
JEE MAIN 2020 5th SEPT SHIFT 1

Physics

Question 1. In a photoelectric effect experiment potential difference between plates increases keeping incident light on cathode plate remains unchanged which of the following is correct about saturation current:

- (1) Increases
- (2) Decreases
- (3) Remains same
- (4) First increases then decreases

Ans. (3)

Sol. Saturation current depends only on intensity of incident light.

Question 2. A disc of moment of inertia I rotating about its own axis with angular speed ω . It is placed on another disc of moment of inertia $3I$ which is at rest. Both disc have common axis of rotation. What will be the loss of kinetic energy upto both discs attain common angular velocity.

- (1) $\frac{I\omega^2}{8}$
- (2) $\frac{I\omega^2}{4}$

$$(3) \frac{3I\omega^2}{8}$$

$$(4) \frac{5I\omega^2}{4}$$

Ans. (3)

Sol. From angular momentum conservation

$$I\omega + 0 = I\omega_c + 3I\omega_c$$

$$\omega_c = \frac{\omega}{4}$$

Loss of kinetic energy

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

$$= \frac{1}{2} I\omega^2 - \frac{1}{2} I \frac{\omega^2}{4}$$

$$= \frac{3}{8} I\omega^2$$

Question 3. A shell of relative density $\frac{27}{9}$ w.r.t. water, is just submerged in water. If its inner and outer radius is r and R then $\frac{r}{R}$ will be:

$$(1) \left(\frac{1}{3}\right)^{1/3}$$

$$(2) \left(\frac{2}{3}\right)^{1/3}$$

$$(3) \left(\frac{3}{4}\right)^{1/3}$$

$$(4) \left(\frac{5}{9}\right)^{1/3}$$

Ans. (2)

Sol. In equilibrium

$$mg = FB$$

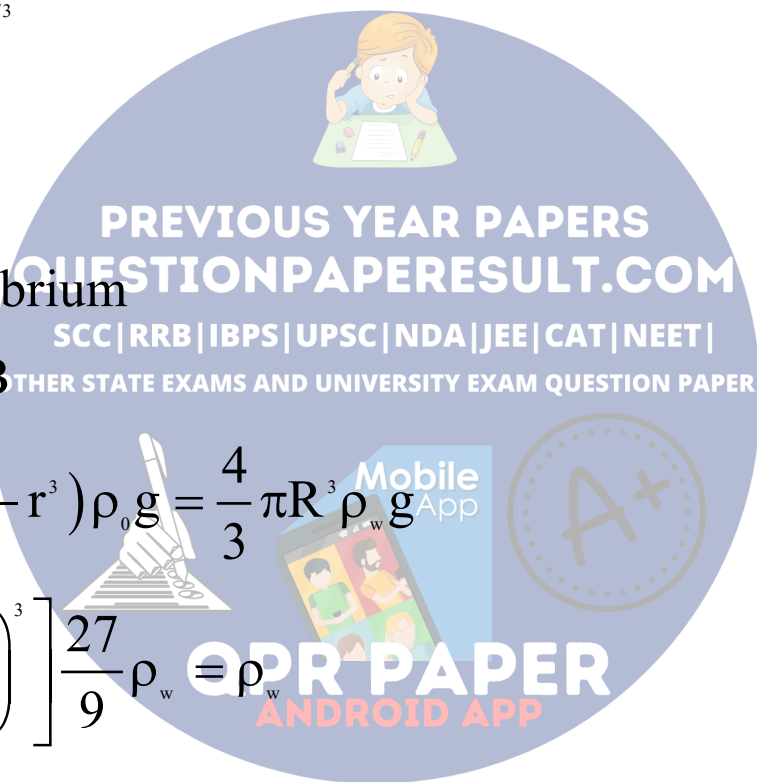
$$\frac{4}{3} \pi (R^3 - r^3) \rho_0 g = \frac{4}{3} \pi R^3 \rho_w g$$

$$\left[1 - \left(\frac{r}{R}\right)^3\right] \frac{27}{9} \rho_w = \rho_w$$

$$1 - \frac{r^3}{R^3} = \frac{9}{27}$$

$$1 - \frac{1}{3} = \frac{r^3}{R^3}$$

$$\frac{2}{3} = \frac{r^3}{R^3}$$



$$\frac{r}{R} = \left(\frac{2}{3}\right)^{1/3}$$

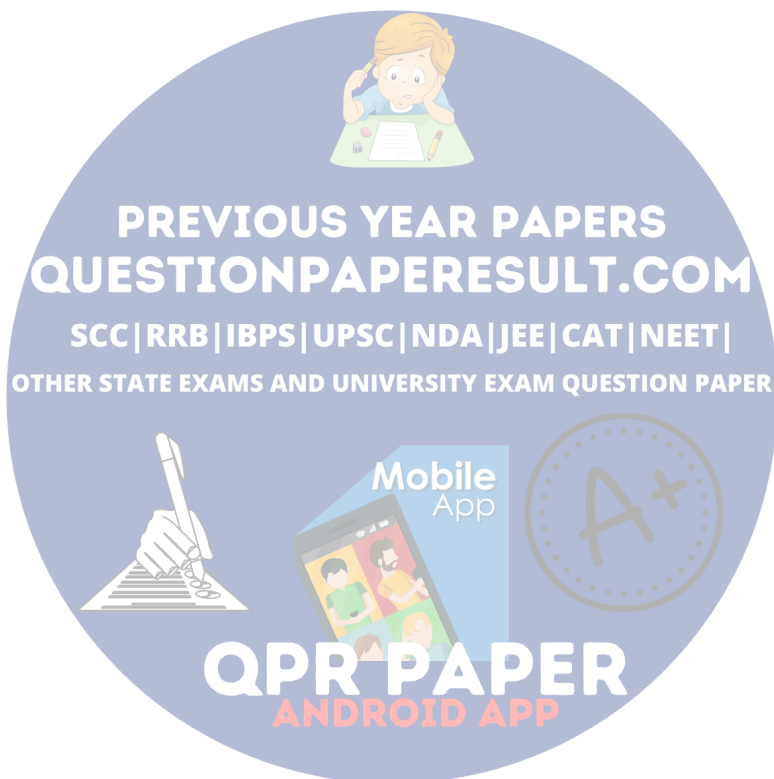
Question 4. Acceleration due to gravity at height $h = \frac{R}{2}$ is equal to acceleration due to gravity at depth d from the surface of earth then find d in terms of R . when R is radius of earth.

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

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

(3) $\frac{5}{9}R$

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



Ans. (3)

Sol. Given that

$$g_n = g_d$$

$$\frac{GM}{(R+h)^2} = \frac{GM}{R^3}(R-d)$$

$$\frac{GM}{(R+R/2)^2} = \frac{GM}{R^3}(R-d)$$

$$\frac{4GM}{9R^2} = \frac{GM}{R^2} \left(1 - \frac{d}{R} \right)$$

$$\frac{4}{9} = 1 - \frac{d}{R}$$

$$\frac{d}{R} = 1 - \frac{4}{9} = \frac{5}{9}$$

$$d = \frac{5}{9}R$$

Question 5. Voltage range of Galvanometer of resistance R is 0 to 1V. When its range increases, up to 2V, for this the additional resistance required in series will be:

- (1) R
- (2) $2R$
- (3) $3R$
- (4) $4R$

Ans. (1)

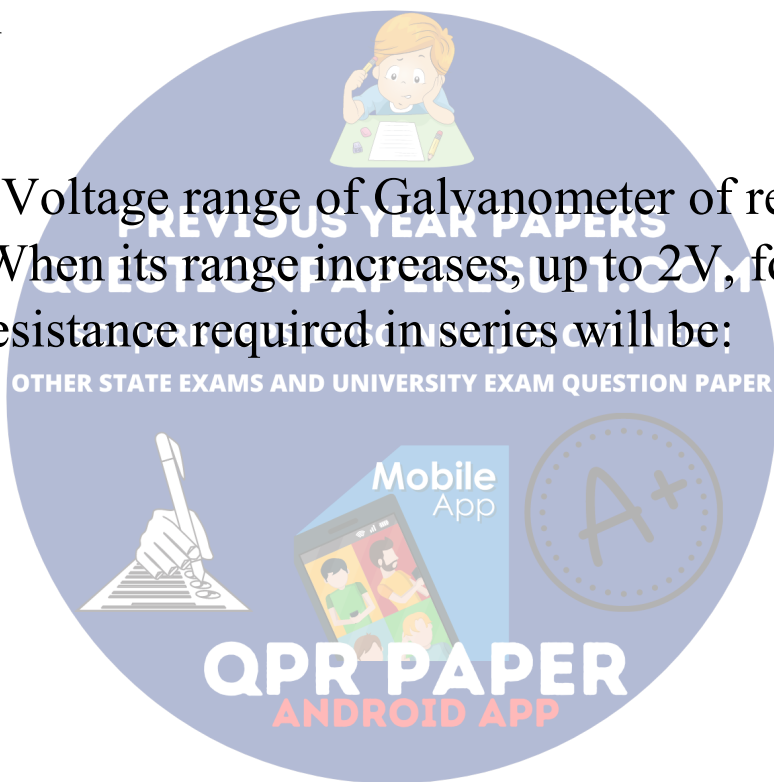
Sol. Given $i_g R = 1$

Let the required resistance be r

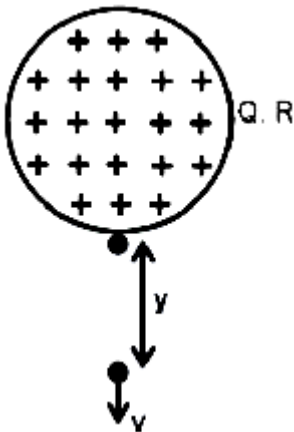
$$i_g (R + r) = 2$$

$$\frac{R + r}{R} = 2$$

$$r = R$$



Question 6. A uniformly charged sphere of charge Q and radius R is placed at some height from ground surface and sphere is fixed. Now a charged particle of mass m and charge q is released from rest just below to the sphere. What will be speed of particle after travelling Y -distance.



(1) $\sqrt{2gy}$

(2) $\sqrt{\frac{2kQq}{m} \frac{y}{R(R+y)}}$

(3) $\sqrt{2gy + \frac{2kQq}{m} \frac{y}{R(R+y)}}$

(4) $\sqrt{gy + \frac{kQq}{m} \frac{y}{R(R+y)}}$

Ans. (3)

Sol. By using total energy conservation

$$\Delta KE + (\Delta PE)_{\text{Electro}} + (\Delta PE)_{\text{gravitational}} = 0$$

$$\frac{1}{2}mV^2 + \left(k \frac{Qq}{R+y} - k \frac{Qq}{R} \right) + (-mgy) = 0$$

$$\frac{1}{2}mV^2 = mgy + kQq \left(\frac{1}{R} - \frac{1}{R+y} \right)$$

$$V = \sqrt{2gy + \frac{2kQq}{m} \frac{y}{R(R+y)}}$$

Question 7. A helicopter is rising up from ground with an acceleration of $g \text{ m/s}^2$, starting from rest after rising a height h , it attain a velocity of $v \text{ m/s}$. At this instant a particle is now released from helicopter. Take $t = 0$ at releasing time, calculate the time t when particle reaches to the ground.

(1) $\sqrt{\frac{2h}{g}}$

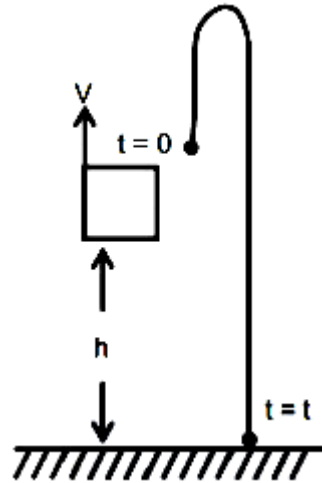
(2) $2\sqrt{\frac{2h}{g}}$

(3) $\left(1 + \sqrt{2} \sqrt{\frac{2h}{g}} \right)$

(4) $4\sqrt{\frac{2h}{g}}$

Ans. (3)

Sol.



⇒ For upward motion of helicopter

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + 2gh$$

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

⇒ Now particle will start moving under gravity.

$$s = ut + \frac{1}{2}at^2$$

$$-h = \sqrt{2gh} t - \frac{1}{2}gt^2$$

$$\frac{1}{2}gt^2 - \sqrt{2gh} t - h = 0$$

$$\text{than } t = \frac{\sqrt{2gh} \pm \sqrt{2gh + 4 \times \frac{g}{2} \times h}}{2 \times \frac{g}{2}}$$

$$t = \sqrt{\frac{2gh}{g}} (1 + \sqrt{2})$$

$$t = \sqrt{\frac{2h}{g}} (1 + \sqrt{2})$$

Question 8. Two parallel plate capacitors of capacitance C and $2C$ are charged upto a potential difference V and $2V$ respectively. Now these capacitors are connected in parallel to each other such that positive charged plate of capacitor C is connected to negative charged plate of capacitors $2C$. Find amount of change in potential energy of system.

(1) CV^2

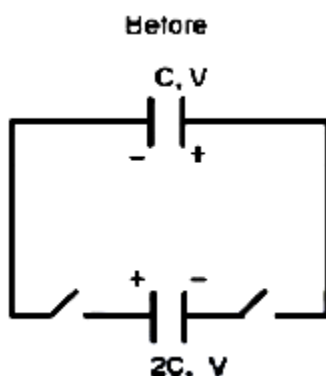
(2) $\frac{CV^2}{2}$

(3) $2CV^2$

(4) $3CV^2$

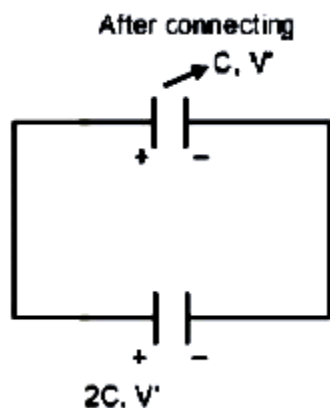
Ans. (4)

Sol.



Charge on $C = CV$

Charge on $2C = (2C) 2V$



From charge conservation, $2C(2V) - CV = (C + 2C) V'$

Common potential $V' = V$

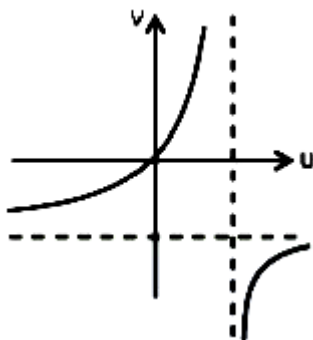
$$\Delta U = U_{\text{in}} = U_{\text{final}}$$

$$= \left(\frac{1}{2} CV^2 + \frac{1}{2} 2C \times 4V^2 \right) = \left(\frac{1}{2} CV^2 + \frac{1}{2} \times 2CV^2 \right)$$

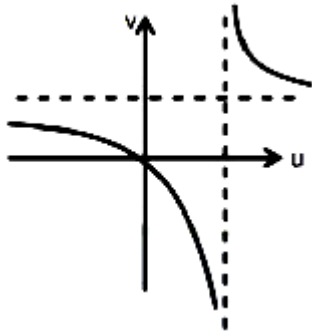
$$\Delta U = 3CV^2$$

Question 9. Which of the following graph represents relation between the image position (v) and object position (u) from the concave lens.

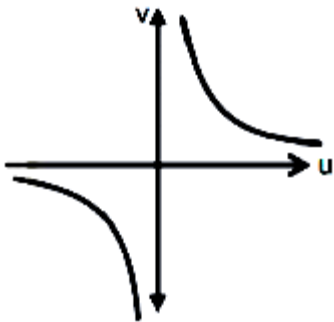
(1)



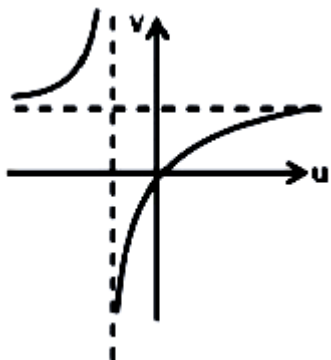
(2)



(3)



(4)



Ans. (1)

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

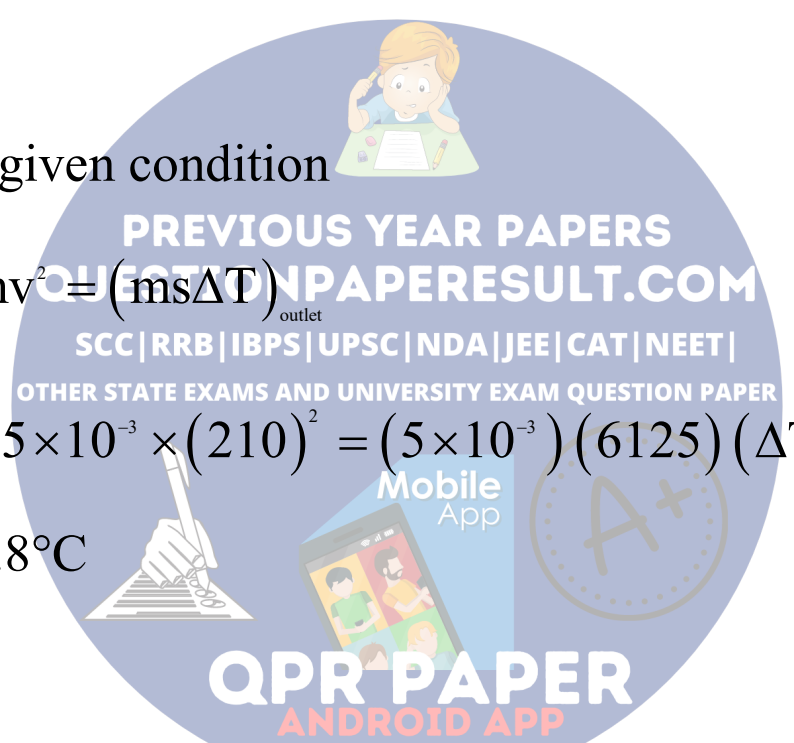
Question 10. A bullet of mass 5g moving with a speed of 210 m/s hit a stationary plank and comes to rest. If half of its kinetic energy is absorbed by bullet itself and remaining

half kinetic energy by plank, then what is size in the temperature of bullet in °C: (Given specific heat of bullet is 6125 J/kg°C)

- (1) 1
- (2) 1.2
- (3) 1.6
- (4) 1.8

Ans. (4)

Sol. As per given condition



$\frac{1}{2} \times \frac{1}{2} mv^2 = (ms\Delta T)$
 $\frac{1}{2} \times \frac{1}{2} \times 5 \times 10^{-3} \times (210)^2 = (5 \times 10^{-3}) (6125) (\Delta T)$
 $\Delta T = 1.8^\circ\text{C}$

Chemistry

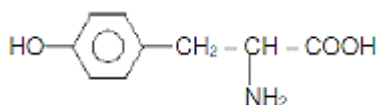
Question 11. Which amino acid is not a essential amino acid.

- (1) Tyrosine
- (2) Lysine
- (3) Valine
- (4) Threonine

Answer: (1)

Solution:

Tyrosine



is a non-essential amino acid.

Question 12. When atmosphere become polluted

- (1) When CO₂ value is 0.03% in atmosphere
- (2) When B.O.D value is 5 ppm
- (3) Due to presence of Eutrophication
- (4) If concentration of dissolved oxygen of water is greater than 6 ppm

Answer: (1)

Solution:

(2) Clean water would have B.O.D value of less than 5 ppm whereas highly polluted water could have a B.O.D value of 17 ppm or more.

(3) The process in which nutrient enriched water bodies support a dense plant population which kill animal life by depriving it of oxygen results in subsequent loss of biodiversity is known as Eutrophication.

(4) If the concentration of dissolved oxygen of water is below 6 ppm, the growth of fish get inhibited

Question 13. Which of the following is suggested to suppress the effect of Noradrenaline:

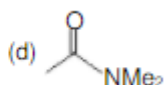
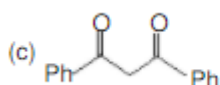
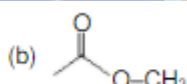
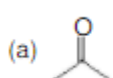
- (1) Analgesic
- (2) Anti-depressant drugs
- (3) Anti histamine
- (4) Anti inflammatory

Answer: (2)

Solution:

If the level of noradrenaline is low for some reason, then the signal-sending activity becomes low, and the person suffers from depression. In such situations, the antidepressant drugs are required.

Question 14. What is the correct order of acidity of α -hydrogens of the following compounds

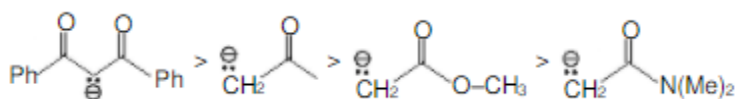


- (1) (c) > (a) > (b) > (d)
- (2) (c) > (a) > (d) > (b)
- (3) (a) > (b) > (c) > (d)
- (4) (b) > (a) > (d) > (c)

Answer: (1)

Solution:

Acidity \propto stability of conjugate base



(Stability of conjugate base)

Question 15. Correct structure of PCl_5 in solid state is:

(1) Square pyramidal

(2) Trigonal bipyramidal

(3) It exist as

$[\text{PCl}_4]^+$ square planer

$[\text{PCl}_6]^-$ Octahedral

(4) It exist as

$[\text{PCl}_4]^+$ tetrahedral

$[\text{PCl}_6]^-$ Octahedral

Answer: (4)

Solution:



Tetrahedral Octahedral

Question 16. What is the value of CFSE for complex having $3d^6$ configuration in high spin situation

(1) $-0.4\Delta_0, -0.6\Delta t$

(2) $-0.8\Delta_0, -0.6\Delta t$

(3) $-0.4\Delta_0, -1.2\Delta t$

(4) $-0.4\Delta_0, -0.27\Delta t$

Answer: (1)

Solution:

For d_6 configuration, high spin

(1) In case of octahedral complex

t_{2g}^2, e_g^4

$$CFSE = [-0.4n_{t_{2g}} + 0.6n_{e_g}]\Delta_0 + 0$$

$$= [-0.4 \times 4 + 0.6 \times 2]\Delta_0 + 0$$

$$= -0.4\Delta_0$$

(2) In case of tetrahedral complex

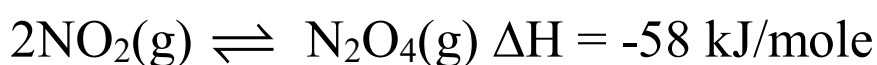
e^2, t_2^4

$$CFSE = [-0.6n_e + 0.4n_{t_2}]\Delta t$$

$$= [-0.6 \times 3 + 0.4 \times 3]\Delta t$$

$$= -0.6\Delta t$$

Question 17. For the following reaction at equilibrium



Following change are made then identify in which direction reaction shift.

(1) Increase in temperature – towards product side, Increase in pressure – towards product side

(2) Increase in temperature – towards reactant side, Increase in pressure – towards product side

(3) Increase in temperature – towards reactant side, Increase in pressure – towards reactant side

(4) Increase in temperature – towards product side, Increase in pressure – towards reactant side

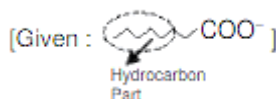
Answer: (2)

Solution:

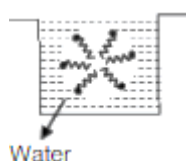
(1) As reaction is exothermic so on increases in temperature equilibrium shift in reactant side.

(2) On increase in pressure reaction shift in direction where no of gaseous mole decreases, so reaction shift in product side.

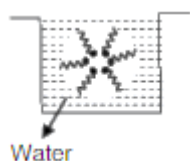
Question 18. Above 'CMC' correct diagram for micelle formation is.



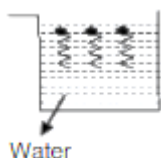
(1)



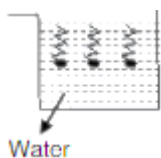
(2)



(3)



(4)



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Answer: (1)

Solution:

In micelle formation, above 'CMC' hydrocarbon chains are pointing towards the centre of sphere with COO part remaining outward on the surface

Question 19. What is the correct configuration and magnetic moment (spin only) for 64Gd^{3+} ion?

(1) $[\text{Xe}]54 4f^7, 7.93 \text{ BM}$

(2) $[\text{Xe}]54 6s^1, 7.93 \text{ BM}$

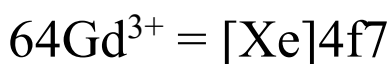
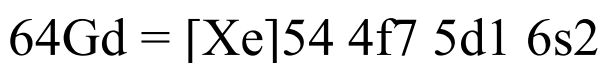
(3) $[\text{Xe}]54 4f^5 6s^2, 9.2 \text{ BM}$

(4) $[\text{Xe}]54 5f^7, 7.93 \text{ BM}$

Answer: (1)

Solution:

Electronic configuration of



No. of unpaired electron = 7

$$\mu = \sqrt{n(n+2)} \text{ BM} = \sqrt{63} = 7.93 \text{ BM}$$

Question 20. Difference in radius of 3rd and 4th orbit in H^{e+} ion in $(R_0)_1$ and in Li^{2+} ion in $(R_0)_2$, then ratio of $(R_0)_1$ to $(R_0)_2$ is

(1) 1 : 2

(2) 2 : 1

(3) 3 : 2

(4) 2 : 3

Answer: (3)

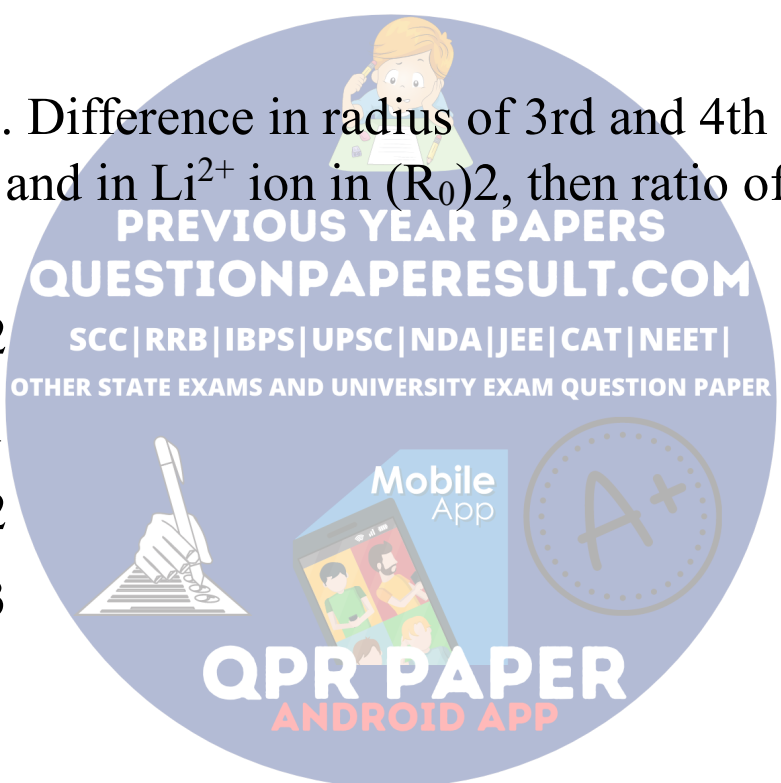
Solution:

$$r = 0.529 \frac{n^2}{Z} \text{ \AA}$$

For H^{e+}

$$\left(r_{\text{He}^+} \right)_{n=4} - \left(r_{\text{He}^+} \right)_{n=3} = \frac{0.529}{2} [16 - 9] = (R_0)_t$$

For Li^{2+}



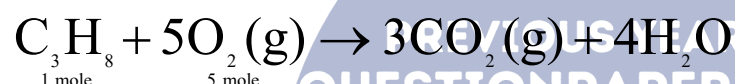
$$\left(r_{\text{Li}^{2+}} \right)_{n-4} - \left(r_{\text{Li}^{2+}} \right)_{n-4} = \frac{0.529}{2} [16 - 9] = \left(R_0 \right)_2 ; \frac{\left(R_0 \right)_1}{\left(R_0 \right)_2} = \frac{3}{2}$$

Question 21. For complete combustion of 1 mole of each propane and butane, Find sum of minimum number of moles of O₂ required

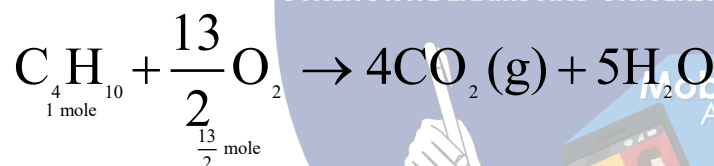
Answer: 11.50

Solution:

(1) Combustion of propane.



(2) Combustion of butane



So total mole of O₂ required = $5 + \frac{13}{2} = 11.5$

Question 22. How many isomers are possible for the complex [Pt(en)₂(NO₂)₂]

Answer: 9.00

Solution:

(1) Cis-NO₂|NO₂ – (2) Trans-NO₂|NO₂ – (1)

(2) Cis-NO₂|ONO – (2) Trans-NO₂|ONO – (1)

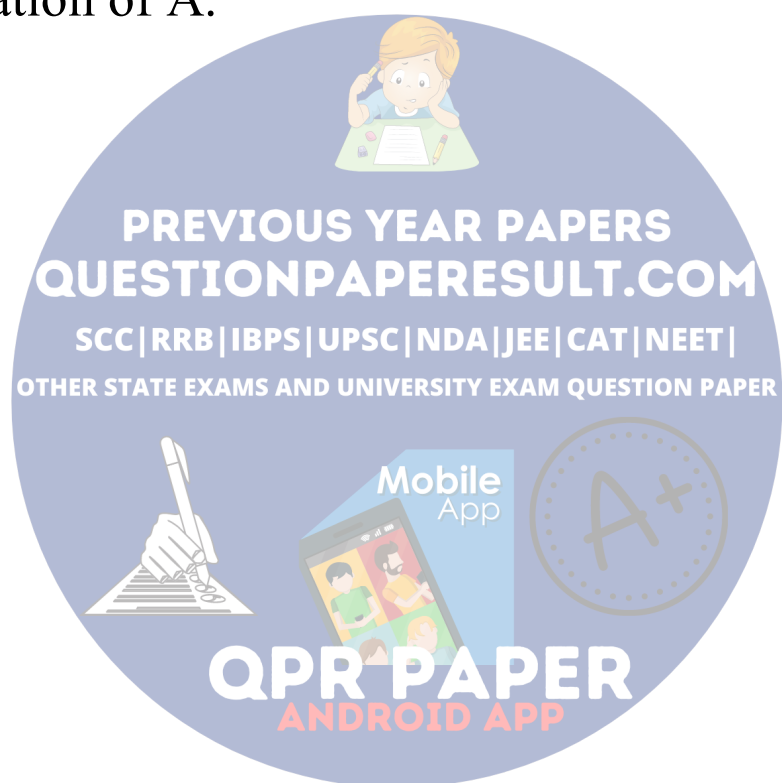
(3) Cis-ONO|ONO – (2) Trans-ONO|ONO – (1)

So total possible isomers are – (9)

Question 23. Reaction $A \rightarrow \text{product}$ and $B \rightarrow \text{product}$ are 1st order reactions. Half life of 1st reaction is 180 sec and for 2nd reaction it is 300 sec. Initially $[A] = [B]$, then after how much time (in min) concentration of B become 4 times of concentration of A.

Answer: 15

Solution:



$$C_t = C_0 e^{-kt} \quad k_A = \frac{\ln 2}{180} \left(k = \frac{\ln 2}{T_{\frac{1}{2}}} \right)$$

$$(C_t), A = (C_0) A e^{-k_A t} \quad k_B = \frac{\ln 2}{300}$$

$$(C_t), B = (C_0) B e^{-k_B t}$$

$$\frac{(C_t), B}{(C_t), A} = \frac{(C_0), B}{(C_0), A} \times e^{(k_A - k_B)t}$$

$$4 = e^{(k_A - k_B)t}$$

$$2 \ln 2 = \left[\frac{\ln 2}{180} - \frac{\ln 2}{300} \right] t$$

$$2 = \left(\frac{120}{180 \times 300} \right) t$$

$$t = \frac{2 \times 180 \times 300}{120} = 900 \text{ sec} = 15 \text{ min}$$

Question 24. For galvanic cell $M^{2+}(aq) + Zn(s) \rightarrow M(s) + Zn^{2+}(aq)$ $\Delta G^0 = -386 \text{ kJ/mole}$

Then value of E^0_{cell} (in V) is

Answer: 2.00

Solution:

$$\Delta G^0 = -nF E^0_{\text{cell}}$$

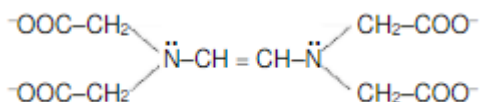
$$-386 \times 10^3 = -2 \times 96500 \times E^0_{\text{cell}}$$

$$E_{\text{cell}} = 2 \text{ V}$$

Question 25. What is the denticity of $[\text{EDTA}]^{4-}$

Answer: 6.00

Solution:



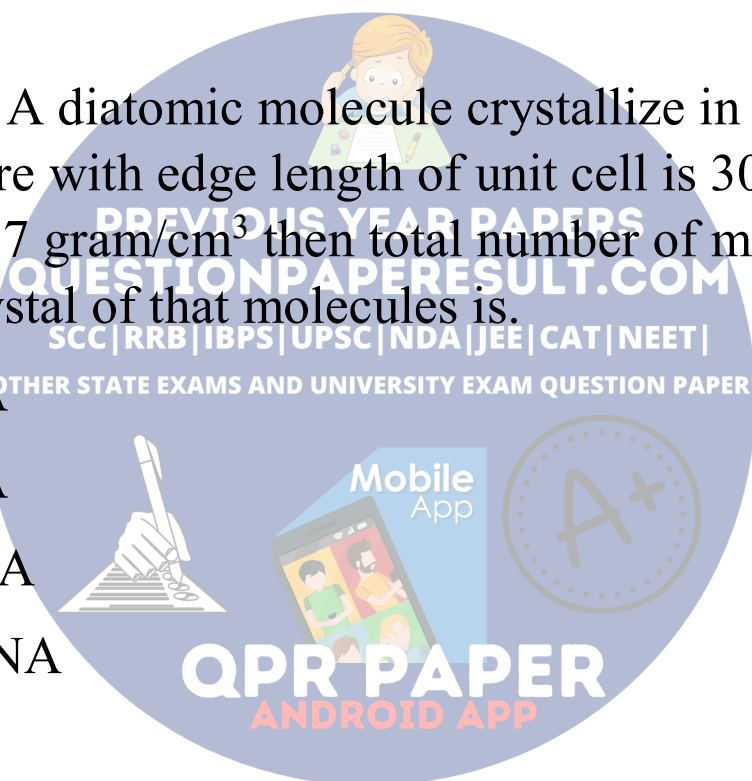
Question 26. A diatomic molecule crystallize in body center cubic structure with edge length of unit cell is 300 pm and density is 6.17 gram/cm^3 then total number of molecule in 200 gram crystal of that molecules is.

- (1) 4 NA
- (2) 8 NA
- (3) 40 NA
- (4) 400 NA

Answer: (1)

Solution:

For BCC, $Z = 2$



$$d = \frac{Z \times M}{N_A \times \text{Volume}}$$

$$6.17 = \frac{2 \times M}{6.02 \times 10^{23} \times [3 \times 10^{-8}]^3}$$

$$6.17 = \frac{2 \times M}{6.02 \times 2.7}$$

$$M = 50$$

$$\text{No. of mole} = \frac{200}{50} = 4$$

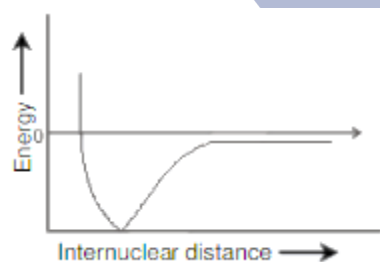
$$\text{No. of molecule} = 4 N_A$$

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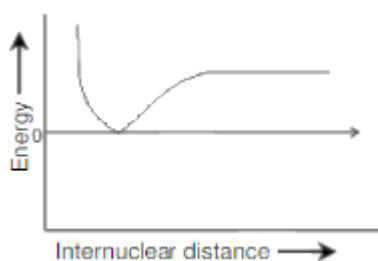
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Question 27. Identify the correct potential energy curve for the formation of H_2 molecule as a function of inter nuclear distance of the H atoms

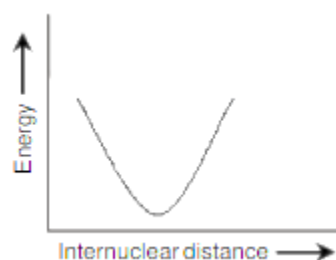
(1)



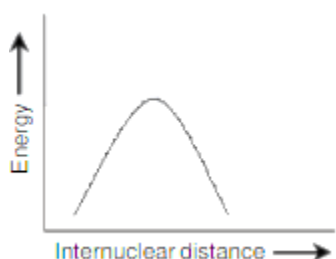
(2)



(3)



(4)



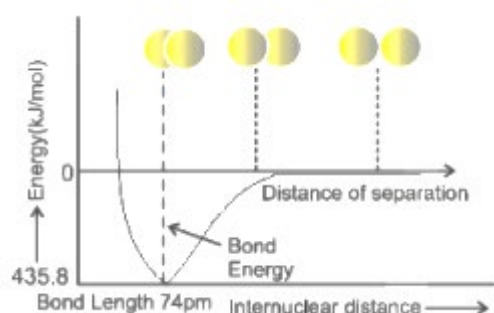
Answer: (1)

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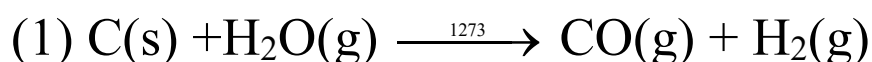
Solution:

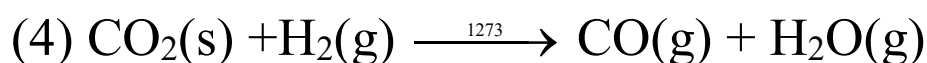
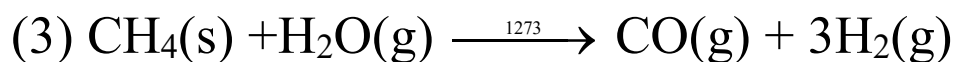
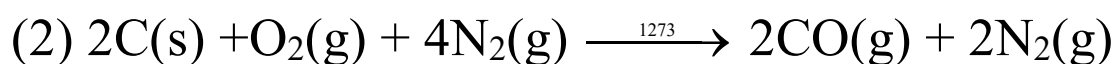
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OTHER STATE EXAMS AND UNIVERSITY EXAM QUESTION PAPER

The potential energy curve for the formation of H₂ molecule as a function of inter nuclear distance of the H atoms. The minima in the curve corresponds to the most stable state of H₂



Question 28. Which of the following reaction is used for preparation of water gas on commercial scale.



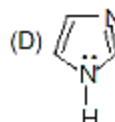
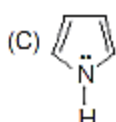
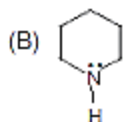
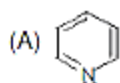


Answer: (1)

Solution:



Question 29. Arrange the following in increasing order of basicity:



Answer: (2)

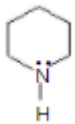
Solution:

(A)



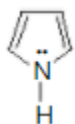
Nitrogen atom is sp^2 hybridised and lone pair is localized

(B)



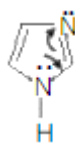
Nitrogen atom is sp^3 hybridised and lone pair is localized

(C)



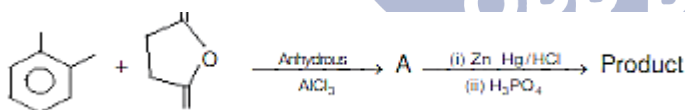
Nitrogen atom is sp^2 hybridised and lone pair is delocalized

(D)



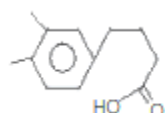
Nitrogen atom is sp^2 hybridised and lone pair is localized with partial negative charge

Question 30.

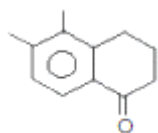


Product is?

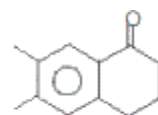
(1)



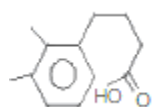
(2)



(3)

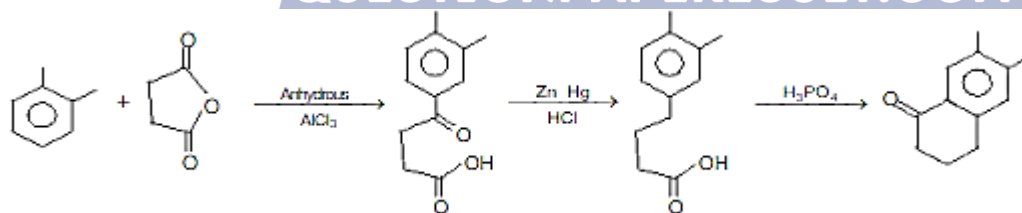


(4)



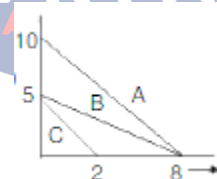
Answer: (3)

Solution:



Question 31. In(rate)

QPR PAPER



Using the above graph the correct $T_{\frac{1}{2}}$ ratio of A, B, C is

(1) 2 : 4 : 1

(2) 2 : 4 : 3

(3) 3 : 2 : 4

(4) 2 : 3 : 4

Answer: (1)

Solution:

For 1st order reaction $C = C_0 e^{-kt}$

$$\text{Rate} = -\frac{dc}{dt} = KC_0 e^{-kt}$$

$$\ln(\text{rate}) = \ln(KC_0) - kt$$

So graph between $\ln(\text{rate})$ and time will be straight line with slope = $-k$, so from graph

$$K_A = \frac{10}{8}, K_B = \frac{5}{8} \text{ and } K_C = \frac{5}{2} = \frac{20}{8}$$

$$\text{Since } T_{\frac{1}{2}} = \frac{\ln 2}{K}$$

$$\text{So } T_A : T_B : T_C = \frac{1}{K_A} : \frac{1}{K_B} : \frac{1}{K_C}$$

$$= \frac{8}{10} : \frac{8}{5} : \frac{8}{20}$$

$$= 2 : 4 : 1$$

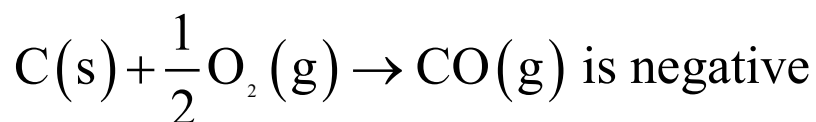
Question 32. Select the correct statement about Ellingham diagram

(a) Ellingham diagram is graph between ΔH_1^0 & T if any metal or element oxide

(b) Any metal will reduce the oxide of other metals which lie above it in the Ellingham diagram.

(c) Any metal will reduce the oxide of other metals which lie lower it in the Ellingham diagram.

(d) Slope of ΔG_0 Vs T plot of the reaction



(1) b, d

(2) c, d

(3) a, b, d

(4) a, c, d

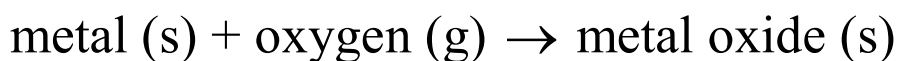
Answer: (1)

Solution:

Ellingham diagram is graph of ΔG_0 Vs T of any metal/element oxide, Since

$$\Delta G_0 = \Delta H_0 - T\Delta S_0$$

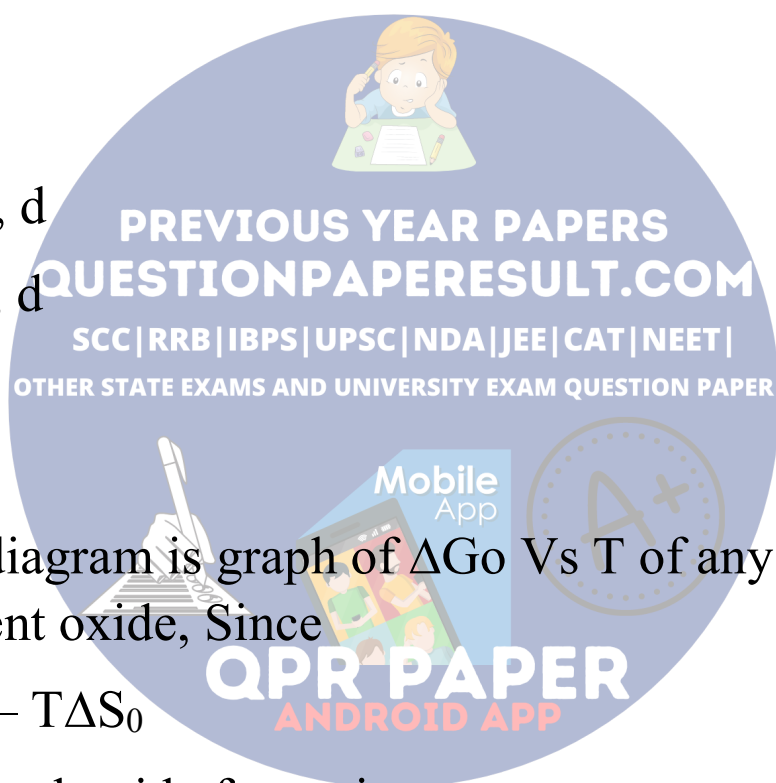
For most metal oxide formation



$$\Delta H_0 = -ve$$

$$\Delta S_0 = -ve$$

So graph will be a straight line with -ve y – intercept & +ve slope



Mathematics

Question 33. The number of four letters word while each consisting 2 distinct and two alike letters taken from word 'SYLLABUS'

- (1) 240
- (2) 144
- (3) 288
- (4) 432

Ans. (1)

Sol. SYLLABUS

S – 2, L – 2, A, B, Y, U

$$\text{Required no. of ways} = {}^2C_1 \cdot {}^5C_2 \cdot \frac{4!}{2!} = 2 \cdot 10 \cdot \frac{24}{2} = 240$$

Question 34. The common tangent of curves $x^2 = 4y$ and $y^2 = 4x$ also touches the curve $x^2 + y^2 = c^2$ then find value of c^2

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

Ans. (1)

Sol. $y^2 = 4x$ & $x^2 = 4y$

Any tangent of $y^2 = 4x$ is $y = mx + \frac{1}{m}$

It is also tangent for $x^2 = 4y$

$$\Rightarrow x^2 = 4\left(mx + \frac{1}{m}\right)$$

$$\Rightarrow x^2 - 4mx - \frac{4}{m} = 0$$

Now, $D = 0$

$$\therefore 16m^2 - 4(1)\left(-\frac{4}{m}\right) = 0$$

$$\therefore \frac{1}{m} = -m^2 \Rightarrow m = -1$$

\therefore common tangent is $y = -x - 1$, it also touches $x^2 + y^2 = c^2$

$$\therefore 1 = c^2 \cdot (1 + 1) \Rightarrow c^2 = \frac{1}{2}$$

Question 35. If P is a point lying on $\frac{x^2}{16} + \frac{y^2}{9} = 1$ and

$A(\sqrt{7}, 0), B(-\sqrt{7}, 0)$ are two points then $PA + PB = ?$

(1) 4

(2) 10

(3) 8

(4) 5

Ans. (3)

Sol. For ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$, $a = 4$, $b = 3$, $e = \sqrt{1 - \frac{9}{16}} = \frac{\sqrt{7}}{4}$

A and B are foci = $(\pm ae, 0) = (\pm\sqrt{7}, 0)$

Then $PA + PB = 2a = 2(4) = 8$

Question 36. If distance between lines $2x - y + 3 = 0$ and $4x - 2y + \alpha = 0$ is $\frac{1}{\sqrt{5}}$ while distance between $2x - y + 3 = 0$ and $6x - 3y + \beta = 0$ is $\frac{2}{\sqrt{5}}$ can be?

(1) 23

(2) 10

(3) 20

(4) 12

Ans. (1)

Sol. $2x - y + 3 = 0$ (i)

$4x - 2y + \alpha = 0 \Rightarrow 2x - y + \frac{\alpha}{2} = 0$... (ii)

$$6x - 3y + \beta = 0 \Rightarrow 2x - y + \frac{\beta}{2} = 0 \quad \dots(\text{iii})$$

$$d_1 = \frac{\left| \frac{\alpha}{2} - 3 \right|}{\sqrt{2^2 + 1^2}} = \frac{1}{\sqrt{5}} \Rightarrow |\alpha - 6| \Rightarrow \alpha - 6 = 2, -2 \Rightarrow \alpha = 8, 4$$

$$d_2 = \frac{\left| \frac{\beta}{3} - 3 \right|}{\sqrt{2^2 + 1^2}} = \frac{2}{\sqrt{5}} \Rightarrow |\beta - 9| \Rightarrow \beta - 9 = 6, -6 \Rightarrow \beta = 15, 3$$

$$\alpha + \beta = 8 + 15 \text{ or } 8 + 3 \text{ or } 4 + 15 \text{ or } 4 + 3 = 23 \text{ or } 11 \text{ or } 19 \text{ or } 7$$

Question 37. $p \Leftrightarrow \sim q$ is equivalent to

(1) $(p \vee \sim q) \vee (p \vee q)$

(2) $(p \wedge \sim q) \vee (q \wedge \sim p)$

(3) $(p \vee q) \wedge (q \vee p)$

(4) $p \Leftrightarrow q$

Ans. (2)

Sol.

$$\begin{aligned}
 p \leftrightarrow \sim q &\equiv \sim (p \leftrightarrow q) \\
 &\equiv \sim ((p \Rightarrow q) \wedge (q \Rightarrow p)) \\
 &\equiv \sim (p \Rightarrow q) \vee \sim (q \Rightarrow p) \\
 &\equiv (p \wedge \sim q) \vee (q \wedge \sim p)
 \end{aligned}$$

Question 38. From a survey, 73% like coffee, 65% like tea, and 55% like both coffee and tea, then how many person do not like both tea and coffee

- (1) 16%
- (2) 17%
- (3) 18%
- (4) 20%

Ans. (2)

Sol. $n(C) = 73$, $n(T) = 65$, $n(C \cap T) = 55$

$$n(C \cup T) = 73 + 65 - 55 = 83$$

$$\therefore n(C' \cup T') = n(\cup) - n(C \cup T)$$

$$= 100 - 83$$

$$= 17$$

Question 39. Sum of series $\tan^{-1} \frac{1}{3} + \tan^{-1} \frac{1}{7} + \tan^{-1} \frac{1}{13} + \dots 10$

terms, is equal to

$$(1) \left(\tan^{-1} 11 - \frac{\pi}{4} \right)$$

$$(2) \left(\tan^{-1} 11 + \frac{\pi}{4} \right)$$

$$(3) \left(\tan^{-1} 12 + \frac{\pi}{4} \right)$$

$$(4) \left(\tan^{-1} 10 - \frac{\pi}{4} \right)$$

Ans. (1)

Sol. $S = \tan^{-1} \frac{1}{3} + \tan^{-1} \frac{1}{7} + \tan^{-1} \frac{1}{13} + \dots$ upto 10 terms

$$S = \tan^{-1} \left(\frac{2-1}{1+1.2} \right) + \tan^{-1} \left(\frac{3-2}{1+2.3} \right) + \tan^{-1} \left(\frac{4-3}{1+3.4} \right) + \dots + \tan^{-1} \left(\frac{11-10}{1+11.10} \right)$$

$$S = (\tan^{-1} 2 - \tan^{-1} 1) + (\tan^{-1} 3 - \tan^{-1} 2) + \dots + (\tan^{-1} 11 - \tan^{-1} 10)$$

$$S = \tan^{-1} 11 - \tan^{-1} 1$$

$$S = \tan^{-1} (11) - \frac{\pi}{4}$$

Question 40. If $\frac{dy}{2+y} = \frac{e^x dx}{5+e^x}$, where $y(0) = 4$, then find

$y(\log_e 13)$

Ans. (16)

Sol. Given $\frac{dy}{2+y} = \frac{e^x dx}{5+e^x}$,

Integrating both sides,

$$\ln(2+y) = \ln(5+e^x) + \ln C$$

$$y = (5+e^x)C - 2$$

$$y(0) = 4 \therefore 4 = 6C - 2 \Rightarrow C = 1$$

$$\therefore y = 3 + e^x$$

$$\therefore y = (\log_e 13) = 3 + e^{\log_e 13} = 3 + 13 = 16$$

Question 41. Mean and variance of 7 observation 2, 4, 10, 12, 14, x, y are 8 and 16 respectively find $xy =$

Ans. (48)

$$\text{Sol. } \bar{x} = \frac{2+4+10+12+14+x+y}{7} = 8 \Rightarrow 42+x+y = 56$$

$$\Rightarrow x+y = 14$$

$$\sigma^2 = \frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n} \right)^2$$

$$16 = \frac{4 + 16 + 100 + 144 + 196 + x^2 + y^2}{7} - (8)^2$$

$$\Rightarrow 16 + 64 = \frac{460 + x^2 + y^2}{7}$$

$$\Rightarrow 560 = 460 + x^2 + y^2 \Rightarrow x^2 + y^2 = 100 \quad \text{..(2)}$$

$$\Rightarrow xy = 48$$

Question 42. If $P(x) = x^2 - x - 2$ and α is positive root of

$P(x) = 0$ then $\lim_{x \rightarrow \alpha^+} \frac{\sqrt{1 - \cos P(x)}}{x - \alpha}$ is equal to

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

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

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

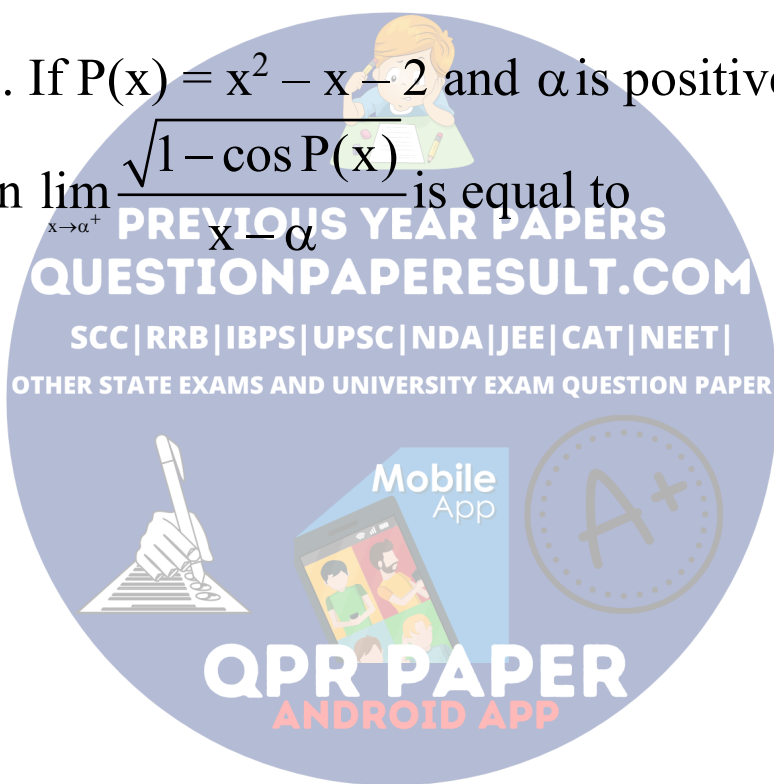
(4) $\frac{1}{\sqrt{2}}$

Ans. (2)

Sol. $P(x) = 0$

$$x^2 - x - 2 = 0$$

$$(x - 2)(x + 1) = 0$$



$$x = 2, -1 \therefore \alpha = 2$$

Now

$$\lim_{x \rightarrow 2^+} \frac{\sqrt{1 - \cos(x^2 - x - 2)}}{x - 2} \Rightarrow \lim_{x \rightarrow 2^+} \frac{\sqrt{2 \sin^2 \left(\frac{x^2 - x - 2}{2} \right)}}{x - 2}$$

$$\Rightarrow \lim_{x \rightarrow 2^+} \frac{\left| \sin^2 \left(\frac{x^2 - x - 2}{2} \right) \right|}{x - 2} \Rightarrow \text{for } x \rightarrow 2^+, \frac{x^2 - x - 2}{2} \rightarrow 0^+$$

$$\Rightarrow \lim_{x \rightarrow 2^+} \frac{\sqrt{2} \sin \left(\frac{x^2 - x - 2}{2} \right)}{\left(\frac{x^2 - x - 2}{2} \right)} \cdot \frac{2}{x - 2} \Rightarrow \lim_{x \rightarrow 2^+} \frac{1}{\sqrt{2}} \cdot \frac{(x - 2)(x + 1)}{(x - 2)} =$$

Question 43. If $210 + 29.3 + 28.32 + \dots + 310 = S$. 211
then $S =$

(1) $\frac{3^{11}}{2^{11}}$

(2) $\frac{3^{11}}{2^{11}} - 1$

(3) $\frac{2^{11}}{3^{11}} - 1$

(4) $\frac{3^{11}}{2^{11}} - 2$

Ans. (2)

Sol. $S' = 210 + 29.3 + 28.32 + \dots + 2.39 + 310$

G.P. $\rightarrow a = 2^{10}, r = \frac{3}{2}, n = 11$

$$S' = 2^{10} \frac{\left(\left(\frac{3}{2}\right)^{11} - 1\right)}{\frac{3}{2} - 1} = 2^{11} \left(\frac{3^{11}}{2^{11}} - 1\right).$$



Question 44. Four different dice are thrown independently 27 times, then find the expectation of number of times if at least two of them shows either 3 or 5.

Ans. (11)

Sol. $P(\text{at least 2 dice show 3 or 5}) =$

$${}^4C_2 \cdot \left(\frac{2}{6}\right)^2 \left(\frac{4}{6}\right)^2 + {}^4C_3 \left(\frac{2}{6}\right)^3 \left(\frac{4}{6}\right) + {}^4C_4 \left(\frac{2}{6}\right)^4$$
$$= \frac{384 + 128 + 16}{6^4} = \frac{11}{27}$$

$N = 27$

\therefore expectation of number of times = np

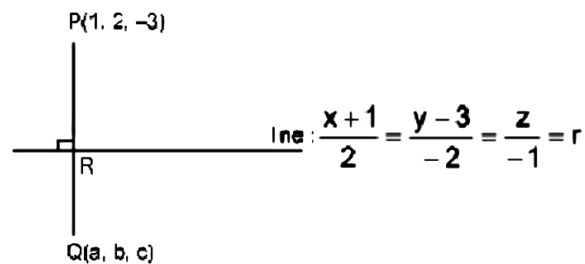
$$= 27 \cdot \frac{11}{27} = 11$$

Question 45. If (a, b, c) is the image of the point $(1, 2, -3)$ in the line $\frac{x+1}{2} = \frac{y-3}{-2} = \frac{z}{-1}$ then value of $a + b + c$ is equal

to:

Ans. (2)

Sol.



$R(-1 + 2r, 3 - 2r, -r)$

dir's of PR are $(2 - 2r, -1 + 2r, -3 + r)$

Then $2(2 - 2r) + 2(1 - 2r) + 1(3 - r) = 0$

$9 - 9r = 0 \Rightarrow r = 1$

$R(1, 1, -1)$

Then $a + 1 = 2$ $b + 2 = 2$ $c - 3 = -2$

$a = 1$ $b = 0$ $c = 1$

$\therefore a + b + c = 2$

Question 46. $\int (e^{2x} + 2e^x - e^{-x} - 1)(e^{e^x + e^{-x}}) dx = g(x)e^{(e^x + e^{-x})} + C$
then value of $g(0)$ is equal to

- (1) 1
- (2) 2

(3) 3

(4) 4

Ans. (2)

Sol. $I = \int (e^{2x} + 2e^x - e^{-x} - 1)e^{(e^x + e^{-x})} dx$

$$I = \int (e^{2x} + 2e^x - e^{-x} - 1)e^{(e^x + e^{-x})} dx + \int (e^x - e^{-x}) \cdot e^{e^x + e^{-x}} dx$$

$$I = \int (e^x + 1 - e^{-x}) e^{e^x + e^{-x} + x} dx + e^{e^x + e^{-x}}$$

$$e^x + e^{-x} + x = du$$

$$(e^x - e^{-x} + 1) dx = du$$

$$I = e^{e^x + e^{-x} + x} + e^{e^x + e^{-x}} = e^{e^x + e^{-x}} (e^x + 1)$$

Then $g(x) = e^{e^x + e^{-x}} + 1$

$$g(0) = 2$$

Question 47. If function $f(x) = \begin{cases} k_1 (X - \pi)^2 - 1 & X \leq \pi \\ k_2 \cos x & X > \pi \end{cases}$ is

twice differentiable function. Then ordered pair (k_1, k_2) is;

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

(2) $\left(\frac{1}{2}, 1\right)$

(3) $\left(\frac{1}{2}, -1\right)$

$$(4) \left(-\frac{1}{2}, -1 \right)$$

Ans. (2)

Sol. $f(x)$ is differentiable then will also be continuous

$$\text{then } f(\pi) = -1, f(\pi^+) = -k_2$$

$$k_2 = 1$$

$$\text{Now, } f(x) = \begin{cases} 2k_1 (x - \pi)^2 - 1 & x \leq \pi \\ -k_2 \cos x & x > \pi \end{cases}$$

$$f'(x) = \begin{cases} 2k_1 (x - \pi) & x \leq \pi \\ -k_2 \sin x & x > \pi \end{cases}$$

$$\text{then } f'(\pi^-) = f'(\pi^+) = 0$$

$$f''(x) = \begin{cases} 2k_1 & x \leq \pi \\ -k_2 \cos x & x > \pi \end{cases}$$

$$\text{then } 2k_1 = k_2$$

$$k_1 = \frac{1}{2}$$

Question 48. If volume of parallelepiped whose coterminous edges are $\vec{a} = \hat{i} + \hat{j} + n\hat{k}$, $\vec{b} = 2\hat{i} + 4\hat{j} - n\hat{k}$, $\vec{c} = \hat{i} + n\hat{j} + 3\hat{k}$ is 158 cubic units. Then

$$(1) n = 7$$

$$(2) n = 9$$

$$(3) \bar{a} \cdot \bar{c} = 17$$

$$(4) \bar{b} \cdot \bar{c} = 17$$

Ans. (4)

Sol. Volume of parallelepiped $v = \left| \begin{bmatrix} \bar{a} & \bar{b} & \bar{c} \end{bmatrix} \right|$

$$v = \begin{vmatrix} 1 & 1 & n \\ 2 & 4 & -n \\ 1 & n & 3 \end{vmatrix} = 158$$

$$|1(12 + n^2) - 1(6 + n) + n(2n - 4)| = 158$$

$3n^2 - 5n - 152 = 0$ or $3n^2 - 5n + 164 = 0$ (rejected as roots are not real)

$$n = 8, -\frac{19}{3} \Rightarrow n = 8$$

$$\text{then } \bar{b} \cdot \bar{c} = 2 + 4n - 3n = 10$$

$$\bar{a} \cdot \bar{c} = 1 + n + 3n = 33$$

Question 49. If coefficient of x in the expansion of

$\left(x^m + \frac{1}{x^2}\right)^{22}$ is 1540 and $m \in \mathbb{N}$ then value of m is

Ans. (13)

$$\text{Sol. } T_{r+1} = {}^{22}C_r (x^m)^{22-r} x^{-2r}$$

$$T_{r+1} = {}^{22}C_r x^{m(22-r)-2r}$$

$$m(22 - r) - 2r = 1$$

$$r = \frac{22m - 1}{m + 2} = \frac{22m + 44 - 45}{m + 2}$$

$$r = 22 - \frac{45}{m + 2}, r \in [0, 22], r \in W$$

$$\Rightarrow m \in N$$

$$m + 2 = 3, 5, 15, 45$$

$$m = 1, 3, 13, 43$$

$$\therefore {}^{22}C_r = 1540$$

$$\text{then } r = 19, m = 13$$

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Question 50. If the point P lies on the curve $4x^2 + 5y^2 - 20 = 0$ is farthest from the point $Q(0, -4)$ then $(PQ)^2$ is equal to

Ans. (36)

Sol. Equation $\frac{x^2}{5} + \frac{y^2}{4} = 1$ then $P(\sqrt{5} \cos \theta, 2 \sin \theta)$

$$\begin{aligned} (PQ)^2 &= 5 \cos^2 \theta + (2 \sin \theta + 4)^2 = 5(1 - \sin^2 \theta) + 4 \sin^2 \theta + 16 \sin \theta + 16 \\ &= 85 - (\sin \theta - 8)^2 \end{aligned}$$

$$\Rightarrow (PQ)_{\max}^2 = 85 - 49 = 36, \therefore (\sin \theta - 8)^2 \in [49, 81]$$

Question 51. If $3^{2\sin 2\theta-1}$, 14 and $3^{4-2\sin 2\theta}$ are first three terms of an AP for some θ . Then 6th term of A.P. is

Ans. (66)

Sol. a, b, c are in AP then

$$2b = a + c$$

$$28 = 3^{2\sin 2\theta-1} + 3^{4-2\sin 2\theta}$$

$$\text{Put } 3^{2\sin 2\theta} = x$$

$$28 = \frac{x}{3} + \frac{81}{x} \Rightarrow x^2 - 84x + 243 = 0$$

$$(x - 3)(x - 81) = 0$$

$$3^{2\sin 2\theta} = 3 \text{ or } 3^4$$

$$2 \sin 2\theta = 1 \text{ or } 4$$

$$\sin 2\theta = \frac{1}{2}$$

terms are 1, 14, 27, then $T_6 = 1 + 5(13)$

Question 52. The product of roots of the equation $9x^2 - 18|x| + 5 = 0$ is equal to

(1) $\frac{25}{81}$

(2) $\frac{81}{25}$

(3) $\frac{29}{81}$

(4) 0

Ans. (1)

Sol. \therefore Let, $x^2 = |x|^2 = t$

$$9t^2 - 18t + 5 = 0$$

$$(3t - 1)(3t - 5) = 0$$

$$|x| = \frac{1}{3}, \frac{5}{3}$$

product of roots = $\frac{1}{3} \left(\frac{-1}{3} \right) \left(\frac{5}{3} \right) \left(\frac{-5}{3} \right) = \frac{25}{81}$

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Question 53. If four complex numbers $z, \bar{z}, \bar{z} - 2 \operatorname{Re}(\bar{z})$ and $z - 2 \operatorname{Re}(z)$ represent the vertices of a square of side length 4 units, in argand plane, then the value of $|z|$ is equal to

(1) $\sqrt{2}$

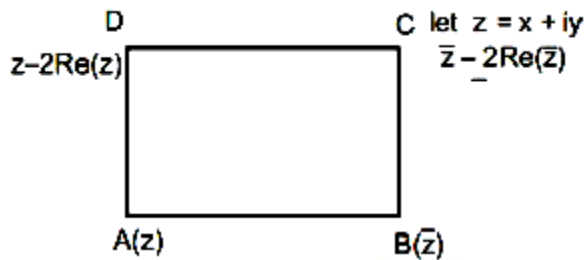
(2) $2\sqrt{2}$

(3) 2

(4) 4

Ans. (2)

Sol.



Let, $z = x + iy$

length of side = 4

then $|z - \bar{z}| = 4$

$|2iy| = 4$

$|y| = 2$

also $|z - (z - 2\text{Re}(z))| = 4$

$|2x| = 4 \Rightarrow |x| = 2$

$|z| = \sqrt{x^2 + y^2} = 2\sqrt{2}$

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- Top: An illustration of a boy thinking at a desk.
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- Very bottom: The text "QPR PAPER" in large white letters.

Question 54. The value of integration $I = \int_{-\pi/2}^{\pi/2} \frac{1}{1 + e^{\sin x}} dx$ is

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

Ans. (3)

$$\text{Sol. } I = \int_{-\pi/2}^{\pi/2} \frac{1}{1 + e^{\sin x}} dx$$

$$I = \int_0^{\pi/2} \left(\frac{1}{1 + e^{\sin x}} + \frac{1}{1 + e^{-\sin x}} \right) dx$$

$$I = \int_0^{\pi/2} 1 dx$$

$$I = [x]_0^{\pi/2} \Rightarrow I = \frac{\pi}{2}$$



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