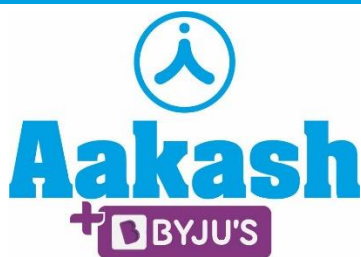


01/02/2024

Morning



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-1

(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.

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 dimensions of angular impulse is equal to

- (1) $[M^1L^2T^{-1}]$ (2) $[M^1L^2T^1]$
 (3) $[M^1L^2T^2]$ (4) $[M^1L^1T^{-1}]$

Answer (1)

Sol. Angular impulse = Change in angular momentum

$$[J] = [mvr]$$

$$[J] = [M^1L^2T^{-1}]$$

2. A vernier caliper has 10 main scale divisions coinciding with 11 vernier scale divisions. 1 main scale division equals 5 mm. The least count of the device is

- (1) $\frac{1}{2}$ mm (2) $\frac{5}{12}$ mm
 (3) $\frac{5}{11}$ mm (4) 0.3 mm

Answer (3)

Sol. $10 M = 11 V$

$$\Rightarrow 1V = \frac{10}{11} \times 5 \text{ mm}$$

$$\Rightarrow LC = |M - V|$$

$$= \frac{5}{11} \text{ mm}$$

3. On increasing temperature, the elasticity of a material

- (1) Increases
 (2) Decreases
 (3) Remains constant
 (4) May increase or decrease

Answer (2)

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

As temperature increases, strain increases

\therefore Elasticity decreases

4. Determine the lowest energy of photon emitted in Balmer series of hydrogen atom.

- (1) 10.02 eV
 (2) 1.88 eV
 (3) 1.65 eV
 (4) 2.02 eV

Answer (2)

Sol. For $3 \rightarrow 2$ transitions

$$\Delta E = 13.6 \left(\frac{1}{4} - \frac{1}{9} \right)$$

$$= 13.6 \times \frac{5}{36}$$

$$= 1.88 \text{ eV}$$

5. de Broglie wavelength of proton = λ and that of an α particle is 2λ . The ratio of velocity of proton to that of α particle is :

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

Answer (1)

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

$$\Rightarrow \lambda = \frac{h}{mv_p}$$

and $2\lambda = \frac{h}{4mv_\alpha}$

$$\Rightarrow \frac{1}{2} = \frac{4v_\alpha}{v_p}$$

$$\Rightarrow \frac{v_p}{v_\alpha} = 8$$

6. 2 moles of monoatomic gas and 6 moles of diatomic gas are mixed. Molar specific heat, for constant volume, of mixture shall be (R is universal gas constant)

- (1) $1.75R$ (2) $2.25R$
 (3) $2.75R$ (4) $2.50R$

Answer (2)

Sol. $(C_V)_{\text{mix}} = \left(\frac{2 \times \frac{3}{2} + 6 \times \frac{5}{2}}{2 + 6} \right) R$
 $= \frac{(3 + 15)R}{8} = \frac{9}{4}R$

7. A gas undergoes a thermodynamic process from state (P_1, V_1, T_1) to state (P_2, V_2, T_2) . For the given

process if $PV^{\frac{3}{2}} = \text{constant}$, find the work done by the gas.

- (1) $\frac{(P_2V_2 - P_1V_1)}{2}$ (2) $\frac{(P_1V_1 - P_2V_2)}{2}$
 (3) $\frac{3}{2}(P_1V_1 - P_2V_2)$ (4) $2(P_1V_1 - P_2V_2)$

Answer (4)

Sol. $W = \frac{P_1V_1 - P_2V_2}{\alpha - 1}$
 $= \frac{P_1V_1 - P_2V_2}{\left(\frac{3}{2} - 1\right)}$
 $= 2(P_1V_1 - P_2V_2)$

8. For measuring resistivity, the relation

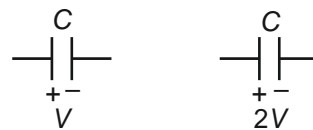
$R = \rho \frac{l}{A} = \frac{\rho l}{\pi r^2}$ is used. Percentage error in resistance (R), in length (l) and in radius (r) are given x , y and z respectively. Find percentage error in resistivity ρ .

- (1) $x + y + 2z$ (2) $x + 2y + z$
 (3) $\frac{x}{2} + y + z$ (4) $x + 2z - y$

Answer (1)

Sol. $\frac{\Delta \rho}{\rho} = \frac{\Delta R}{R} + \frac{2\Delta r}{r} + \frac{\Delta l}{l}$
 $= x + 2z + y.$

9. Two capacitors are charged as shown. When both the positive terminals and negative terminals of capacitors are connected the energy loss will be



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

Answer (3)

Sol. $V_c = \frac{CV + 2CV}{2C} = \frac{3V}{2}$

$\therefore \text{Energy loss} = \frac{1}{2}CV^2 + \frac{1}{2}C(2V)^2 - \frac{1}{2}2C\left(\frac{3V}{2}\right)^2$
 $= \frac{1}{4}CV^2$

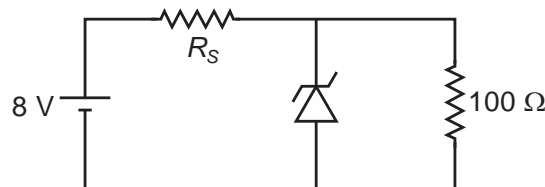
10. A moving coil galvanometer has resistance 50Ω and full deflection current is 5 mA . The resistance needed to convert this galvanometer into voltmeter of range 100 volt is

- (1) 19550Ω (2) 18500Ω
 (3) 19850Ω (4) 18760Ω

Answer (1)

Sol. $I_g(G + R) = 100 \text{ V}$
 $5 \times 10^{-3}(50 + R) = 100$
 $50 + R = 20000$
 $R = 19550 \Omega$

11. In the voltage regulator circuit shown below, the reverse breakdown voltage of zener diode is 5 V and power dissipated across it is 100 mW . Find R_s



- (1) 120Ω (2) 250Ω
 (3) 1000Ω (4) 1500Ω

Answer (1)

Sol. $i_{1000 \Omega} = 5 \text{ mA}$

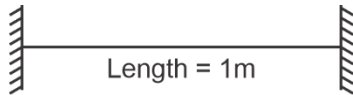
$$i_z = \frac{P}{V_z} = 20 \text{ mA}$$

$$\therefore i_R = 25 \text{ mA}$$

$$V_R = 3 \text{ V}$$

$$\therefore R = \frac{3}{25} \times 10^3 = 120 \Omega$$

12. Two strings are identical and fixed at both ends with tension 6 N each. If the tension in one string fixed at both end is changed from 6 N to 52 N, then find beats frequency.



Linear mass density = 1 kg/m

- (1) 2.38 Hz (2) 3.25 Hz
(3) 2.75 Hz (4) 5.25 Hz

Answer (1)

Sol. $f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$

$$f_1 = \frac{1}{2L} \sqrt{\frac{T_1}{\mu}}$$

$$f_2 = \frac{1}{2L} \sqrt{\frac{T_2}{\mu}}$$

$$\text{Beats frequency} = \Delta f = f_2 - f_1 = \frac{1}{2L} \left(\sqrt{\frac{52}{\mu}} - \sqrt{\frac{6}{\mu}} \right)$$

$$= \frac{1}{2} (\sqrt{52} - \sqrt{6})$$

$$= \frac{1}{2} (7.21 - 2.45)$$

$$= 2.38 \text{ Hz}$$

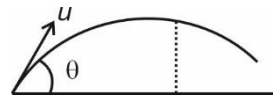
13. A particle is moving in a circle of radius R in time period of T . This moving particle is projected at angle θ with horizontal & attains a maximum height of $4R$. Angle θ can be given as (g is acceleration due to gravity)

(1) $\sin^{-1} \left(\frac{T}{2\pi} \sqrt{\frac{2g}{R}} \right)$ (2) $\sin^{-1} \left(\frac{T}{\pi} \sqrt{\frac{g}{R}} \right)$

(3) $\sin^{-1} \left(\frac{T}{\pi} \sqrt{\frac{2g}{R}} \right)$ (4) $\sin^{-1} \left(T \sqrt{\frac{2g}{R}} \right)$

Answer (3)

Sol. $\frac{2\pi R}{T} = u$

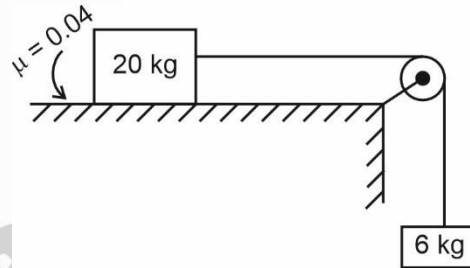


$$\frac{u^2 \sin^2 \theta}{2g} = 4R$$

$$\frac{4\pi^2 R^2}{T^2 2g} \sin^2 \theta = 4R$$

$$\sin^2 \theta = \frac{2gT^2}{\pi^2 R} = \left(\frac{T}{\pi} \sqrt{\frac{2g}{R}} \right)^2$$

14. A block of mass 20 kg is placed on rough surface having co-efficient of friction 0.04 as shown in figure. Find acceleration of system when it released.



- (1) 3 m/s
(2) 2 m/s
(3) 1 m/s
(4) 4 m/s

Answer (2)

Sol. Maximum friction (F_{\max}) = $0.04 \times 20 \times 10 = 8 \text{ N}$

Pulley force (F) = 60 N

$$\text{Acceleration (a)} = \frac{60 - 8}{26} = 2 \text{ m/s}^2$$

15. In single slit diffraction with slit width 0.1 mm, light of wavelength 6000 \AA is used. A convex lens of focal length 20 cm is used to focus the diffracted ray. Find width of central maxima.
- (1) 24 mm
(2) 2.4 mm
(3) 12 mm
(4) 1.2 mm

Answer (2)

Sol. Angular width = $\frac{2\lambda}{a}$

Linear width = $\frac{2\lambda}{a} f$

$$= \frac{2 \times 6000 \times 10^{-10} \times 20 \times 10^{-2}}{0.1 \times 10^{-3}}$$

$$= 2 \times 6 \times 2 \times 10^{-4}$$

$$= 24 \times 10^{-4}$$

$$= 2.4 \text{ mm}$$

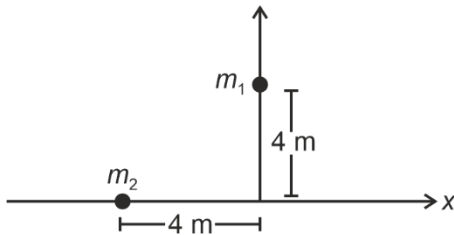
- 16.
- 17.
- 18.
- 19.
- 20.

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. Two particles each of mass 2 kg are placed as shown in xy plane. If the distance of centre of mass from origin is $\frac{4\sqrt{2}}{x}$, find x

from origin is $\frac{4\sqrt{2}}{x}$, find x



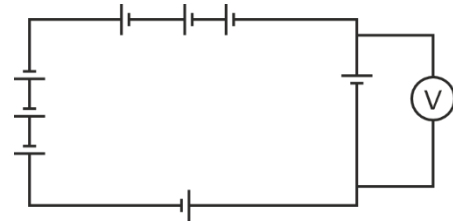
Answer (2)

Sol. $\vec{r}_{cm} = -2\hat{i} + 2\hat{j}$

$\therefore r = 2\sqrt{2}$

$x = 2$

22. Eight identical batteries (5 V, 1 Ω) are connected as shown :



The reading of the ideal voltmeter is _____ volts.

Answer (0)

Sol. $\epsilon = 8 \times 5 = 40 \text{ V}$

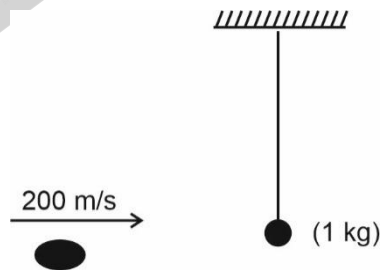
$r = 8 \times 1 = 8 \Omega$

$\Rightarrow i = 5 \text{ A}$

\Rightarrow Voltmeter reads

$= 5 - ir = 0 \text{ volts}$

23. A bullet, of mass 10^{-2} kg and velocity 200 m/s gets embedded inside the bob (mass 1 kg) of a simple pendulum as shown. The maximum height the system rises by is _____ cm.



Answer (20)

Sol. Momentum conservation :

$10^{-2} \times 200 = 1 \times v \quad \dots(1)$

Energy conservation :

$v = \sqrt{2gh} \quad \dots(2)$

$\Rightarrow h = \frac{v^2}{2g} = \frac{4}{20} \text{ m} = 20 \text{ cm}$

24. The length of a seconds pendulum if it is placed at height $2R$ (R : radius of earth) is $\frac{10}{x\pi^2}$ metres. Find x .

Answer (9)

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

$$\Rightarrow 2 = 2\pi\sqrt{\frac{l}{g_0/9}}$$

$$\Rightarrow 2 = 2\pi \times 3\sqrt{\frac{l}{10}}$$

$$\Rightarrow \frac{l}{10} = \frac{1}{9\pi^2}$$

$$\Rightarrow l = \frac{10}{9\pi^2} \text{ m}$$

25. Nuclear mass and size of nucleus of an element A are 64 and 4.8 femtometer. If size of nucleus of element B is 4 femtometer then its nuclear mass will be $\frac{1000}{x}$ then

Answer (27)

Sol. $R^3 = \alpha A$

$$\frac{(4.8^3)}{4^3} = \frac{64}{M}$$

$$M = \frac{16 \times 4 \times 16 \times 4}{48 \times 48 \times 48} \times 10^3$$

26. In a series LCR circuit connected to an AC source, value of the elements are L_0 , C_0 & R_0 such that circuit is in resonance mode. If now capacity of capacitor is made $4C_0$, the new value of inductance, for circuit to still remain in resonance, is $\frac{L_0}{n}$. Find n .

Answer (4)

Sol. $\frac{1}{\sqrt{LC}} = \text{fixed}$

$$\Rightarrow LC = \text{fixed}$$

$$\Rightarrow L = \frac{L_0}{4}$$

27. The current through a conductor varying with time as $i = 3t^2 + 4t^3$.

Find amount of charge (in C) passes through cross section of conductor in interval $t = 1$ sec to $t = 2$ sec.

Answer (22)

Sol. $Q = \int i \cdot dt$

$$= \int_1^2 (3t^2 + 4t^3) \cdot dt = (t^3 + t^4)_1^2$$

$$= (8 + 16) - (2)$$

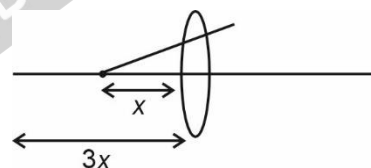
$$= 22 \text{ C}$$

28. Distance between virtual magnified image, (size three times of object) of an object placed in front of convex lens and object is 20 cm. The focal length of lens is x cm, then x is _____

Answer (15)

Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ $\frac{v}{u} = 3$

$$v = 3u$$



$$3x - x = 20$$

$$x = 20$$

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

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

$$\frac{2}{30} = \frac{1}{f} \Rightarrow f = 15$$

29.
30.

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.

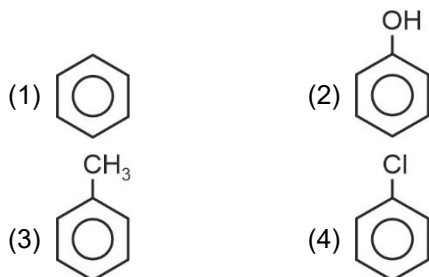
Choose the correct answer :

1. In Kjeldahl's estimation of nitrogen, CuSO_4 act as
- (1) Oxidizing agent
 - (2) Reducing agent
 - (3) Catalyst
 - (4) Reagent

Answer (3)

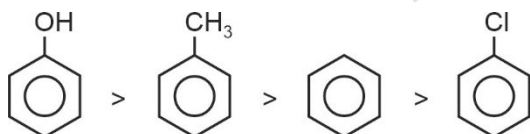
Sol. CuSO_4 acts as catalyst in Kjeldahl's method of estimation of nitrogen.

2. Which of the following is most likely attacked by electrophile?



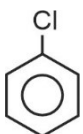
Answer (2)


Sol. Order of reactivity towards electrophile



Strength of +M/+R : $-\text{OH} > -\text{CH}_3 > -\text{Cl}$

In case of halogens, their $-I$ effect dominates over

+M hence $-\text{Cl}$ is deactivating and  is lesser

reactive than  for incoming electrophile.

3. **Statement-I:** PH_3 will have low boiling point than NH_3 .

Statement-II: There are strong van der Waal forces in NH_3 and strong hydrogen-bonding in PH_3 .

- (1) Statement-I and statement-II both are true
- (2) Statement-I and statement-II both are false
- (3) Statement-I is true but statement-II is false
- (4) Statement-I is false but statement-II is true

Answer (3)

Sol. Boiling point: $\overset{(239.7)}{\text{NH}_3} > \overset{(185.5)}{\text{PH}_3}$ due to hydrogen bonding in NH_3 .

4. Which of the following have trigonal bipyramidal shape?
- $\text{PF}_5, \text{PBr}_5, [\text{PtCl}_4]^{2-}, \text{SF}_6, \text{BF}_3, \text{BrF}_5, \text{PCl}_5, [\text{Fe}(\text{CO})_5]$
- (1) $\text{PF}_5, \text{PBr}_5, \text{PCl}_5$ and $[\text{Fe}(\text{CO})_5]$ only
 - (2) $\text{BrF}_5, \text{PF}_5, \text{PCl}_5$ and PBr_5 only
 - (3) $\text{PF}_5, \text{PCl}_5$ and $[\text{Fe}(\text{CO})_5]$ only
 - (4) $[\text{Fe}(\text{CO})_5], \text{BrF}_5, \text{PF}_5, \text{PBr}_5, \text{PCl}_5$ only

Answer (1)

Sol. $\text{PF}_5, \text{PCl}_5, \text{PBr}_5, [\text{Fe}(\text{CO})_5] \Rightarrow$ Trigonal bipyramidal
 $\text{BrF}_5 \Rightarrow$ Square pyramidal
 $[\text{PtCl}_4]^{2-} \Rightarrow$ Square planar
 $\text{SF}_6 \Rightarrow$ Octahedral

5. Which of the following is correct for adiabatic free expansion against vacuum
- (1) $q = 0, \Delta U = 0, W = 0$
 - (2) $q \neq 0, W = 0, \Delta U = 0$
 - (3) $q = 0, \Delta U \neq 0, W = 0$
 - (4) $q = 0, \Delta U \neq 0, W \neq 0$

Answer (1)

Sol. $q = 0$ as adiabatic process is given

$$W = 0 \text{ as } p_{\text{ext}} = 0$$

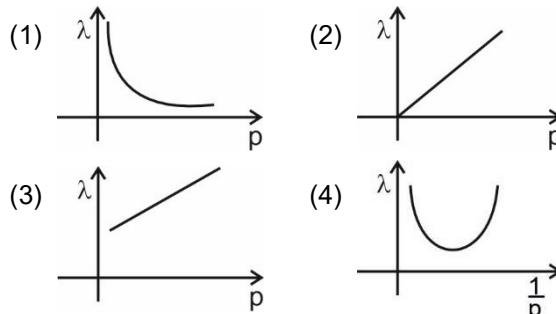
$$q + W = \Delta U$$

$$q = 0$$

$$W = 0$$

$$\Rightarrow \Delta U = 0$$

6. Which of the following is the correct plot between λ (de Broglie wavelength) and p (momentum)?

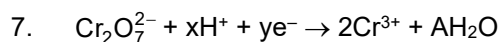
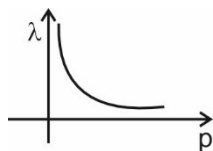


Answer (1)

Sol. $\lambda = \frac{h}{p} \left[\lambda \propto \frac{1}{p} \right]$

$\Rightarrow \lambda p = h$ (constant)

So, the plot is a rectangular hyperbola.

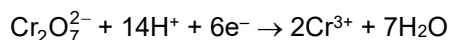


Balance the above reaction and find x, y and A.

- (1) $x = 7, y = 6, A = 14$ (2) $x = 14, y = 6, A = 7$
 (3) $x = 14, y = 3, A = 7$ (4) $x = 8, y = 2, A = 1$

Answer (2)

Sol. The balanced reaction is,



$x = 14$

$y = 6$

$A = 7$

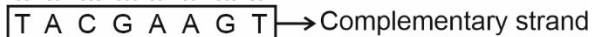
8. Complementary strand of DNA

ATGCTTCA is:

- (1) TACGAAGA
 (2) TACGAAGT
 (3) TAGCAACA
 (4) TAGCTACT

Answer (2)

Sol. Adenine base pairs with thymine with 2 hydrogen bonds and cytosine base pairs with guanine with 3 hydrogen bonds.



9. What is the pH of $\text{CH}_3\text{COO}^- \text{NH}_4^+$ salt?

Given K_a of $\text{CH}_3\text{COOH} = 1.8 \times 10^{-6}$

K_b of $\text{NH}_4\text{OH} = 1.8 \times 10^{-6}$

(At 25°C)

- (1) 7
 (2) 9
 (3) 8.9
 (4) 7.8

Answer (1)

Sol. $\text{pH} = \frac{\text{p}K_w + \text{p}K_a - \text{p}K_b}{2}$

$\text{p}K_a = \text{p}K_b$

$\Rightarrow \text{pH} = \frac{\text{p}K_w}{2} = 7$

10. We are given with 3 NaCl samples and their van't Hoff factors

Sample	van't Hoff factor
Sample-1 (0.1M)	i_1
Sample-2 (0.01M)	i_2
Sample-3 (0.001M)	i_3

Choose the correct answer.

- (1) $i_1 = i_2 = i_3$ (2) $i_1 > i_2 > i_3$
 (3) $i_3 > i_2 > i_1$ (4) $i_1 > i_3 > i_2$

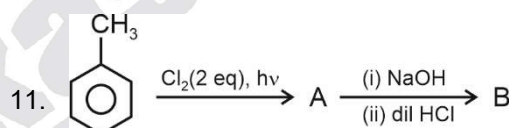
Answer (1)

Sol. As NaCl is strong electrolyte, its degree of dissociation (α) will remain same.

$i = 2$

For each sample,

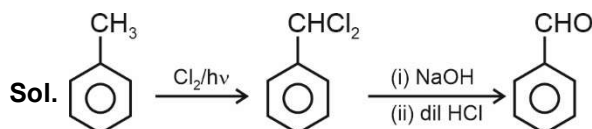
$i_1 = i_2 = i_3$



A and B in above reaction is

- (1) (A) (B)
 (2) (A) (B)
 (3) (A) (B)
 (4) (A) (B)

Answer (3)



12. We have a mixture of gases having 2 moles of monoatomic gas $\left(C_{v,m} = \frac{3R}{2}\right)$ and 6 moles of diatomic gas $\left(C_{v,m} = \frac{5R}{2}\right)$. Find out molar heat capacity (C_{vm}) of the mixture.

- (1) $\frac{9R}{4}$
 (2) $\frac{9R}{2}$
 (3) $3R$
 (4) $4R$

Answer (1)

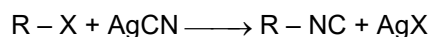
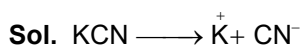
$$\begin{aligned} \text{Sol. } C_{vm} &= \frac{2\left(\frac{3R}{2}\right) + 6\left(\frac{5R}{2}\right)}{2 + 6} \\ &= \frac{3R + 15R}{8} = \frac{18R}{8} \\ &= \frac{9R}{4} \text{ (option (1))} \end{aligned}$$

13. **Assertion (A):** KCN react with R-X to give cyanide and AgCN reacts with R - X to give isocyanide mainly.

Reason (R): KCN and AgCN both are ionic compounds

- (1) Both Assertion and Reason are true and Reason explains Assertion
 (2) Both Assertion and Reason is true but Reason does not explains Assertion
 (3) Assertion is true and Reason is false
 (4) Assertion is false but reason is true

Answer (3)



KCN is ionic therefore ionised and attack occurs through carbon.

AgCN is covalent therefore attack starts with Nitrogen.

14. Consider the following two statements.

Statement I: $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is of green colour

Statement II : $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless

- (1) Statement I is true, statement II is false
 (2) Statement I is true, statement II is true
 (3) Statement I is false, statement II is true
 (4) Statement I is false, statement II is false

Answer (2)

Sol. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is octahedral and $[\text{Ni}(\text{CN})_4]^{2-}$ is square planar.

In $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} \Rightarrow \text{Ni}^{2+}$ has two unpaired electrons and in $[\text{Ni}(\text{CN})_4]^{2-} \Rightarrow \text{Ni}^{2+}$ has no unpaired electrons. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is coloured as it absorbs red light due to suitable d-d transition and complementary light emitted is green.

$[\text{Ni}(\text{CN})_4]^{2-}$ has strong field ligand so the electrons of Ni^{2+} pair up and it is colourless as it cannot absorb light from visible region.

15. **Statement-I:** Potassium hydrogen phthalate is primary standard for NaOH solution.

Statement-II: Phenolphthalein is used to detect completion of titration.

- (1) Both statement-I and statement-II are correct
 (2) Statement-I is correct and statement-II is incorrect
 (3) Statement-I is incorrect and statement-II is correct
 (4) Both statement-I and statement-II are incorrect

Answer (1)

Sol. Potassium hydrogen phthalate is used to standardize NaOH solutions.

Phenolphthalein is used as an indicator to detect completion of titrations.

16. **Statement-I:** In aniline, $-\text{NH}_2$ group is strong deactivating group for all ESR.

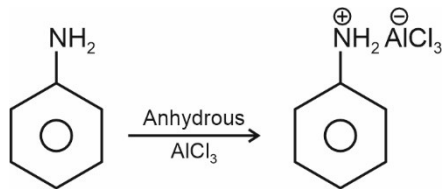
Statement-II: Aniline does not show Friedel-Craft alkylation reaction.

- (1) Both statement-I and statement-II are correct
 (2) Both statement-I and statement-II are incorrect
 (3) Statement-I is correct and statement-II is incorrect
 (4) Statement-I is incorrect and statement-II is correct

Answer (4)

Sol. In aniline $-\text{NH}_2$ is strong activating group due to presence of lone pair in nitrogen.

Aniline does not show Friedel-Craft alkylation reaction, because anhydrous AlCl_3 and aniline form salt together



17. Which of the following is homoleptic complex?

- (1) $[\text{Ni}(\text{CN})_4]^{2-}$
- (2) $[\text{Cu}(\text{H}_2\text{O})_3\text{Cl}_3]$
- (3) $[\text{PtCl}_2\text{Br}_2]^{2-}$
- (4) $[\text{Cu}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$

Answer (1)

Sol. Homoleptic complexes in which a metal is bound to only one kind of donor groups/ligands.

18. For ionic reaction in organic compound which type of bond cleavage occur?

- (1) Heterolytic cleavage
- (2) Homolytic cleavage
- (3) Free radical
- (4) No cleavage of bond

Answer (1)

Sol. In heterolytic bond cleavage ions are formed. hence for ionic reaction in organic compound heterolytic bond cleavage takes place.

19. K_a values of three acids A, B and C are 10^{-3} , 5×10^{-9} , 9×10^{-11} respectively. The acidic strength order of these acids is

- (1) $A > B > C$
- (2) $B > A > C$
- (3) $C > B > A$
- (4) $C > A > B$

Answer (1)

Sol. Higher the value of K_a , more is the acidic strength.

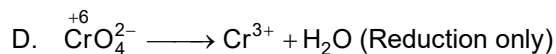
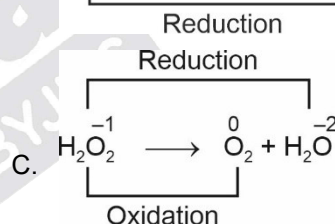
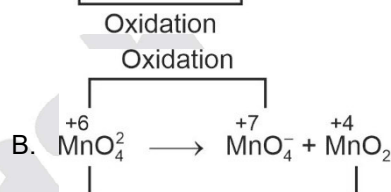
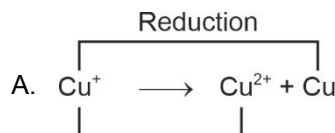
20. Which of the following is a disproportionation reaction?

- A. $\text{Cu}^+ \longrightarrow \text{Cu}^{2+} + \text{Cu}$
- B. $\text{MnO}_4^{2-} \longrightarrow \text{MnO}_4^- + \text{MnO}_2$
- C. $\text{H}_2\text{O}_2 \longrightarrow \text{O}_2 + \text{H}_2\text{O}$
- D. $\text{CrO}_4^{2-} \longrightarrow \text{Cr}^{3+} + \text{H}_2\text{O}$

- (1) All A, B, C and D
- (2) A and B only
- (3) A and C only
- (4) A, B and C only

Answer (4)

Sol. Disproportionation reaction is a reaction in which a substance (element) is simultaneously oxidised and reduced.

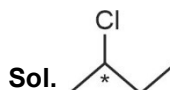


SECTION - B

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. Find out total possible optical isomers of 2-chlorobutane.

Answer (2)



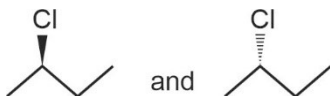
There is one chiral centre present in given compound which is unsymmetrical.

Total number of isomers = 2^n

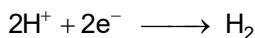
n = number of stereogenic centre

$$\begin{aligned} n &= 1 \\ &= 2^1 \\ &= 2 \end{aligned}$$

Total two optical isomers are possible



22. We are given with following cell reaction :



$$P_{\text{H}_2} = 2 \text{ atm}$$

$$[\text{H}^+] = 1 \text{ M}$$

$$\left(\frac{2.303RT}{F} = 0.06 \right)$$

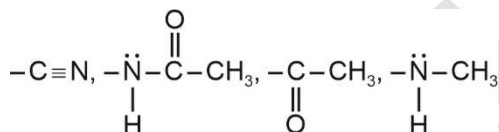
If E_{cell} for reaction is given by $-x \times 10^{-3} \text{ V}$, find out x .

Answer (9)

$$\begin{aligned} \text{Sol. } E_{\text{cell}} &= 0 - \frac{0.06}{2} \log 2 \\ &= -0.03(0.3) \\ &= -0.009 \\ &= -9 \times 10^{-3} \text{ V} \end{aligned}$$

$$x = 9$$

23. Total number of deactivating groups among the following



Answer (2)

Sol. $-\text{C}\equiv\text{N}$, $-\text{C}(=\text{O})-\text{CH}_3$ are $-\text{R}$ group which is deactivating

$-\text{NH}-\text{C}(=\text{O})-\text{CH}_3$ and $-\text{N}(\text{CH}_3)_2$ due to presence of lone pair in nitrogen atom behaves as activating ($+\text{R}$) group.

24. How many oxides are amphoteric in nature?

SnO_2 , PbO_2 , SiO_2 , P_2O_5 , Al_2O_3 , CO_2 , CO , NO , N_2O

Answer (3)

Sol. Amphoteric oxides are those which can react with both acid and base

SnO_2 , PbO_2 and Al_2O_3 are amphoteric oxide

SiO_2 , P_2O_5 , CO_2 are acidic oxides

CO , NO and N_2O are neutral oxides

25. For carbon dating of a wood sample

$$\left(\frac{\text{C}^{14}}{\text{C}^{12}} \right)_t = \frac{1}{8} \left(\frac{\text{C}^{14}}{\text{C}^{12}} \right)_{t=0}$$

If Half life of C^{14} is 1580 years what is the life of wood sample (in yr)

Answer (4740)

$$\text{Sol. } \left(\frac{\text{C}^{14}}{\text{C}^{12}} \right)_t = \frac{\left(\frac{\text{C}^{14}}{\text{C}^{12}} \right)_{t=0}}{(2)^n}$$

$$n = 3$$

$$t = 3 \times 1580$$

$$= 4740 \text{ years}$$

26. What is the minimum energy (in eV) required for an electron to excite from ground state to 1st excited state for hydrogen atom?

Answer (10)

$$\text{Sol. } n_1 = 1$$

$$n_2 = 2$$

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

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

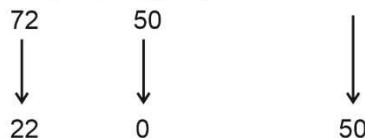
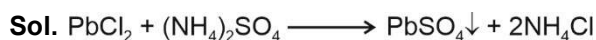
$$\Delta E = 13.6 \left(1 - \frac{1}{4} \right)$$

$$\Delta E = 13.6 \times \frac{3}{4} \text{ eV}$$

$$= 10.05 \text{ eV} \approx 10 \text{ eV}$$

27. Find out moles of precipitate product formed when 72 moles of PbCl_2 reacts with 50 moles of $(\text{NH}_4)_2\text{SO}_4$.

Answer (50)



Moles of PbSO_4 formed = 50 mol

28.

29.

30.

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. If 3, a, b, c are in A.P. and 3, a - 1, b + 1 are in G.P. Then arithmetic mean of a, b and c is
- (1) 11 (2) 10
(3) 9 (4) 13

Answer (1)

Sol. 3, a, b, c are in A.P.

$$a - 3 = b - a \quad (\text{common diff.})$$

$$2a = b + 3$$

and 3, a - 1, b + 1 are in G.P.

$$\frac{a-1}{3} = \frac{b+1}{a-1}$$

$$a^2 + 1 - 2a = 3b + 3$$

$$a^2 - 8a + 7 = 0 \quad [\because 2a = b + 3]$$

$$(a - 7)(a - 1) = 0$$

If a = 7, b = 2(7) - 3 = 11, b = 11

and c - b = a - 3

$$c - 11 = 4$$

$$c = 15$$

$$\therefore \text{A.M of 7, 11, 15} = \frac{7+11+15}{3}$$

$$= \frac{33}{3} = 11$$

2. The value of $\int_0^{\pi/4} \frac{xdx}{\sin^4(2x) + \cos^4(2x)}$ is equal to

- (1) $\frac{\pi^2}{16\sqrt{2}}$ (2) $\frac{\pi^2}{64}$
(3) $\frac{\pi^2}{32}$ (4) $\frac{\pi^2}{8\sqrt{2}}$

Answer (1)

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

Let $2x = t$ then $dx = \frac{1}{2} dt$

$$I = \int_0^{\pi/2} \frac{\frac{t}{2} \cdot \frac{1}{2} dt}{\sin^4 t + \cos^4 t}$$

$$= \frac{1}{4} \int_0^{\pi/2} \frac{t dt}{\sin^4 t + \cos^4 t}$$

$$\therefore I = \frac{1}{4} \int_0^{\pi/2} \frac{\left(\frac{\pi}{2} - t\right) dt}{\sin^4 t + \cos^4 t}$$

$$\therefore 2I = \frac{1}{4} \int_0^{\pi/2} \frac{\frac{\pi}{2} dt}{\sin^4 t + \cos^4 t}$$

$$2I = \frac{\pi}{8} \int_0^{\pi/2} \frac{\sin^4 t dt}{\tan^4 t + 1}$$

Let $\tan t = y$ then

$$2I = \frac{\pi}{8} \int_0^{\infty} \frac{(1+y^2) dy}{1+y^4}$$

$$= \frac{\pi}{8} \int_0^{\infty} \frac{1 + \frac{1}{y^2}}{y^2 + \frac{1}{y^2} - 2 + 2} dy$$

$$= \frac{\pi}{8} \int_0^{\infty} \frac{\left(1 + \frac{1}{y^2}\right) dy}{2 + \left(y - \frac{1}{y}\right)^2}$$

Let $y - \frac{1}{y} = u$

$$2I = \frac{\pi}{8} \int_{-\infty}^{\infty} \frac{du}{2 + u^2}$$

$$= \frac{\pi}{8\sqrt{2}} \left[\tan^{-1} \frac{u}{\sqrt{2}} \right]_{-\infty}^{\infty}$$

$$\therefore I = \frac{\pi^2}{16\sqrt{2}}$$

3. If $A = \begin{bmatrix} \sqrt{2} & 1 \\ -1 & \sqrt{2} \end{bmatrix}$, $B = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$, $C = ABA^T$ and

$X = AC^2A^T$, then $|X|$ is equal to

- (1) 729 (2) 283
(3) 27 (4) 23

Answer (1)

Sol. $|A| = 3$

$|B| = 1$

$\Rightarrow |C| = |ABA^T| = |A||B||A^T| = |A|^2|B|$
 $= 9$

$\Rightarrow |X| = |A||C|^2|A^T|$

$= 3 \times 9^2 \times 3 = 9 \times 9^2 = 729$

4. If $3, 7, 11, \dots, 403 = AP_1$

$2, 5, 8, \dots, 401 = AP_2$

Find sum of common term of AP_1 and AP_2

- (1) 3366 (2) 6699
(3) 9999 (4) 6666

Answer (2)

Sol. $3, 7, 11, 15, 19, 23, 27, \dots, 403 = AP_1$

$2, 5, 8, 11, 14, 17, 20, 23, \dots, 401 = AP_2$

so common terms A.P.

$11, 23, 35, \dots, 395$

$\Rightarrow 395 = 11 + (n - 1) 12$

$\Rightarrow 395 - 11 = 12(n - 1)$

$\frac{384}{12} = n - 1$

$32 = n - 1$

$n = 33$

Sum = $\frac{33}{2} [2 \times 11 + (32)12]$

$= \frac{33}{2} [22 + 384]$

$= 6699$

5. $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{8\sqrt{2} \cos x}{(1 + e^{\sin x})(1 + \sin^4 x)} dx = a\pi + b \log(3 + 2\sqrt{2})$

then find $a + b$.

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

Answer (1)

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

$$= \int_0^{\frac{\pi}{2}} \left\{ \frac{8\sqrt{2} \cos x}{(1 + e^{\sin x})(1 + \sin^4 x)} + \frac{8\sqrt{2} \cos x}{(1 + e^{-\sin x})(1 + \sin^4 x)} \right\} dx$$

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

Let $\sin x = t$

$I = 8\sqrt{2} \int_0^1 \frac{dt}{1 + t^4}$

$= 4\sqrt{2} \int_0^1 \frac{\left(1 + \frac{1}{t^2}\right) - \left(1 - \frac{1}{t^2}\right)}{t^2 + \frac{1}{t^2}} dt$

$= 4\sqrt{2} \int_0^1 \frac{\left(1 + \frac{1}{t^2}\right) dt}{\left(t - \frac{1}{t}\right)^2 + 2} - 4\sqrt{2} \int_0^1 \frac{\left(1 - \frac{1}{t^2}\right) dt}{\left(t + \frac{1}{t}\right)^2 - 2}$

$= 4\sqrt{2} \cdot \frac{1}{\sqrt{2}} \left[\tan^{-1} \frac{t - \frac{1}{t}}{\sqrt{2}} \right]_0^1 - 4\sqrt{2} \cdot \frac{1}{2\sqrt{2}} \left[\log \left| \frac{t + \frac{1}{t} - \sqrt{2}}{t + \frac{1}{t} + \sqrt{2}} \right| \right]_0^1$

$= 2\pi - 2 \log \left| \frac{2 - \sqrt{2}}{2 + \sqrt{2}} \right|$

$= 2\pi + 2 \log(3 + 2\sqrt{2})$

$\therefore a = b = 2$

6. If $(t + 1)dx = (2x + (t + 1)^3)dt$ and $x(0) = 2$, then $x(1)$ is equal to

- (1) 5 (2) 12
(3) 6 (4) 8

Answer (2)

Sol. $(t + 1)dx = (2x + (t + 1)^3)dt$

$\therefore \frac{dx}{dt} - \frac{2x}{t+1} = (t+1)^2$

\therefore I.F. = $e^{\int \frac{-2}{t+1} dt} = \frac{1}{(t+1)^2}$

\therefore Solution is

$\frac{x}{(t+1)^2} = \int 1 dt$

$x = (t + c)(t + 1)^2$

$\therefore x(0) = 2$ then $c = 2$

$\therefore x = (t + 2)(t + 1)^2$

$\therefore x(1) = 12$

7. Five people are distributed in four identical rooms. A room can also contain zero people. Find the number of ways to distribute them.

(1) 47

(2) 53

(3) 43

(4) 51

Answer (4)

Sol. Total ways to partition 5 into 4 parts are:

$5000 \rightarrow 1$

$4100 \rightarrow \frac{5!}{4!} = 5$

$3200 \rightarrow \frac{5!}{3! \cdot 2!} = 10$

$3110 \rightarrow \frac{5!}{3! \cdot 2!} = 10$

$2210 \rightarrow \frac{5!}{2!2!2!} = 15$

$2111 \rightarrow \frac{5!}{2! \times 3!} = 10$

$51 \rightarrow$ Total way

8. $5f(x) + 4f\left(\frac{1}{x}\right) = x^2 - 4$ and $y = 9f(x) \cdot x^2$. If y is strictly increasing function, find interval of x .

(1) $\left(-\infty, \frac{-1}{\sqrt{5}}\right] \cup \left(\frac{-1}{\sqrt{5}}, 0\right)$

(2) $\left(\frac{-1}{\sqrt{5}}, 0\right) \cup \left(0, \frac{1}{\sqrt{5}}\right)$

(3) $\left(0, \frac{1}{\sqrt{5}}\right) \cup \left(\frac{1}{\sqrt{5}}, \infty\right)$

(4) $\left(-\sqrt{\frac{2}{5}}, 0\right) \cup \left(\sqrt{\frac{2}{5}}, \infty\right)$

Answer (4)

Sol. $5f(x) + 4f\left(\frac{1}{x}\right) = x^2 - 4 \dots(1)$

Replace x by $\frac{1}{x}$

$5f\left(\frac{1}{x}\right) + 4f(x) = \frac{1}{x^2} - 4 \dots(2)$

$5 \times$ equation (1) $- 4 \times$ equation (2)

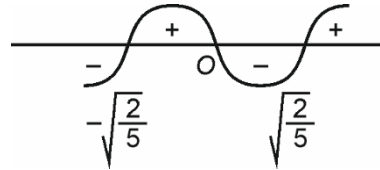
$9f(x) = 5x^2 - \frac{4}{x^2} - 4$

$y = 9f(x) \cdot x^2 = \frac{5x^4 - 4 - 4x^2}{x^2} \cdot x^2$

$y = 5x^4 - 4 - 4x^2$

$y' = 20x^3 - 8x > 0$

$4x(5x^2 - 2) > 0$



$x \in \left(-\sqrt{\frac{2}{5}}, 0\right) \cup \left(\sqrt{\frac{2}{5}}, \infty\right)$

9. If hyperbola $x^2 - y^2 \operatorname{cosec}^2 \theta = 5$ and ellipse $x^2 \operatorname{cosec}^2 \theta + y^2 = 5$ has eccentricity e_H and e_e respectively and $e_H = \sqrt{7}e_e$, then θ is equal to

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

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

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

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

Answer (1)

Sol. $x^2 - y^2 \operatorname{cosec}^2 \theta = 5 \Rightarrow \frac{x^2}{1} - \frac{y^2}{\sin^2 \theta} = 5$

$x^2 \operatorname{cosec}^2 \theta + y^2 = 5 \Rightarrow \frac{x^2}{\sin^2 \theta} + \frac{y^2}{1} = 5$

$e_H = \sqrt{7}e_e$

$e_H = \sqrt{1 + \frac{\sin^2 \theta}{1}}$

and $e_e = \sqrt{1 - \frac{\sin^2 \theta}{1}}$

$\Rightarrow \sqrt{1 + \sin^2 \theta} = \sqrt{7} \sqrt{1 - \sin^2 \theta}$

$\Rightarrow 1 + \sin^2 \theta = 7 - 7 \sin^2 \theta$

$\Rightarrow 8 \sin^2 \theta = 6$

$\Rightarrow \sin \theta = \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2}$

$\Rightarrow \theta = \frac{\pi}{3}$

10. A bag contains 8 balls (black and white). If four balls are chosen without replacement then $2W$ and $2B$ are found then the probability that number of white and black balls are same in bag is equal to

- (1) $\frac{1}{7}$ (2) $\frac{2}{7}$
 (3) $\frac{3}{5}$ (4) $\frac{1}{2}$

Answer (2)

Sol. $P(2W \text{ and } 2B) = P(2B, 6W) \times P(2W \text{ and } 2B)$

$$+ P(3B, 5W) \times P(2W \text{ and } 2B)$$

$$+ P(4B, 4W) \times P(2W \text{ and } 2B)$$

$$+ P(5B, 3W) \times P(2W \text{ and } 2B)$$

$$+ P(6B, 2W) \times P(2W \text{ and } 2B)$$

$$= \frac{1}{9} \left(0+0 + \frac{{}^2C_2 \times {}^6C_2}{{}^8C_4} + \frac{{}^3C_2 \cdot {}^5C_2}{{}^8C_4} + \frac{{}^4C_2 \cdot {}^4C_2}{{}^8C_2} \right)$$

$$= \frac{1}{9} \times \frac{1}{{}^8C_4} (15+30+36+30+15)$$

$$= \frac{1}{9} \times \frac{1}{{}^8C_4} \times 126$$

$$P\left(\frac{4B \text{ and } 4W}{2W \text{ and } 2B}\right) = \frac{\frac{1}{9} \times \frac{{}^4C_2 \times {}^4C_2}{{}^8C_4}}{\frac{1}{9} \times \frac{1}{{}^8C_4} \times 126}$$

$$= \frac{36}{126}$$

$$= \frac{18}{63}$$

$$= \frac{6}{21}$$

$$= \frac{2}{7}$$

11. If two circle $x^2 + y^2 = 4$ and $x^2 + y^2 - 4\lambda x + 9 = 0$ intersect at two distinct points, then find the range of λ .

(1) $\left(-\infty, -\frac{13}{2}\right) \cup \left(\frac{13}{2}, \infty\right)$

(2) $\left(-\infty, -\frac{13}{8}\right) \cup \left(\frac{13}{8}, \infty\right)$

(3) $\left[-\frac{13}{8}, \frac{13}{8}\right]$

(4) $\lambda \in \left(\frac{3}{2}, \infty\right)$

Answer (2)

Sol. $|r_1 - r_2| < c_1 c_2 < r_1 + r_2$

$$\Rightarrow \left|2 - \sqrt{4\lambda^2 - 9}\right| < |2\lambda| < 2 + \sqrt{4\lambda^2 - 9}$$

$$\Rightarrow |2\lambda| - 2 < \sqrt{4\lambda^2 - 9}$$

$$\Rightarrow 4\lambda^2 + 4 - 8|\lambda| < 4\lambda^2 - 9$$

$$\lambda > \frac{13}{8}, \lambda < -\frac{13}{8}$$

$$\sqrt{4\lambda^2 - 9} > 0$$

$$\Rightarrow \lambda > \frac{3}{2}, \lambda < -\frac{3}{2}$$

$$\therefore \lambda \in \left(-\infty, -\frac{13}{8}\right) \cup \left(\frac{13}{8}, \infty\right)$$

Now,

$$\left|2 - \sqrt{4\lambda^2 - 9}\right| < |2\lambda|$$

$$\Rightarrow 4 + 4\lambda^2 - 9 - 4\sqrt{4\lambda^2 - 9} < 4\lambda^2$$

$$\Rightarrow 4\sqrt{4\lambda^2 - 9} > -5 \Rightarrow \lambda \in \mathbb{R}$$

$$\therefore \lambda \in \left(-\infty, -\frac{13}{8}\right) \cup \left(\frac{13}{8}, \infty\right)$$

12. If $S = \left\{x \in \mathbb{R} : 3(\sqrt{3} + \sqrt{2})^x + (\sqrt{3} - \sqrt{2})^x = \frac{10}{3}\right\}$

then number of elements in set S is

- (1) Zero (2) 1
 (3) 2 (4) 3

Answer (3)

Sol. $\sqrt{3} - \sqrt{2} = \frac{(\sqrt{3} + \sqrt{2})(\sqrt{3} - \sqrt{2})}{(\sqrt{3} + \sqrt{2})} = \frac{1}{\sqrt{3} + \sqrt{2}}$

Let $\sqrt{3} + \sqrt{2} = t$

$$\Rightarrow t^x + \frac{1}{t^x} = \frac{10}{3}$$

Let $t^x = y \Rightarrow y + \frac{1}{y} = \frac{10}{3}$

$$\Rightarrow y = 3 \text{ or } \frac{1}{3}$$

$$\Rightarrow (\sqrt{3} + \sqrt{2})^x = 3 \text{ or } \frac{1}{3}$$

$$x \log(\sqrt{3} + \sqrt{2}) = \ln 3 \text{ or } -\ln 3$$

$$\Rightarrow x = \frac{\ln 3}{\ln(\sqrt{3} + \sqrt{2})} \text{ or } \frac{-\ln 3}{\sqrt{3} + \sqrt{2}}$$

\Rightarrow two real values of x

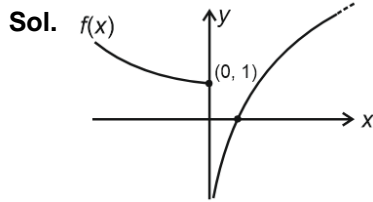
$$13. f(x) = \begin{cases} e^{-x}, & x < 0 \\ \ln x, & x > 0 \end{cases}$$

$$g(x) = \begin{cases} e^x, & x < 0 \\ x, & x > 0 \end{cases}$$

The *gof*: $A \rightarrow R$ is

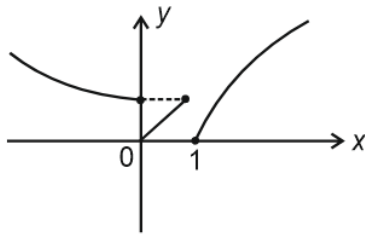
- (1) Onto but not one-one
- (2) Into and many one
- (3) Onto and one-one
- (4) Into and one-one

Answer (2)



$$gof(x) = \begin{cases} f(x), & f(x) < 0 \\ f(x), & f(x) > 0 \end{cases}$$

$$= \begin{cases} e^{\ln x} = x & (0, 1) \\ e^{-x} & (-\infty, 0) \\ \ln x & (1, \infty) \end{cases}$$



$\therefore gof(x)$ is many one and into

$$14. \text{ If } \tan A = \frac{1}{\sqrt{x^2 + x + 1}}, \tan B = \frac{\sqrt{x}}{\sqrt{x^2 + x + 1}} \text{ and}$$

$$\tan C = \frac{1}{\sqrt{x(x^2 + x + 1)}}, \text{ then } A + B =$$

- (1) 0
- (2) $\pi - C$
- (3) $\frac{\pi}{2} - C$
- (4) None

Answer (3)

Sol. $\tan B \times \tan C = \frac{\sqrt{x}}{\sqrt{x^2 + x + 1}} \times \frac{1}{\sqrt{x(x^2 + x + 1)}}$

$$= \frac{1}{x^2 + x + 1} = \tan^2 A$$

$$\tan^2 A = \tan B \tan C$$

It is only possible when $A = B = C$ at $x = 1$

$$\Rightarrow A = 30^\circ, B = 30^\circ, C = 30^\circ$$

$$\left[\tan A = \tan B = \tan C = \frac{1}{\sqrt{3}} \right]$$

$$\therefore A + B = \frac{\pi}{2} - C$$

$$15. \lim_{x \rightarrow 0} \frac{\cos^{-1}(1 - \{x\}^2) \sin^{-1}(1 - \{x\})}{\{x\} - \{x\}^3}, \text{ where } \{ \} \text{ is fractional part function.}$$

If L.H.L = L and R.H.L = R , then the correct relation between L and R is

- (1) $\sqrt{2}R = 4L$
- (2) $\sqrt{2}L = 4R$
- (3) $R = L$
- (4) $R = 2L$

Answer (1)

Sol. *RHL* $\Rightarrow \lim_{x \rightarrow 0^+} \frac{\cos^{-1}(1 - x^2) \sin^{-1}(1 - x)}{x - x^3}$

$$\Rightarrow \lim_{x \rightarrow 0^+} \frac{\pi}{2} \cdot \frac{\cos^{-1}(1 - x^2)}{x}$$

$$\frac{\pi}{2} \lim_{x \rightarrow 0^+} \frac{-1}{\sqrt{(1 - (1 - x^2))^2}} (-2x)$$

$$= \frac{\pi}{2} \lim_{x \rightarrow 0^+} \frac{2x}{\sqrt{2x^2 - x^4}} = \pi \lim_{x \rightarrow 0^+} \frac{x}{x\sqrt{2 - x^2}}$$

$$= \frac{\pi}{\sqrt{2}}$$

$$LHL \Rightarrow \lim_{x \rightarrow 0^-} \frac{\cos^{-1}(1 - (1 + x)^2) \sin^{-1}(1 - (1 + x))}{1 \cdot (1 - (1 + x)^2)}$$

$$= \lim_{x \rightarrow 0^-} \frac{\cos^{-1}(-x^2 - 2x) \cdot \sin^{-1}(-x)}{-x^2 - 2x}$$

$$= \frac{\pi}{2} \lim_{x \rightarrow 0^-} \frac{-\sin^{-1} x}{-x(x + 2)} = \frac{\pi}{2} \times \frac{1}{2} = \frac{\pi}{4}$$

- 16.
- 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.

$$21. \text{ Let } S = \{1, 2, 3, \dots, 20\}$$

$$R_1 = \{(a, b) : a \text{ divide } b\}$$

$$R_2 = \{(a, b) : a \text{ is integral multiple of } b\} \text{ } a, b \in S$$

$$n(R_1 - R_2) = ?$$

Answer (46)

Sol. $R_1 = \{(1, 1), (1, 2), (1, 3), \dots, (1, 20), (2, 2), (2, 4), \dots, (2, 20), (3, 3), (3, 6), \dots, (3, 18), (4, 4), (4, 8), \dots, (4, 20), (5, 5), (5, 10), (5, 15), (5, 20), (6, 6), (6, 12), (6, 18), (7, 7), (7, 14), (8, 8), (8, 16), (9, 9), (9, 18), (10, 10), (10, 20), (11, 11), (12, 12), \dots, (20, 20)\}$

$n(R_1) = 66$

$R_2 = \{a \text{ is integral multiple of } b\}$

So $n(R_1 - R_2) = 66 - 20 = 46$

as $R_1 \cap R_2 = \{(a, a) : a \in s\} = \{(1, 1), (2, 2), \dots, (20, 20)\}$

22. The number of solution of equation $x + 2y + 3z = 42$ and $x, y, z \in \mathbb{Z}$ and $x, y, z \geq 0$ is

Answer (168)

Sol. $x + 2y + 3z = 42$

- 0 $x + 2y = 42 \Rightarrow 22$ cases
- 1 $x + 2y = 39 \Rightarrow 19$ cases
- 2 $x + 2y = 36 \Rightarrow 19$ cases
- 3 $x + 2y = 33 \Rightarrow 17$ cases
- 4 $x + 2y = 30 \Rightarrow 16$ cases
- 5 $x + 2y = 27 \Rightarrow 14$ cases

- 6 $x + 2y = 24 \Rightarrow 13$ cases
- 7 $x + 2y = 21 \Rightarrow 11$ cases
- 8 $x + 2y = 18 \Rightarrow 10$ cases
- 9 $x + 2y = 15 \Rightarrow 8$ cases
- 10 $x + 2y = 12 \Rightarrow 7$ cases
- 11 $x + 2y = 9 \Rightarrow 5$ cases
- 12 $x + 2y = 6 \Rightarrow 4$ cases
- 13 $x + 2y = 3 \Rightarrow 2$ cases
- 14 $x + 2y = 0 \Rightarrow 1$ cases

- 23.
- 24.
- 25.
- 26.
- 27.
- 28.
- 29.
- 30.

