03/04/2025
Evening

Aakash
Medical | IIT-JEE | Foundations

Corporate Office : AESL, 3rd Floor, Incuspaze Campus-2, Plot-13, Sector-18, Udyog Vihar, Gurugram, Haryana-122015

Join our Youtube channel for JEE Main Memory Based Paper Live Discussion

Memory Based Answers & Solutions

for

JEE (Main)-2025 (Online) Phase-2

(Physics, Chemistry and Mathematics)

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.

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. The ratio of intensities of two coherent sources is 1 : 9. The ratio of the maximum to the minimum intensities is

(1) 9 : 1

(2) 16 : 1

(3) 8 : 1

(4) 4 : 1

Answer (4)

Sol. $\frac{I_{max}}{I_{min}}=\left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2=\left(\frac{\sqrt{9}+\sqrt{1}}{\sqrt{9}-\sqrt{1}}\right)^2$

$\frac{I_{max}}{I_{min}}=\left(\frac{3+1}{3-1}\right)^2=4$

2. Excess pressure inside bubble *A* is half of that of bubble *B*. Find ratio of volume of bubble *A* to bubble *B*

(1) 8

(2) 4

(3) 27

(4) 16

Answer (1)

Sol. $\frac{4T}{R_A}=\frac{1}{2}\cdot\frac{4T}{R_B}$

$\frac{R_A}{R_B}=2$

$\frac{V_A}{V_B}=2^3=8$

3. In a resonance tube experiment at one end, resonance is obtained at two consecutive lengths l_1 = 100 cm and l_2 = 140 cm. If the frequency of the sound is 400 Hz, the velocity of sound is

(1) 320 m/s (2) 340 m/s

(3) 380 m/s (4) 300 m/s

Answer (1)

Sol. $\Delta l=\frac{\lambda}{2}$

$\lambda = 2 \times 40 = 80$ cm

$v=f\lambda=\frac{400\times80}{100}=320\,\text{m/s}$

4. Physical quantity S is given as $S=\frac{pq}{r^3\sqrt{t}}$. Find to percentage change in S if percentage change in p, q, r and t are 1, 1, 3 and 2 respectively.

(1) 7% (2) 9%

(3) 5% (4) 12%

Answer (4)

Sol. $\%S = \%p + \%q + 3\%r + \frac{1}{2}\%t$

$=1+1+3\times3+\frac{1}{2}(2)$

= 12%

5. In a medium of refractive index 2, the frequency of light is 5×10^{14} Hz, the wavelength of the light in the medium is

(1) 200 nm

(2) 300 nm

(3) 500 nm

(4) 600 nm

Answer (2)

Sol. $v = \frac{3}{2} \times 10^8$ m/s

$$\lambda = \frac{v}{f} = \frac{3}{2} \times \frac{10^8}{5 \times 10^{14}} = 3 \times 10^{-7}$$

= 300 nm

6. A capacitor C_1 = 100 pF is connected to a 60 V cell and then disconnected. C_1 is now connected to an uncharged capacitor C_2 such that the final potential across C_1 becomes 20 V. Find C_2 .

(1) 200 pF (2) 100 pF

(3) 600 pF (4) 50 pF

Answer (1)

Sol. $V_{final} = \frac{C_1V_1 + C_2V_2}{C_2 + C_2}$

$$20V = \frac{(100\,pF)(60V) + C_2(0V)}{100\,pF + C_2}$$

On Solving

C_2 = 200 pF

7. A bulb rated 100 W, 220 V connected to an ac supply of 220 V. Find peak current in the bulb.

(1) 8 A

(2) 0.64 A

(3) 3.2 A

(4) 2 A

Answer (2)

Sol. $P = V_{rms}\, I_{rms}$

$100 = 220\, I_{rms}$

$$I_{rms} = \frac{10}{22}$$

$$I = \frac{10}{22}\sqrt{2}$$

I = 0.64 A

8. **Statement-I :** O^{2-} and H^+ are projected in a magnetic field perpendicular to the field with same speed. The radius of curvature of O^{2-} will be less than H^+.

Statement-II : e^- and p^+ are projected in a magnetic field perpendicular to the field with same speed. The radius of curvature of e^- will be more the proton.

(1) Statement-I is correct, statement-II is incorrect

(2) Both statement-I and statement-II are correct

(3) Both statement-I and statement-II are incorrect

(4) Statement-I is incorrect, statement-II is correct

Answer (3)

Sol. $r = \frac{Vm}{Bq}$

$r_{O^{2-}} > r_{H+}$

$r_{p+} > r_{e-}$

9. The pressure of an ideal gas is increased by 0.4% keeping the volume constant. Find the initial temperature of the gas if there is a 1°C rise in temperature.

(1) 250 K

(2) 250°C

(3) 2500 K

(4) 2500°C

Answer (1)

Sol. $P \propto T$ (T is measured in K)

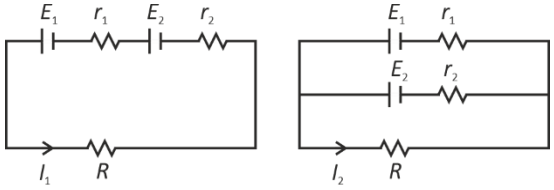
$\Rightarrow$ % change in P = % change in T

i.e. 0.4% change in T_i = 1°C

$$\frac{0.4}{100} \times T_i = 1°C = 1\,K$$

$$T_i = \frac{100}{0.4}\,K$$

= 250 K

10. 

In two situations given in figures (i) and (ii) current through R is I_1 and I_2 respectively. If $E_1 = 2$ V, $r_1 = 1\ \Omega$, $E_2 = 1$ V, $r_2 = 2\ \Omega$, $R = 6\ \Omega$ then find $\frac{I_1}{I_2}$.

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

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

(3) $\frac{9}{4}$

(4) $\frac{4}{9}$

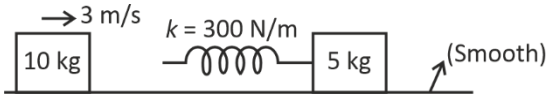
Answer (2)

Sol. $I_1 = \frac{E_{eq}}{r_1 + r_2 + R} = \frac{1}{3}$ $I_2 = \frac{E_{eq}}{r_{eq} + R}$ $E_{eq} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_1}} = \frac{5}{3}$

$i_2 = \frac{1}{4}$

$\frac{i_1}{i_2} = \frac{4}{3}$

11. A block of mass 10 kg is moving with speed 3 m/s collides with a spring connected to another block of mass 5 kg initially at rest. Find the compression in spring when both move with same speed



(1) 0.1 m (2) 0.2 m

(3) 1 m (4) 2 m

Answer (1)

Sol. $v_f = \frac{10 \times 3}{15} = 2$ m/s

$\frac{1}{2} k x^2 = \frac{1}{2} \times 10 \times 9 - \frac{1}{2} \times 15 \times 4$

$x^2 = \frac{30}{3000} = \frac{1}{100}$

$x = \frac{1}{10}$ m

12. The torque experienced by a magnetic dipole in a uniform magnetic field is $80\sqrt{3}$ N-m. If the angle between the magnetic moment and the magnetic field is 60°, the potential energy of the dipole is

(1) –80 J

(2) –60 J

(3) $\frac{80}{3}$ J

(4) –40 J

Answer (1)

Sol. Torque = $MB\sin\theta$

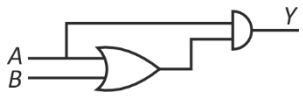
Potential Energy = $-MB\cos\theta$

$\Rightarrow$ Potential Energy = –(Torque) cot θ

i.e., = $-(80\sqrt{3})\cot 60°$ J

= – 80 J

13. The truth-table of the circuit shown is



(1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(2)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(3)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(4)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

Answer (D)

Sol. $Y = (A + B)A$

$= A + AB$

$= A(1 + B)$

$= A$

14. Match the following:

(i)	Boltzmann's constant	(a)	ML^2T^{-1}
(ii)	Coefficient of viscosity	(b)	$ML^2T^{-2}K^{-1}$
(iii)	Thermal conductivity	(c)	$ML^{-1}T^{-1}$
(iv)	Planck's constant	(d)	$MLT^{-3}K^{-1}$

(1) (i)-(c), (ii)-(b), (iii)-(a), (iv)-(d)

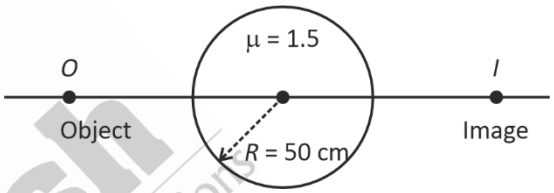
(2) (i)-(b), (ii)-(c), (iii)-(d), (iv)-(a)

(3) (i)-(b), (ii)-(d), (iii)-(a), (iv)-(c)

(4) (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)

Answer (2)

15. Find the distance of the object from the left surface, if the distance of the final image from the left surface is 200 cm



(1) 100 cm (2) 50 cm

(3) 200 cm (4) 75 cm

Answer (1)

Sol. Final image is at a distance + 100 cm from right surface

$$\Rightarrow \frac{1}{+100\text{ cm}} - \frac{1.5}{u'} = \frac{1-1.5}{-50\text{ cm}}$$

or $u' = \infty$

i.e., the rays become parallel after refraction from left surface

or $$\frac{1.5}{\infty} - \frac{1}{u} = \frac{1.5-1}{+50\text{ cm}}$$

$$-\frac{1}{u} = \frac{1}{100\text{ cm}}$$

$u = -100$ cm

16. The displacement of a particle is given as $x = C_0(t^2 - z) + C(t - z)^2$, where t is time in seconds and C_0 and C are constants the acceleration of the particle is

(1) C_0 (2) $2(C_0 + C)$

(3) C_0t^2 (4) $2(C_0 - 2C)$

Answer (2)

Sol. $x = C_0(t^2 - z) + C(t - z)^2$

$$\frac{dx}{dt} = 2C_0t + 2C(t - z)$$

$$a = \frac{d^2x}{dt^2} = 2C_0 + 2C = 2(C_0 + C)$$

17.

18. A solid ball of diameter 3.6 mm and having density 7825 kg/m^3. This ball has terminal velocity 2.56×10^{-2} m/s in a liquid of density 925 kg/m^3 find coefficient (in pascal sec) of viscosity.

(1) 190 (2) 1.9

(3) 256×10^{-3} (4) 38×10^{-3}

Answer (2)

Sol. $$V_T = \frac{2r^2(\rho - \rho_0)g}{9\eta}$$

$\eta = 1.89$

$\eta \simeq 1.9$

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. A block of mass 1 kg moves from $x = 0.1$ m to $x = 1.9$ m. The speed of block at $x = 0.1$ is 10 m/s. A resistive force $F = -10x$ acts on the block. Find speed of block (in m/s) when it is at $x = 1.9$ m.

Answer (8)

Sol. $$\text{Work} = -\int_{0.1}^{1.9} 10x\,dx$$

$$= -5(1.9^2 - 0.1^2)$$

$$= -5 \times 2 \times 1.8$$

$$= -18 \text{ J}$$

$$\frac{1}{2}1.v^2 = \frac{1}{2}1.(10)^2 - 18$$

$v^2 = 64$

$v = 8$ m/s

22. A projectile is fired with an initial velocity u, such that range of the projectile is 3 times the maximum height. If the range of the projectile is $\frac{Nu^2}{25g}$, Find value of N

Answer (24)

Sol. $$\frac{2u^2\sin\theta\cos\theta}{g} = \frac{3u^2\sin^2\theta}{2g}$$

$$\tan\theta = \frac{4}{3}$$

$$R = \frac{24u^2}{24g}$$

23. In a Hydrogen atom, an electron makes a transition from n^{th} orbit to 4^{th} excited state. Energy released in this transition 0.33 eV find the value of n.

Answer (8)

Sol. $$\Delta E = -13.6\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$0.33 = -13.6\left(\frac{1}{n^2} - \frac{1}{5^2}\right]$$

$n = 8$

24.

25.

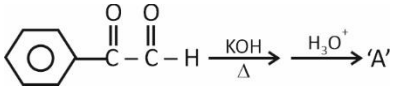
CHEMISTRY

SECTION - A

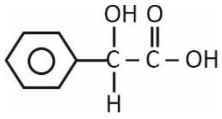
Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

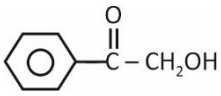
Choose the correct answer :

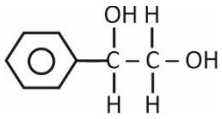
1. Consider the following reaction.

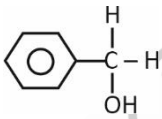


What is the product 'A'?

(1) 

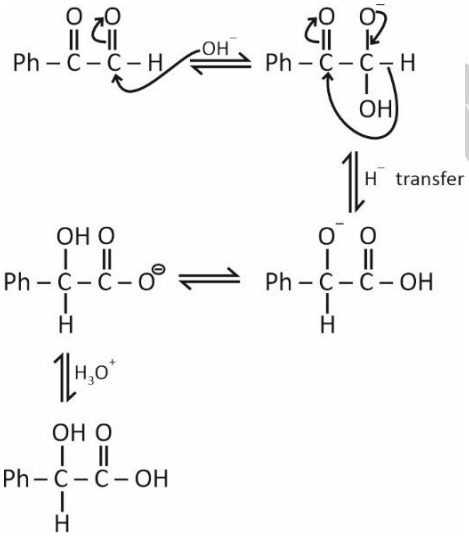
(2) 

(3) 

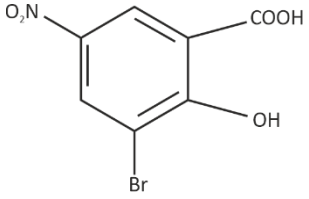
(4) 

Answer (1)

Sol.



2. The correct IUPAC name of the given compound is:



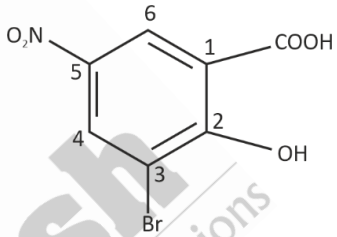
(1) 2-Hydroxy-3-bromo-5-nitrobenzoic acid

(2) 3-Bromo-2-hydroxy-5-nitrobenzoic acid

(3) 5-Bromo-6-hydroxy-3-nitrobenzoic acid

(4) 3-Nitro-6-hydroxy-6-bromobenzoic acid

Answer (2)

Sol. 

→ 3-Bromo-2-hydroxy-5-nitrobenzoic acid.

Naming will be done according to alphabetical order of substituents.

3. At 715 mm Hg pressure, 300 K, volume of N_2 (g) evolved was 80 mL by a 0.4 g sample of organic compound. Find % of N in organic compound

Aq. tension at 300 K = 15 mm Hg

(1) 20.95 (2) 25.85

(3) 30.25 (4) 15.83

Answer (1)

Sol. V_{N_2} at STP $= \dfrac{273\times(715-15)\times 80}{300\times 760}$

= 67.05 mL

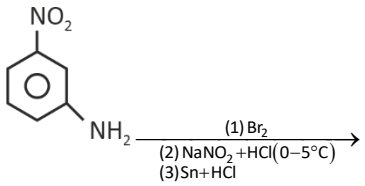
22400 mL weighs 28 g

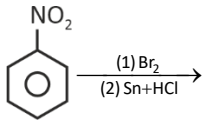
67.05 mL weighs $\frac{28}{22400}\times 67.05$

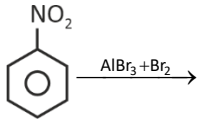
0.0838 g

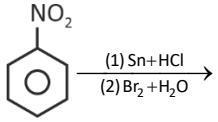
$\%\text{ of N} = \frac{0.0838}{0.4}\times 100 = 20.95$

4. Which of the following reagent is used to prepare tribromoaniline?

(1) 

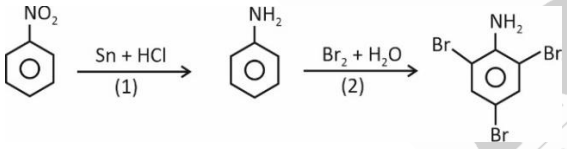
(2) 

(3) 

(4) 

Answer (4)

Sol.



Step (1) involves reduction of nitrobenzene to aniline and step (2) involves bromination of aniline to give 2, 4, 6-tribromoaniline

5. Match the following list-I with list-II :

List-I (Groups)	**List-II (Elements)**
(A) Pnictogens	(I) Rn
(B) Chalcogens	(II) At
(C) Halogens	(III) Te
(D) Noble gases	(IV) Bi

(1) A-I, B-II, C-III, D-IV (2) A-IV, B-III, C-II, D-I

(3) A-IV, B-II, C-III, D-I (4) A-I, B-III, C-II, D-IV

Answer (2)

Sol. Pnictogens $\rightarrow$ group-15 $\Rightarrow$ N, P, As, Sb, Bi

Chalcogens $\rightarrow$ group-16 $\Rightarrow$ O, S, Se, Te, Po

Halogens $\rightarrow$ group-17 $\Rightarrow$ F, Cl, Br, I, At

Noble gases $\rightarrow$ group-18 $\Rightarrow$ He, Ne, Ar, Kr, Xe, Rn

6. Find orbital angular momentum for 2*s* and 2*p* energy levels

(1) $0, \frac{h}{\left(\sqrt{2}\right)\pi}$ (2) $0, \frac{h}{\sqrt{2\pi}}$

(3) $\frac{h}{\pi}, \frac{h}{\pi}$ (4) $0, \frac{h}{2\pi}$

Answer (1)

Sol. Orbital angular momentum = $\frac{h}{2\pi}\sqrt{l(l+1)}$

For 2*s* l = 0

Orbital angular momentum = 0

For 2*p* l = 1 $\Rightarrow \frac{h}{2\pi}\sqrt{l(l+1)}$

$\frac{h}{\left(\sqrt{2}\right)\pi}$

7. Which of the following order is correct?

(A) Electronegativity : B > Tl > In > Ga > Al

(B) First Ionisation energy : B > Tl > Ga > Al > In

(C) Density : Tl > In > Ga > Al > B

(D) Size : B > Al > Ga > In > Al

(1) (A, B, C) only

(2) (B, C, D) only

(3) (A, B, D) only

(4) (A, B, C, D)

Answer (1)

Sol. EN : B > Tl > In > Ga > Al

(2.0) (1.8) (1.7) (1.6) (1.5)

IE_1 : B > Tl > Ga > Al > In

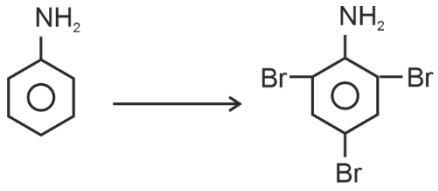
(801) (589) (579) (577) (558) (in kJ/mol)

Density : Tl > In > Ga > Al > B

(11.85) (7.31) (5.9) (2.7) (2.35) (in g/ml)

Size : B < Ga < Al < In < Tl

(85) (135) (143) (167) (170) (in pm)

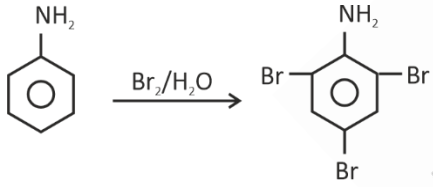
8.  ; reagent X in this reaction is

(1) Br_2/CCl_4 (2) Br_2/H_2O

(3) HBr/H_2SO_4 (4) Br_2/acetone

Answer (2)

Sol. Br_2 in water causes tribromination



H_2O Promotes formation of Br^+ in excess

9. Which of the following vitamins are fat-soluble?

B_{12}, C, D, B, E

(1) B and C

(2) D and E

(3) B and E

(4) C, D and E

Answer (2)

Sol. Fat soluble vitamins are (A, D, E and K)

10. Statement-I : CrO_3 is a strong oxidising agent

Statement-II : Cr^{+6} is more stable than Mo^{+6}

considering the above statements, choose the correct option.

(1) Both statement-I and Statement-II are correct

(2) Both statement-I and Statement-II are incorrect

(3) Statement-I is correct but Statement-II is incorrect

(4) Statement-I is incorrect but Statement-II is correct

Answer (3)

Sol. CrO_3 is a strong oxidising agent and itself is reduced to Cr^{3+} which is more stable than Cr^{6+} because Cr^{3+} has stable electronic configuration.

$Cr^{+6} + 3e \rightarrow Cr^{+3}$

Cr^{+3} : $3d^3$ or $t_{2g}^3 e_g^0$

$\therefore$ Statement-I is correct.

Stability of +6 state in group-6 increases down the group. Therefore, Mo^{+6} is more stable than Cr^{+6}. So, statement-II is incorrect.

11. Which of the following compound or complex ions is/are diamagnetic in nature

(a) CrO_3 (b) $[Fe(CN)_6]^{4-}$

(c) $[Co(H_2O)_3F_3]$ (d) $[Cr(NH_3)_6]^{3+}$

(1) a and b only

(2) a, b and c only

(3) a, b, c and d

(4) c and d only

Answer (2)

Sol. Species having unpaired electron are paramagnetic in nature

$CrO_3 \Rightarrow Cr^{+6} \Rightarrow$ 0 unpaired electron hence diamagnetic

$[Fe(CN)_6]^{4-}$

$Fe^{2+} \Rightarrow$ with CN^- (SFL)

$\Rightarrow t_{2g}^6 e_g^0$

Number of unpaired electron = 0

$\Rightarrow$ diamagnetic

$[Cr(NH_3)_6]^{3+}$

Cr^{3+} $3d^3$

t_{2g}^3 e_g^0

Number of unpaired electrons = 3

$\Rightarrow$ Paramagnetic

12. 20 mL 1M NaOH is mixed with 10 mL 2M HCl which is further diluted to 100 mL. Find concentration of final solution?

(1) 2×10^{-3} M

(2) 0.2 M

(3) 2×10^{-2} M

(4) 0.1 M

Answer (2)

Sol. $NaOH + HCl \rightarrow NaCl + H_2O$

20×1	10×2		
20mmol	20mmol		
0	0	20mmol	

So, concentration of NaCl = $\frac{20 \text{ m mol}}{100 \text{ mL}}$

= 0.2 M

13. Which of the following statement is correct w.r.t. Arrhenius equation?

(1) Dimensions of k and A are same

(2) k decreases with increase in temperature generally

(3) A decreases with increase in temperature always

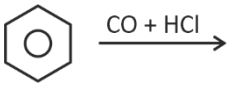
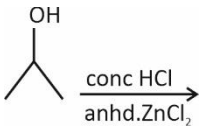
(4) k increases as value of E_a increase

Answer (1)

Sol. $k = Ae^{-\frac{E_a}{RT}}$

$E_a \uparrow$ $k \downarrow$

14. Match the column-I with column-II and choose the correct option

Column I	Column II
(P) Finkelstein reaction	(1) 
(Q) Lucas Test	(2) $R - X \xrightarrow[\text{Dry ether}]{Na}$
(3) Wurtz reaction	(3) 
(4) Gatterman Koch Reaction	(4) $CH_3CH_2Cl \xrightarrow[\text{Acetone}]{NaI}$

(1) P → (4), Q → (3), R → (2), S → (1)

(2) P → (1), Q → (2), R → (3), S → (4)

(3) P → (1), Q → (3), R → (2), S → (4)

(4) P → (3), Q → (2), R → (1), S → (4)

Answer (1)

Sol. P → (4), Q → (3), R → (2), S → (1)

15. **Statement-I :** When ice and water are at equilibrium, heat is absorbed by system, yet there is no increase in temperature until ice melts completely.

Statement-II : System absorbs the heat to break inter molecular H-bond and there is no increase in kinetic energy.

(1) Both statement-I and Statement-II are correct

(2) Statement-I is correct. Statement-II is incorrect

(3) Statement-I is incorrect. Statement-II is correct

(4) Both statements-I and II are incorrect

Answer (1)

Sol. Heat absorbed is consumed in conversion of solid ice to liquid water. So no temperature change. Even kinetic energy is same is the trasition.

16. **Statement-I :** Wet cotton clothes made up of cellulose based carbohydrates take a comparatively longer time to get dried than wet nylon based clothes.

Statement-II : Both form intermolecular H-bonds with water molecules

(1) Both statement-I and statement-II are correct

(2) Both statement-I and statement-II are incorrect

(3) Statement-I is correct but statement-II is incorrect

(4) Statement-I is incorrect but statement-II is correct

Answer (1)

Sol. Wet cellulose-based cotton clothes take longer time to dry than wet nylon-based clothes due to more number of H-bonds between cellulose and water molecules. So statement-I is correct. Statement-II is also correct as both the cellulose and nylon form intermolecular H-bonds with water molecules.

17.

18.

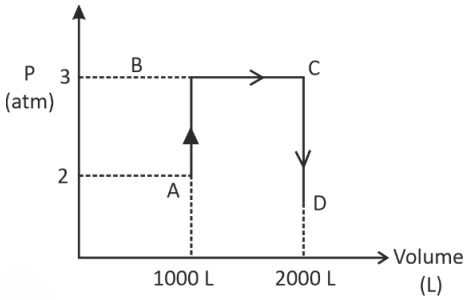
19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Find out magnitude of work done in the process ABCD (in kJ) (1 Latm = 101.3 J)



Answer (304)

Sol. (W) = 3 × 1000

= 3000 atm L

(W) = 303900 Joule

= 303.9 kJ

= 304 kJ

22. Amount of magnesium (Mg) (in mg) required to liberate 224 mL of H_2 gas at STP, when reacted with HCl.

Answer (240)

Sol. $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Moles of H_2 gas at STP $= \frac{224}{22400}$ mol

= 0.01 mol

1 mol H_2 formed by 1 mol of Mg.

mol of Mg required = 0.01 mol

mass of Mg required = 0.01 × 24

= 0.24 g

= 240 mg

23. Among Sc, Ti, Mn and Co, calculate the spin only magnetic moment in +2 oxidation state of metal having highest heat of atomisation

Answer (3)

Sol. Enthalpy of atomisation

Sc – 326 kJ mol^{-1}

Ti – 473 kJ mol^{-1}

Mn – 281 kJ mol^{-1}

Co – 425 kJ mol^{-1}

Ti has highest heat of atomisation

$Ti^{2+} \Rightarrow 3d^2$

$\mu_{spin\ only} = \sqrt{n(n+2)}$ BM

n = number of unpaired electrons

= 2

$\mu = \sqrt{2(2+2)}$

$= \sqrt{8}$ BM

= 2.82 BM

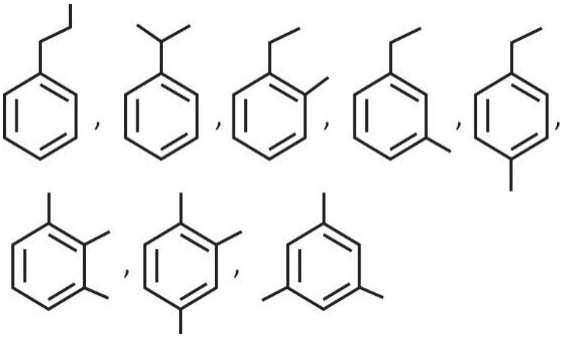
≈ 3 BM

24. C_9H_{12} is a derivative of benzene, how many total structural isomers of molecular formula C_9H_{12} are possible.

Answer (8)

Sol. Degree of unsaturation =

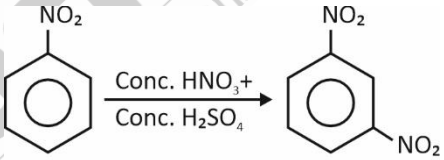
$$\frac{2\times 9+2-12}{2}=4$$



25. 'x' g of nitrobenzene gives 4.2 g 1, 3-dinitrobenzene with 100% yield. Find the value of 'x'.

Answer (3)

Sol.



'x' g 4.2 g

Molar mass of $C_6H_5NO_2$ = 123 g mol^{-1}

Molar mass of $C_6H_4(NO_2)_2$ = 168 g mol^{-1}

No. of moles of $C_6H_5NO_2$ = No of moles $C_6H_4(NO_2)_2$

$$\frac{x}{123}=\frac{4.2}{168}$$

x = 3.075 g ≃ 3 g

MATHEMATICS

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:

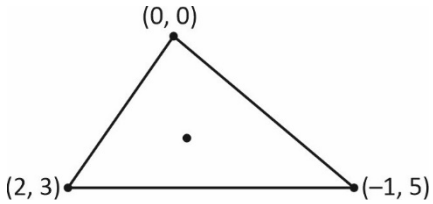
1. Let a circle C with radius r passes through four distinct points (0, 0), (K, $3k$), (2, 3) and (–1, 5), such that $k \neq 0$, then $(10k + 2r^2)$ is equal to

(1) 35 (2) 34

(3) 27 (4) 32

Answer (3)

Sol.



Centre $\equiv \left(\frac{-1}{2}, \frac{5}{2}\right)$

$\Rightarrow$ Radius $= \frac{\sqrt{26}}{2}$

$\Rightarrow \left(x+\frac{1}{2}\right)^2 + \left(y-\frac{5}{2}\right)^2 = \frac{26}{4}$

$(2x + 1)^2 + (2y – 5)^2 = 26$

$\Rightarrow 4x^2 + 4y^2 + 4x – 20y = 0$

$(K, 3k)$ lie on circle

$4k^2 + 36k^2 + 4k – 60k = 0$

$40k – 56 = 0 \Rightarrow k = \frac{7}{5}$

$\Rightarrow 10k + 2r^2 = 14 + 13 = 27$

2. $I = \int_0^{\pi} \frac{8x}{4\cos^2 x + \sin^2 x} dx$ equals to

(1) π^2 (2) $4\pi^2$

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

Answer (3)

Sol. $I = \int_0^{\pi} \frac{8x}{4\cos^2 x + \sin^2 x} dx$ ...(1)

$I = \int_0^{\pi} \frac{8(\pi - x)}{4\cos^2(\pi - x) + \sin^2(\pi - x)} dx$

$I = \int_0^{\pi} \frac{8(\pi - x)}{4\cos^2 x + \sin^2 x} dx$ ...(2)

Adding (1) and (2)

$2I = 8\pi \int_0^{\pi} \frac{1}{4\cos^2 x + \sin^2 x} dx$

$I = 4\pi \times 2 \int_0^{\frac{\pi}{2}} \frac{\sec^2 x}{4\tan^2 x} dx$

Put $\tan x = t$

$\sec^2 x\, dx = dt$

$I = 8\pi \int_0^{\infty} \frac{dt}{4 + t^2}$

$I = 8\pi \frac{1}{2}\left(\tan^{-1}\frac{t}{2}\right)_0^{\infty}$

$I = 4\pi\left(\frac{\pi}{2}\right)$

$\boxed{I = 2\pi^2}$

3. $S = 1 + \frac{1+3}{1!} + \frac{1+3+5}{2!} + ...\infty$. The value of S is equal to

(1) $4e - 2$ (2) $4e$

(3) $5e$ (4) $7e$

Answer (3)

Sol. $S=\frac{1^2}{0!}+\frac{2^2}{1!}+\frac{3^2}{2!}+\ldots$

$$T_n=\frac{n^2}{(n-1)!}$$

$$=\frac{n^2-1}{(n-1)!}+\frac{1}{(n-1)!}$$

$$=\frac{(n-1)(n+1)}{(n-1)!}+\frac{1}{(n-1)!}$$

$$=\frac{n+1}{(n-2)!}+\frac{1}{(n-1)!}$$

$$=\frac{n-2+3}{(n-2)!}+\frac{1}{(n-1)!}$$

$$T_n=\frac{1}{(n-3)!}+\frac{3}{(n-2)!}+\frac{1}{(n-1)!}$$

$$\sum_{n=1}^{\infty}T_n=e+3e+e=5e$$

4. Let $y = f(x)$ be the solution of the differential equation $\frac{dy}{dx}+3y\tan^2 x+3y=\sec^2 x$ such that $f(0)=\frac{e^3}{3}+1$, then $f\left(\frac{\pi}{4}\right)$ is equal to

(1) $(1+e^{-3})$ (2) $\frac{2}{3}\left(1+\frac{1}{e^3}\right)$

(3) $\frac{1}{3}\left(1-\frac{1}{e^3}\right)$ (4) $\frac{1}{3}\left(1+\frac{1}{e^3}\right)$

Answer (2)

Sol. $\frac{dy}{dx}+3y(1+\tan^2 x)=\sec^2 x$

$$\Rightarrow \frac{dy}{dx}+y(3\sec^2 x)=\sec^2 x$$

I.F. = $e^{\int 3\sec^2 dx}=e^{3\tan x}$

$$\Rightarrow y(e^{3\tan x})=\int e^{3\tan x}\cdot\sec^2 x dx+c$$

$$=\frac{e^{3\tan x}}{3}+c$$

$$f(0)=\frac{e^3}{3}+1$$

$$y(e^0)=\frac{e^0}{3}+c=\frac{e^3}{3}+1$$

$$\Rightarrow c=\frac{e^3}{3}+\frac{2}{3}$$

$$f\left(\frac{\pi}{4}\right)\Rightarrow y\left(\frac{\pi}{4}\right)e^3=\frac{e^3}{3}+\frac{e^3}{3}+\frac{2}{3}$$

$$\Rightarrow y\left(\frac{\pi}{4}\right)=\frac{1}{e^3}\left[\frac{2e^3+2}{3}\right]$$

$$=\frac{2}{3}\left[1+\frac{1}{e^3}\right]$$

5. Area bounded by $|x-y|\le y\le 4\sqrt{x}$ is equal to (in square units)

(1) $\frac{2048}{3}$ (2) $\frac{1024}{3}$

(3) $\frac{512}{3}$ (4) $\frac{128}{3}$

Answer (2)

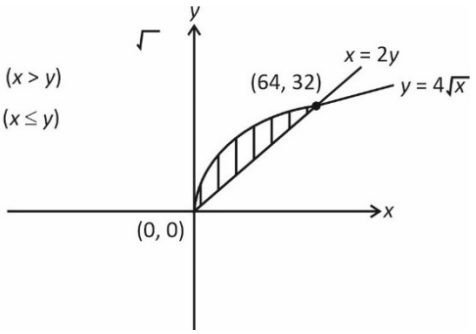
Sol. $|x-y|\le y\le 4\sqrt{x}$

$x=2y$

$x-y=y \quad (x>y)$

$x-y=-y \quad (x\le y)$

$x=0$



$$\text{Area}=\int_0^{64}\left(4\sqrt{x}-\frac{x}{2}\right)dx$$

$$=\frac{4x^{3/2}}{\frac{3}{2}}-\frac{x^2}{4}\Bigg]_0^{64}=\frac{8}{3}(8)^3-\frac{64^2}{4}=\frac{1024}{3}$$

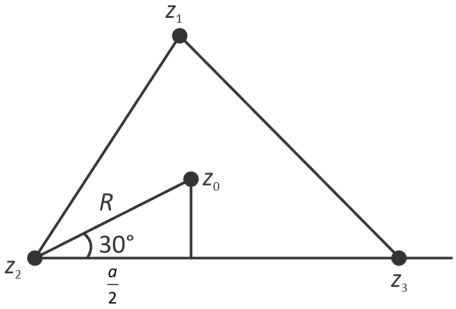
6. Let $A(z_1)$, $B(z_2)$ and $C(z_3)$ are the vertices of an equilateral triangle. If z_0 is the centroid of triangle ABC and $|z_1 - z_2| = 1$ then the value of $\sum_{i=1}^{3}|z_i - z_0|^2$ is equal to

(1) 1 (2) 2

(3) 3 (4) 9

Answer (1)

Sol.



$$\Rightarrow \cos 30^\circ = \frac{\sqrt{3}}{2} = \frac{\frac{a}{2}}{R} \Rightarrow R = \frac{a}{\sqrt{3}}$$

$$\Rightarrow |z_1 - z_0| = |z_2 - z_0| = |z_3 - z_0| = \frac{a}{\sqrt{3}}$$

$$\Rightarrow \sum_{i=1}^{3}|z_i - z_0|^2 = 3\cdot\left(\frac{a}{\sqrt{3}}\right)^2 = \frac{3.a^2}{3}$$

$= a^2 = |z_1 - z_2|^2 = 1$

7. If $f(x) = \|x+2| - 2|x|\|$, then the sum of number of points of local maxima and local minima is

(1) 5 (2) 3

(3) 2 (4) 7

Answer (2)

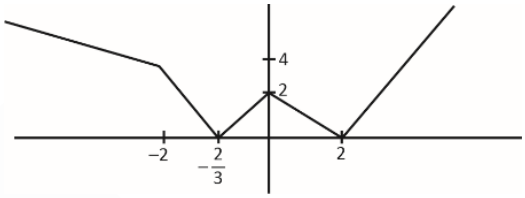
Sol. $$f(x) = \begin{cases} |-x-2+2x| & x \le -2 \\ |x+2+2x| & -2 \le x \le 0 \\ |x+2-2x| & x \ge 0 \end{cases}$$

$$f(x) = \begin{cases} |-x-2+2x| & x \le -2 \\ |x+2+2x| & -2 \le x \le 0 \\ |x+2-2x| & x \ge 0 \end{cases}$$

$$f(x) = \begin{cases} |x-2| & x \le -2 \\ |3x+2| & -2 < x \le 0 \\ |2-x| & x > 0 \end{cases}$$

$$f(x) = \begin{cases} 2-x & x \le -2 \\ -3x-2 & -2 < x \le -\frac{2}{3} \\ 3x+2 & -\frac{2}{3} < x \le 0 \end{cases}$$

$$f(x) = \begin{cases} 2-x & x \le -2 \\ -3x-2 & -2 < x \le -\frac{2}{3} \\ 3x+2 & -\frac{2}{3} < x \le 0 \\ 2-x & 0 < x < 2 \\ x-2 & x \ge 2 \end{cases}$$



No. of maxima = 1

No. of minima = 2

8. If $x(x-2)(12-k) = 2$ has both roots same. Then the distance of $\left(k, \frac{k}{2}\right)$ from the line $3x + 4y + 5 = 0$ is

(1) 24 (2) 14

(3) 15 (4) 20

Answer (3)

Sol. $x^2 - 2x - \frac{2}{12-k} = 0$

$D = 0$

$$4 - 4\cdot\left(-\frac{2}{12-k}\right) = 0$$

$$\Rightarrow 1 + \frac{2}{12-k} = 0$$

$$\Rightarrow k = 14$$

$$\therefore \left(k, \frac{k}{2}\right) \equiv (14, 7)$$

$$d = \left|\frac{3\times 14 + 4\times 7 + 5}{5}\right|$$

$= 15$

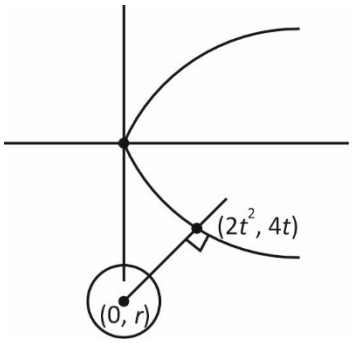
9. The shortest distance between the parabola $y^2 = 8x$ and the circle $x^2 + y^2 + 12y + 35 = 0$ is

(1) $(2\sqrt{2}-1)$ units (2) $(\sqrt{2}-1)$ units

(3) $(2\sqrt{2}+1)$ units (4) $(\sqrt{2}+1)$ units

Answer (1)

Sol.



The common normal passes through centre and on which shortest distance will lie.

$$y^2 = 8x \Rightarrow 2y\frac{dy}{dx} = 8 \Rightarrow \frac{dy}{dx} = \frac{4}{y}$$

$\Rightarrow$ Slope of normal: $\frac{-y}{4} = \frac{-4t}{4} = -t$

$\Rightarrow \quad -t = \frac{4t+6}{2t^2-0} \Rightarrow 2t^3 + 4t + 6 = 0$

$\Rightarrow (t + 1)(2t^2 - 2t + 6) = 0$

$\Rightarrow$ $t = -1$ is only point

$\Rightarrow$ distance = distance between (0, –6) to (2, –4) – radius of circle = $= 2\sqrt{2} - 1$

10. Let $f(x) = \log_4(1 - \log_7(x^2 - 9x + 8))$. If the domain of $f(x)$ is $(\alpha, \beta) \cup (\gamma, \delta)$. Then $\alpha + \beta + \gamma + \delta$ equals to

(1) 18 (2) 27

(3) 21 (4) 9

Answer (1)

Sol. $1 - \log_7(x^2 - 9x + 8) > 0$

$\Rightarrow \log_7(x^2 - 9x + 8) < 1$

$\Rightarrow x^2 - 9x + 8 < 7$

$\Rightarrow x^2 - 9x + 1 < 0$

$\Rightarrow x = \frac{9 \pm \sqrt{81-4}}{2}$

$\Rightarrow x = \frac{9 \pm \sqrt{77}}{2}$

$x^2 - 9x + 8 > 0$

$\Rightarrow x^2 - 8x - x - 8 > 0$

$\Rightarrow x(x-8) - 1(x-8) > 0$

$\Rightarrow (x-1)(x-8) > 0$

$\therefore x \in \left(\frac{9-\sqrt{77}}{2}, 1\right) \cup \left(8, \frac{9+\sqrt{77}}{2}\right)$

$\therefore \alpha + \beta + \gamma + \delta = \frac{9-\sqrt{77}}{2} + 1 + 8 + \frac{9+\sqrt{77}}{2}$

$\therefore \boxed{\alpha + \beta + \gamma + \delta = 18}$

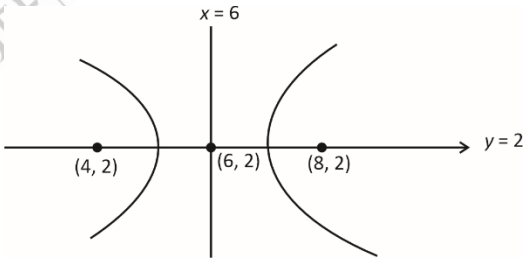
11. If the coordinates of foci of a hyperbola $3x^2 - y^2 - \alpha x + \beta y + \gamma = 0$ are (4, 2) and (8, 2). Then $(\alpha + \beta + \gamma)$ is equal to

(1) 81 (2) 137

(3) 121 (4) 141

Answer (4)

Sol.



Hyperbola:

$$\frac{(x-6)^2}{a^2} - \frac{(y-2)^2}{b^2} = 1$$

$b^2x^2 - a^2y^2 - 12xb^2 + 4ya^2 + 4ya^2 + 36b^2 - 4a^2 - a^2b^2 = 0$

Comparing: $\frac{b^2}{a^2}=3 \Rightarrow e^2=1+\frac{b^2}{a^2}=4$

$\Rightarrow e=2$

Similarly, $2ae=4 \Rightarrow a=1 \Rightarrow b=\sqrt{3}$

$\frac{(x-6)^2}{1}-\frac{(y-2)^2}{3}=1$

$\Rightarrow 3x^2-y^2-36x+4y+108-4-3=0$

$3x^2-y^2-36x+4y+101=0$

$\Rightarrow \alpha = 36$

$\beta = 4$

$\gamma = 101$

$\Rightarrow \alpha+\beta+\gamma = 141$

12. Let the probability distribution is defined for a random variable x as $p(x)=k(1-3^{-x})$ for x = 0, 1, 2, 3. Then $P(x \geq 2)$ is

(1) $\frac{5}{17}$ (2) $\frac{25}{34}$

(3) $\frac{25}{68}$ (4) $\frac{7}{25}$

Answer (2)

Sol. $\Rightarrow \sum p(x)=1$

$\Rightarrow k\left[1-3^{-0}+1-3^{-1}+1-3^{-2}+1-3^{-3}\right]=0$

$k\left[4-\left(1+\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}\right)\right]=1$

$\Rightarrow k=\frac{27}{68}$

Now $P(x \geq 2)=p(x=3)+P(x=2)$

$=\frac{27}{68}\left(1-\frac{1}{3^3}\right)+\frac{27}{68}\left(1-\frac{1}{3^2}\right)$

$=\frac{26}{68}+\frac{3}{68}(8)=\frac{50}{68}=\frac{25}{34}$

13. If the mean and variance of a data x_1 = 1, x_2 = 4, x_3 = a, x_4 = 7, x_5 = b are 5 and 10 respectively. If new data is $r+x_r$, $r \in \{1, 2, 3, 4, 5\}$, then the new variance is

(1) 17.6 (2) 16.9

(3) 20.4 (4) 21.4

Answer (3)

Sol. $5=\frac{1+4+a+7+b}{5} \Rightarrow a+b=13$

$10=\frac{1+16+a^2+49+b^2}{5}-(5)^2$

$a^2+b^2 = 109$

$a = 3, b = 10$

New digits: $r+x_r$, $r \in [1, 5]$

$1+x_1, 2+x_2, 3+x_3, 4+x_4, 5+x_5$

$\equiv 2, 6, 6, 11, 15$

Variance = $\frac{2^2+6^2+6^2+11^2+15^2}{5}-\left(\frac{2+6+6+11+15}{5}\right)^2$

= 20.4

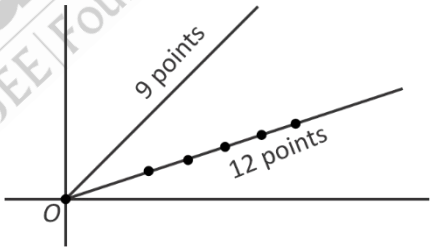
14. Let 9 points lie on the line $y = 2x$ and 12 points on the $y=\frac{x}{2}$ in the first quadrant. Find the number of triangles formed using these points and origin.

(1) 1134 (2) 1096

(3) 1120 (4) 1026

Answer (1)

Sol.



Total triangles : (two points of $y = 2x$, 1 point of $y=\frac{x}{2}$) + (two points on $y=\frac{x}{2}$, 1 point of $y = 2x$) + (1 point on $y = 2x$, 1 point of $y=\frac{x}{2}$ and origin)

$= {}^9C_2 \cdot {}^{12}C_1 + {}^9C_1 \cdot {}^{12}C_2 + {}^1C_1 \cdot {}^9C_1 \cdot {}^{12}C_1$

= 1134

15.

16.

17.

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If $\lim\limits_{x\to 0}\left(\frac{\tan x}{x}\right)^{\frac{1}{x^2}} = P$,

then 96 ln P is

Answer (32)

Sol. $\lim\limits_{x\to 0}\left(\frac{\tan x}{x}\right)^{\frac{1}{x^2}}$ 1^{∞} (form)

I^L

$$L = \lim_{x\to 0}\left(\frac{\tan x}{x} - 1\right)^{\frac{1}{x^2}}$$

$$= \lim_{x\to 0}\left(\frac{\tan - x}{x^3}\right)$$

$$= \lim_{x\to 0}\left(\frac{x + \frac{x^3}{3} + \frac{2}{15}x^5 + \cdots - x}{x^3}\right)$$

$$= \frac{1}{3}$$

$$\therefore \quad = \lim_{x\to 0}\left(\frac{\tan x}{x}\right)^{\frac{1}{x^2}} = e^{1/3} = P$$

$$96 \ln P = \frac{96}{3} = 32$$

22. Let $A = \{-3, -2, -1, 0, 1, 2, 3\}$. A relation R is defined such that xRy iff $y = \max\{x, 1\}$.

Number of elements required to make it reflexive is l, number of elements required to make it symmetric is m and number of elements in the relation R is n. Then value of $l + m + n$ is equal to

Answer (15)

Sol. $R = \{(-3, 1), (-2, 1), (-1, 1), (0, 1), (1, 1), (2, 2), (3, 3)\}$

$\therefore \quad l = 4$ i.e., $(-3, -3), (-2, -2), (-1, -1), (0, 0)$

$m = 4$ i.e., $(1, -3), (1, -2), (1, -1), (1, 0)$

$n = 7$

$l + m + n = 15$

23. If $(1 + x + x^2)^{10} = 1 + a_1 x + a_2 x^2 + \ldots$, then $(a_1 + a_3 + a_5 + \ldots + a_{19}) - 11a_2$ equals to

Answer (28919)

Sol. $(1 + x + x^2)^{10} = 1 + a_1 x + a_2 x^2 + \ldots + a_{20} x^{20}$ ...(i)

$x = 1$

$3^{10} = 1 + a_1 + a_2 + \ldots + a_{20}$ ...(ii)

$x = -1$

$1 = 1 - a_1 + a_2 + \ldots + a_{20}$ ...(iii)

(ii) – (iii)

$3^{10} - 1 = 2\left[a_1 + a_3 + \ldots + a_{19}\right]$

$$\Rightarrow a_1 + a_3 + a_5 + \ldots + a_{19} = \frac{3^{10} - 1}{2}$$

Diff. (i) w.r.t. x

$10(1 + x + x^2)^9 (1 + 2x) = a_1 + 2a_2 x + \ldots + 20a_{20} x^{19}$

Again diff. w.r.t. x and substitute $x = 0$

$10\left[9(1 + x + x^2)^8 (1 + 2x)^2 + (1 + x + x^2)^9 (2)\right] = 2a_2 + \ldots$

$10\left[9 + 2\right] = 2a_2$

$55 = a_2$

Now

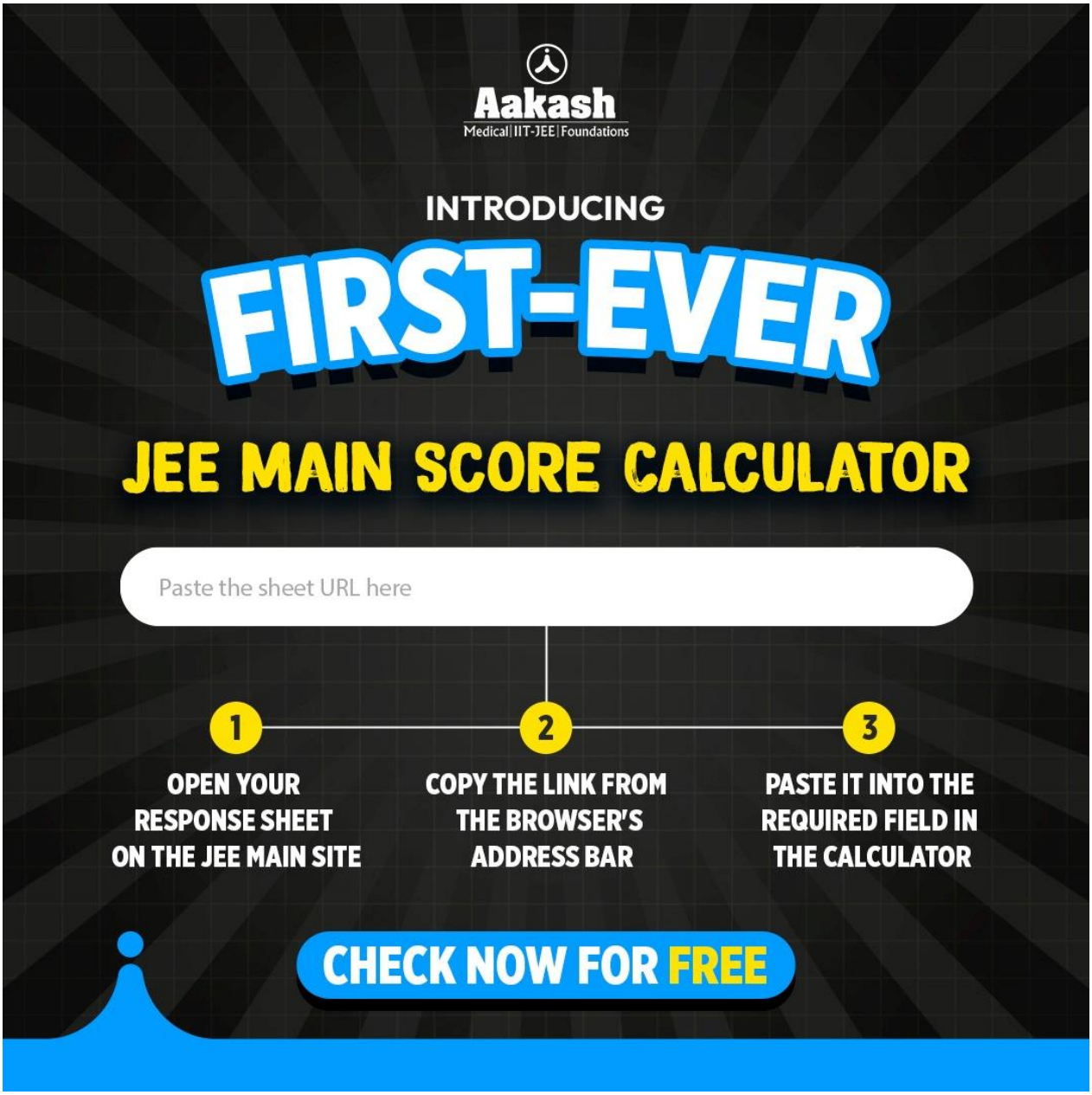
$$(a_1 + a_3 + \ldots + a_{19}) - 11a_2 = \frac{3^{10} - 1}{2} - 55 \times 11$$

$= 28919$

24.

25.

❑ ❑ ❑



Curious about your JEE Main score?

Get an instant estimate with our JEE Main Score Calculator - https://bit.ly/4jau6gR