23/01/2026
Morning

Aakash
Medical | IIT-JEE | Foundations

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Memory Based
Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2026 (Online) Phase-1

(Physics, Chemistry and Mathematics)

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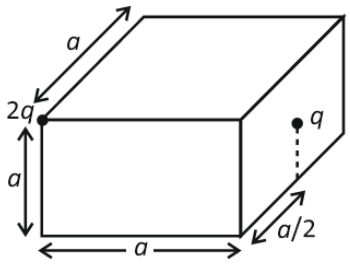
PHYSICS

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. There are two point charges, one at vertex and other at face as shown the cube. Find electric flux through the cube.



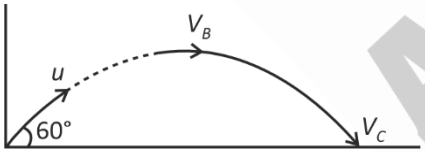
(1) $3q/\varepsilon_0$ (2) q/ε_0

(3) $3q/4\varepsilon_0$ (4) $5q/\varepsilon_0$

Answer (3)

Sol. $\phi = \frac{q_{enc}}{\varepsilon_0} = \frac{\frac{2q}{8}+\frac{q}{2}}{\varepsilon_0} = \frac{3q}{4\varepsilon_0}$

2. If a projectile is being projected with speed v at an angle 60° with horizontal. Find the ratio of speed at highest point (V_B) to the speed at final point (V_C).



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

(3) 1 : 2 (4) 1 : 12

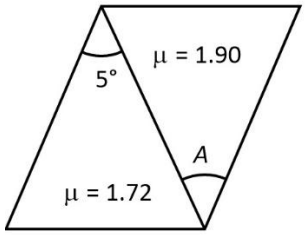
Answer (3)

Sol. $V_C = v$

$V_B = v\cos 60° = \frac{v}{2}$

$\frac{V_B}{V_C} = \frac{1}{2}$

3. Find A for dispersion without deviation.



(1) 3 (2) 4

(3) 4.5 (4) 5

Answer (2)

Sol. $A_1(\mu_1 - 1) = A_2(A_2 - 1)$

$5(0.72) = A(.9)$

$\Rightarrow A = 4$

4. For the given set of measurement find relative error.

20.00, 19.75, 18.25, 17.01

(1) 0.12 (2) 0.06

(3) 0.09 (4) 0.17

Answer (2)

Sol. $\bar{x} = \frac{20.00+18.25+19.75+17.01}{4}$

$\Rightarrow \bar{x} = 18.75$

$\Rightarrow |\Delta\bar{x}| = \frac{1.25+0.5+1+1.74}{4} = 1.12$

$\frac{\Delta\bar{x}}{\bar{x}} = \frac{1.12}{18.75} = 0.06$

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5. Find out the correct energy for the ground state or energy transition. (symbols have usual meaning & $n \rightarrow m$ gives the transition)

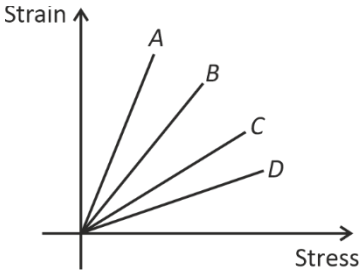
(1) H (–6.8 eV) (2) Li^{2+} (–13.6 eV)

(3) $He^{+}_{2\rightarrow1}$ (40.8 eV) (4) $Be^{3+}_{2\rightarrow1}$ (+13.6 eV)

Answer (3)

Sol. $E_n = 13.6\,\frac{z^2}{n^2}$

6. Which of the following material has bigger Young's modulus



(1) *A* (2) *B*

(3) *C* (4) *D*

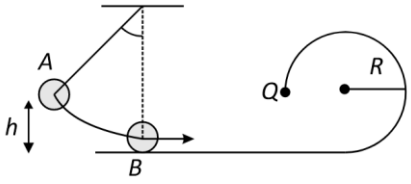
Answer (4)

Sol. $\text{Slope} = \frac{\text{Strain}}{\text{Stress}}$

$Y = \frac{1}{\text{Slope}}$

Thus *D*

7. Find *h* (in m) such that ball *B* just be able to reach *Q* after elastic collision with A. Mass of both the bodies are same m. (R = 10 cm)



(1) $\frac{3}{5}$ (2) $\frac{1}{\sqrt{5}}$

(3) $\frac{1}{4}$ (4) $\frac{1}{5}$

Answer (3)

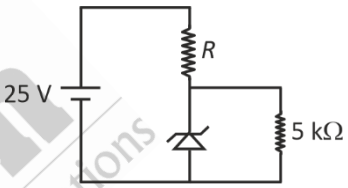
Sol. $V_A = V_B$, $V_A = \sqrt{5gR}$

$m_A gh = \frac{1}{2} m_A v_A^2$

$h = \frac{5}{2}R$

$h = \frac{5}{2}R = \frac{5}{2} \times \frac{1}{10} = \frac{1}{4}$

8. For the given circuit the breakdown voltage of Zener diode is V_z = 5 volts. And it can with stand maximum current of I_Z = 5 mA.



Find the value of *R*.

(1) $\frac{10}{3}$ kΩ (2) 5 kΩ

(3) $\frac{15}{4}$ kΩ (4) 8 kΩ

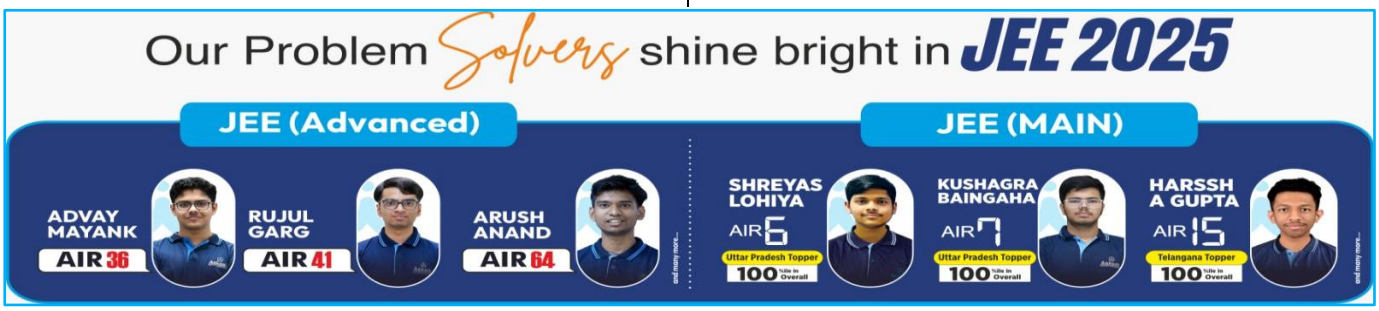
Answer (1)

Sol. I_1 across 6 kΩ is

$I_1 = \frac{5}{5000} = 1$ mA

So, total I = 6 mA

$R = \frac{20}{6} \times 1000 = \frac{10}{3}$ kΩ



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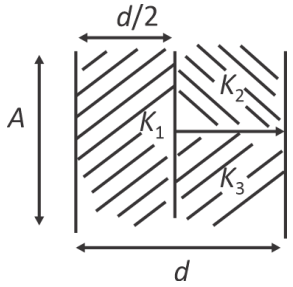
9. Find capacitance of capacitor given below if each plate has area A and separation is d between them.



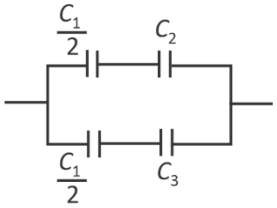
$K_1 = 3 \quad K_2 = 5 \quad K_3 = 2$

(1) $\frac{123\varepsilon_0 A}{40d}$ (2) $\frac{140\varepsilon_0 A}{6d}$

(3) $\frac{120\varepsilon_0 A}{30d}$ (4) $\frac{128\varepsilon_0 A}{4d}$

Answer (1)

Sol.



$C_1 = \frac{6\varepsilon_0 A}{d} \quad C_2 = \frac{5\varepsilon_0 A}{d} \quad C_3 = \frac{2\varepsilon_0 A}{d}$

$C_{eq} = \frac{123\varepsilon_0 A}{40d}$

10. A simple pendulum of length 3 m completes 20 oscillations in 10 sec. What is length of another pendulum which completes 40 oscillations in same times

(1) 0.75 m (2) 1.5 m

(3) 12 m (4) 6 m

Answer (1)

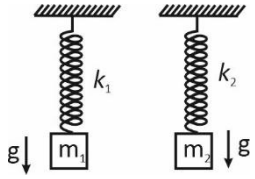
Sol. $T = 2\pi\sqrt{\frac{l}{g_{eff}}}$

$\frac{Y_2}{Y_4} = \frac{\sqrt{3}}{\sqrt{l}}$

$l = \frac{3}{4}\text{m}$

11. Find ratio of energy stored in the two springs as shown in figure below

Given: $\frac{K_1}{K_2} = \frac{1}{2}$ and $\frac{m_1}{m_2} = \frac{1}{4}$



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

(3) $\frac{1}{8}$ (4) 1

Answer (3)

Sol. Given : $\frac{k_1}{k_2} = \frac{1}{2}$ and $\frac{m_1}{m_2} = \frac{1}{4}$

$E = \frac{2kq}{r^2} \Rightarrow E_{net} = E\sqrt{3}$

12. In two different YDSE setup, two different monochromatic wave are used but fringe width on the screen is same. If $\frac{\lambda_1}{\lambda_2} = \frac{1}{2}$ and $\frac{d_1}{d_2} = \frac{2}{1}$, then find the ratio of $\frac{D_1}{D_2}$ (All symbols are standard).

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

(3) 2 (4) 4

Answer (4)

Sol. $\Delta\omega = \frac{\lambda D}{d}$

So, $\frac{\lambda_1 D_1}{d_1} = \frac{\lambda_2 D_2}{d_2}$

$\frac{D_1}{D_2} = \left(\frac{d_1}{d_2}\right)\cdot\left(\frac{\lambda_2}{\lambda_1}\right) = \left(\frac{2}{1}\right)\times\left(\frac{2}{1}\right)$

$\frac{D_1}{D_2} = 4$

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13. A 25 kg mass moving with 30 m/s and another mass 15 kg of same material moving with 10 m/s in opposite direction, collides perfectly inelastically. Find the rise in temperature of the system.

(Given: $C = 5 \times$ cal/g°C & 1 cal = 4.2 J)

(1) $\frac{1}{50}$ °C

(2) $\frac{1}{112}$ °C

(3) $\frac{1}{150}$ °C

(4) $\frac{1}{125}$ °C

Answer (1)

Sol. $25 \times 30 - 15 \times 10 = 40\ V_f \Rightarrow V_f = 15$ m/s

$$K\varepsilon_i - K\varepsilon_f = \frac{1}{2}25\times900+\frac{1}{2}\times15\times100-\frac{1}{2}40(225) = 7500 \text{ J}$$

$$ms\Delta T = 7500 \Rightarrow \Delta T = \frac{7500}{40\times5000\times4.2} = \frac{1}{112} \text{ °C}$$

14. Two point particles of masses $2m$ and m are attached to ends of a massless rod of length l. Find Angular momentum of this system about an axis passing through their center of mass and perpendicular to the rod if the system is rotating with angular velocity ω about the axis.

(1) $\frac{2}{3}m\omega l^2$

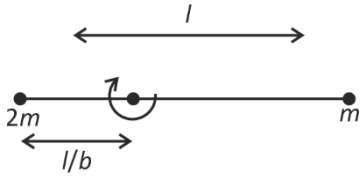
(2) $\frac{1}{3}m\omega l^2$

(3) $\frac{m\omega l^2}{9}$

(4) $m\omega l^2$

Answer (1)

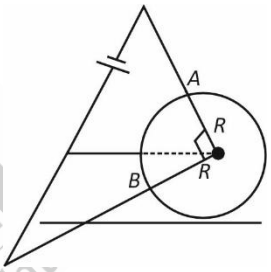
Sol.



$$L = 2m\omega\left(\frac{l}{3}\right)^2 + m\omega\left(\frac{20}{3}\right)^2$$

$$L = \frac{2}{9}m\omega l^2 + \frac{4}{9}m\omega l^2 = \frac{2}{3}m\omega l^2$$

15. A uniform wire is bent into the shape of a circle of radius R has resistance per unit length = λ. A battery is connected across point A and B which substends an angle of 90° at its centre as shown. Find the equivalent resistance of this circuit.



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

(3) $\frac{3\pi}{8}\lambda R$ (4) $\frac{\pi}{4}\lambda R$

Answer (3)

Sol. $R_1 = \lambda\frac{3\pi R}{2}; R_2 = \frac{\lambda\pi}{2}R$

$$R_{eq} = \frac{\lambda\frac{\pi}{2}R\,\lambda\frac{3\pi}{2}R}{\pi\frac{\pi}{2}R+\lambda\frac{3\pi}{2}R} = \frac{\lambda^2\frac{3\pi^2}{4}R^2}{\lambda\times2\pi R}$$

$$R_{eq} = \frac{3\pi}{8}\lambda R$$

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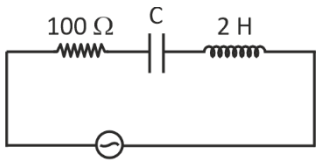
16. The peak current in given LCR series Ac circuit shown is 5 mA then capacitance in μF is nearly.



$\varepsilon = 50\sin 100t$

(1) 1 (2) 3

(3) 4 (4) 5

Answer (1)

Sol. $5\times10^{-3} = \dfrac{50}{\sqrt{(100)^2 + (200 - X_C)^2}}$

$10^4 + (200 - X_C)^2 = 10^8$

$(200 - X_C) \approx \pm 10^4$

$X_C \approx 10^4 = \dfrac{1}{\omega C}$

$C = 10^{-6}$

17. Two media of refractive indices n_1 & n_2 have plane interface. Speed of light in 1st is 2.4×10^8 m/s & in 2nd is 2.8×10^8 m/s.

Find critical angle of incidence when light travels from 1st to 2nd.

(1) $\sin^{-1}\left(\dfrac{6}{7}\right)$ (2) $\sin^{-1}\left(\dfrac{7}{8}\right)$

(3) $\sin^{-1}\left(\dfrac{8}{9}\right)$ (4) $\tan^{-1}\left(\dfrac{9}{8}\right)$

Answer (1)

Sol. $\dfrac{n_1}{n_2} = \dfrac{2.8\times10^8}{2.4\times10^8} = \dfrac{1}{\sin(\theta_c)}$

$\Rightarrow \quad \theta_c = \sin^{-1}\left(\dfrac{6}{7}\right)$

18. **Assertion (A):** In a ferromagnetic material, magnetic dipole are aligned in a localized domain.

Reason (R): When ferromagnetic substance is heated above the curie temperature, its magnetic properties are weakened heavily.

(1) A is correct, R is correct and correct explanation of A

(2) A is correct, R is correct but not correct explanation of A

(3) Both A and R are incorrect

(4) A is correct, R is incorrect

Answer (2)

Sol. Conceptual.

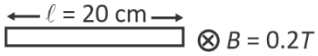
19.

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 emf induced in Rod after it has fallen through 2000 *m* under gravity (in volt).



Answer (8)

Sol. $\varepsilon = Bvl = 0.2\times\sqrt{2gh}\times l$

$\Rightarrow$ 8 volt

22.

23.

24.

25.

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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:

1. The correct order of ionisation energy of

Cl, S, P, Al, Si is

(1) Cl > P > S > Si > Al

(2) P > Cl > S > Al > Si

(3) Cl > S > P > Si > Al

(4) Cl > Al > Si > P > S

Answer (1)

Sol. **kJ/mol**

Cl ⇒ 1256

S ⇒ 999

P ⇒ 1012

Al ⇒ 577

Si ⇒ 786

2. Consider the statements below :

Statement I : $[CoBr_4]^{2-}$ absorbs lesser energy than $[CoCl_4]^{2-}$.

Statement II : $[CoCl_4]^{2-}$ has higher crystal field splitting energy than $[CoBr_4]^{2-}$.

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

(3) Statement I correct and statement II incorrect

(4) Statement I incorrect and statement II correct

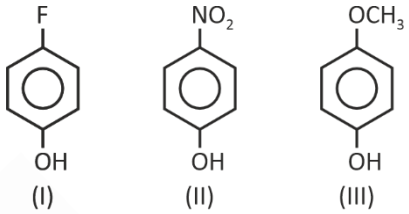
Answer (1)

Sol. Order of ligand strength $Cl^- > Br^-$

$[CoCl_4]^{2-}$ absorb more energy than $[CoBr_4]^{2-}$

$[CoCl_4]^{2-}$ has more CFSE value due to strength of ligand.

3. Arrange in increasing order of acid strength.



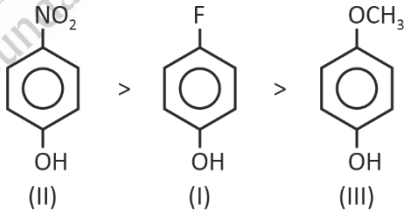
(1) (II) > (I) = (III)

(2) (I) > (II) > (III)

(3) (II) > (I) > (III)

(4) (II) = (I) > (III)

Answer (3)

Sol. K_a order 

4. Which of the following undergo nitration at fastest rate?

(1) $C_6H_5NO_2$

(2) $C_6H_5CH_3$

(3) C_6H_5COOH

(4) C_6H_5Br

Answer (2)

Sol. Methyl group is activating group

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5. For the following change,

$$\underset{5°C}{H_2O(\ell)} \rightarrow \underset{100°C}{H_2O(g)}$$

Select the correct answer:

(1) q = +ve, w = +ve, ΔH = +ve

(2) q = –ve, w = –ve, ΔH = +ve

(3) q = +ve, w = –ve, ΔH = +ve

(4) q = –ve, w = –ve, ΔH = –ve

Answer (3)

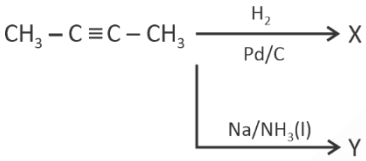
Sol. $\underset{5°C}{H_2O(\ell)} \rightarrow \underset{100°C}{H_2O(g)}$

$\rightarrow \because$ expansion w = –ve.

$\rightarrow$ It is heat absorbing, so, q = +ve.

ΔH = +ve

6. Consider the following reaction



Choose the correct option.

(1) X $\Rightarrow$ $CH_3–CH_2–CH_2–CH_3$

Y $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (cis)

(2) X $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (cis)

Y $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (trans)

(3) X $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (cis)

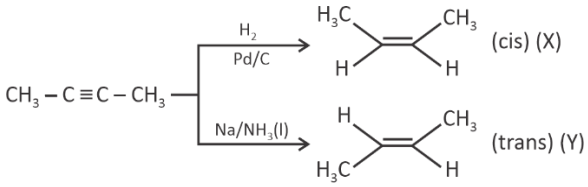
Y $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (cis)

(4) X $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (trans)

Y $\Rightarrow$ $CH_3 – CH = CH – CH_3$ (cis)

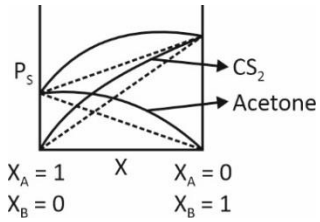
Answer (2)

Sol.

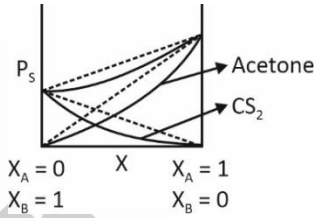


7. A binary solution is formed by mixing Acetone (A) and CS_2 (B). The variation of vapour pressure v/s mole fraction will be

(1)



(2)



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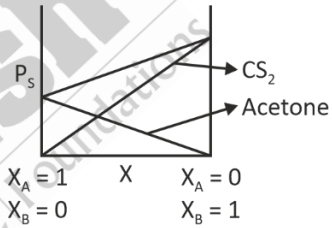
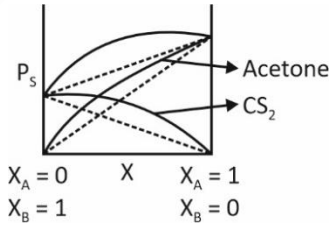


(4)



Answer (1)

Sol. $P^o_{CS_2} \approx 510\,mm\,Hg$

$P^o_{Acetone} \approx 310\,mm\,Hg$

CS_2 and Acetone shows positive deviation

$P_S > P^o_A X_A + P^o_B X_B$

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8. Match the List-I with List-II and choose the correct option :

	List-I		List-II
(a)	2nd orbit of He^+ ion	(i)	-1.96×10^{-17} J
(b)	3rd orbit of H-atom	(ii)	-2.42×10^{-19} J
(c)	1st orbit of Li^{2+} ion	(iii)	-2.178×10^{-18} J
(d)	2nd orbit of Li^{2+} ion	(iv)	-4.9×10^{-18} J

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

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

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

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

Answer (1)

Sol. $E_n = -2.178 \times 10^{-18} \frac{z^2}{n^2} J$

(a) z – 2, n = 2

(b) z = 1, n = 3

(c) z = 3, n = 1

(d) z = 3, n = 2

9. Given below are two statements.

Statement I: Sublimation is a purification technique that is used to separate those solid substances which changes from solid to vapour state without passing through liquid state.

Statement II: If external atmospheric pressure is reduced, then boiling point of substance is decreased.

In the light of 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

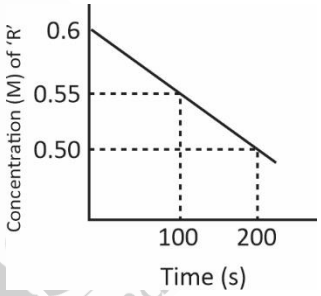
(4) Statement I is incorrect but statement II is correct

Answer (1)

Sol. Sublimable compounds are those compounds which changes from solid to vapour state without passing through liquid state.

Boiling point depends on external atmospheric pressure.

10. Consider the following graph of concentration vs time, of a reaction, R → P



Find half-life of reaction.

(1) 600 s

(2) 200 s

(3) 300 s

(4) 100 s

Answer (1)

Sol. The graph shows straight line for concentration vs time.

For zero order

$A_t = -kt + A_0$

At, t = 100 s, conc. = 0.55

At t = 200 s, conc. = 0.5

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$$k = -\frac{\text{Change in concentration}}{\text{Change in time}}$$

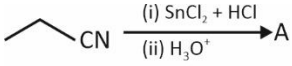
$$= \frac{0.5-0.55}{200-100} = \frac{0.05}{100}$$

$k = 5 \times 10^{-4}\ ms^{-1}$

$$t_{\frac{1}{2}} = \frac{A_0}{2k}$$

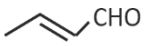
$$= \frac{0.6}{2\times5\times10^{-4}}$$

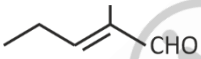
$$= \frac{6000}{100} = 600\ s$$

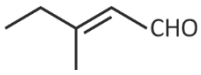


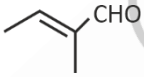
11. $CH_3 - CH = CH - CH_3 \xrightarrow[(ii)\ Zn\text{-}H_2O]{(i)\ O_3} A$

A and B are mixed and treated with dil. base to give mixture of products. Choose the incorrect product.

(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. $CH_3 - CH_2 - CN \xrightarrow[(ii)\ H_3O^+]{(i)\ SnCl_2+HCl} \underset{(A)}{CH_3 - CH_2 - CHO}$

$CH_3 - CH = CH - CH_3 \xrightarrow[Zn\text{-}H_2O]{O_3} \underset{(B)}{CH_3 - CHO}$

$CH_3 - CH_2 - CHO + CH_3 - CHO \xrightarrow{OH^-}$

$CH_3 - CH_2 - CH = CH - CHO$

$+$

$CH_3 - CH = CH - CHO$

$+$

$CH_3 - CH = CH - CH_3$
$\quad\quad\quad

CFSE = $-0.4 \times 6\ \Delta_o = -2.4\ \Delta_0$

Ratio of CFSE $= \frac{-1.2\Delta_o}{-2.4\Delta_o} = \frac{1}{2}$

14. Select the correct statement about 13th group elements.

A. Electronegativity decreases regularly down the graph.

B. Ionic radii decreases down the graph.

C. Boron has highest ionisation energy.

D. Trichloride of aluminium are covalent in nature.

(1) A, B, C only (2) C, D only

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

Answer (2)

Sol. (A) is false

EN → B > Al < Ga < In < Tl

2 1.5 1.6 1.7 1.8

(B) is false

Ionic radii → $B^{3+} < Al^{3+} < Ga^{3+} < In^{3+} < Tl^{3+}$

(C) is true

I.E. →	B	Al	Ga	In	Tl
(kJ/mol^{-1})	800	577	579	558	589

15. Match List-I with List-II.

	List-I		List-II
A.	Bayer's unsaturation test	(I)	Violet/purple colour
B.	Cerric ammonium nitrate test of alcohols	(II)	Red colour
C.	Tollen's reagent test	(III)	Silver mirror obtained
	$FeCl_3$ test of phenol	(IV)	Pink colour discharge

Select the correct option.

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

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

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

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

Answer (3)

Sol. A. Bayer's unsaturation test → Pink colour discharges

B. Cerric ammonium nitrate test of alcohols → The colour of solution changes from yellow to red

C. Tollen's reagent test → Silver mirror (Ag↓) is observed

D. $FeCl_3$ test of phenol → Violet colour complex is formed

16. Consider the given cell

$Ag(s)|AgCl(s)|Cl^-(aq)|FeCl_2(aq), FeCl_3(aq)|Pt(s)$

In which of the following cases, E_{cell} will increase

(1) $[Fe^{2+}]$ increases
$[Cl^-]$ increases

(2) $[Fe^{2+}]$ increases
$[Cl^-]$ decreases

(3) $[Fe^{3+}]$ & $[Cl^-]$ increase

(4) $[Fe^{2+}]$ decreases
$[Fe^{3+}]$ decreases

Answer (3)

Sol.

Anode $Ag(s) + Cl^-_{(aq)} \rightarrow AgCl(s) + e^-$

Cathode $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$

$$Ag(s) + Cl^-(aq) + Fe^{3+}(aq) \rightarrow Fe^{2+}(aq) + AgCl(s)$$

$$Q = \frac{[Fe^{2+}]}{[Fe^{3+}][Cl^-]}$$

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$$E_{cell} = E^{\circ}_{cell} - \frac{0.06}{1}\log\frac{[Fe^{2+}]}{[Fe^{3+}][Cl^{-}]}$$

E_{cell} increase if $[Fe^{3+}]$ & $[Cl^{-}]$ increases

E_{cell} decreases if $[Fe^{2+}]$ increases

17. Consider the following statements and choose the correct option(s)

(A) Ni^{2+} forms cherry red colour complex with dimethyl glyoximate ligand (dmg)

(B) Ni^{2+} complex with dmg contains two ring of five membered

(C) Ni^{2+} has 2 unpaired electron in d-orbitals in the complex

(D) Ni^{2+} complex with dmg is soluble at $p^H = 9$

(1) Only A & B

(2) Only B & C

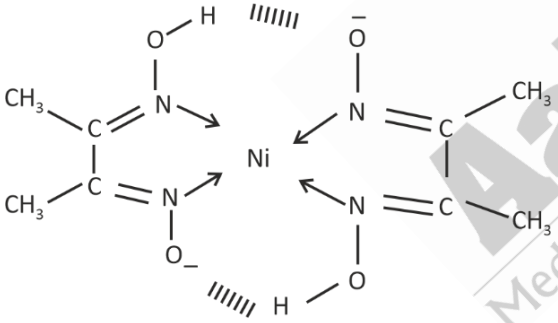
(3) Only A & C

(4) Only A, C and D

Answer (1)

Sol. $Ni^{2+} + 2dmg \rightarrow [Ni(dmg)_2]$

1. $[Ni(dmg)_2]$ is of pink colour



2. 2 five membered ring is present.

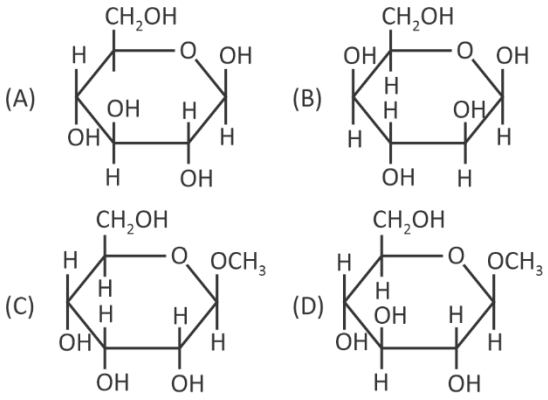
3. Ni^{2+} with dmg for dsp^2 hybridised square planar complex

$Ni^{2+} \Rightarrow 3d^8$

no unpaired electron

4. $[Ni(dmg)_2]$ is soluble at low pH

18. Consider the following molecules.



The examples of non-reducing sugar(s) are

(1) A, B only (2) A, C only

(3) B, D only (4) C, D only

Answer (4)

Sol. (A), (B) are reducing sugars as it contains hemiacetal linkage.

(C), (D) are non-reducing sugar as it contain acetal linkage.

19. Following molecules are given :

HNO_3, NF_3, H_2SO_4, O_3

Consider the molecule (T) having maximum number of lone pairs (on all atoms).

The bond angle (∠XMX), where M is central atom in T is

(1) 110° (2) 97°

(3) 102° (4) 115°

Answer (3)

Sol. NF_3 has 10 lone pairs.

Bond angle is 102.3°.

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.

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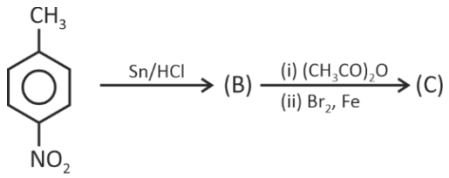
21. In the reaction sequence, what is the mass (in grams) of product (C) formed?

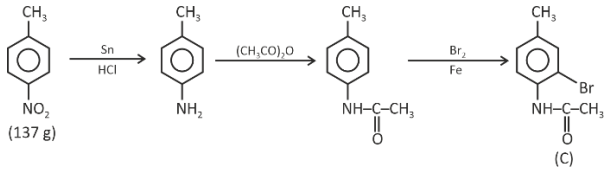


(A)

(137 g)

Answer (228)

Sol.



moles of (A) = $\frac{137}{137} = 1$ mole.

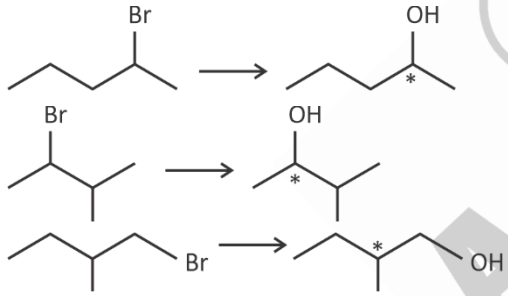
moles of (C) formed = 1 moles

mass of (C) = 1 × 228 = 228 (g)

22. $C_5H_{11}Br$ reacts with aq. KOH without rearrangement. How many optically active compounds are formed.

Answer (3)

Sol.



23. x g of pure Cl_2 is reacted with $Ba(OH)_2$ to form $Ba(ClO_3)_2$. $Ba(OH)_2$ concentration is 1 M and volume is 25 mL. Find x.

Answer (2)

Sol. $6Cl_2 + 6Ba(OH)_2 \rightarrow Ba(ClO_3)_2 + 5BaCl_2 + 6H_2O$

1 M × 25 mL

= 25 m mol

6 mol of $Ba(OH)_2$ reacted with 6 mol Cl_2

25 m mol of $Ba(OH)_2$ reacted with 25 m mol of Cl_2

mol of Cl_2 reacted = 25×10^{-3} mol

mass of $Cl_2 = 25 \times 10^{-3} \times 71 = 1.775\ g \approx 2g$

24. For the reaction,

$$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$$

Total pressure at equilibrium = $\sqrt{3}$ atm

K_p = 9 atm

$\alpha = x \times 10^{-1}$

Use $\sqrt{2} = 1.41$

Find x. (Report to nearest integer)

Answer (9)

$$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$$

Sol. $t = 0$ P

$t = t_{eq}$ $P - \alpha P$ $\frac{\alpha P}{2}$ $\frac{3\alpha P}{2}$

$P + \alpha P = \sqrt{3}$ ...(1)

$$9 = K_p = \frac{\left(\frac{3\alpha P}{2}\right)^{3/2}\left(\frac{\alpha P}{2}\right)^{1/2}}{P(1-\alpha)} \quad ...(2)$$

$P(1+\alpha) = \sqrt{3} \Rightarrow P = \frac{\sqrt{3}}{1+\alpha}$

$$\Rightarrow 9 = \frac{\left[\frac{3\alpha \times \sqrt{3}}{2(1+\alpha)}\right]^{3/2}\left[\frac{\alpha \times \sqrt{3}}{1+\alpha}\right]^{1/2}}{\frac{\sqrt{3}}{1+\alpha}[1-\alpha]}$$

$$= \frac{\left[\frac{3\sqrt{3}}{2}\right]^{3/2}[\sqrt{3}]^{1/2}\left[\frac{\alpha}{1+\alpha}\right]^{3/2}\left[\frac{\alpha}{1+\alpha}\right]^{1/2}}{(\sqrt{3})\left(\frac{1-\alpha}{1+\alpha}\right)}$$

Solving α = 0.86

= 8.6×10^{-1}

25.

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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. A rectangle is formed by lines $x = 0$, $y = 0$, $x = 3$, $y = 4$. A line perpendicular to $3x + 4y + 6 = 0$ divides the rectangle into two equal parts, then the distance of the line from $\left(-1, \frac{3}{2}\right)$ is

(1) 2 (2) $\frac{17}{10}$

(3) $\frac{6}{5}$ (4) $\frac{8}{5}$

Answer (2)

Sol. Concept : line passes through centre of the rectangle $\equiv \left(\frac{3}{2}, 2\right)$

$\Rightarrow 4x - 3y = C$ passes through $\left(\frac{3}{2}, 2\right)$

$\Rightarrow C = 0$

$\Rightarrow$ distance of $\left(-1, \frac{3}{2}\right)$ from $4x - 3y = 0$ is $\frac{\left|-4 - \frac{9}{2}\right|}{5} = \frac{17}{10}$

2. Let $A = \{-2, -1, 0, 1, 2, 3, 4\}$ and R be a relation R, such that $R = \{(x, y) : (2x + y) \le -2, x \in A, y \in A\}$

Let l = number of elements in R

m = minimum number of elements to be added in R to make it reflexive

n = minimum number of elements to be added in R to make it symmetric, then $(l + m + n)$ is

(1) 10 (2) 17

(3) 11 (4) 14

Answer (2)

Sol. $R = \{(x, y) : 2x + y \le -2, x \in A, y \in A\}$

$A = \{-2, -1, 0, 1, 2, 3, 4\}$

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

$l = 9$

$m = 5$

$n = \{(-2, 1), (-2, 2), (-1, 0)\} = 3$

3. Number of 4 letter words with or without meaning formed from the letters of the word PQRSSSTTUVV is

(1) 1232 (2) 1400

(3) 1422 (4) 1162

Answer (3)

Sol. Case A : The word is ABCD

$\Rightarrow {}^7C_4 \cdot 4! = 840$

Case B: The word is AAAB

$\Rightarrow (SSS) \times ({}^6C_1) \Rightarrow {}^6C_1 \cdot \frac{4!}{3!} = 24$

Case C : The word is AABB

$\Rightarrow {}^3C_2 \cdot \frac{4!}{2!2!} = 18$

Case (D) : The word is AABC

$\Rightarrow \left({}^3C_1\right) \cdot \left({}^6C_2\right) \cdot \frac{4!}{2!} = 3 \times 15 \times 12 = 540$

Answer 1422

4. The area (in square units) bounded by the curve $f(x) = \max\{\sin x, \cos x\}$ and x-axis between $x = 0$ and $x = \frac{3\pi}{2}$ is A sq. unit. Then, the value of $A + A^2$ is

(1) $8 - 2\sqrt{2}$ (2) $8 + 2\sqrt{2}$

(3) $6 - 2\sqrt{2}$ (4) $6 + 2\sqrt{2}$

Answer (1)

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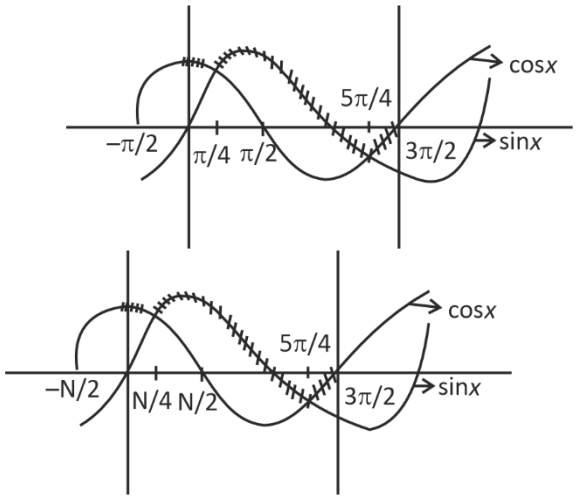
Sol.



$$\text{Required Area} = = \int_0^{\pi/4} \cos x dx + \int_{\pi/4}^{5\pi/4} \sin x dx$$

$$+ \int_{5\pi/4}^{3\pi/2} \cos x dx$$

$$= [\sin x]_0^{\pi/4} + [-\cos x]_{\pi/4}^{5\pi/4} + [\sin x]_{5\pi/4}^{3\pi/2}$$

$$= \frac{1}{\sqrt{2}} - \left[\frac{-1}{\sqrt{2}} - \frac{1}{\sqrt{2}}\right] + \left[-1 + \frac{1}{\sqrt{2}}\right]$$

$$= \frac{1}{\sqrt{2}} + \sqrt{2} - 1 + \frac{1}{\sqrt{2}}$$

$$A = 2\sqrt{2} - 1$$

$$A + A^2 = (2\sqrt{2} - 1) + (2\sqrt{2} - 1)^2$$

$$= 2\sqrt{2} - 1 + 8 + 1 - 4\sqrt{2} = 8 - 2\sqrt{2} \text{ sq. unit}$$

5. The value of $\frac{{}^{100}C_{50}}{51} + \frac{{}^{100}C_{51}}{52} + \ldots\ldots \frac{{}^{100}C_{100}}{101}$ is

(1) $\frac{2^{100}}{100}$ (2) $\frac{2^{101}}{101}$

(3) $\frac{2^{100}}{101}$ (4) $\frac{2^{101}}{100}$

Answer (3)

Sol. $(1+x)^{100} = {}^{100}C_0 + {}^{100}C_1 x + {}^{100}C_2 x^2 + \ldots\ldots + {}^{100}C_{100} x^{100}$

$$\sum_{r=50}^{100} \frac{{}^{100}C_r}{r+1} = \frac{1}{101} \sum_{r=50}^{100} {}^{101}C_{r+1}$$

$$\Rightarrow \frac{1}{101} \sum_{r=51}^{100} {}^{101}C_r$$

$$\Rightarrow \frac{2^{100}}{101}$$

6. For given vectors $\vec{a} = -\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{b} = 2\hat{i} - \hat{j} + \hat{k}$ where $\vec{c} = \vec{a} \times \vec{b}$ and $\vec{d} = \vec{c} \times \vec{b}$. Then the value of $(\vec{a} - \vec{b}) \cdot \vec{d}$ is

(1) -35 (2) 53

(3) -52 (4) 25

Answer (1)

Sol. $\vec{a} = -\hat{c} + \hat{j} + 2\hat{k}$

$\vec{b} = 2\hat{c} - \hat{j} + \hat{k}$

$\vec{c} = \vec{a} \times \vec{b} = 3\hat{c} + 5\hat{j} - \hat{k}$

$\vec{d} = \vec{c} \times \vec{b}$

Now

$$(\vec{a} - \vec{b}) \cdot \vec{d} = (\vec{a} - \vec{b}) \cdot (\vec{c} \times \vec{b})$$

$$= \vec{a} \cdot (\vec{c} \times \vec{b}) - \vec{b} \cdot (\vec{c} \times \vec{b})$$

$$= -[\vec{a}\ \vec{b}\ \vec{c}]$$

$$= -35$$

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{c} & \hat{j} & \hat{k} \\ -1 & 1 & 2 \\ 2 & -1 & 1 \end{vmatrix} = 3\hat{c} + 5\hat{j} - \hat{k}$$

$$\text{And } [\vec{a}\ \vec{b}\ \vec{c}] = \begin{vmatrix} -1 & 1 & 2 \\ 2 & -1 & 1 \\ 3 & 5 & -1 \end{vmatrix} = 35$$

$$\Rightarrow -[\vec{a}\ \vec{b}\ \vec{c}] = -35$$

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7. The line $y = x + 1$ intersects the ellipse $\frac{x^2}{2}+\frac{y^2}{1}=1$ at A and B. Find the angle sub-stained by segment AB and centre of ellipse is

(1) $\frac{\pi}{2}+\tan^{-1}\left(\frac{1}{4}\right)$

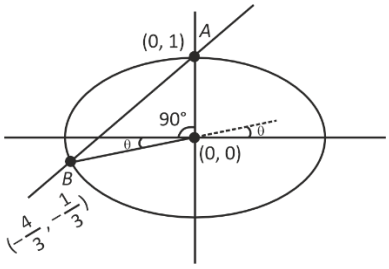
(2) $\frac{\pi}{2}-\tan^{-1}\left(\frac{1}{4}\right)$

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

(4) $\frac{\pi}{4}+\tan^{-1}\left(\frac{1}{4}\right)$

Answer (1)

Sol.



$y = x + 1$ intersects $\frac{x^2}{2}+y^2=1$

$\Rightarrow \frac{x^2}{2}+(x+1)^2=1 \Rightarrow x^2 + 2x^2 + 4x = 0$

$\Rightarrow x = 0, \frac{-4}{3}$

$\Rightarrow$ Points A and B are

$(0, 1), \left(\frac{-4}{3},\frac{-1}{3}\right)$

$\theta=\tan^{-1}\left(\frac{\frac{-1}{3}}{\frac{-4}{3}}\right)=\tan^{-1}\left(\frac{1}{4}\right)$

$\Rightarrow \angle AOB = \frac{\pi}{2}+\tan^{-1}\left(\frac{1}{4}\right)$

8. Find $\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{dx}{1+(\tan 2x)^{1/3}}$

(1) $\frac{\pi}{24}$ (2) $\frac{\pi}{12}$

(3) $\frac{\pi}{6}$ (4) $\frac{\pi}{48}$

Answer (2)

Sol. $I=\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{1}{1+(\tan 2x)^{1/3}}dx$ ...(1)

$\Rightarrow I=\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{1}{1+\tan\left(2\left(\frac{5\pi}{24}+\frac{\pi}{24}-4\right)\right)^{1/3}}dx$

$I=\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{1}{1+\tan\left(\frac{\pi}{2}-2x\right)^{1/3}}dx$ ...(2)

From equation (1) and (2)

$2I=\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{(\tan(2x))^{1/3}+1}{1+(\tan 2x)^{1/3}}dx$

$=(x)\Big|_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \Rightarrow I=\frac{1}{2}\times\frac{4\pi}{24}=\frac{\pi}{12}$

9. The number of solutions of $13\cos 2\theta + 8\cos\theta - 3\sqrt{3} = 0$ if $\theta \in [-3\pi, 2\pi]$ is

(1) 4 (2) 3

(3) 0 (4) 5

Answer (4)

Sol. $13[2\cos^2\theta - 1] + 8\cos\theta - 3\sqrt{3} = 0$

$26\cos^2\theta + 8\cos\theta - 13 - 3\sqrt{3} = 0$

$\cos\theta=\frac{-8\pm\sqrt{64+4\times26(13+3\sqrt{3})}}{52}$

$=\frac{-8\pm\sqrt{1416+312\sqrt{3}}}{52}\approx 0.69$

$\therefore$ 5 Solution

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10. For the differential equation $x^4dy + (4x^3y + \sin x)dx = 0$ it is given that $y\left(\frac{\pi}{2}\right)=0$. Then the value of $\pi^4 y\left(\frac{\pi}{3}\right)$ is equal to

(1) $\frac{9}{2}$ (2) $\frac{81}{2}$

(3) $\frac{27}{2}$ (4) $\frac{243}{2}$

Answer (2)

Sol. $x^4dy + (4x^3y + \sin x)dx = 0$

$$\frac{dy}{dx}+\frac{4x^3}{x^4}y=\frac{-\sin x}{x^4}$$

$$\frac{dy}{dx}+\frac{4}{x}y=\frac{-\sin x}{x^4}$$

IF = $e^{\int\frac{4}{x}dx}=e^{\ln x^4}=x^4$

$$x^4\frac{dy}{dx}+4x^3y=-\sin x$$

$$\frac{d}{dx}(x^4y)=-\sin x$$

$\Rightarrow x^4 + y = \cos x + C$

$$y\left(\frac{\pi}{2}\right)=0$$

$\Rightarrow C = 0$

$$\therefore\ x^4y=\cos x\Rightarrow y=\frac{\cos x}{x^4}$$

$$y\left(\frac{\pi}{3}\right)=\frac{\cos\left(\frac{\pi}{3}\right)}{\left(\frac{\pi}{3}\right)^4}=\frac{\frac{1}{2}}{\frac{\pi^4}{81}}=\frac{81}{2\pi^4}$$

$$\pi^4y\left(\frac{\pi}{3}\right)=\frac{81}{2}$$

11. If coefficients of x, x^2 and x^3 are in arithmetic progression of the binomial expansion of $(1 + x^2)^2 (1 + x)^n$, $n \in N$. Then sum of all values of n is

(1) 9 (2) 7

(3) 8 (4) 10

Answer (1)

Sol. Coefficient of x in

$(1 + 2x^2 + x^4)\ (1 + x)^4$ is

${}^nC_1$

Coefficient of x^2 is

$\Rightarrow {}^nC_2 + 2\cdot{}^nC_0$

Coefficient of x^3 is

${}^nC_3 + 2\cdot{}^nC_1$

$\Rightarrow$ since they are in *A.P.*

$$\Rightarrow \left({}^nC_1\right)+\left({}^nC_3+2\cdot{}^nC_1\right)=2\left({}^nC_2+2\cdot{}^nC_0\right)$$

$$\Rightarrow {}^nC_3+3\cdot n=2.\left({}^nC_2+2\right)$$

$$\Rightarrow \frac{n(n-1)(n-2)}{6}+3n=2(n(n-1)+4$$

$\Rightarrow (n^2–n)\ (n –2) + 18x = 6n^2 – 6n + 24$

$\Rightarrow n^3 – 3x^2 + 20n = 6n^2 – 6n + 24$

$\Rightarrow n^3 – 9n^2 + 26n – 24 = 0$

$n = 2, 3, 4$

$\Rightarrow$ sum of all $n = 2 + 3 + 4 = 9$

12. Let $f(x)=\int\frac{e^x(2-x^2)}{\sqrt{1+x}(1-x)^{\frac{3}{2}}}dx$, with $f(0) = 0$, then $f\left(\frac{1}{2}\right)$ is

(1) $\sqrt{2e}+1$ (2) $\sqrt{2e}-1$

(3) $\sqrt{3e}+1$ (4) $\sqrt{3e}-1$

Answer (4)

Sol. $$f(x)=\int e^x\left[\frac{1}{\sqrt{1-x^2}(1-x)}+\frac{(1-x^2)}{\sqrt{1-x^2}(1-x)}\right]dx$$

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$$= \int e^x \left(\frac{1}{(1-x)\sqrt{1-x^2}} + \frac{\sqrt{(1-x^2)}}{\sqrt{(1-x^2)}} \right)$$

$$= \int e^x \left(\underbrace{\frac{1}{(1-x)\sqrt{1-x^2}}}_{f'(x)} + \underbrace{\sqrt{\frac{1+x}{1-x}}}_{f(x)} \right)$$

$$= e^x \sqrt{\frac{1+x}{1-x}} + c$$

$\because f(0) = 0 \Rightarrow 0 = 1 + c \Rightarrow c = -1$

$$f\left(\frac{1}{2}\right) \Rightarrow e^{\frac{1}{2}}\sqrt{3} - 1$$

13. If A is matrix of order 3 and $x = |3\text{adj}(A^2)\cdot\text{adj}(2A)|$ and $|A| = 6$ and $x = 2^n\cdot 3^m$, then $m + n$ is

(1) 21 (2) 25

(3) 27 (4) 19

Answer (1)

Sol. $|3\text{adj}(A^2)\cdot\text{adj}(2A)| = 3^3|\text{adj}(A^2)||\text{adj}(2A)|$

$= 3^3|A^2|^2|2A|^2 = 3^3|A|^4\cdot 2^6|A|^2$

$= 3^3\cdot 2^6\cdot|A|^6 = 3^3\cdot 2^6\cdot 6^6$

$= 2^{12}\cdot 3^9$

$m + n = 21$

14. Let the domain of $f(x) = \log_3\left(\log_5\left(\log_7\left(9x - x^2 - 13\right)\right)\right)$ is (m, n). Let $\frac{n}{3}$ and $\frac{3m}{8}$ be eccentricity and length of latus rectum of hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ respectively, then the value of $\left(\frac{a+b^2}{a-b^2}\right)$ is equal to

(1) 7 (2) 9

(3) 3 (4) 13

Answer (1)

Sol. $\Rightarrow \log_5\left(\log_7\left(9x - x^2 - 13\right)\right) > 0 = \log_5 1$

$\log_7\left(9x - x^2 - 13\right) > 1 = \log_7 7$

$\Rightarrow 9x - x^2 - 13 > 7$

$\Rightarrow 9x - x^2 + 20 < 0 \Rightarrow x \in (4, 5)$

$\Rightarrow e = \frac{5}{3}, \frac{2b^2}{a} = \frac{3}{8}\times 4 = \frac{3}{2}$

$\Rightarrow \frac{b^2}{a} = \frac{3}{4} \Rightarrow \frac{a+b^2}{a-b^2} = \frac{3+4}{4-1} = 7$

$e^2 = 1 + \frac{b^2}{a^2} = 1 + \frac{3a}{4a^2} = \frac{25}{9}$

$\Rightarrow 1 + \frac{3}{4a} = \frac{25}{9} \Rightarrow \frac{30}{4a} = \frac{16}{9}$

$\Rightarrow a = \frac{27}{64}, b^2 = \frac{81}{256}$

15. If point B and C lies on line $\frac{x}{1} = \frac{1-y}{-2} = \frac{z-2}{3}$ and point A is (1, 6, 3). If $BC = 10$. Then, the area of ΔABC is

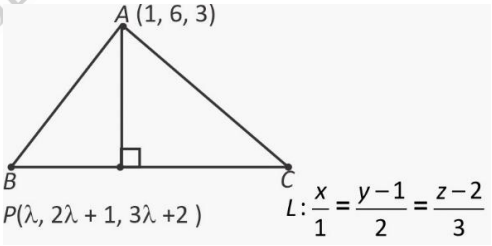
(1) $2\sqrt{13}$ (2) $5\sqrt{13}$

(3) $6\sqrt{13}$ (4) $4\sqrt{13}$

Answer (2)

Sol. $L: \frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{3}$

Let any point on line L is $(\lambda, 2\lambda + 1, 3\lambda + 2)$



$1(\lambda - 1) + 2(2\lambda - 5) + 3(3\lambda - 1) = 0$

$\lambda - 1 + 4\lambda - 10 + 9\lambda - 3 = 0$

$14\lambda - 14 = 0$

$\lambda = 1$

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$P(1, 3, 5)$

$AP = \sqrt{(1-1)^2 + (6-3)^2 + (3-5)^2}$

$= \sqrt{9+4}$

$= \sqrt{13}$

Area $(\Delta ABC) = \frac{1}{2} \times 10 \times \sqrt{13}$

$= 5\sqrt{13}$

16.

17.

18.

19.

20.

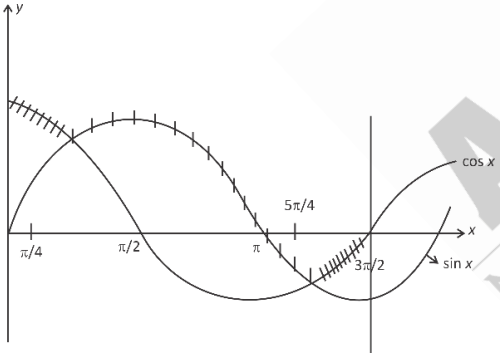
SECTION - B

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. The area (in square units) bounded by the curve $f(x)$ = Max{sin$x$, cos$x$} and x-axis between $x = 0$ and $x = \frac{3\pi}{2}$ is A. Then, the value of $A + A^2$ is

Answer (3)

Sol.



$$\text{Requiret area} = \int_0^{\pi/4} \cos x\, dx + \int_{\pi/4}^{\pi} \sin x\, dx$$

$$+ \int_{\pi}^{5\pi/4} (-\sin x)\, dx + \int_{5\pi/4}^{3\pi/2} (-\cos x)\, dx$$

$$= [\sin x]_0^{\pi/4} + [-\cos x]_{\pi/4}^{\pi} + [\cos x]_{\pi}^{5\pi/4} - [\sin x]_{5\pi/4}^{3\pi/2}$$

$$= \frac{1}{\sqrt{2}}\left[1 + \frac{1}{\sqrt{2}}\right] + \left[-\frac{1}{\sqrt{2}} + 1\right] - \left[-1 + \frac{1}{\sqrt{2}}\right]$$

$$= \sqrt{2} + 1 - \frac{1}{\sqrt{2}} + 1 + 1 - \frac{1}{\sqrt{2}}$$

$= 3$

22. The mean and variance of the 8 observations –10, –7, –1, x, y, 16, 2, 9 are $\frac{7}{2}$ and $\frac{293}{4}$ respectively. Then, the mean of x, y, $x + y + 1$, $|x - y|$ is

Answer (11)

Sol. Mean = $\frac{7}{2}$

$$\frac{-10-7-1+x+y+16+2+9}{8} = \frac{7}{2}$$

$\Rightarrow x + y + 9 = 28$

$\Rightarrow \boxed{x + y = 19}$

Var = $\frac{293}{4}$

$$\frac{100+49+1+x^2+y^2+256+4+8}{8} - \frac{49}{4} = \frac{293}{4}$$

$$\frac{491 + x^2 + y^2}{8} = \frac{342}{4} \times 2$$

$x^2 + y^2 = 193$

$\Rightarrow (x, y) = (7, 12)$ or $(12, 7)$

Mean = $\frac{x+y+x+y+1+(x-y)}{4}$

$= \frac{19+20+5}{4}$

$= 11$

23.

24.

25.

❑ ❑ ❑

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