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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2021

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 27 July, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

SUBJECT: PHYSICS

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PART : PHYSICS

1. Two masses each of mass 1 kg are separated by a distance 2R, rotating under their mutual gravitation force. Find their angular velocity :

(1) $\frac{1}{2}\sqrt{\frac{G}{R^3}}$ (2) $\sqrt{\frac{G}{R^3}}$ (3) $\sqrt{\frac{2G}{R^3}}$ (4) $\sqrt{\frac{G}{2R^3}}$

Ans. (1)

Sol. $\frac{Gm^2}{4R^2} = m\omega^2 R$

$\sqrt{\frac{Gm}{}}$

$\omega = \sqrt{\frac{4R^3}{}}$

$\omega = \frac{1}{2}\sqrt{\frac{G}{R^3}}$

2. A conducting wire has resistance 16Ω at 15ºC and 20Ω at 100ºC. Find temperature coefficient of resistance

(1) $\frac{1}{85}$ (2) $\frac{1}{85}$ (3) $\frac{1}{85}$ (4) $\frac{1}{85}$

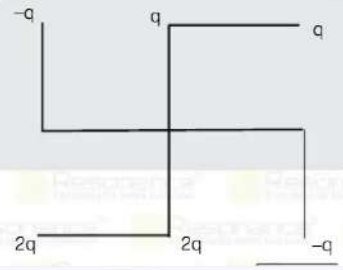
Ans. (1)

Sol. $R' = R(1 + \alpha\Delta t)$

$20 = 16(1 + \alpha . 85)$

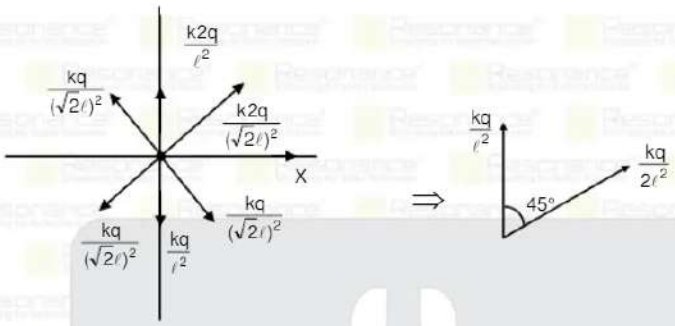
$\alpha = \frac{\frac{20}{16} - 1}{85} = \frac{1}{4 \times 85} = \frac{1}{340}\,^{\circ}C^{-1}$

3. In the figure each side has length ℓ. Find electric field at centre :



Ans. (3)

Sol.



$E = \frac{kq}{\ell^2}\left(\sqrt{1 + \frac{1}{4} + 2 \times \frac{1}{2} \times \frac{1}{\sqrt{2}}}\right)$

4. A force $F = F_0\left[1 - \left(\frac{T-t}{T}\right)^2\right]$ start to act on a ball of mass m at t = 0. Initially ball was at rest. Find velocity of the ball at t = 2T :

(1) $\frac{F_0}{m}\left[\frac{4T}{3}\right]$ (2) $\frac{F_0}{m}\left[\frac{3T}{2}\right]$ (3) $\frac{F_0}{m}\left[\frac{T}{3}\right]$ (4) $\frac{F_0}{m}\left[\frac{T}{2}\right]$

Ans. (1)

Sol. acceleration of ball

$$a = \frac{F}{m}$$

$$a = \frac{F_0}{m}\left[1-\left(\frac{T-t}{T}\right)^2\right]$$

$$\frac{dv}{dt} = \frac{F_0}{m}\left[1-\left(\frac{T-t}{T}\right)^2\right]$$

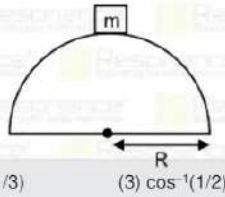
$$v = \int_0^{2T}$$

$$V = \frac{F_0}{m}\left[t+\frac{1}{3T^2}(T-t)^3\right]_0^{2T}$$

$$V = \frac{F_0}{m}\left\{\left[2T+\frac{1}{3T^2}(T-2T)^3\right]-\left[0+\frac{T^3}{3T^2}\right]\right\}$$

$$V = \frac{F_0}{m}\left[\frac{4T}{3}\right]$$

5. A block of mass m as shown in figure is released from rest from the top of a fixed smooth hemisphere. Find the angle made by this particle with vertical at the instant when it looses contact with the hemisphere:



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

Ans. (1)

Sol.

From work energy theorem $W = \Delta K$

$Mg(R - R\cos\theta) = 1/2\ mv^2$

$v = \sqrt{2gR(1-\cos\theta)}$

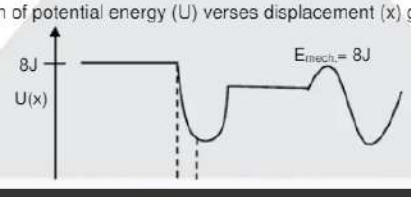
To loose contact $\frac{mv^2}{R} = mg\cos\theta$

$M2g(1 - \cos\theta) = mg\cos\theta$

$2 - 2\cos\theta = \cos\theta$

$\cos\theta = 2/3$; $\theta = \cos^{-1}(2/3)$

6. Figure shows variation of potential energy (U) verses displacement (x) graph :



Find the correct statement :

(1) $x < x_1$, KE is least and body has constant speed.

(2) $x = x_2$, K.E is minimum

(3) $x > x_3$ K.E. is maximum and velocity is maximum

(4) $x > x_2$ K.E. is minimum so velocity is minimum

Ans. (1)

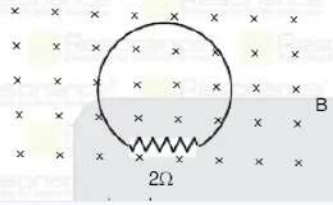
Sol. K + U = E mechanical energy = constant

7. Magnetic flux in a circular loop having resistance of 2Ω is varying with time as $\phi = 10t^2 + 20t$. What will be the current in circuit at t = 5sec. (in Ampere)

(1) 20 (2) 40 (3) 60 (4) 80

Ans. (3)

Sol.



at t = 5sec, $\varepsilon = 120$ V

thus, $i = \frac{\varepsilon}{R} = \frac{120}{2} = 60$ Amp.

8. Match list-I with list-II and select the correct option from below the list

List -I	List-II (Dimension)
1. Electric field intensity (E)	(i) $M^{-1}L^{-2}I^2T^{+4}$
2. Magnetic permeability (μ_0)	(ii) $M^{-1}L^{-3}T^4I^2$
3. Electrical permittivity (ϵ_0)	(iii) $MLI^{-1}T^{-3}$
4. Capacitance (C)	(iv) $ML^2T^{-4}I^{-2}$

(1) 1→ (ii), 2 → (iii), 3 → (iv), 4 → (i) (2) 1→ (iii), 2 → (i), 3 → (iii), 4 → (ii)

(3) 1→ (iii), 2 → (iv), 3 → (ii), 4 → (i) (4) 1→ (ii), 2 → (iv), 3 → (i), 4 → (iii)

Ans. (3)

9. A block of mass 1kg connected to a massless spring fixed from one end executing SHM. Initially at mean position. Its amplitude is 5 cm and time period is 0.2 sec. Find potential energy after 0.05 sec.

(1) 1 (2) 3 (3) 5 (4) 5

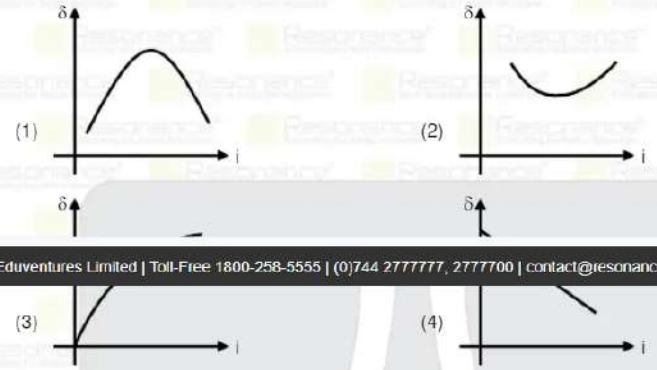
Ans. (4)

Sol. A $t = \frac{T}{4}$ particle is at extreme. $U = K.E_{max} = \frac{1}{2} m\omega^2A^2$, $T = 2\pi\sqrt{\frac{m}{K}}$

$= \frac{1}{2}m\left(\frac{2\pi}{0.2}\right)^2 A^2$

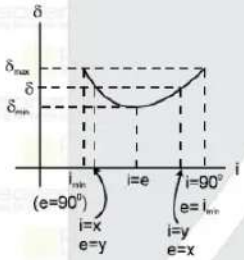
$= \frac{1}{2} \times 100\pi^2 \times \frac{25}{10000} = \frac{5}{4}$ J

10. Which of the following is correct graph between deviation (δ) and angle of incident 'i', if a ray of light passes through a prism :

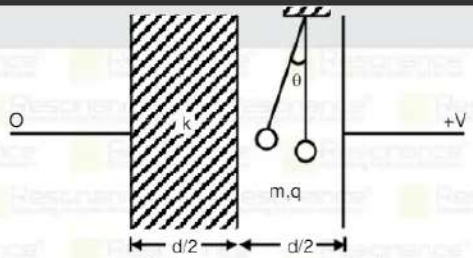


Ans. (2)

Sol. $\therefore\ \delta = i + e - A.$



11. Pendulum bob of mass m and charge q is hinge between the plates of a parallel plate capacitor. The first half of space between the plates is filled with dielectric of dielectric constant K and another half is vacuum,



(1) $\tan^{-1}\frac{qvk}{(k+1)mgd}$ (2) $\tan^{-1}\frac{2qvk}{(k+1)mgd}$ (3) $\tan^{-1}\frac{3qvk}{(k+1)mgd}$ (4) $\tan^{-1}\frac{4qv(k+1)}{(k)mgd}$

Ans. (2)

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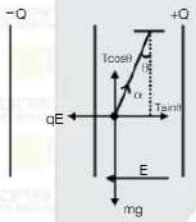
Sol. (C_{eq}) Equivalent capacitance = $\frac{\varepsilon_0 A}{\frac{d}{2k}+\frac{d}{2}} = \frac{2\varepsilon_0 Ak}{d(k+1)}$

potential difference = V

charge on capacitor = $v \times C_{eq} = \frac{2\varepsilon_0 AVk}{d(k+1)}$

$\Rightarrow$ Electric field in vacuum $= \frac{Q}{A\varepsilon_0} \Rightarrow \frac{2Vk\varepsilon_0 A}{d(k+1)A\varepsilon_0}$

$E = \frac{2Vk}{d(k+1)}$



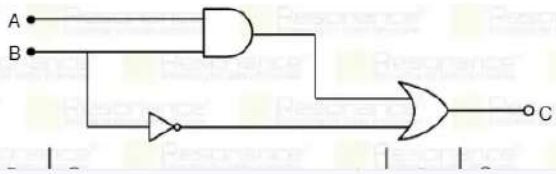
As bob is in equilibrium

$\tan\theta = \frac{qE}{mg}$

$\tan\theta = \frac{q2Vk}{mgd(k+1)}$

$\theta = \tan^{-1}\left(\frac{2qVk}{mgd(k+1)}\right)$

12. For the given gate circuit, choose the correct truth table ?



(1)

0	1	0
1	0	1
1	1	1

(2)

0	1	0
1	0	1
1	1	1

(3)

A	B	C
0	0	1
0	1	1
1	0	1
1	1	1

(4)

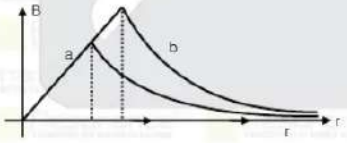
A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

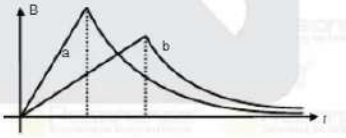
Ans. **(3)**

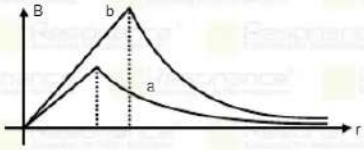
13. Write the approx. Value of plank's constant & permittivity constant :
(1) 6.6×10^{-34} J-s, 8.85×10^{-12} F/m
(2) 6.6×10^{-19} J-s, 8.85×10^{-12} F/m
(3) 6.6×10^{-34} J-s, 9×10^{9} m/F
(4) None

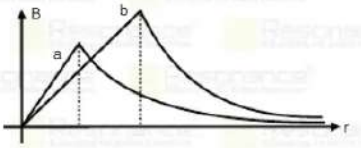
Ans. **(1)**

of magnetic field intensity v/s r :

(1) 

(2) 

(3) 

(4) 

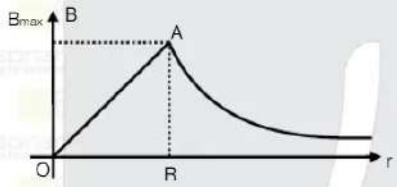
Ans. **(2)**

Sol. B due to wire :

$r < R \quad B = \frac{\mu_0 J r}{2}$

where $J = \frac{i}{\pi R^2}$

for wire of radius b $J_2 = \frac{i}{\pi b^2}$



slope of OA = J

$B_{max} = \frac{\mu_0 J R}{2} = \frac{\mu_0 i R}{2\pi R^2} = \frac{\mu_0 i}{2\pi R}$

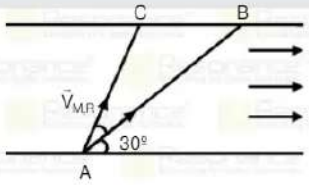
we can see slope of wire of radius a (J_1) > slope of wire of radius b (J_2)
as b > a then B_{max} for a > B_{max} for b.
So Ans (B)

15. If Thomson model is considered and α rays are bombard on this model then, α rays will :

Ans. **(3)**

Sol. Theory based

16. A man crosses a river flowing with speed same as speed of man with respect to river. If man cross the river along path AB making an angle of 30º with the direction of river flow. Man starts swimming along line Ac, making an angle θ with path AB. then value of θ was ?



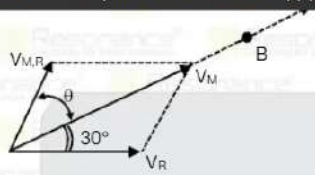
(1) 60º (2) 30º (3) 45º (4) 75º

Ans. (2)

Sol. $\vec{V}_M = \vec{V}_{M,R} + \vec{V}_R$

V_M should be along line AB

$\Rightarrow \quad |\vec{V}_{M,R}| = |\vec{V}_R|$



$\therefore$ V_M should be along angle bisector of angle between $\vec{V}_{M,R}$ and $\vec{V}_R$

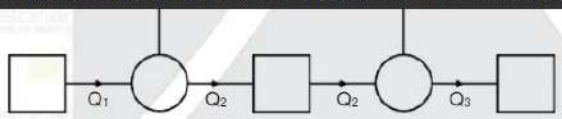
$\therefore$ $\theta = 30°$

17. Two Carnot engines A and B are operated in series. The first one, A receives heat at T_1 (=600 K) and rejects to a reservoir at temperature T_2. The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at T_3 (=400K). Calculate the temperature T_2 if the work outputs of the two engines are equal :

(1) 500 k (2) 300 K (3) 600 K (4) 400 K

Ans. (1)

Sol.



$W = Q_1 - Q_2$

$W = Q_2 - Q_3$

$Q_1 - Q_2 = Q_2 - Q_3$

$Q_1 + Q_3 = 2Q_2$

$$\frac{Q_1}{Q_2} + \frac{Q_3}{Q_2} = 2$$

$$\frac{T_1}{T_2} + \frac{T_3}{T_2} = 2 \Rightarrow T_2 = \frac{T_1 + T_3}{2} = 500 \text{ K}.$$

18. An electron and a proton combined to form a H-atom in which electron is in 2nd excited state. From this

(1) 9.0 eV (2) 3.1 eV (3) 7.1 eV (4) 13.6 eV

Ans. (1)

Sol. $E = 13.6\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]ev$

$E = 13.6\left[\frac{1}{1} - \frac{1}{(3)^2}\right]$

$E = 13.6\left[\frac{8}{9}\right] = 12.1\ eV$

$KE_{max} = E - \frac{hc}{\lambda_0} = 12.1 - \frac{12400}{4000}\ eV$

$= 12.1 - 3.1\ eV = 9.0\ eV$

19. Rain drops are falling vertically on earth with speed of 20m/s. Now wind start blowing horizontally with speed of 5m/s and a cyclist is moving with speed of 35 m/s opposite to the wind. Then find the velocity of rain with which rain hitting the cyclist.

$\sqrt{5}$

Ans. (3)

Sol. $V_{rg} = V_{rw} + V_{wg}$

$= -20\hat{j} + 5\hat{i}$

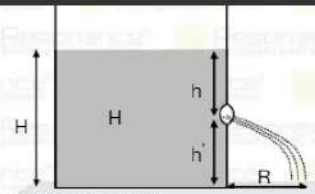
$V_{rain,cy} = V_{raing} - V_{cy,g}$

$= -20\hat{j} + 5\hat{i} - 35(-\hat{i}) = -20\hat{j} + 40(\hat{i})$

$V_{rain,\ cy} = \sqrt{20^2 + 40^2} = 20\sqrt{5}\ m/s$

20. A beaker filled to the height of 12 cm was given, find the location where a hole should be made for max range.

Ans. 6



R is maximum when h'= h

$\therefore$ h' = h = H/2

= 12/2 = 6

21. A particle performing SHM is given by $x = A\sin(\omega T + \Phi)$. At t = 0, particle is at x = 2 and its velocity is 2ω then find amplitude :

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

Ans. **(1)**

Sol. $2 = A\sin(0 + \phi)$

$\Rightarrow \sin\phi = \frac{2}{A}$

$\Rightarrow \cos\phi = \sqrt{1 - \frac{4}{A^2}} = \sqrt{\frac{A^2}{A^2}}$

$V = \frac{dx}{dt}$

$V = A\omega\cos(\omega t + \phi)$

$\Rightarrow 2\omega = A\omega\cos(0 + \phi)$

$\Rightarrow 2 = A\cos\phi$

$\Rightarrow A = \frac{2}{\cos\phi}$ ..... (i)

$\Rightarrow A = \frac{2}{\sqrt{\frac{A^2-4}{A^2}}}$

$\Rightarrow A = \frac{2A}{\sqrt{A^2-4}}$

$\Rightarrow \sqrt{A^2-4} = 2$

$\Rightarrow A = \pm\sqrt{8}$

22. A body of mass m at rest starts moving along straight line by a machine delivering a constant power. Distance travelled by body in time t is :

(1) $\frac{4\sqrt{\frac{2p}{m}}}{3}\times t^{3/2}$ (2) $\frac{2\sqrt{\frac{2p}{m}}}{3}\times t^{3/2}$ (3) $\frac{\sqrt{\frac{2p}{m}}}{3}\times t^{3/2}$ (4) $2\sqrt{3\frac{2p}{m}}\times t^{3/2}$

Ans. **(2)**

Sol. Energy supply = Pt

in t sec

$Pt = \frac{1}{2}mv^2$

$V = \sqrt{\frac{2pt}{m}}$

$\frac{dS}{dt} = \sqrt{\frac{2p}{m}}\sqrt{t}$

$S = \int$

$S = \frac{2\sqrt{\frac{2p}{m}}t^{3/2}}{3}$

$t^{3/2} = \frac{3S}{2\sqrt{\frac{2p}{m}}}$

$$S = \frac{2\sqrt{\frac{2p}{m}}}{3} \times t^{3/2}$$

23. In a communication, a message signal of amplitude 4 V is modulated with carrier signal of amplitude 12V, then find modulation index.

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

Ans. **(2)**

$$\therefore\ m = \frac{A_{max} - A_{min}}{A_{max} + A_{min}} = \frac{16-8}{16+8} = \frac{8}{24} = \frac{1}{3}$$

24. 1 moles of an ideal gas undergoes adiabatic process, which increases the temperature form 27°C to 37°C. Gas is polyatomic has 4 vibrational modes of freedom. Find net work :

(1) Work done by the gas 528 J (2) Work done on the gas 582 J
(3) Work done on the gas 382 J (4) Work done by the gas 382 J

Ans. **(2)**

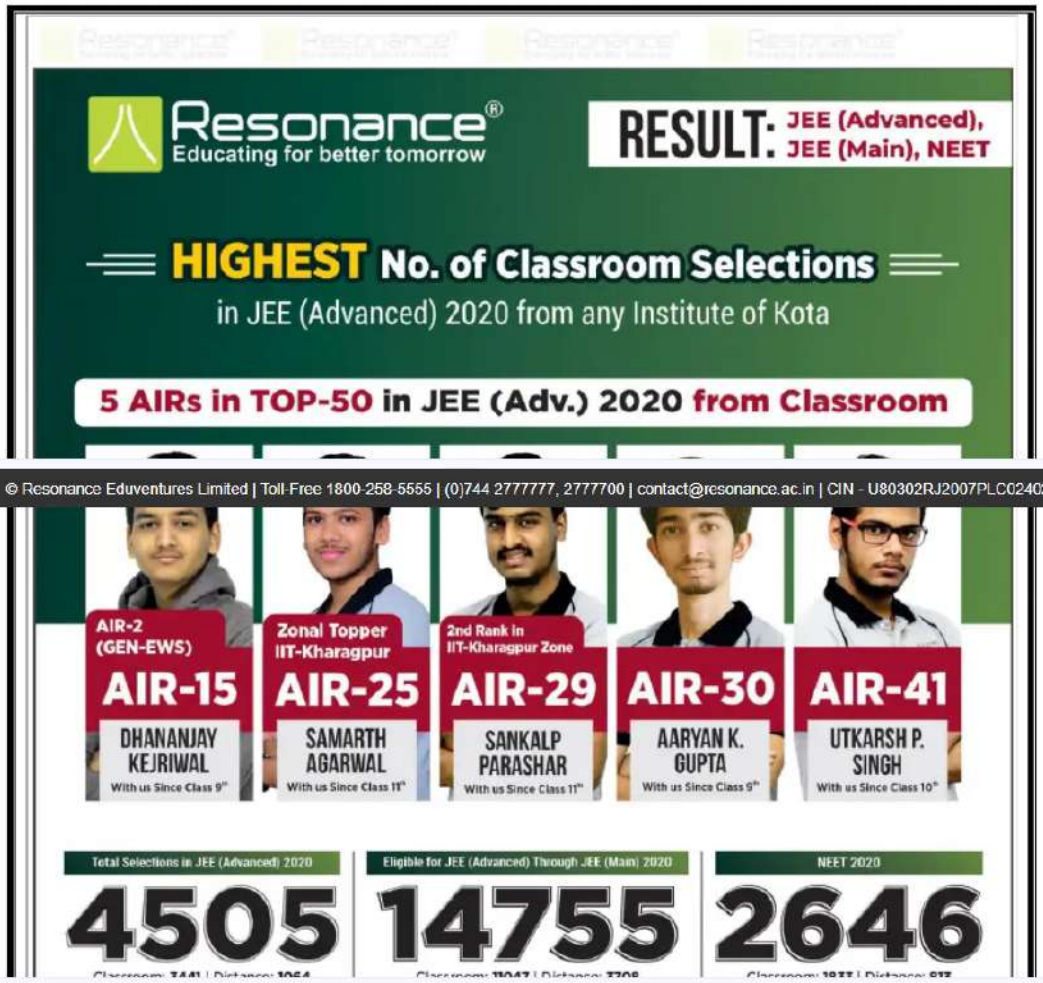
Sol. $f = 3 + 3 + (4 \times 2)$

$f = 14$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{nR(T_1 - T_2)}{\gamma - 1}$$

$$= \frac{1 \times 8.314 \times (-10)}{\left(\frac{8}{7} - 1\right)} \quad \left(\because \gamma = 1 + \frac{2}{f} = \frac{8}{7}\right)$$

$= -582$ J



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COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 27 July, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: CHEMISTRY

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1. If Thomson model is considered to be true then in Rutherford model.

(1) All α particles deflects at 180° (2) They deflect at wide range of angle

(3) All will pass through foil without deflection (4) They will pass but with reduced speed.

Ans. **(1)**

Sol. Theory Based.

2. Identify the correct increasing order of 1st ionisation enthalpy order of Mg, Al, P, S

(1) Al, Mg, S, P (2) Mg, Al, P, S (3) Al, Mg, P, S (4) Mg, Al, S, P

Ans. **(1)**

Sol. Correct increasing order of 1st ionisation enthalpy is : Al < Mg < S < P.

(a) Li	(i) used in devising photoelectric cell
(b) Na	(ii) used to make electrochemical cell
(c) K	(iii) used as coolant in nuclear reactor
(d) Cs	(iv) used in absorption of CO_2

Identify the correct match

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

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

Ans. (1)

Sol. (a) Li ⇒ used in electrochemical cell

(b) Na ⇒ used as coolant in fast breeder nuclear reactors

(c) K ⇒ used as an absorbent of CO_2

(d) Cs ⇒ used in devising photoelectric cell.

4. How many number of electron are there in bonding molecular orbital of O_2^{2-}.

Ans. 10

Sol. O_2^{2-} (Total electron = 18)

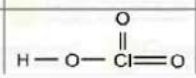
EC = $(\sigma 1s)^2(\sigma^* 1s)^2(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x^2 = \pi 2p_y^2)(\pi^* 2p_x^2 = \pi^* 2p_y^2)$

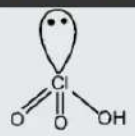
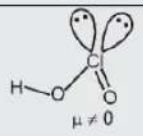
Total electron in BMO = 10.

5. How many total Cl=O bonds are there in $HClO_4$, $HClO_3$ and $HClO_2$.

Ans. 6

Sol.

Compounds	Structure	Total C=O bond
$HClO_4$		3

$HClO_3$		2
$HClO_2$		1

6. Identify the incorrect statement from following.

(1) crystalline solids are isotropic

(2) amorphous solids are also called pseudo solid

Ans. (1)

Sol. Crystalline solids are anisotropic in nature.

7. 10 ml 0.05 M $KMnO_4$ is titrated with 10 ml of oxalic acid, find strength of oxalic acid (in g/l).

[Report your answer to nearest integer]

Ans. 11

Sol. $MnO_4^- + C_2O_4^{2-} \xrightarrow{H^+} Mn^{2+} + CO_2$

Valency factor = 5 Valency factor = 2

mili eq. of $C_2O_4^{2-}$ = mili eq. of MnO_4^-

2 [M × 10] = 5 [0.05 × 10]

M = 0.125 mole/lit.

Strength of oxalic acid = 0.125 × 90 = 11.25 gm.

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8. 1 mole of A takes 100 minutes to give 0.2 mole of B in the reaction A ⟶ 2B (According to 1st order reaction). The half life of the reaction is :

[Report your answer to nearest integer]

[Given $\ell n2 = 0.693$ & $\ell n10 = 2.303$]

Ans. 752

Sol.

	A	⟶	2B
Initially	1 mole		0
After 100 min	(1 – 0.1)mole		0.2 mole

$$k = \frac{1}{t}\ell n\left(\frac{a}{a-x}\right)$$

$$k = \frac{2.303}{100}\log\left(\frac{1}{0.9}\right)$$

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$$\frac{0.693}{t_{1/2}} = \frac{2.303}{100}[1 - 2 \times 0.48]$$

$$t_{1/2} = \frac{69.3}{2.303 \times 0.04}\ \text{min}$$

$t_{1/2}$ =752.3 min

9. The total number of neutrons and electrons present in radioactive isotope of Hydrogen is :

Ans. (3)

Sol. Radioactive isotope of Hydrogen is tritium (^3_1H)

Number of {P = 1, n = 2, e^- = 1}, so (n + e^-) = 3

10. For reaction $MO(s) \longrightarrow M(s) + \frac{1}{2}O_2(g)$

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K_p is 4, then partial pressure of $O_2(g)$ in atm is :

Ans. **(16)**

Sol. $K_p = (P_{O_2})^{\frac{1}{2}} = 4$

$P_{O_2} = 16$

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critical temperature, easier is liquification of gas and more is adsorption of gas on charcoal.

12. An electrolyte AB is 50% dimerise and rest is ionise in a solvent, then Van't hoff factor (i) for this acid is.
(1) 1 (2) 1.25 (3) 2 (4) 1.5

Ans. **(2)**

Sol. $i = \frac{\text{Total no. of particle after dissociation/association}}{\text{Total number of particle before dissociation/association}}$

dissociation [Let total mole of acid HA = a]

HA $\longrightarrow$ H^+ + A^-

0.5a 0.5a 0.5a

association

$2HA \longrightarrow (HA)_2$

0.5a $\left(\frac{0.5a}{a}\right)$

$i = \left(\frac{\quad}{a}\right) = 1.25$

13. S_1 : $[Mn(CN)_6]^{3-}$, $[Fe(CN)_6]^{3-}$ and $[Co(CN)_6]^{3-}$ have d^2sp^3 hybridisation.
S_2 : $[MnCl_6]^{3-}$ and $[FeCl_6]^{3-}$ are paramagnetic with 4 and 5 unpaired electrons respectively.
(1) Both S_1 & S_2 are true. (2) S_1 is true and S_2 is false
(3) S_1 is false and S_2 is true (4) Both S_1 & S_2 are false.

Ans. **(1)**

Sol. $[Mn(CN)_6]^{3-} \Rightarrow Mn^{3+} \Rightarrow 3d^4 \Rightarrow t_{2g}^{2,1,1}, eg^{0,0}$ d^2sp^3

$[Fe(CN)_6]^{3-} \Rightarrow Fe^{3+} \Rightarrow 3d^5 \Rightarrow t_{2g}^{2,2,1}, eg^{0,0}$ d^2sp^3

$[Co(CN)_6]^{3-} \Rightarrow Co^{3+} \Rightarrow 3d^6 \Rightarrow t_{2g}^{2,2,2}, eg^{0,0}$ d^2sp^3

$[MnCl_6]^{3-} \Rightarrow Mn^{3+} \Rightarrow 3d^4 \Rightarrow t_{2g}^{1,1,1}, eg^{1,0}$ 4 unpaired e^-

so both S_1 & S_2 are true.

$\begin{cases} 2^{nd} \text{ group cation } Cu^{2+} \\ 3^{rd} \text{ group cation } Al^{3+}, Fe^{3+} \\ 4^{th} \text{ group cation } Co^{2+}, Ni^{2+}, Zn^{2+} \\ 5^{th} \text{ group cation } Ba^{2+} \end{cases}$

16. In a closed container initially SO_2 and O_2 are taken at 750 bar and 250 bar and following reaction takes place.

$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

then what will be the total pressure of gases after completion of reaction (in bar.)

Ans. 750

Sol.

	$2SO_2(g)$	+	$O_2(g)$	$\longrightarrow$	$2SO_3(g)$	
Initially	750 bar		250 bar			(LR is O_2)

$P_{Total} = 250 + 500 = 750$ bar

17. 1 Mole of complex $CoCl_3.6NH_3$ on reaction with $AgNO_3$ gives 3 moles of AgCl precipitate. The secondary valency of complex is-

Ans. 6

Sol. As complex give 3 moles AgCl precipitate so all 3 chloride ions are in ionisation sphere so complex is $[Co(NH_3)_6]Cl_3$

secondary valency of complex = 6.

18.

List - I (Metal)	List - II (Colour during flame test)
a) Li	(i) Golden yellow
b) Na	(ii) Crimson red
c) Ca	(iii) Apple green
d) Ba	(iv) Brick Red

Identify the correct matching from List – I with List - II :

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

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

Ans. **(1)**

Sol.

Metal	Flame coloure test
(i) Li	Crimson Red
(ii) Na	Golden Yellow
(iii) Ca	Brick Red
(iv) Ba	Apple green

19. Statement-I : Hyper conjugation is a permanent effect.

(1) Both Statement–I & Statement–II are correct.

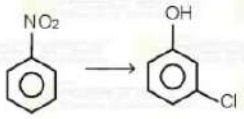
(2) Statement–I is correct and Statement–II is incorrect.

(3) Statement–I is incorrect and Statement–II is correct.

(4) Both Statement–I and Statement–II are incorrect.

Ans. **(2)**

20. For the following conversion



the appropriate sequence of reagent will be.

Ans. **(3)**

21. D-Galactose & D-Glucose are formed by the hydrolysis of following disaccharide.

(1) Sucrose (2) Lactose (3) Maltose (4) Amylose

Ans. **(2)**

22. Satement-I : Penicillin is Bacteriostatic.

Satement-II : The correct structure of penicillin is.

(1) Both Statement–I & Statement–II are correct

(2) Statement–I is correct and Statement–II is incorrect

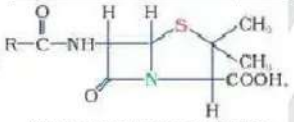
(3) Statement–I is incorrect and Statement–II is correct

(4) Both Statement–I and Statement–II are incorrect

Ans. **(3)**

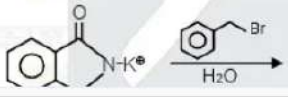
Sol

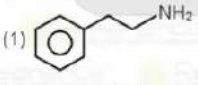
Penicillin	Erythromycin
Aminoglycosides	Tetracycline
Ofloxacin	Chloramphenicol

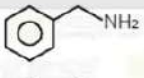


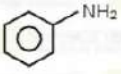
General Sturcture of Penicillin

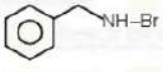
23. In following sequence of reaction final product will be



(1) 

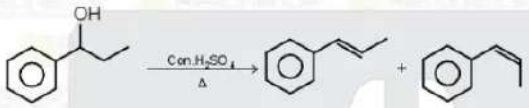
(2) 

(3) 

(4) 

Ans. **(2)**

25.



(1) The Rx is not possible in acid medium (2) Compound B will be major product

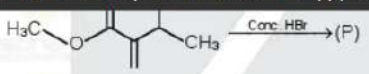
(3) Compound A will be major product (4) Both A and B are equally formed

Ans. (3)

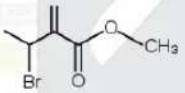
26. Dihedral angle in 1,1,1-trichloro ethane in staggered conformation (in degree) is

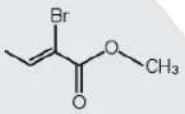
Ans. 60

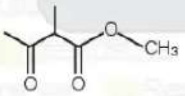
27. Which of the following product is not possible

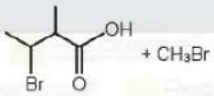


Product (P)

(1) 

(2) 

(3) 

(4) 

Ans. (4)

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Memory Based Questions & Solutions

Date: 27 July, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: MATHEMATICS

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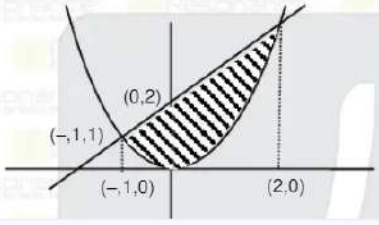
1 Area bounded by the curve $y = x^2$ and the line $y-x=2$ is

(1) $\frac{7}{2}$ (2) $\frac{9}{2}$ (3) $\frac{11}{2}$ (4) $\frac{13}{2}$

Ans. **(2)**

Sol.



$x^2-x-2 = 0$

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

Required area $= \frac{1}{2}(3)(5) - \int_{-1}^{2} x^2 dx$

$$= \frac{15}{2} - \frac{1}{3}(8+1)$$

$$= \frac{15}{2} - 3 = \frac{9}{2} \text{ sq. unit}$$

2. If $A_{3\times3} = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$ and $M = A + A^2 + A^3 + \ldots\ldots A^{20}$, then the sum of all the elements of M is :

Sol. $A^2 = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$

$A^3 = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 3 & 6 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix}$

$T_n = 1 + 2 + \ldots\ldots + n = \frac{n(n+1)}{2} = \frac{20\times21}{2} = 210$

$$S_n = \frac{1}{2}\left(\frac{n(n+1)(2n+1)}{6} + \frac{n(n+1)}{2}\right)$$

$$= \frac{n(n+1)}{4}\left(\frac{2n+1}{3} + 1\right)$$

$$= \frac{n(n+1)(n+2)}{6} = \frac{20\times21\times22}{6} = 1540$$

$$\begin{bmatrix} 1+1+1\ldots 20\text{times} & 1+2+3+\ldots+20 & \\ 0 & 1+1+1\ldots 20\text{times} & \\ 0 & 0 & 1+1+1\ldots 20\text{times} \end{bmatrix}$$

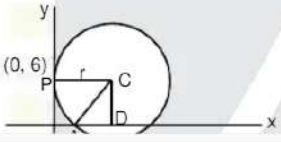
$$M = \begin{bmatrix} 20 & 210 & 1540 \\ 0 & 20 & 210 \\ 0 & 0 & 20 \end{bmatrix}$$

Sum of elements of M = 3(20) + 420 + 1540 = 2020

3. A circle touches y-axis at (0, 6) and has x-intercept equal to $6\sqrt{5}$ then radius of the circle is :

Ans. **9**

Sol.



$AD = 3\sqrt{5}$

$CA^2 = CD^2 + AD^2$

$= 36 + 45$

$CA^2 = 81$

$CA = 9$

$\Rightarrow r = 9$

4. Three vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ with magnitude $\sqrt{2}$, 1 and 2 respectively follows the relation $\vec{a} = \vec{b} \times (\vec{b} \times \vec{c})$.

The acute angle between the vectors $\vec{b}$ & $\vec{c}$ is θ. Then the value of $(1 + \tan\theta)$ is :

Ans. **2**

Sol. $\vec{a} = \vec{b} \times (\vec{b} \times \vec{c})$

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

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$\vec{a} \cdot \vec{b} = 2\cos\theta - 2\cos\theta$

$\Rightarrow \vec{a} \cdot \vec{b} = 0$

$\vec{a} \cdot \vec{a} = 2\cos\theta\,(\vec{b} \cdot \vec{a}) - \vec{c} \cdot \vec{a}$

$\vec{c} \cdot \vec{a} = -2$

$\vec{a} \cdot \vec{c} = 2\cos\theta\,(\vec{b} \cdot \vec{c}) - 4$

$-2 + 4 = 2\cos\theta \times 2\cos\theta$

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

$\cos\theta = \frac{1}{\sqrt{2}}$

$\theta = 45^\circ$

So, $(1 + \tan\theta) = 2$

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5. Two square matrices A & B are such that $A^2 + B^2$ is invertible and $A^3 = B^3$, $A^2B^2 = B^2A^2$. Then the value of $|A^3 - B^3|$ is :

Ans. **0**

Sol. $(A^3 - B^3)(A^2 + B^2) = A^5 - B^5 + A^3B^2 - B^3A^2 = 0$

Since $|A^2 + B^2| \neq 0 \Rightarrow |A^3 - B^3| = 0$

6. Evaluate $\lim\limits_{x\to 0} \frac{x}{\sqrt[3]{1-\sin x} - \sqrt[3]{1+\sin x}}$

(1) 0 (2) – 4 (3) 8 (4) 2

Ans. **(2)**

Sol. Rationalize denominator three times

$$\lim_{x\to 0} \frac{x\left\{(1-\sin x)^{1/3} + (1+\sin x)^{1/3}\right\}\left\{(1-\sin x)^{1/4} + (1+\sin x)^{1/4}\right\}\left\{(1-\sin x)^{1/2} + (1+\sin x)^{1/2}\right\}}{(1-\sin x - 1 - \sin x)}$$

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$= -4$

7. If two given APs are $\tan\frac{\pi}{9}$, x, $\tan\frac{7\pi}{18}$ and $\tan\frac{\pi}{9}$, y, $\tan\frac{5\pi}{18}$. Then the value of $|x-2y|$ is :

Ans. **0**

Sol. $\left|\frac{1}{2}\left(\tan\frac{\pi}{9} + \tan\frac{7\pi}{18}\right) - \tan\frac{\pi}{9} - \tan\frac{5\pi}{18}\right|$

$\because 2x = \tan\frac{\pi}{9} + \tan\frac{7\pi}{18}$ and $2y = \tan\frac{\pi}{9} + \tan\frac{5\pi}{18}$

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$$\left|\frac{1}{2}\left(\cot\frac{\pi}{9}-\tan\frac{\pi}{9}\right)-\tan\frac{5\pi}{18}\right|$$

$$\left|\frac{1}{2}\times 2\cot\frac{2\pi}{9}-\tan\frac{5\pi}{18}\right|$$

$|\cot 40^\circ - \tan 50^\circ| = 0$

roots, then the minimum number of roots of the equation $g'(x)\,g(x) = 0$ is :

(1) 12 (2) 3 (3) 5 (4) 7

Ans. **(4)**

Sol. $f'(x) = g(x)$

$g'(x) = f''(x)$

$$f(x) = \int_a^x g(t)dt$$

$g(x) = f'(x)$

$g'(x) = f''(x)$

$g(x) \cdot g'(x) = f'(x)\, f''(x)$

Graph of f(x) can be drawn as

If $f(x) = 0$ has atleast 5 real roots

$f'(x) = 0$ has atleast 4 real root

$f''(x) = 0$ has atleast 3 real root

$f'(x)\, f''(x) = 0$ has atleast 7 real root

$g(x)\, g'(x) = 0$ has atleast 7 real root

9. If $(x + x^3)\,dy = (y + yx^2 + x^3)dx$ and $y(1) = 0$, then $y(2)$ is :

(1) $\ln\left(\frac{17}{2}\right)$ (2) 0 (3) $\ln\left(\frac{5}{2}\right)$ (4) $\ln\left(\frac{2}{5}\right)$

Ans. **(3)**

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

$$\frac{dx}{x} \quad x \quad x^2+1$$

$$I.F = e^{-\int\frac{1}{x}dx} = \frac{1}{x}$$

$$y\left(\frac{1}{x}\right) = \int\frac{x^2}{x^2+1}\left(\frac{1}{x}\right)dx$$

$$\Rightarrow \frac{y}{x} = \frac{1}{2}\ln(1+x^2) + \ln c$$

$$\Rightarrow y = \frac{x}{2}(\ln(1+x^2) + \ln c)$$

Now $y(1) = 0$

$\Rightarrow 0 = \frac{1}{2}(\ln 2 + \ln c)$

$\ln 2c = 0$

Now $y(2) = \frac{2}{2}(\ln 5 + \ln\frac{1}{2})$

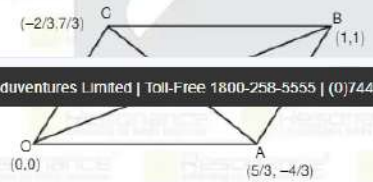
$y(2) = \ln\frac{5}{2}$

10. If two sides of a parallelogram are $4x + 5y = 0$ and $7x + 2y = 0$. If one of the diagonals is $11x + 7y = 9$ then the other diagonal passes through the point :

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

Ans. **(2)**

Sol. AC : $11x + 7y = 9$



OA : $4x + 5y = 0$

OC : $7x + 2y = 0$

$\Rightarrow A\left(\frac{5}{3}, \frac{-4}{3}\right)$ and $C\left(\frac{-2}{3}, \frac{7}{3}\right) \Rightarrow M = \left(\frac{1}{2}, \frac{1}{2}\right)$

equation of OB $\Rightarrow y = x$

11. The point P(a, b) undergoes following transformation to a new co-ordinate $P'\left(-\frac{1}{\sqrt{2}}, \frac{7}{\sqrt{2}}\right)$

(i) Reflection about $y = x$

(ii) Translation through 2 units in the positive direction of x-axis

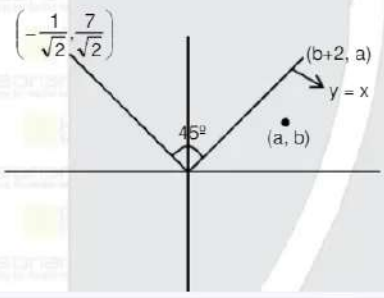
(iii) Rotation through an angle $\frac{\pi}{4}$ in anti-clockwise sense about the origin

Then the value of $2a + b$ is :

(1) 1 (2) 3 (3) 4 (4) 9

Ans. (4)

Sol.



$\frac{-1}{\sqrt{2}} + \frac{7}{\sqrt{2}}i = \{(b+2) + ai\}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

$\sqrt{2}$ $\sqrt{2}$ $\left(\frac{b+2}{4}, \frac{a}{4}\right)$

$\frac{-1}{\sqrt{2}} + \frac{7}{\sqrt{2}}i = \left(\frac{b+2}{\sqrt{2}} - \frac{a}{\sqrt{2}}\right) + i\left(\frac{b+2}{\sqrt{2}} + \frac{a}{\sqrt{2}}\right)$

$b - a + 2 = -1$ ..... (i)

$b + 2 + a = 7$ ..... (ii)

Using equation (i) & (ii)

$a = 4, b = 1$

$\Rightarrow 2a + b = 9$

12. If $\alpha^{1/5}$ and $\beta^{1/5}$ are roots of the equation $8x^2 + bx + c = 0$ where α = max $(2^{6\sin 3x + 8\cos 3x})$ and β = min$(2^{6\sin 3x + 8\cos 3x})$. Then the value of |b–c| is :

Ans. (42.0)

β = min$(2^{6\sin 3x + 8\cos 3x}) = 2^{-10}$

$\alpha^{1/5} = 2^2$ and $\beta^{1/5} = 2^{-2}$

$\Rightarrow 8x^2 + bx + c = 0$ $\begin{matrix}\nearrow \alpha^{1/5} \\ \searrow \beta^{1/5}\end{matrix}$

$\Rightarrow \alpha^{1/5} + \beta^{1/5} = 4 + \frac{1}{4} = \frac{17}{4} = \frac{-b}{8}$

$b = -34$

$= \alpha^{1/5} + \beta^{1/5} = 1 = \frac{c}{8} \Rightarrow c = 8$

$|b-c| = 42$

13. For an ellipse E, centre lies at the point (3, – 4), one of the foci is at (4, – 4) & one of vertices is at (5, – 4). If the equation of tangent on the ellipse E is $mx - y - 4(m > 0)$. The value of $5m^2$ is :

Ans. (1)

Sol. Equation of the ellipse is $\frac{(x-3)^2}{a^2} + \frac{(y+4)^2}{b^2} = 1$

$\frac{4}{a^2} = 1 \Rightarrow a^2 = 4$

$a - ae = 1$

$2 - 2e = 1 \Rightarrow e = \frac{1}{2}$

$b^2 = a^2 - a^2e^2 = 4 - 4\left(\frac{1}{4}\right) = 3$

$\Rightarrow \frac{(x-3)^2}{4} + \frac{(y+4)^2}{3} = 1$

Given tangent is $y = mx - 4$

$3m = \pm\sqrt{4m^2 + 3} \Rightarrow 9m^2 = 4m^2 + 3$

$5m^2 = 3$

14. The number of solutions of the equation $e^{4x} - e^{3x} - 4e^{2x} - e^x + 1 = 0$ is :

Ans. (2)

Sol. $e^{4x} - e^{3x} - 4e^{2x} - e^x + 1 = 0$

$$e^{2x} - e^x - 4 - \frac{1}{e^x} + \frac{1}{e^{2x}} = 0$$

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

$$\Rightarrow \left(e^x + \frac{1}{e^x}\right)^2 - \left(e^x + \frac{1}{e^x}\right) - 6 = 0$$

$$\Rightarrow t^2 - t - 6 = 0$$

$t = 3, t = -2$ (not possible)

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

$$e^{2x} - 3e^x + 1 = 0$$

Put $e^x = p$

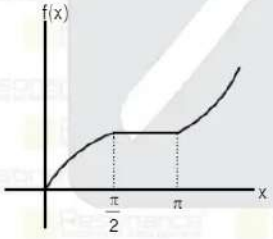
$$\Rightarrow p^2 - 3p + 1 = 0$$

$\Rightarrow$ number of solutions = 2

15. If $f(x) = \begin{cases} \max(\sin t) & ; \ 0 \le t \le x, \ x \in [0, \pi] \\ 2 + \cos x & ; \ x > \pi \end{cases}$ then the number of points where of f(x) is not continuous or non-differentiable.

Ans. (1)

Sol.



Critical point $\frac{\pi}{2}$ & π

At $x = \frac{\pi}{2}$

at $x = \pi$

f(x) is again continuous and differentiable at $x = \pi$ $\Rightarrow$ LHD = RHD = 0

So, number of dis-continuous and non differentiable point = 0

16. If $f(x)=\frac{1-\sin x+\cos x}{1+\sin x+\cos x}, x \neq \pi$ then the value of $f(\pi)$ so that $f(x)$ is continuous.

(1) 1 (2) 0 (3) –1 (4) 2

Ans. **(3)**

Sol. Since $f(x)$ is continuous at $x = \pi$

$$\Rightarrow f(\pi)=\lim_{x\to\pi}\frac{1-\sin x+\cos x}{1+\sin x+\cos x}$$

$$=\lim_{x\to\pi}\frac{2\cos^2\frac{x}{2}-2\sin\frac{x}{2}\cos\frac{x}{2}}{2\cos^2\frac{x}{2}+2\sin\frac{x}{2}\cos\frac{x}{2}}$$

$$\cos\frac{x}{2}+\sin\frac{x}{2}$$

So $f(\pi) = -1$

17. Let $\left(3^{\frac{1}{6}\log_3(25^{x-1}+7)}+3^{\frac{1}{8}\log_3(5^{x-1}+1)}\right)^{10}$ is expanded in the increasing power of $3^{\frac{1}{8}\log_3(5^{x-1}+1)}$. If 9th terms of the expansion is 180 then the value of x is :

(1) –1 (2) 1 (3) 0 (4) 2

Ans. **(2)**

Sol. 9th terms of the expansion $\left((25^{x-1}+7)^{\frac{1}{6}}+(5^{x-1}+1)^{\frac{1}{8}}\right)^{10}$ is

$${}^{10}C_8\left((25^{x-1}+7)^{\frac{2}{6}}\times(5^{x-1}+1)^{\frac{8}{8}}\right)=180$$

$$\Rightarrow \frac{10\times9}{2}\left((25^{x-1}+7)^{\frac{2}{3}}\times(5^{x-1}+1)\right)=180$$

After solving x :

$x = 1$