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JEE (Main)

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

2021

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

1. A deuteron & α-particle both enters in a region of magnetic field perpendicular to it with same kinetic energy find the ratio of their radii ?

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

Ans. (3)

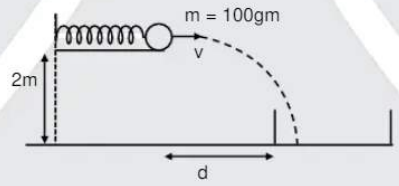
Sol. $r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}$

$r \propto \frac{\sqrt{m}}{q}$

$m_\alpha = 2m_d$

$\frac{r_d}{r_\alpha} = \frac{\sqrt{m_d}}{q_d} \times \frac{2q_d}{\sqrt{2m_d}} = \sqrt{2}$

2. In the given arrangement, spring of spring constant 100 N/m is compressed by 0.5m. The height of the arrangement is 2m. A basket is placed at distance d such that after projection, ball will fall in the basket. If the mass of the ball is 100 gm, find maximum value of d ?



(1) 5 m (2) 10 m (3) 15 m (4) 20 m

Sol. By energy conservation

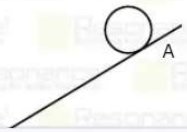
$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \Rightarrow v = x\sqrt{\frac{k}{m}} \qquad v = 0.5 \times \sqrt{\frac{100}{0.1}} = 5\sqrt{10}\,m/s$

Time of flight of ball $T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2\times 2}{10}} = \frac{2}{\sqrt{10}}\,sec$

Range of ball s = ut

$d = 5\sqrt{10} \times \left(\frac{2}{\sqrt{10}}\right) = 10m$

3. When a disc slides on smooth inclined surface from rest, the time taken to move from A to B it t_1. When disc performs pure rolling from rest then time taken to move from A to B is t_2. If $\frac{t_2}{t_1} = \sqrt{\frac{3}{x}}$ find x.



Ans. 2

Sol. When disc slides $a_1 = g\sin\theta$ So $S = ut_1 + \frac{1}{2}a_1t_1^2 = \frac{1}{2}g\sin\theta.t_1^2$ ...(1)

When disc do pure rolling $a_2 = \frac{g\sin\theta}{1+k^2/R^2} = \frac{g\sin\theta}{1+1/2} = \frac{2}{3}g\sin\theta$

So $S = ut_2 + \frac{1}{2}a_2t_2^2 = \frac{1}{2}.\frac{2}{3}g\sin\theta.t_2^2$ ...(2)

From (1) & (2)

$\frac{t_2}{t_1} = \sqrt{\frac{3}{2}}$

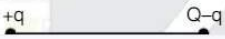
4. We have a charge of magnitude Q. If we divide charge in two parts, what should be their ratio so that there will be max repulsion force between them ?

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

Ans. (1)

Sol.

Sol.



$\frac{kq}{r^2} = \frac{k(Q-q)}{r^2}$

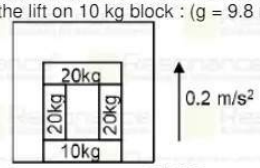
$\frac{dF}{dq} = 0$

$Q - 2q = 0$

$q = Q/2$

ratio = 1 : 1

5. Four planks are arranged in a lift going upwards with an acceleration of 0.2 m/s² as shown in figure. Find the normal reaction applied by the lift on 10 kg block : (g = 9.8 m/s²)



(1) 500 (2) 700 (3) 672 (4) 800

Ans. (2)

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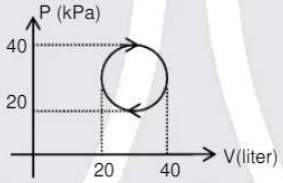
Sol.

$N - 70g = 70 \times 0.2$

$N = 70(g + 0.2)$

$N = 700$

6. For given PV curve, Find net heat taken by gas system in cyclic process.



(1) 25 π (2) 50 π (3) 75 π (4) 100 π

Ans. (4)

$= \left[\frac{40-20}{2} \times 10^3\right] \times \left[\frac{40-20}{2} \times 10^{-3}\right]$

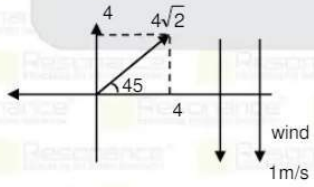
$= 100\ \pi$ Joule

7. A butterfly is flying in North–East with $4\sqrt{2}$ m/s w.r.t. wind. Wind is blowing at 1 m/s southwards. Displacement of butterfly in 3s is

(1) 10 meter (2) 15 meter (3) 20 meter (4) 5m

Ans. (2)

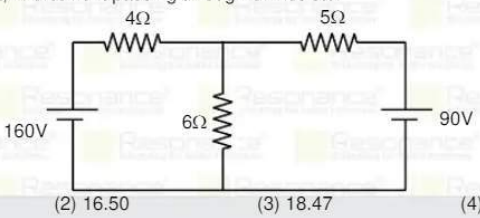
Sol.



$\vec{D} = v_{F,G} \times T$

$|\vec{D}| = 15m$

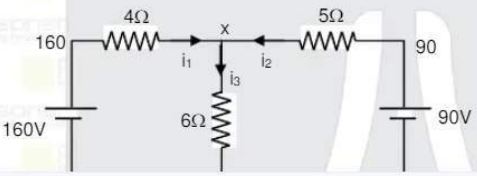
8. In the given circuit, find current passing through 6Ω resistor



(1) 15.67 (2) 16.50 (3) 18.47 (4) 10.46

Ans. (1)

Sol.



Let potential at junction point = x

By KCL $\sum i_{in} = 0$

$$\Rightarrow \frac{160-x}{4} + \frac{90-x}{5} + \frac{0-x}{6} = 0$$

$$\Rightarrow \frac{160\times15 - 15x + 90\times12 - 12x + 0 - 10x}{60} = 0$$

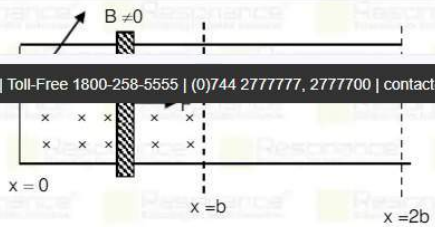
$$\Rightarrow 37x = 2400 + 1080$$

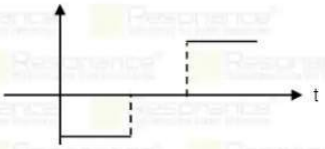
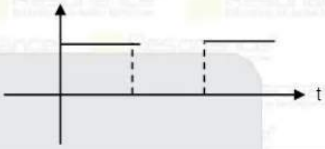
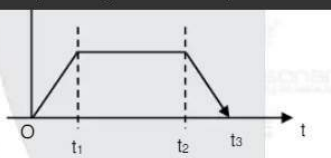
$$x = 94.05$$

So current $i_3 = \frac{x}{6}$

$$= \frac{94.05}{6} = 15.67$$

9. In the given system, uniform magnetic field exists from x = 0 to x = b. A rod is first moved from x = 0 to x = 2b uniformly and then moved reverse uniformly from x = 2b to x = 0. Match the quantities with proper curves



Column-I		Column-II	
(a)	Flux (ϕ)	(i)	
(b)	EMF (e)	(ii)	
(c)	Power (P)	(iii)	

(1) (a) – (iii), (b) – (i), (c) – (ii)
(2) (a) – (ii), (b) – (iii), (c) – (i)
(3) (a) – (iii), (b) – (ii), (c) – (i)
(4) (a) – (i), (b) – (iii), (c) – (ii)

Ans. (1)

Sol. Flux = ϕ = B.A

$\Rightarrow$ B × A cos0

Where A = ℓvt

ϕ = Bℓvt

One rod go at x > b then ϕ stop changing this constant flux = Bℓb.

When rod come back and when x < b flux start decreasing so graph ϕv/st

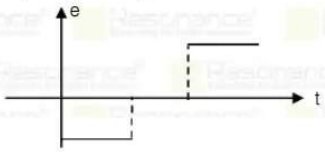
b $\rightarrow$ (ii)

$e = \frac{-d\phi}{dt}$

e = – slope of ϕ – t graph

In 0 – t_1 graph slope +ve and constant so e = negative and zero.

in t_2–t_3 slope of ϕ–t is negative and constant so e = positive and zero



Power = $\frac{e^2}{R}$

Resistance is only of rod so R of the circuit is constant

$P = \frac{B^2\ell^2v^2}{R}$ = constant

10 A uniform rod of young's modulus Y is stretched by two tensions T_1 and T_2 such that rods get suspended

10. A uniform rod of young's modulus Y is stretched by two tension T_1 and T_2 such that rods get expanded to length L_1 and L_2 respectively. Find initial length of rod ?

(1) $\frac{L_1T_1 - L_2T_2}{T_1 - T_2}$ (2) $\frac{L_2T_1 - L_1T_2}{T_2 - T_1}$ (3) $\frac{L_1T_2 - L_2T_1}{T_2 - T_1}$ (4) $\frac{L_1}{T_1} \times \frac{T_2}{L_2}$

Ans. (3)

Sol. Let initial length of rod be L_0 and Area A.

As $\frac{T}{A} = Y\frac{\Delta\ell}{\ell}$

So, $\frac{T_1}{A} = \frac{Y(L_1 - L_0)}{L_0}$

$\frac{T_2}{A} = \frac{Y(L_2 - L_0)}{L_0}$

Dividing

$\frac{T_1}{T_2} = \frac{L_1 - L_0}{L_2 - L_0}$; $T_1L_2 - T_1L_0 = T_2L_1 - T_2L_0$; $L_0 = \frac{L_1T_2 - L_2T_1}{T_2 - T_1}$

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

(2) $\sqrt{A^2 + B^2 + \sqrt{2}AB}$

(3) A – B

(4) A + B

Ans. (1)

Sol. $\vec{A} \cdot \vec{B} = |\vec{A} \times \vec{B}|$

$\Rightarrow$ $AB\cos\theta = AB\sin\theta$

$\therefore$ $\theta = 45°$

$\therefore$ $|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - 2AB\cos 45°}$

$= \sqrt{A^2 + B^2 - \sqrt{2}AB}$

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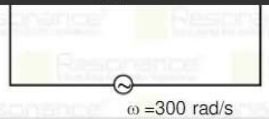
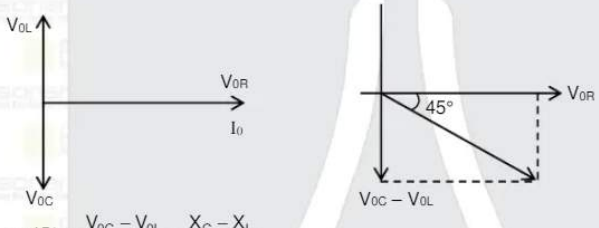
12. In the L-C-R series A.C. circuit shown fellow, current leads source voltage by 45°. Find capacitance of the capacitor.



(1) 2.1 mF (2) 3.33 mF (3) 4.3 mF (4) 5.1 mF

Ans. (2)

Sol.



$\tan 45° = \frac{V_{0C} - V_{0L}}{V} = \frac{X_C - X_L}{R}$

ωC

$0.1\Omega = \frac{1}{300C} - 3 \times 10^{-3} \times 300$

$\Rightarrow C = 3.33$ mF (approx)

$\Rightarrow$ C = 3.33 nF (approx)

13. A radioactive material having number of active nuclei N is decaying by two processes, one with half-life of 1400 yr and other with half-life of 700 yr. After how much time number of active nuclei will be N/3?

(1) 520 yr (2) 740 yr (3) 470 yr (4) 640 yr

Ans. (2)

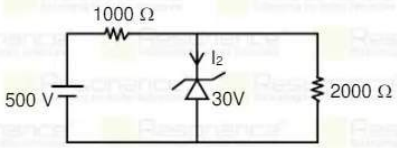
Sol.

$$-\frac{dN_x}{dt} = \lambda_1 N_x + \lambda_2 N_x$$

$$\int_{N}^{N/3} \frac{dN_x}{N_x} = \int_0^t (\lambda_1 + \lambda_2)dt$$

$$t = \frac{\ln 3}{\ln 2} \times \frac{1400}{3} = 740 \text{ year}$$

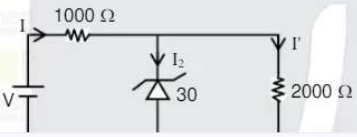
14. In the given circuit find current 'I' passing through Zener diode?



(1) 0.445 A (2) 0.345 A (3) 0.245 A (4) 0.145 A

Ans. (1)

Sol.



$$I' = \frac{30}{2000} = 0.015$$

$I = I_2 + I'$

$I_2 = I - I' = 0.47 - 0.015 = 0.445$ A

15. The wave number of the spectral line in the emission spectrum of hydrogen will be equal to 8/9 times of the Rydberg's constant. Then the electron jumps from

(1) $5 \to 2$ (2) $5 \to 3$ (3) $3 \to 1$ (4) $4 \to 2$

Ans. (3)

Sol. $\bar{\nu} = Rz^2\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)$

If $n_L = 1$, $n_H = 3$; $\bar{\nu} = R.1\left[\frac{1}{1} - \frac{1}{9}\right]$; $\bar{\nu} = \frac{8}{9}R$

A vehicle moving with velocity v and releasing sound of frequency 500 Hz. Listening the reflected sound from a wall of frequency 500 Hz. Find the velocity of vehicle v.

(1) 36.67 m/s (2) 30.12 m/s (3) 22.37 m/s (4) 20.25 m/s

Ans. **(1)**

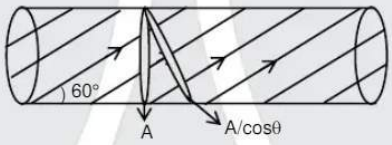
Sol. Frequency received by wall $f' = \left(\frac{v_s}{v_s - v}\right) f_0$

Reflected frequency received by man is $f'' = \left(\frac{v_s + v}{v_s}\right) f'$

$\Rightarrow \quad f'' = \left(\frac{v_s + v}{v_s}\right)\left(\frac{v_s}{v_s - v}\right) f_0 \Rightarrow \quad f'' = \left(\frac{v_s + v}{v_s - v}\right) f_0 \Rightarrow \quad 500 = \left(\frac{330 + v}{330 - v}\right) 400$

$\Rightarrow \quad v = \frac{330}{9} = 36.67 \text{ m/s}$

material is 44×10^{-2} ohm × m. Find electric field inside the rod?



(1) 0.567 (2) 0.367 (3) 0.667 (4) 0.767

Ans. (2)

Sol. $J = \sigma E$

$$\frac{I}{A_{effective}} = \frac{E}{\rho}$$

$$E = \frac{\rho I}{A} \cos 60° = \frac{44 \times 10^{-2} \times 5}{3 \times 2} \; ; \; E = 0.367$$

by it is zero.

(1) 700 R (2) 600 R (3) 500 R (4) 100 R

Ans. (3)

Sol. $n = 4$

$\Delta T = 50K$

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

As W = 0. It means isochoric process

$Q = \Delta U$

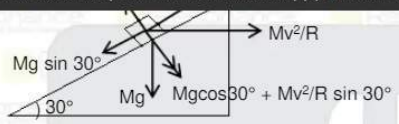
$= nC_v\Delta T = 4 \times \frac{5R}{2} \times 50 = 500 \text{ R}$

19. A car is moving on a Banked rough road, the mass of car is 800 kg. The angle of Banking is 30°, car is moving with maximum speed given that $\mu_s = 0.2$. find the Normal Reaction (in Newton)?

(1) 24000 (2) 5000 (3) 10000 (4) 9000

Ans. (3)

Sol.



Perpendicular to inclined plane

$$N = mg\cos30° + \frac{mv^2}{R}\sin30°$$

$$N - mg\cos30° = \frac{mv^2}{R}\sin30° \quad ...(1)$$

along inclined plane

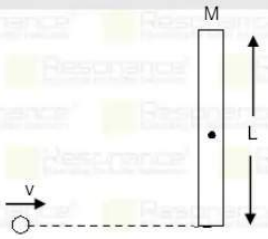
$$mg\sin30° + \mu_s N = \frac{mv^2}{R}\cos30° \quad ...(2)$$

Dividing (1) by (2)

$$\frac{N - mg\cos30°}{mg\sin30° + \mu_s N} = \tan30°$$

Solving N = 10000 (Approx)

20. A particle of mass m moving with speed v collide elastically with the end of a uniform rod of mass M and length L perpendicularly as shown in figure. If the particle comes to rest after collision find the value of $\frac{m}{M}$.



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

Sol.

Conservation of angular momentum about centre of mass of rod

$$(L) = \frac{ML^2}{}$$

$mv\left(\frac{L}{2}\right) = \frac{ML}{12}(\omega)$ ...(i)

$mv = Mv_1$ ....(ii)

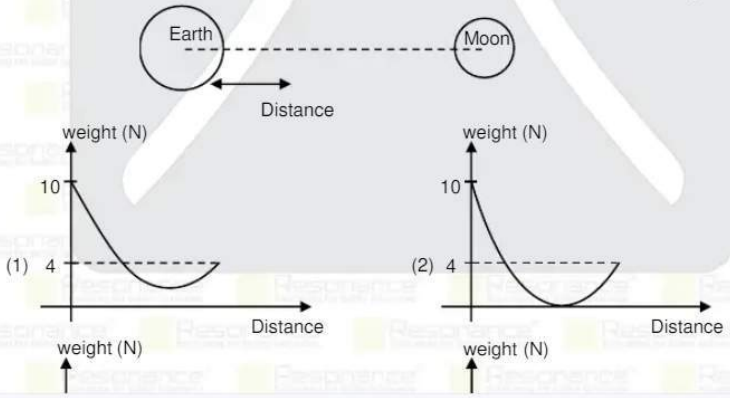
$1 = \frac{v_1 + \omega\frac{L}{2}}{v}$ ....(iii)

Putting v_1 from (ii) and ωL from (i) in (iii)

$v = \frac{m}{M}v + \frac{6mv}{2M}$

$\frac{4m}{}$

21. An object is moved from earth to moon. Choose the correct weight vs distance curve. Gravitational acceleration on earth surface is 10 m/s² and that on moon is 4m/s². Mass of the object is 1kg.



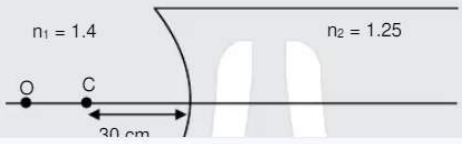
Ans. (2)

Sol. $\vec{g}$ (at any point) = $\vec{g}_{Earth} + \vec{g}_{moon}$. Since distance is large so $|\vec{g}| = |\vec{g}_E| = 10$.

As we move away from earth, It decrease to zero at a point where $\vec{g}_E + \vec{g}_M = 0$

Then it increase to $|\vec{g}| = |\vec{g}_M| = 4$ at moon surface.

22. For the spherical interface of radius of curvature R = 30 cm shown in figure. The two different media having refractive indices $n_1 = 1.4$ and $n_2 = 1.25$, an object is placed at 40 cm from the interface as shown in figure. Find position of image.



40 cm

(1) 41.67 (2) 35.42 (3) 22.27 (4) 15.25

Ans. (1)

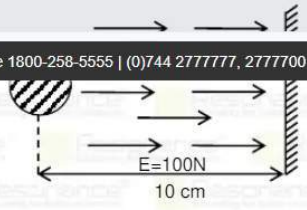
Sol. $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

$\Rightarrow \quad \frac{1.25}{v} - \frac{1.4}{-40} = \frac{1.25 - 1.4}{(-30)}$

$\Rightarrow \quad \frac{1.25}{v} = 0.005 - 0.035$

$\Rightarrow$ $v = -41.67$ cm

23. A ball of charge to mass ratio $8\mu C/g$ is placed at a distance of 10 cm from a wall. An electric field 100 N/m is switched on in the direction of wall. Find time period of its oscillations? Assume all collisions elastic.



(1) 1 sec (2) 2 sec (3) 3 sec (4) 4 sec.

Ans. (1)

Sol. $a = \frac{qE}{m} = \frac{8\times10^{-6}}{10^{-3}}\times100 = 0.8$ m/s^2

As electric field is switched on, ball first strikes to wall and returns back.

one oscillation.

Thus $s = ut + \frac{1}{2}at_1^2$

$0.1 = \frac{1}{2}\times0.8t_1^2$

Thus time period $T = 2\times\frac{1}{2} = 1$ sec.

24. A body of mass m emits a photon of frequency ν, then loss in its internal energy ?

(1) $h\nu$ (2) $h\nu\left(1-\frac{h\nu}{2mc^2}\right)$ (3) $h\nu\left(1+\frac{h\nu}{2mc^2}\right)$ (4) zero

Ans. (3)

Sol.

$; \nu = c/\lambda$

$mv = \frac{h}{\lambda} = \left(\frac{h\nu}{c}\right)$

$= \frac{1}{2}\frac{p^2}{m} + h\nu$

$= \frac{1}{2m}\left(\frac{h\nu}{c}\right)^2 + h\nu$

$= h\nu\left(1+\frac{h\nu}{2mc^2}\right)$

25. Consider an equation $S = \alpha^2\beta/n\left(\frac{nkR}{J\beta^2} - 1\right)$

Where S = Entropy
n = No. of moles
k = Boltzmann constant
R = Universal gas constant

(1) $[M^0L^0T^0]$, $[M^1L^2T^2K^{-1}]$ (2) $[M^1L^2T^{-2}]$, $[M^1L^2T^{-2}K^{-1}]$
(3) $[M^1L^2T^{-2}K^{-1}]$, $[M^0L^0T^0]$ (4) None of these

Ans. (1)

Sol. $S = \frac{Q}{\Delta T}$

$[S] = \frac{ML^2T^{-2}}{K}$

$K = \frac{\text{Energy}}{T}$

$[K] = [S] = \frac{ML^2T^{-2}}{K}$

$[R] = \left[\frac{\text{Energy}}{nT}\right] = \frac{ML^2T^{-2}}{molK}$

$[J] = M^0L^0T^0$

Now, $[nKR] = [J\beta^2]$

$(mol) \times \frac{ML^2T^{-2}}{K} \times \frac{ML^2T^{-2}}{mol\,K} = [\beta^2]$

$[\alpha^2] = \left[\frac{\alpha}{\beta}\right] = \frac{}{K \times ML^2T^{-2}K^{-1}}$; $\alpha = M^0L^0T^0$

26. The shape of travelling wave at t = 0, is given by $y = \frac{1}{1+x^2}$. If after 3 sec shape of the wave pulse is represented by $y = \frac{1}{1+(1-x)^2}$, then speed of wave is :

(1) $\frac{1}{2}$ m/s (2) $\frac{4}{3}$ m/s (3) $\frac{1}{3}$ m/s (4) $\frac{5}{6}$ m/s

Ans. (3)

Sol. $x \to (x - vt)$

$y = \frac{1}{1+(x-vt)^2}$

At t = 0 ; $y = \frac{1}{1+x^2}$

at t = 3 ; $y = \frac{1}{1+(x-3v)^2}$

By comparing

incident on a gold plate from which electron is emitted which will make a radius of 7 mm in a uniform magnetic field of intensity 5×10^{-4} T find the work function of gold plate?

(1) 3.4 eV (2) 5.12 eV (3) 1.031 eV (4) 11.01 eV

Ans. (4)

Sol. $Ep = 13.6\left[\frac{1}{R_1^2} - \frac{1}{R_2^2}\right]eV$

$= 13.6\left[\frac{1}{1} - \frac{1}{9}\right]$

$Ep = 12.08$ eV

For Gold plate

$\phi = Ep - KEmax$

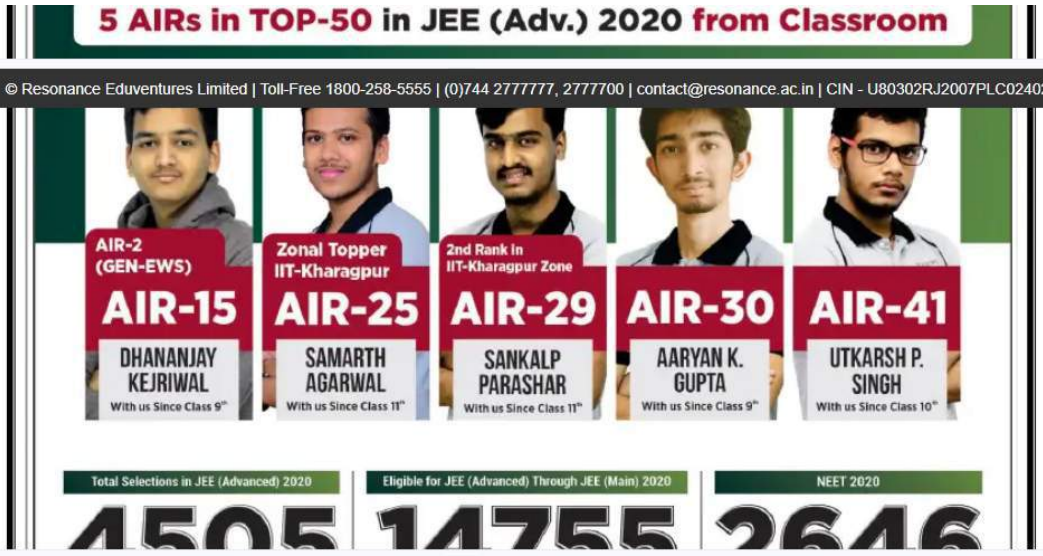
$v = \frac{RqB}{m}$

$K.E. = \frac{1}{2}mV^2$

$K.E = \frac{1}{2} \times \frac{9.1\times10^{-31}\times(6.15\times10^{5})^2}{1.6\times10^{-19}}eV = 1.075$ eV

$\phi = 12.05 - 1.075$

$\phi = 11.01$ eV



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JEE (Main)

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

2021

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 20 July, 2021 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

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PART : CHEMISTRY

1. Arrange the following complex in increasing order of intensity of colour.

[illegible]

(3) $[Co(CN)_6]^{3-}$, $[CoCl_4]^{2-}$, $Co(H_2O)_6]^{2+}$ (4) $Co(H_2O)_6]^{2+}$, $[Co(CN)_6]^{3-}$, $[CoCl_4]^{2-}$

Sol. **(1)**

	Complex	Colour
1.	$[Co(CN)_6]^{3-}$,	Yellow
2.	$Co(H_2O)_6]^{2+}$	Pink
3.	$[CoCl_4]^{2-}$	Blue

2. Which of the following does not disproportionate

(1) BrO^- (2) BrO_2^- (3) BrO_3^- (4) $BrO_4^{\ominus}$

Ans. (4)

Sol. In BrO_4^-, Br is in maximum oxidation state. So it can only reduce

3. A metal M on reaction with excess oxygen give MO_2 type oxide (as main product) then possible metal is.

(1) Li (2) Na (3) K (4) Mg

Ans. (3)

Potassium on reaction with excess oxygen give superoxide

4. Identify the correct increasing order of 1st ionisation energy of following
Al, Mg, Si, S, P

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

Ans. **(2)**

Sol. Mg $3s^2$

Al $3s^23p^1$

Si $3s^23p^2$

P $3s^23p^3$

S $3s^23p^4$

So correct order : - Al < Mg < Si < S < P

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5. Four moles of a diatomic gas is heated from 0°C to 50°C, find the heat supplied to the gas if work done by it is zero.

(1) 780 R (2) 500 R (3) 100 R (4) 650 R

Ans. **(2)**

Sol. $w = 0$

$\Delta E = q_v = nC_v\Delta T$

$= 5R$

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6. HNO_3 on reaction with P_4O_{10} gives an oxide 'A'

$P_4O_{10} + HNO_3 \longrightarrow$ A(oxide)

Nature of oxide A is

(1) acidic (2) Basic (3) Neutral (4) Amphoteric

Sol. $P_4O_{10} + 4HNO_3 \longrightarrow \underset{\text{'A'}}{2N_2O_5} + 4HPO_3$

Nature of oxide 'A' is "acidic".

7. An equimolar mixture of benzene ($P^o_{Benzene}$ = 70 torr and methyl benzene ($P^o_{Methyl\ Benzene}$ = 20 torr) is prepared, then find mole fraction of benzene in vapour phase.

Ans. 0.7

Sol. $P_{Total} = P^o_{Benzene}\ X_{Benzene} + P^o_{Toluene}\ X_{Toluene}$

$= (70)\ \frac{1}{2} + (20)\ \frac{1}{2}$

$= 35 + 10$

$= 45$

$\frac{1}{P} = \frac{Y_{Benzene}}{P^o_{Benzene}} + \frac{Y_{Toluene}}{P^o_{Toluene}}$

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$$\frac{1}{45} = \frac{Y_{Benzene}}{70} + \frac{1-Y_{Benzene}}{20}$$

$$\frac{1}{45} = \frac{2Y_{Benzene} + 7(1-Y_{Benzene})}{140}$$

$$\frac{1}{45} = \frac{2Y_{Benzene} + 7 - 7Y_{Benzene}}{140}$$

$$\frac{1}{45} = \frac{7-5Y_{Benzene}}{140}$$

$$\frac{1}{9} = \frac{7-5Y_{Benzene}}{28}$$

$28 = 63 - 45\ Y_{Benzene}$

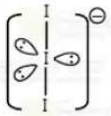
$Y_{Benzene} = \frac{35}{45} = \frac{7}{9}$

$Y_{Benzene} = 0.7$

8. Find total number of lone pair of electron on central atom in I_3^-

Ans. 3

Sol.



Total lone pair on central atom = 3.

Ans. (3)

Sol. $Cu^{2+}(aq) + 2e^- \longrightarrow Cu$ $\qquad E^0_{Cu^{2+}/Cu} = 0.34V$

10. Which of the following is most easily economically refined by Fractional distillation.
(1) Zn (2) Ni (3) Cu (4) Fe

Ans. (1)

Sol. "Theory Based"
Fractional distillation process utilizes the boiling point difference between metal and that of impurity. Using this process, crude zinc containing Cd, Fe and Pb as impurities can be refined.

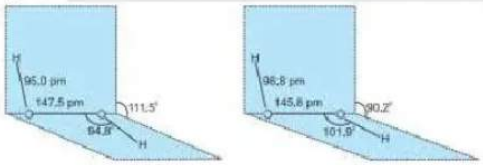
11. Among the following pairs which is incorrect regarding similarity in properties.
(1) $Be(OH)_2$, $Al(OH)_3$ (2) NaOH, $Ca(OH)_2$ (3) $B(OH)_3$, H_3PO_4 (4) $B(OH)_3$, $Mg(OH)_2$

Ans. (4)

Sol. $B(OH)_3$ is H_3BO_3 is acidic in nature.
$Mg(OH)_2$ is basic in nature.

12. **Statement-1 :** Dihedral angle of H_2O_2 in gas is around 90°.
Statement-2 : Dihedral angle of H_2O_2 in solid is around 111.5°.
are the statements ture of false.

Sol.



(a) Gas phase (b) Solid phase

(a) H_2O_2 structure in gas phase, dihedral angle is 111.5°. (b) H_2O_2 structure in solid phase at 110 K, dihedral angle is 90.2°.
The dihedral angle of H_2O_2 in gaseous phase is approximate 111.5°. While dihydral angle in solid H_2O_2 is affected by hydrogen bonding and it is 90.2° in solid state.

13. 4.5 gram mass of a substance [molar mass = 90 g/mol] is dissolved in 250 ml solution, then molarity of solution is -

Ans. 0.2

Sol. $\text{Molarity (M)} = \frac{W_{solute} \times 1000}{GMM_{solute} \times V_{sol^n}}$

$M = \frac{4.5 \times 1000}{90 \times 250} = \frac{4.5 \times 4}{90} = 0.2\ M.$

14. What is the magnetic moment (Spin only) of complex $[Co(CN)_6]^{4-}$:
[Report your answer to nearest integer]

Ans. (2)

Sol. So number of unpaired electrons = 1.

$\mu = \sqrt{n(n+2)} = \sqrt{3}$

$\mu = 1.73\ BM \approx 2\ BM.$

15. 10000 KJ energy is needed per day, if heat of combustion of glucose is 2700 KJ/Mole. Then how many gram of glucose is needed per day for this : [Report your answer to nearest integer].

Ans. 667

Sol. $C_6H_{12}O_6 + 6H_2O \longrightarrow 6CO_{2(g)} + 6H_2O,\ \Delta H = 2700\ KJ/mole$
Glucose

No. of mole of glucose require for production of 10,000 KJ heat is = $\frac{10,000}{2700}$ mole.

Total mass of glucose = $\frac{10,000}{2700} \times 180 = 666.67$ gram.

16. The value of ℓ (azimuthal quantum number) for valence shell electron of Ga^+ ion is ____.

Ans. 0

Sol. $Ga = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$

Azimuthal Quantum number (ℓ) for valence shell electron is 0.

17. What is the difference in energy between 2nd and 3rd orbit of He^+ ion (in eV) is -
[Report your answer to nearest integer]

Ans. 8

Sol. $(E_{He^+})_{n=2} = -13.6 \times \frac{(2)^2}{(2)^2} = -13.6\ ev$

$(E_{He^+})_{n=3} = -13.6 \times \frac{(2)^2}{(3)^2} = -13.6 \times \frac{4}{9}$

$(E_{He^+})_{n=3} - (E_{He^+})_{n=2} = 13.6\left[1 - \frac{4}{9}\right]$

$= 13.6\left[\frac{5}{9}\right] = 7.55\ eV$

18. Anion of a compound 'x' gives brown ring test and cation gives deep blue coloration with NH_4OH and also gives precipitate with HCl & H_2S, then compound 'x' is

Sol. Nitrates give brown ring test.

$Cu^{2+} + 4NH_3(aq) \longrightarrow [Cu(NH_3)_4]^{2+}(aq)$

Deep Blue

$Cu^{2+} + H_2S \xrightarrow{H^+} Cu_2S \downarrow$

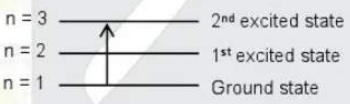
Black

19. What is the value of second excitation energy of Li^{2+}

(1) 108.8 eV (2) 81.6 eV (3) 13.6 eV (4) 95.2 eV

Ans. (1)

Sol.



$$\left|\Delta E_{u^{2+}}\right|_{1\to 3} = 13.6 \times 2^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$= 13.6 \times 9 \left[\frac{8}{9}\right]$$

$= 13.6 \times 8 = 108.8$ eV

20. $P + CHCl_3 \xrightarrow{KOH} \underset{\text{Poisonous Product}}{Q}$

Identify compound P and Q respectively

(1) Primary amine, secondary amine (2) Primary amine, Primary amine

(3) Primary amine, Isonitrile (4) Secondary amine, Isonitrile

Ans. (3)

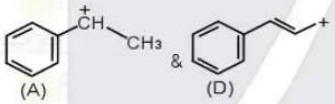
Sol. Only 1° amines give carbylamines reaction

$$\underset{\substack{1^\circ \text{ Amine} \\ (P)}}{R-NH_2} + CHCl_3 + 3KOH \longrightarrow \underset{\substack{\text{Isonitrile} \\ \text{(Poisonous product)} \\ (Q)}}{R-NC} + 3KCl + 3H_2O$$

21. In which of the following carbocation are resonance stabilised

(1) A, B (2) A, C (3) A, D (4) A, B, C

Ans. (3)

Sol.  are resonance stabilised carbocations.

(A) (D)

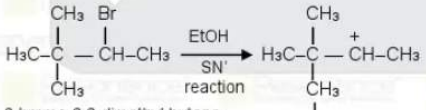
22. When ethanol is reacts with 3-Bromo-2,2-dimethyl butane then product formed is :

(1) 2, 2-Dimethyl-3-ethoxybutane (2) 2-Ethoxy-2,3-dimethyl butane

(3) 2-Ethoxy-2-methyl pentane (4) 3-Ethoxy-2,2-Dimethyl butane

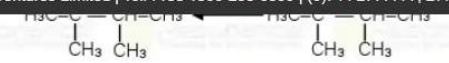
Ans. (2)

Sol.



3-bromo-2,2-dimethyl butane

1,2-methyl shift



2-Ethoxy-2,3-dimethyl butane

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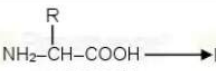
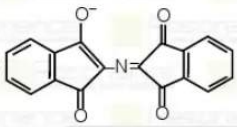
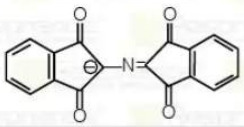
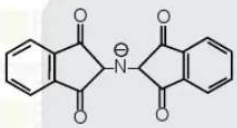
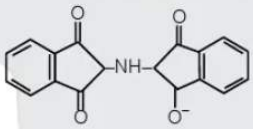
23. Ninhydrin +  Product is ?

α-amino acid

(1) 

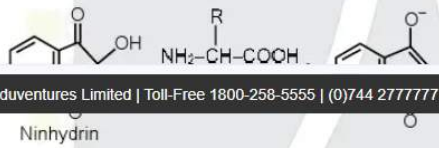
(2) 

(3) 

(4) 

Ans. (1)

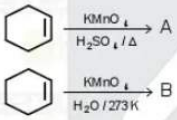
Sol.



Ninhydrin

Deep Blue
Ruhe mann's purple

Ninhydrin is useful for identification of α-amino acid which react with ninhydrin and give deep blue colour.

24. 

A, B are respectively.

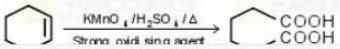
(1) both diol

(2) both dicarboxylic acid

(3) A is dicarboxylic acid and B is diol

(4) A is diol and B is dicarboxylic acid

Ans. (3)

Sol. 

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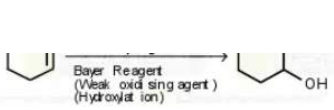


(1) Polyamide (2) Polyester (3) Polyacrylonitrile (4) Polycarbonate

Ans. (3)

Sol. Orlon is a polymer of acrylonitrile also known as PAN

$$CH_2 = CH - C \equiv N \longrightarrow \left(\begin{array}{c} CN \\ | \\ -CH_2 - CH - \end{array} \right)_n$$

Acrylonitrile PAN or orlon

26. Which of the following is better for green chemistry in day to day life (Domestic Purpose)

(1) $Cl_2C = CCl_2$ as dry cleaning agent liquid (2) Liquid CO_2 for cloth cleaning

(2) Cl_2 gas a bleaching agent of paper (4) CCl_4 as dry cleaning agent

Ans. (2)

Sol. $CCl_2 = CCl_2$ was earlier used as solvent for dry cleaning agent but it is carcinogen. So liquid CO_2 is used. Replacement of halogenated solvent by liquid CO_2 will result in less harm to ground water.

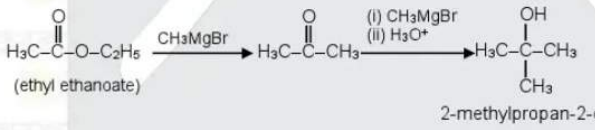
27. Which of the following incorrect :

Ans. (1)

28. How many mole of CH_3MgBr are required to convert ethylethanoate to 2-methylpropan-2-ol :

Ans. (2)

Sol.



(ethyl ethanoate) 2-methylpropan-2-ol

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PART : MATHEMATICS

1 All possible words with or without meaning were formed using all the letters of the word 'EXAMINATION'. The probability that 'M' appears at fourth position is :

(1) $\frac{2}{11}$ (2) $\frac{1}{11}$ (3) $\frac{4}{11}$ (4) $\frac{8}{11}$

Ans. (2)

Sol. EXAMINATION

$2!\,2!2!$

$X \to 1$ $\quad n(E) = \frac{10!}{2!\,2!2!}$

$A \to 2$ $\quad P(E) = \frac{n(E)}{n(s)} = \frac{1}{11}$

$M \to 1$

$O \to 1$

$T \to 1$

$N \to 2$

$I \to 2$

2 If a cricket team consist of 15 players have 6 batsmen , 7 Ballers and 2 wicket keepers then the number

of ways in which cricket team formed with atleast 4 batsmen, 5 ballers and 1 wicket keeper

(1) 567 (2) 525 (3) 462 (4) 777

Sol. **Case-I :** Team consist 5 Batsman , 5 Bowlers

and 1 wicket keeper then number of ways.

$= {}^6C_5 \times {}^7C_5 \times {}^2C_1 = 6 \times 21 \times 2 = 252$

Case - II 4 Batsmen, 6 blowers and 1 wicket keeper

$= {}^6C_4 \times {}^7C_6 \times {}^2C_1 = 15 \times 7 \times 2 = 210$

Case-III 4 Batsmen, 5 bowler and 2 wicket keepers

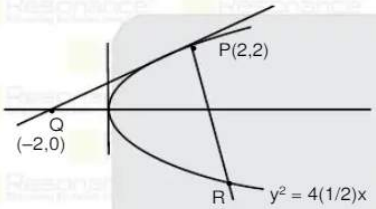
${}^6C_4 \times {}^7C_5 \times {}^2C_2 = 15 \times 21 \times 1 = 315$

Total 252 + 210 + 315 = 777

3 Tangent drawn at a point P(2,2) to parabola $y^2 = 2x$ cuts x-axis at point Q and normal drawn at point P(2,2) to parabola cut parabola again at point R then area of ΔPQR is

(1) 25 (2) $\frac{25}{2}$ (3) $\frac{15}{2}$ (4) 50

Sol.



Equation of tangent at P(2,2) is T = 0

$2y = x + 2$

$y^2 = 4$ So, Q (–2,0)

$2at_1 = 1 \Rightarrow t_1 = 2$

$t_1 \quad t_2 \quad 2 \quad -2 \quad 2 \quad -2$

$\therefore R\left(\frac{1}{2}(-3)^2, 2\left(\frac{1}{2}\right)(-3)\right) = \left(\frac{9}{2}, -3\right)$

Area of $\Delta PQR = \frac{1}{2}\begin{vmatrix} 2 & 2 & 1 \\ -2 & 0 & 1 \\ \frac{9}{2} & -3 & 1 \end{vmatrix}$

$= \frac{1}{2}[2(0+3) - 2(-2 - 9/2) + 1(6 - 0)] = \frac{1}{2}[6 + 4 + 9 + 6] = \frac{25}{2}$ sq. unit.

4. Coefficient of x^{256} in the expansion of $(1 - x)^{101}(x^2 + x + 1)^{100}$ is

(1) ${}^{100}C_{86}$ (2) ${}^{100}C_{85}$ (3) ${}^{100}C_{84}$ (4) ${}^{100}C_{83}$

Ans. **(2)**

Sol. $\Rightarrow (1 - x)^{101}(x^2 + x + 1)^{100}$

$\Rightarrow (1 - x)^{100}(x^2 + x + 1)^{100}(1 - x)$

$\Rightarrow (1 - x^3)^{100}(1 - x)$

$\Rightarrow {}^{100}C_{85}x^{256}$

so, the coefficient of x^{256} is ${}^{100}C_{85}$

5. The value of $\lim_{x\to 0}\left(2-\cos x\sqrt{\cos 2x}\right)^{\frac{x^2+2}{x}}$ is

Ans. 1

Sol. $\lim_{x\to 0}\left(2-\cos\sqrt{\cos 2x}\right)^{\frac{x^2+2}{x}}$ $\quad(1^\infty \text{ form})$

$$= e^{\lim_{x\to 0}\frac{\left(1-\cos x\sqrt{\cos 2x}\right)}{x}\left(x^2+2\right)}$$

$$= e^{\lim_{x\to 0}\left\{\frac{1-\cos^2 x(\cos 2x)}{x}\right\}(x^2+2)}$$

$$= e^{\lim_{x\to 0}\left\{\frac{1-\cos^2 x(\cos 2x)}{x}\right\}\left\{\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}\right\}}$$

$$= e^{\lim_{x\to 0}\left\{\frac{1-\cos^2\left(2\cos^2 x-1\right)}{x}\right\}\left\{\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}\right\}}$$

$$= e^{\lim_{x\to 0}\frac{\left(1-2\cos^4 x+\cos^2 x\right)}{x}\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$$

$$= e^{\lim_{x\to 0}\frac{-\left(2\cos^4 x-\cos^2 x-1\right)}{x}\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$$

$$= e^{\lim_{x\to 0}\frac{(2\cos^2 x+1)(\cos^2 x-1)}{x}\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$$

$$= e^{\lim_{x\to 0}\frac{+(2\cos^2 x+1)\sin^2 x}{x}\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$$

$$= e^{\lim_{x\to 0}(2\cos^2 x+1)\frac{\sin x}{x}.\sin x\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$$

$= e^0 = 1$

6. If the focal chord $y = mx + c$ of parabola $y^2 = -64x$ is also the tangent to the circle $(x+10)^2 + y^2 = 4$ then absolute value of $4\sqrt{2}(m + c)$ is

Ans. 34

Sol. Focus of parabola is $(-16, 0)$

Now slope form of tangent to the circle

$(x+10)^2 + y^2 = 4$ is given by

$y = m(x+10) \pm 2\sqrt{1+m^2}$

So, $c = 10m \pm 2\sqrt{1+m^2}$ ..... (ii)

By (i) and (ii)

$16m = 10m \pm 2\sqrt{1+m^2}$

$\Rightarrow 9m^2 = 1+ m^2 \Rightarrow m = \pm\frac{1}{2\sqrt{2}}$

$\Rightarrow c = 16m = \pm\frac{8}{\sqrt{2}}$

$\therefore \quad 4\sqrt{2}(m+c) = \pm 34$

7. The mean of 6 numbers is 6.5 and its variance is 10.25 if 4 numbers are 2, 4, 5 and 7, then find the other two :

(1) 10, 11 (2) 11, 12 (3) 9, 12 (4) 9, 11

Sol. Let two number x and y according to question

$18 + x + y = 39$

$x + y = 21$ .....(1)

$10.25 = \frac{\sum x_i^2}{n} - (\bar{x})^2$

$10.25 = \frac{x^2+y^2+4+16+25+49}{6} - (6.5)^2$

$10.25 = \frac{x^2+y^2+94}{6} - (6.5)^2$

$\Rightarrow x^2 + y^2 = 221$ .....(2)

solving (1) and (2)

So, x = 10 or y = 11

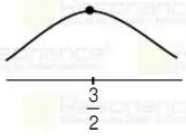
8. A continuous & differentiable function f(x) is increasing in $(\quad 3)$ and decreasing in $(3 \quad)$ then x = $\frac{3}{2}$ is :

(1) point of local maxima (2) point of local minima

(3) point of Inflection (4) None of these

Ans. (1)

Sol. Roughly graph of f(x) can be drawn as



Thus $x = \frac{3}{2}$ is a point of local maxima

9. If the roots of the quadratic equation $x^2 + 3^{\frac{1}{4}}x + 3^{\frac{1}{2}} = 0$ are α and β then the value of $\alpha^{96}(\alpha^{12}-1) + \beta^{96}(\beta^{12}-1)$

(1) 50.3^{24} (2) 51.3^{24} (3) 52.3^{24} (4) 104.3^{24}

Ans. (3)

Sol. $x^2 + \sqrt{3} = -3^{\frac{1}{4}}x$

$\Rightarrow x^2 + \sqrt{3}x^2 + 3 = 0$

$\Rightarrow x^{8} + 6x^{4} + 9 = 3x^{4}$

$\Rightarrow x^8 + 3x^4 + 9 = 0$

$\Rightarrow \alpha^8 = -9 - 3\alpha^4$

$\Rightarrow \alpha^{12} = -9\alpha^4 - 3\alpha^8 = -9\alpha^4 - 3(-9-3\alpha^4) = 27$

Similarly $\beta^{12} = 27$

$\Rightarrow \alpha^{96}(\alpha^{12}-1) + \beta^{96}(\beta^{12}-1) = (27)^8 .26 + (27)^8 .26 = 52.(27)^8 = 52.3^{24}$

10. In a ΔABC, If AB = 5, $\angle B = \cos^{-1}(3/5)$ and radius of circumcircle of triangle is 5 then the area of ΔABC is :

(1) $6+8\sqrt{3}$ (2) $3+4\sqrt{3}$ (3) $3+8\sqrt{3}$ (4) $6+4\sqrt{3}$

Ans. (1)

3 4

$\Rightarrow \frac{b}{2R} = \frac{4}{5} \Rightarrow b = 8,\ c = 5$

$\cos B = \frac{a^2 + c^2 - b^2}{2ac} = \frac{3}{5} \Rightarrow \frac{a^2 + 25 - 64}{2a(5)} = \frac{3}{5}$

$a^2 - 39 = 6a \Rightarrow a^2 - 6a - 39 = 0$

$\Rightarrow a = \frac{6 + 8\sqrt{3}}{2} \Rightarrow a = 3 + 4\sqrt{3}$

$\Delta = \frac{abc}{4R} = \frac{(3+4\sqrt{3})(8)(5)}{4(5)} = 6 + 8\sqrt{3}$

11. The number of integral terms is the expansion of $\left(4^{\frac{1}{4}} + 5^{\frac{1}{6}}\right)^{120}$ is :

(1)11 (2)21 (3)20 (4)30

Ans. (2)

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Sol. General term of $\left(2^{\frac{1}{2}} + 5^{\frac{1}{6}}\right)^{120}$ is

given by $T_{r+1} = {}^{120}C_r \left(2^{\frac{1}{2}}\right)^{\quad} \left(5^{\frac{1}{6}}\right)^{\quad}$

For integral term, r should be a multiple of 6

i.e $r \in \{0,6,12,18, \ldots\ldots, 120\}$

$\therefore$ 21 integral terms are there in the expansion $\left(2^{\frac{1}{2}} + 5^{\frac{1}{6}}\right)^{20}$

12. If the shortest distance between the lines $\vec{r}_1 = \alpha\hat{i} + 2\hat{j} + 2\hat{k} + \lambda(\hat{i} - 2\hat{j} + 2\hat{k}), \lambda \in R, \alpha > 0$ and $\vec{r}_2 = -4\hat{i} - \hat{k} + \mu(3\hat{i} - 2\hat{j} - 2\hat{k}), \mu \in R$ is 9, then the value of α is

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

Ans. **(3)**

Sol. Shortest distance $= \left|\frac{(a_2 - a_1).(b_1 \times b_2)}{|b_1 \times b_2|}\right|$

$\Rightarrow 9 = \left|\frac{((\alpha+4)\hat{i} + 2\hat{j} + 3\hat{k}).(8\hat{i} + 8\hat{j} + 4\hat{k})}{\sqrt{64+64+16}}\right|$

$$\Rightarrow \left|\begin{matrix} 8(\alpha+4)+16+12 \\ 12 \end{matrix}\right| = 9$$

$\therefore \alpha = 6$

13. If $\vec{a},\vec{b},\vec{c}$ are mutually $\perp$ unit vectors equally inclined to $\vec{a}+\vec{b}+\vec{c}$ at an angle θ, find $36\cos^2 2\theta$.

Ans. **4**

Sol. $\left|\vec{a}+\vec{b}+\vec{c}\right|^2 = \left(\vec{a}+\vec{b}+\vec{c}\right).\left(\vec{a}+\vec{b}+\vec{c}\right) = |\vec{a}|^2+|\vec{b}|^2+|\vec{c}|^2 = 3$

$\Rightarrow \left|\vec{a}+\vec{b}+\vec{c}\right| = \sqrt{3}$

Now $\vec{a}\left(\vec{a}+\vec{b}+\vec{c}\right) = |\vec{a}||\vec{a}+\vec{b}+\vec{c}|\cos\theta$

$\Rightarrow \cos 2\theta = -\frac{1}{3} \Rightarrow \cos^2 2\theta = \frac{1}{9} \Rightarrow 36\cos^2 2\theta = 4$

14. If z and ω are complex number such that $|z\omega| = 1$, $\arg(z) - \arg(\omega) = \frac{3\pi}{2}$. Find the $\arg\left(\frac{1-2\bar{z}\omega}{1+3\bar{z}\omega}\right)$.

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

Ans. **(4)**

Sol. Let $z = re^{i\theta}$ & $\omega = \frac{1}{r}e^{i\left(\theta-\frac{3\pi}{2}\right)}$

then $\frac{1-2\bar{z}\omega}{1+3\bar{z}\omega} = \frac{1-2re^{-i\theta}.\frac{1}{r}e^{i\left(\theta-\frac{3\pi}{2}\right)}}{1+3re^{-i\theta}.\frac{1}{r}e^{i\left(\theta-\frac{3\pi}{2}\right)}}$

$1-2e^{-i\frac{3\pi}{2}} \quad 1-2i$

$= -\frac{1}{2}-\frac{1}{2}i$

The $\arg\left(-\frac{1}{2}-\frac{1}{2}i\right) = -\frac{3\pi}{4}$

15. If $f(x) = \begin{cases} \sin x - e^x ; & x \le 0 \\ a+[-x] ; & 0 < x < 1 \\ 2x-b ; & x \ge 1 \end{cases}$ is continuous and differentiable function then find the value of a + b.

(where [•] is GIF)

Ans. **(03.00)**

Sol. Since f(x) is continuous at x = 0

So $\lim_{x\to 0^-} f(x) = \lim_{x\to 0^+} f(x) = f(0)$

$-1 = a - 1 = -1 \Rightarrow a = 0$

So $\lim_{x\to 1^-} f(x) = \lim_{x\to 1^+} f(x) = f(1)$

$a - 1 = 2 - b = 2 - b$

$\Rightarrow a = 0$, so $0 - 1 = 2 - b$

$\Rightarrow -3 = -b$

$\Rightarrow$ b = 3

So the value of a + b = 3

16. If $A = [a_{ij}]_{3\times3}$ where $a_{ij} = \begin{cases} 1 & i = j \\ -x & |i-j| = 1 \\ 2x+1 & \text{otherwise} \end{cases}$ and f(x) = det (A), then the sum of local maximum and local minimum value of f(x) is:

(1) $\frac{20}{27}$ (2) $\frac{-20}{27}$ (3) $\frac{88}{27}$ (4) $\frac{-88}{27}$

Ans. **(4)**

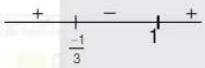
Sol. $|A| = \begin{vmatrix} 1 & -x & 2x+1 \\ -x & 1 & -x \end{vmatrix} = 1 + x^2(2x+1) + x^2(2x+1) - (2x+1)^2 - x^2 - x^2$

$\Rightarrow f(x) = 4x^3 - 4x^2 - 4x$

$\Rightarrow f'(x) = 12x^2 - 8x - 4$

$= 4(3x^2 - 2x - 1)$

$= 4(x-1)(3x+1)$



$\Rightarrow$ f(x) is maximum at $x = \frac{-1}{3}$ and minimum at x = 1

$\therefore$ maximum value = $\frac{20}{27}$ and minimum value = –4

$\therefore$ sum = $\frac{20}{27} - 4 = -\frac{88}{27}$

17. The coefficient of $a^3 b^4 c^5$ in $(ab + bc + ac)^6$ is:

(1) 60 (2) 45 (3)40 (4) 90

Sol. $(ab + bc + ac)^6 = \sum_{p+q+r=6} \frac{6!}{p!q!r!}(ab)^p (bc)^q (ca)^r$

$= \sum_{p+q+r=6} \frac{6!}{p!q!r!} a^{p+r} b^{p+q} c^{q+r}$

For $a^3b^4c^5$, we need

p + r = 3

p + q = 4

q + r = 5

Solving we get, p = 1, q=3, r=2

$\therefore$ coefficient of $a^3 b^4 c^5$ in $(ab + bc + ac)^6$ is $\frac{6!}{1!.2!.3!} = 60$

18. If an invertible function f(x) is defined as f(x) = 3x – 2 , g(x) is also an invertible function such that $f^{-1}(g^{-1}(x)) = x - 2$ then g(x) is

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

Ans. (2)

$3(x-2) - 2 = g^{-1}(x)$

$3x - 8 = g^{-1}(x)$

$g^{-1}(x) = 3x - 8$

or $x = 3g(x) - 8$

$g(x) = \frac{x+8}{3}$

19. $\int_{-1}^{1} \ell n\left(\sqrt{1-x} + \sqrt{1+x}\right) dx = ?$

(1) $\pi + \ell n2$ (2) $2\ell n2$ (3) $\frac{\pi}{2} - 1 + \ell n2$ (4) $\ell n2 - \frac{\pi}{2} - 1$

Ans. **(4)**

Sol. $f(x) = \ell n\left(\sqrt{1-x} + \sqrt{1+x}\right)$ $x \in [-1, 1]$ is an even function

$$= 2\int_{0}^{1} \ell n\left(\sqrt{1-x} + \sqrt{1+x}\right) dx$$

Put $x = \cos 2\theta \Rightarrow dx = -2\sin 2\theta\, d\theta$

$\therefore \cos 2\theta = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$

$$\Rightarrow I = -4\int_{\frac{\pi}{4}}^{0} \left[\ell n\left(\left(\sin\theta + \cos\theta\right)\sqrt{2}\right)\right] \sin 2\theta\, d\theta$$

$$= 4\int_{0}^{\frac{\pi}{4}} \left[\ell n\left(\left(\sin\theta + \cos\theta\right)\sqrt{2}\right)\right] \sin 2\theta\, d\theta$$

$$= 4\int_{0}^{\frac{\pi}{4}} \ell n\left(\sin\theta + \cos\theta\right) \sin 2\theta\, d\theta + 4\,\ell n\sqrt{2}\int_{0}^{\frac{\pi}{4}} \sin 2\theta\, d\theta$$

$$= 4\left[\left| -\ell n(\sin\theta + \cos\theta)\frac{\cos 2\theta}{2}\right|_{0}^{\frac{\pi}{4}} + \int_{0}^{\frac{\pi}{4}} -\frac{\cos\theta - \sin\theta}{\sin\theta + \cos\theta}\cdot\frac{\cos 2\theta}{2} d\theta\right] + 4\ell n\sqrt{2}\left(-\frac{\cos 2\theta}{2}\right)\Bigg|_{0}^{\frac{\pi}{4}}$$

$$\left[\quad 1\int_{0}^{\frac{\pi}{4}} \quad\right] \quad \sqrt{2}\left(\quad 1\right)$$

$$= -4\left[0 - \frac{1}{2}\int_{0}^{\frac{\pi}{4}} (1 - \sin 2\theta) d\theta\right] + 2\ell n\sqrt{2}$$

$$= -2\left[\theta + \frac{\cos 2\theta}{2}\right]_{0}^{\frac{\pi}{4}} + \ell n2$$

$$= -2\left[\frac{\pi}{4} - \frac{1}{2}\right] + \ell n2$$

$$= -\frac{\pi}{2} - 1 + \ell n2$$

20. The probability of selecting integers $a \in [-5,30]$, such that $x^2 + 2(a+4)x - 5a + 64 > 0$ for all $x \in R$ is :

(1) $\frac{7}{9}$ (2) $\frac{4}{9}$ (3) $\frac{5}{9}$ (4) $\frac{1}{3}$

Ans. (3)

Sol. $x^2 + 2(a+4)x - (5a - 64) > 0$

$D < 0$

$\therefore 4(a+4)^2 + 4(5a - 64) < 0$

$\Rightarrow a^2 + 13a - 48 < 0$

$a = \frac{-13 \pm \sqrt{169 + 192}}{2}$

So, $a \in [-16, 3]$

Total integers are 20 $\therefore$ Probability $= \frac{20}{36} = \frac{5}{9}$

21. If $\int_0^a e^{x-[x]}dx = 10e - 9$, then the value of 'a' is (where [•] is GIF)

(1) $9+\ell n2$ (2) $10+\ell n2$ (3) 10 (4) 9

Ans. (2)

Sol. Let $a = 10 + K$, $0 \le K < 1$

$\int_0^a e^{[x]}dx = 10e - 9$

$e^K - 1 = 1$

$K = \ell n2$

so, $a = 10 + \ell n2$

22. If $\vec{A}.\vec{B} = |\vec{A} \times \vec{B}|$, then $|\vec{A} - \vec{B}|$ is

(1) $\sqrt{A^2 + B^2 + \sqrt{2}AB}$ (2) $\sqrt{A^2 + B^2 - \sqrt{2}AB}$ (3) $\sqrt{A^2 + B^2 + \sqrt{2}AB}$ (4) $\sqrt{A^2 + B^2 - \sqrt{2}AB}$

Ans. (4)

Sol. $\vec{A}.\vec{B} = |\vec{A} \times \vec{B}| \Rightarrow \cos\theta = \sin\theta \Rightarrow \tan\theta = 1$

$\theta = \frac{\pi}{4}$

$|\vec{A} - \vec{B}|^2 = A^2 + B^2 - 2\vec{A}.\vec{B}$

$= A^2 + B^2 - 2AB\cos\left(\frac{\pi}{4}\right)$

$= A^2 + B^2 - \sqrt{2}AB$

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