
18. The EMF of the cell is 0.83 V



Then the EMF value will be increased

- (1) By increasing conc. of  $\text{Cu}^{2+}$ , keeping  $\text{Ti}^+$  constant
- (2) By increasing conc. of  $\text{Ti}^+$ , keeping  $\text{Cu}^{2+}$  constant
- (3) By increasing conc. of both  $\text{Ti}^+$  and  $\text{Cu}^{2+}$
- (4) By decreasing conc. of both  $\text{Cu}^{2+}$  and  $\text{Ti}^+$

**Answer (1)**

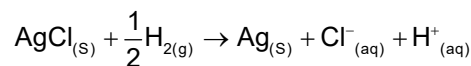


$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{Ti}^+]^2}{[\text{Cu}^{2+}]}$$

$E_{\text{cell}}$  will increase if we

- (i) Decrease  $\text{Ti}^+$
- (ii) Increase  $\text{Cu}^{2+}$

19. For the cell reactions:

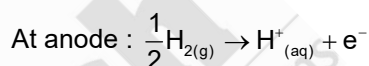
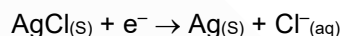
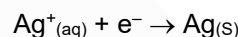
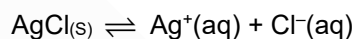


which one of the following represents the correct cell representation?

- (1)  $\text{Pt}|\text{H}_2|\text{H}^+||\text{Cl}^-|\text{AgCl}|\text{Ag}$
- (2)  $\text{H}_2|\text{H}^+||\text{Cl}^-|\text{AgCl}$
- (3)  $\text{Pt}|\text{H}_2|\text{H}^+||\text{AgCl}|\text{Ag}$
- (4)  $\text{Pt}|\text{H}^+|\text{H}_2||\text{Ag}|\text{AgCl}$

**Answer (1)**

**Sol.** At cathode :



So, cell representation is :  $\text{Pt}|\text{H}_2|\text{H}^+||\text{Cl}^-|\text{AgCl}|\text{Ag}$

20. Match the following Column-I and II.

- | Column-I                                   | Column-II        |
|--|------------------|
| (i) Baeyer's test                          | (p) Aldehyde     |
| (ii) Ceric ammonium nitrate test           | (q) Alcohol      |
| (iii) Phenolphthalein test                 | (r) Phenol       |
| (iv) Schiff's test                         | (s) Unsaturation |
| (1) i → (p), ii → (q), iii → (r), iv → (s) |                  |
| (2) i → (s), ii → (q), iii → (r), iv → (p) |                  |
| (3) i → (s), ii → (q), iii → (p), iv → (r) |                  |
| (4) i → (q), ii → (s), iii → (r), iv → (p) |                  |

**Answer (2)**

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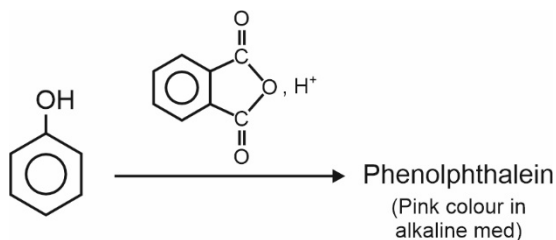


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**Sol.** Unsaturated compounds decolourise the Baeyer's reagent.

Alcohols give red coloured ppt with ceric ammonium nitrate.



Aldehyde gives pink colour with Schiff's reagent.

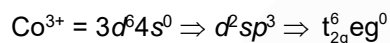
### SECTION - B

**Numerical Value Type Questions:** This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

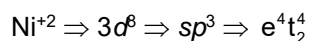
21. The sum of unpaired electron present in complexes  $[\text{Co}(\text{NH}_3)_6]^{3+}$  and  $[\text{NiCl}_4]^{2-}$  is

**Answer (2)**

**Sol.**  $[\text{Co}(\text{NH}_3)_6]^{3+}$



No. of unpaired electron = 0



No. of unpaired electron = 2

Total no. of unpaired  $e^- = (2 + 0) = 2$

22. The total number of compounds having bond order 2 among the following are \_\_\_\_\_.

$\text{F}_2, \text{N}_2, \text{Ne}_2, \text{O}_2, \text{Li}_2, \text{Be}_2$

**Answer (1)**

Sol. Molecule	Bond order
$\text{F}_2$	1
$\text{N}_2$	3
$\text{Ne}_2$	0
$\text{O}_2$	2
$\text{Li}_2$	1
$\text{Be}_2$	0

23. Wave number of a radiation having 5800 Å wavelength is  $x \times 10^4 \text{ cm}^{-1}$ . The value of x to nearest integer is :

**Answer (2)**

$$\begin{aligned} \text{Sol. } \bar{\nu} &= \frac{1}{\lambda} \\ &= \frac{1}{5800 \times 10^{-8} \text{ cm}} \\ &= 1.72 \times 10^4 \text{ cm}^{-1} \\ x &= 1.72 \approx 2 \end{aligned}$$

24. Molality of aqueous solution of urea is 4.44 m. Then mole fraction of urea is  $x \times 10^{-3}$ , then value of x is \_\_\_\_\_

**Answer (74)**

$$\text{Sol. } \frac{X_B}{X_A} = \frac{m \times M_A}{1000}$$

Where m = molality

$M_A$  = molar mass of solvent

$$\frac{X_B}{1 - X_B} = \frac{4.44 \times 18}{1000}$$

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$$\frac{X_B}{1 - X_B} = 0.08$$

$$X_B = 0.08 - 0.08X_B$$

$$1.08 \times B = 0.08$$

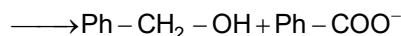
$$X_B = 0.074 = 74 \times 10^{-3}$$

$$x = 74$$

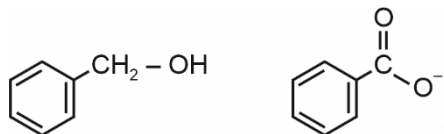
25. 2 moles of benzaldehyde is treated with aq. NaOH. The number of  $\pi$ -bonds present in the resulting compounds is \_\_\_\_\_.

**Answer (7)**

**Sol.**  $\text{Ph-CHO} + \text{NaOH(aq)}$   
(Cannizzaro Reaction)

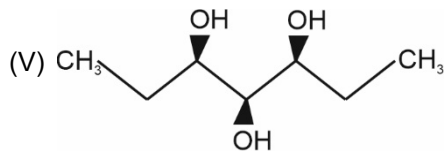
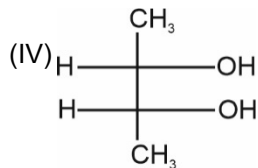
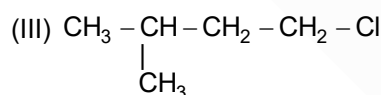
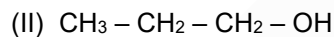
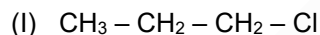


Products are:



Total number of  $\pi$ -bonds = 3 + 4 = 7

26. How many of the following are optically active?



**Answer (0)**

**Sol.** All are optically inactive

27. Consider the following statements :

- (i)  $\text{N}_2$  is stable in divalent form
- (ii) Group-15 exist in +3, -3, +5 oxidation state
- (iii) Stability of +5 oxidation state increases down the group
- (iv)  $\Delta H_{\text{eq}}$  value for N is positive

How many of the above statement(s) is/are correct

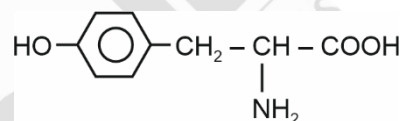
**Answer (3)**

**Sol.** Statement (iii) is incorrect

28. How many carbon atoms are there in a molecule of tyrosine?

**Answer (9)**

**Sol.** The structures of tyrosine is as given below

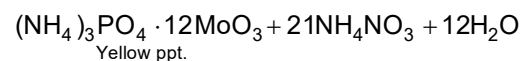


It has a carbon atom in its molecule.

29. In the test for phosphorus using ammonium molybdate, yellow precipitate of compound (X) is obtained. What is the oxidation state of molybdenum in (X)?

**Answer (6)**

**Sol.** NCERT Page – 355 : Test for Phosphorus



Oxidation state of Mo = +6

- 30.

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$$\Rightarrow \frac{\sqrt{4 + (4\lambda - 9)^2 + (5 - 2\lambda)^2}}{\sqrt{21}} = \frac{13}{\sqrt{21}}$$

$$\Rightarrow 20\lambda^2 + 110 - 92\lambda = 169$$

$$\Rightarrow 20\lambda^2 - 92\lambda - 59 = 0$$

4.

2		
5	8	
11	14	17

Then the sum of elements of 10<sup>th</sup> row.

(1) 1505

(2) 1438

(3) 1981

(4) 1745

**Answer (1)**

**Sol.** The given sequence is

2, (5, 8), (11, 14, 17), (20, 21, 24, 27) ...

Before 10<sup>th</sup> term total number of numbers would be

$$1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 = 9 \times 5 = 45$$

It is an A.P. with  $a = 2$  and  $d = 3$

$$T_{46} = 2 + 45 \times 3$$

$$= 137$$

$$\text{Sum of 10<sup>th</sup> terms} = \frac{10}{2} (2 \times 137 + (10 - 1)3)$$

$$= 1505$$

5. If  $y(x)$  be the solution of differential equation

$$\sec y \frac{dy}{dx} + 2x \sin y = x^3 \cos y \text{ and } y(1) = 0 \text{ then}$$

$y(\sqrt{3})$  is equal to

(1)  $\frac{\pi}{4}$

(2)  $\frac{\pi}{12}$

(3)  $\frac{\pi}{6}$

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

**Answer (1)**

**Sol.**  $\sec^2 y \frac{dy}{dx} + 2x \tan y = x^3$

$\Rightarrow$  Let  $z = \tan y$

$$\frac{dz}{dx} = \sec^2 y \frac{dy}{dx}$$

$\Rightarrow \frac{dz}{dx} + 2xz = x^3$

$\Rightarrow$  I.F. =  $e^{\int 2x dx} = e^{x^2}$

$\Rightarrow z \cdot e^{x^2} = \int e^{x^2} \cdot x^3 dx + C$

$\Rightarrow \tan y \cdot e^{x^2} = \frac{1}{2} (x^2 e^{x^2} - e^{x^2}) + C$

$\tan(0) \cdot e^0 = \frac{1}{2} (1 \cdot e^0 - e^0) + C$

$\Rightarrow C = 0$

$\Rightarrow \tan y = \left( \frac{x^2 - 1}{2} \right)$

$f(x) = \tan^{-1} \left( \frac{x^2 - 1}{2} \right)$

$f(\sqrt{3}) = \tan^{-1} \left( \frac{3 - 1}{2} \right) = \frac{\pi}{4}$

6. Two points (5, 2) and (2, a). Line passes through these points makes an angle of  $\frac{\pi}{4}$  at origin. The product of all values of a is equal to

(1) 8

(2) -4

(3) -2

(4) 1

**Answer (2)**

**Sol.**  $m_1 = \frac{2}{5}, m_2 = \frac{a}{2}$

$$1 = \left[ \frac{\frac{2}{5} - \frac{a}{2}}{1 + \frac{2}{5} \cdot \frac{a}{2}} \right] \left( \tan \theta = \left| \frac{m_1 - m_2}{1 + m_1 m_2} \right| \right)$$

$$\pm 1 = \frac{4 - 5a}{10 + 2a}$$

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$$\oplus 10 + 2a = 4 - 5a \quad \ominus -10 - 2a = 4 - 5a$$

$$\Rightarrow 7a = -6 \quad \Rightarrow 3a = 14$$

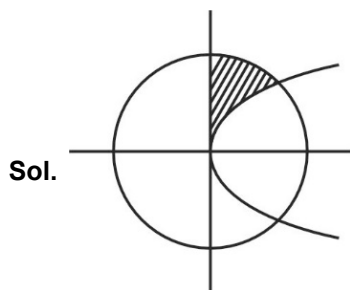
$$\Rightarrow a = \frac{-6}{7} \quad \Rightarrow a = \frac{14}{3}$$

$$a_1 \cdot a_2 = -\frac{6}{7} \times \frac{14}{3} = -4$$

7. A circle  $x^2 + y^2 = 8$  and a parabola  $y^2 = 2x$  are given. Find area bounded by these two curves in first quadrant which lie inside the circle and outside the parabola.

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

Answer (1)



Sol.

$$\text{Area} = \int_0^2 (\sqrt{8-x^2} - \sqrt{2x}) dx$$

$$= \left[ \frac{x}{2} \sqrt{8-x^2} + \frac{8}{2} \sin^{-1} \left( \frac{x}{2\sqrt{2}} \right) \right]_0^2 - \sqrt{2} \times \frac{2}{3} [x^{3/2}]_0^2$$

$$= 2 + 4 \sin^{-1} \left( \frac{1}{\sqrt{2}} \right) - \frac{2\sqrt{2}}{3} (2\sqrt{2})$$

$$= \left( \pi - \frac{2}{3} \right) \text{ sq. units.}$$

8. If  $\alpha \neq a, \beta \neq b, \gamma \neq c$  and

$$\begin{vmatrix} \alpha & b & c \\ a & \beta & c \\ a & b & \gamma \end{vmatrix} = 0, \text{ then}$$

$$\frac{a}{\alpha-a} + \frac{b}{\beta-b} + \frac{\gamma}{\gamma-c} \text{ is equal to}$$

- (1) 3
- (2) 2
- (3) 0
- (4) 1

Answer (3)

Sol.  $\begin{vmatrix} \alpha & b & c \\ a & \beta & c \\ a & b & \gamma \end{vmatrix} = 0$

$$R_1 \rightarrow R_1 - R_2$$

$$R_2 \rightarrow R_2 - R_3$$

$$\begin{vmatrix} \alpha-a & b-\beta & 0 \\ 0 & \beta-b & c-\gamma \\ a & b & \gamma \end{vmatrix} = 0$$

Take  $(\alpha - a), (\beta - b)$  and  $(\gamma - c)$  common from column 1, column 2 and column 3 respectively.

$$\begin{vmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ \frac{a}{\alpha-a} & \frac{b}{\beta-b} & \frac{\gamma}{\gamma-c} \end{vmatrix} = 0$$

$$\Rightarrow \frac{b}{\beta-b} + \frac{\gamma}{\gamma-c} + \frac{a}{\alpha-a} = 0$$

9. Bag X contains five one-rupee coins, four five-rupee coins. Bag Y contains 4 one rupee and 5 five rupees. Bag Z contains 3 one-rupee coin and 6 five-rupee coins. If 1 rupee coin is selected at random, what is the probability it is drawn from bag Y?

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

Answer (1)

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**Sol.** By Baye's theorem

Probability (coin drawn from bag Y)

$$= \frac{\frac{1}{3} \cdot \frac{4}{9}}{\frac{1}{3} \cdot \frac{5}{9} + \frac{1}{3} \cdot \frac{4}{9} + \frac{1}{3} \cdot \frac{3}{9}} = \frac{4}{12} = \frac{1}{3}$$

10. If  $\frac{3\cos 36^\circ - 2\sin 18^\circ}{2\cos 36^\circ - 3\sin 18^\circ} = \frac{a\sqrt{5} + b}{c}$ , where  $a$  and  $c$  are co-primes. The value of  $a + b + c$  is equal to

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

**Answer (1)**

**Sol.**  $\cos 36^\circ = \frac{\sqrt{5} + 1}{4}$

$$\sin 18^\circ = \frac{\sqrt{5} - 1}{4}$$

$$\frac{3\cos 36^\circ - 2\sin 18^\circ}{2\cos 36^\circ - 3\sin 18^\circ} = \frac{\sqrt{5} + 3}{2}$$

$\therefore b = 3, a = 1, c = 2$

11.  $\lim_{x \rightarrow 0^+} \frac{e^{\sqrt{\tan x}} - e^{\sqrt{x}}}{\sqrt{\tan x} - \sqrt{x}}$  is equal to

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

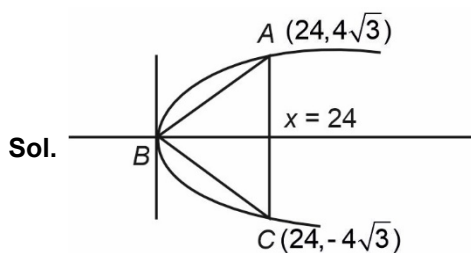
**Answer (1)**

**Sol.**  $\lim_{x \rightarrow 0^+} \frac{e^{\sqrt{x}} (e^{\sqrt{\tan x} - \sqrt{x}} - 1)}{\sqrt{\tan x} - \sqrt{x}} = 1$

12. A triangle is drawn inside bounded region of  $y^2 = 2x$  and  $x = 24$ . Then maximum area of triangle is

- (1)  $64\sqrt{3}$  (2)  $108\sqrt{3}$   
(3)  $96\sqrt{3}$  (4)  $120\sqrt{3}$

**Answer (3)**



**Sol.**

Base is constant i.e.,  $AC = 8\sqrt{3}$

Area of  $\triangle ABC$  will be maximum when height is maximum

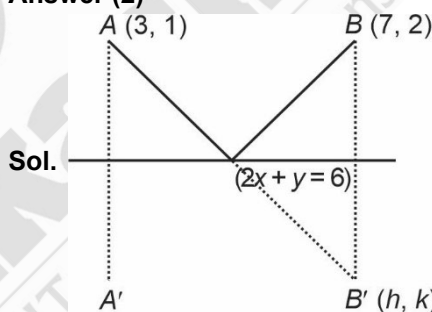
$\therefore B$  is  $(0, 0)$

$$\therefore (\text{Area})_{\max} = \frac{1}{2} \times 24 \times 8\sqrt{3} = 96\sqrt{3}$$

13. A ray of light coming from  $(3, 1)$  incident on  $2x + y = 6$  and deflected ray passing through  $(7, 2)$ . If equation of incident ray is  $ax + by + 1 = 0$ , then  $a^2 + b^2 + 3ab =$

- (1)  $\frac{11}{25}$  (2)  $-\frac{11}{25}$   
(3)  $-\frac{3}{5}$  (4)  $\frac{3}{5}$

**Answer (2)**



**Sol.**

$$\frac{h-7}{2} = \frac{k-2}{1} = -2 \frac{(14+2-6)}{5} = -4$$

$\therefore h = -1, k = -2$

$\therefore B'(-1, -2)$

$$\therefore AB' = \frac{4}{5}y - \frac{3}{5}x + 1 = 0$$

$$a = \frac{4}{5}, b = \frac{-3}{5}$$

$$a^2 + b^2 + 3ab = \frac{16}{25} + \frac{9}{25} - \frac{36}{25} = \frac{-11}{25}$$

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**SECTION - B**

**Numerical Value Type Questions:** This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If  $|x + 1||x + 3| - 4|x + 2| + 5 = 0$ , then sum of squares of solutions is

**Answer (16.00)**

**Sol.** Let  $t = x + 2$

$$\Rightarrow |t^2 - 1| - 4|t| + 5 = 0$$

(1)  $t \in [1, \infty)$

$$t^2 - 4t + 4 = 0 \Rightarrow t = 2$$

(2)  $t \in [0, 1]$

$$\Rightarrow (t + 2)^2 = 10 \Rightarrow t = \sqrt{10} - 2 \text{ or } t = -\sqrt{10} - 2$$

No solution

(3)  $t \in [-1, 0]$

$$\Rightarrow (t + 2)^2 = 10 \Rightarrow \text{Again no solution}$$

(4)  $t \in (-\infty, -1), (t + 2)^2 = 0, t = -2$

$$\Rightarrow x + 2 = 2 \Rightarrow x = 0$$

$$x + 2 = -2 \Rightarrow x = -4$$

$$\Rightarrow \text{Sum of squares} = 0^2 + (-4)^2 = 16$$

22. For a given GP if sum of  $T_2 + T_6 = \frac{70}{3}$  and product  $(T_3 \times T_5) = 49$  and common ratio  $r > 1$  then find the sum of  $(T_4 + T_6 + T_8)$

**Answer (91)**

**Sol.**  $T_2 + T_6 = \frac{70}{3}$

$$ar + ar^5 = \frac{70}{3} \Rightarrow ar(1 + r^4) = \frac{70}{3} \quad \dots(1)$$

$$ar^2 \times ar^4 = 49$$

$$\Rightarrow a^2r^6 = 49$$

$$\Rightarrow (ar^3)^2 = 49$$

$$\Rightarrow ar^3 = \pm 7 \quad \dots(2)$$

Multiply equation (1) by  $r^2$

$$ar^3(1 + r^4) = \frac{70}{3} r^2$$

$$(1 + r^4) = \frac{10}{3} r^2$$

$$r^4 - \frac{10}{3}r^2 + 1 = 0$$

$$3r^4 - 10r^2 + 3 = 0$$

$$3r^4 - 9r^2 - r^2 + 3 = 0$$

$$3r^2(r^2 - 3) - 1(r^2 - 3) = 0$$

$$r^2 = 3, r^2 = \frac{1}{3}$$

Now,  $T_4 + T_6 + T_8$

$$= ar^3(1 + r^2 + r^4)$$

$$= 7(1 + 3 + 9) = 91$$

23. If  $\int \frac{dx}{\sqrt[5]{(x-1)^4(x+3)^6}} = A \left( \frac{ax-1}{bx-3} \right)^B$  then  $a + b$  is equal to

**Answer (12)**

**Sol.** Let  $\left( \frac{x+3}{x-1} \right) = t \Rightarrow x = \left( \frac{3+t}{t-1} \right)$

$$\Rightarrow dx = \frac{(t-1)(1) - 1(3+t)}{(t-1)^2} = \frac{-4}{(t-1)^2} dt$$

$$(x-1)^4(x+3)^6 = ((x-1)(x+3))^5 \left( \frac{x+3}{x-1} \right)$$

$$\Rightarrow I = \int \frac{\frac{-4}{(t-1)^2} dt}{t^{\frac{1}{5}} \left( \frac{3+t}{t-1} - 1 \right) \left( \frac{3+t}{t-1} + 3 \right)}$$

$$I = \int \frac{-4 dt}{t^{\frac{1}{5}} [t+3 - (t-1)] [3+t+3t-3]}$$

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$$I = \int \frac{-4 dt}{2t^5 (4t)}$$

$$= \frac{(-4)}{8} \int \frac{dt}{t^6} = \frac{(-4)}{8} \frac{\left(\frac{x+3}{x-1}\right)^{-1}}{\frac{-1}{5}}$$

$$\Rightarrow I = \frac{5}{2} \left(\frac{x-1}{x+3}\right)^{\frac{1}{5}}$$

Comparing,  $A = \frac{5}{2}, B = \frac{1}{5}, a = 1, b = 1$

$$\Rightarrow a + b + 20AB = 1 + 1 + 20 \times \frac{1}{2} = 12$$

24. Given  $f(x) = \begin{cases} \frac{\tan((a+1)x) + \tan x \cdot b}{x} & x < 0 \\ 3 & x = 0 \\ \frac{\sqrt{ax + b^2x^2} - \sqrt{ax}}{\sqrt{a} bx \sqrt{x}} & x > 0 \end{cases}$

It is continuous function at  $x = 0$ , then find  $\frac{b}{a}$ .

**Answer (6)**

**Sol.**  $\lim_{x \rightarrow 0^-} f(x) = f(0) = \lim_{x \rightarrow 0^+} f(x)$

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

$$\lim_{x \rightarrow 0^+} \frac{\sqrt{ax + b^2x^2} - \sqrt{ax}}{\sqrt{abx}\sqrt{x}}$$

$$= \lim_{x \rightarrow 0^+} \frac{\sqrt{a + b^2x} - \sqrt{a}}{\sqrt{abx}}$$

Rationalising

$$= \lim_{x \rightarrow 0} \frac{b^2x}{\sqrt{abx}(\sqrt{a + b^2x} + \sqrt{a})}$$

$$3 = \frac{b}{2a}$$

$$\Rightarrow \frac{b}{a} = 6$$

25. If complex number  $\frac{1+2i \cos \theta}{1-3i \cos \theta}$  is purely imaginary, then find the number of values of  $\theta$  in the interval  $[-2\pi, 2\pi]$ .

**Answer (08.00)**

**Sol.**  $\therefore \frac{1+2i \cos \theta}{1-3i \cos \theta} = \frac{(1+2i \cos \theta)(1+3i \cos \theta)}{1+9 \cos^2 \theta} =$  purely imaginary

$$\therefore 1 - 6 \cos^2 \theta = 0$$

$$\Rightarrow \cos^2 \theta = \frac{1}{6}$$

$$\therefore \cos \theta = \pm \frac{1}{\sqrt{6}}$$

$\therefore$  Total 8 solutions

26. If solution of differential equation  $xdy - ydx = xy(xdy - ydx)$  and  $y(1) = 1$  is

$$\alpha|y| = |x|e^{(\alpha y - \beta)}$$
 then  $(\alpha + \beta)$  is equal to

**Answer (02.00)**

**Sol.**  $(xdy - ydx) = xy(xdy + ydx)$

$$\Rightarrow \frac{dy}{y} - \frac{dx}{x} = xdy + ydx = d(xy)$$

$$\Rightarrow \ln|y| - \ln|x| = xy + c$$

$$\Rightarrow \ln\left(\frac{y}{x}\right) = (xy + c) \Rightarrow \left|\frac{y}{x}\right| = Ae^{xy}, A > 0$$

$$y(1) = 1$$

$$\Rightarrow 1 = Ae^1 \Rightarrow A = \frac{1}{e}$$

$$\Rightarrow \left|\frac{y}{x}\right| = e^{(xy-1)}$$

$$\Rightarrow |y| = |x|e^{(xy-1)}$$

27.

28.

29.

30.

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