

JEE-Main-20-07-2021-Shift-2 (Memory Based)

PHYSICS

Question: In a series LCR circuit, $R = 5\Omega$, $L = 0.5\text{ mH}$, $C = 2.5\mu\text{F}$. The RMS value of external voltage is 250 V. Find the power dissipated if circuit is in Resonance

Answer: 12500 W

Solution:

$$\text{Power} = V_{rms} I_{rms} \left(\frac{R}{Z} \right)$$

$Z = R$ (at resonance)

$$\begin{aligned}\text{Power} &= 250 \times \frac{250}{5} \times \frac{5}{5} \\ &= 12500 \text{ W}\end{aligned}$$

Question: The wavelength of sodium lamp is observed to be $2886\text{ \AA}$ from earth & original wavelength was $2880\text{ \AA}$. Find speed of galaxy.

Options:

- (a) $3 \times 10^5 \text{ ms}^{-1}$
- (b) $4 \times 10^5 \text{ ms}^{-1}$
- (c) $6.25 \times 10^5 \text{ ms}^{-1}$
- (d) None

Answer: (c)

Solution: $\Delta\lambda = 2886 - 2880 = 6\text{ \AA}$

Using doppler shift,

$$-\frac{\Delta\lambda}{\lambda} = -\frac{V_{\text{radial}}}{C}$$

$$\Rightarrow V_{\text{radial}} = C \left(\frac{\Delta\lambda}{\lambda} \right) = 3 \times 10^8 \times \left(\frac{6 \times 10^{-10}}{2880 \times 10^{-10}} \right)$$

$$= 6.25 \times 10^5 \text{ ms}^{-1}$$

Hence, speed of galaxy $= 6.25 \times 10^5 \text{ ms}^{-1}$.

Question: A body is under the influence of a force such that it delivers a constant power P. The variation of position with time of body as

Options:

(a) $t^{\frac{1}{2}}$

(b) $t^{\frac{3}{2}}$

(c) $t^{\frac{5}{2}}$

(d) None

Answer: (b)

Solution: Power = P

$$F v = P$$

$$m \left(\frac{dv}{dt} \right) \cdot v = P$$

$$\Rightarrow \int_0^v v dv = \int_0^t \frac{P}{m} \cdot dt$$

$$\Rightarrow v = \sqrt{\frac{2P}{m} t}$$

$$\Rightarrow \frac{dx}{dt} = \sqrt{\frac{2P}{m} t} \text{ [assuming at } t=0, x=0 \text{ \& } v=0]$$

$$\Rightarrow \int_0^x dx = \int_0^t \sqrt{\frac{2P}{m} t} \cdot dt$$

$$\Rightarrow t = x = \sqrt{\frac{2P}{m}} \frac{2}{3} t^{3/2}$$

$$\Rightarrow x \propto t^{3/2}$$

Question: When a metal is illuminated by light of wavelength λ , the stopping potential is V_0 and for wavelength 2λ , it is $3V_0$. Then the threshold wavelength is?

Options:

(a) $\frac{2\lambda}{3}$

(b) $\frac{4\lambda}{5}$

(c) $\frac{\lambda}{3}$

(d) $\frac{5\lambda}{2}$

Answer: (b)

Solution: $eV_0 = \frac{hc}{\lambda} - \phi \dots (1)$

$$3eV_0 = \frac{hc}{2\lambda} - \phi \dots (2)$$

Multiply by 3 in equation (1)

$$3eV = \frac{3hc}{\lambda} - 3\phi \dots (3)$$

Equation (3) – (2)

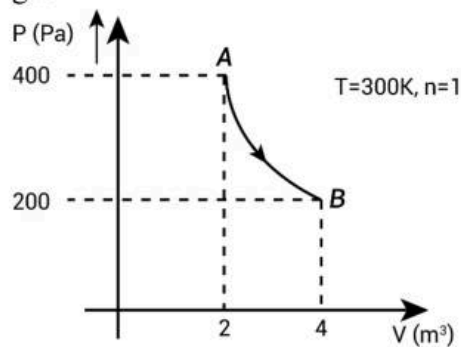
$$\frac{3hc}{\lambda} - \frac{hc}{2\lambda} - 2\phi = 0$$

$$\frac{5hc}{2\lambda} = 2\phi = \frac{2hc}{\lambda_0}$$

$$\frac{5}{4} \frac{hc}{\lambda} = \frac{hc}{\lambda_0}$$

$$\lambda_0 = \frac{4\lambda}{5}$$

Question: A gas is taken through an isothermal process as shown. Find the work done by the gas



Options:

- (a) 240 J
- (b) 360 J
- (c) 560 J
- (d) None

Answer: (c)

Solution: $\text{Work} = PV \ln \frac{v_2}{v_1}$

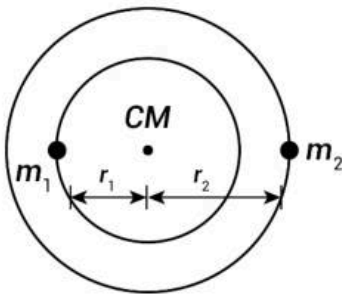
$$= 400 \times 2 \ln \frac{4}{2}$$

$$= 800 \ln 2$$

$$= 800 \times 0.7$$

$$= 560 \text{ J}$$

Question: Two stars of masses m_1 and m_2 form a binary system, revolving around each other in circular orbits of radii r_1 and r_2 respectively. Time period of revolution for this system is



Options:

(a) $2\pi \sqrt{\frac{(r_1 + r_2)^3}{G(m_1 + m_2)}}$

(b) $2\pi \sqrt{\frac{(r_1 + r_2)r_2^2}{G(m_1 + m_2)}}$

(c) $\frac{2\pi(r_1 + r_2)^{\frac{3}{2}}}{\sqrt{G(m_1 + m_2)}}$

(d) $\frac{2\pi(r_1 + r_2)^2 r_1}{G(m_1 + m_2)}$

Answer: (c)

Solution:

$$\frac{Gm_1m_2}{(r_1 + r_2)^2} = \frac{m_1v_1^2}{r_1}$$

$$v_1^2 = \frac{Gm_2r_1}{(r_1 + r_2)^2} \Rightarrow v_1 = \frac{\sqrt{Gm_2r_1}}{(r_1 + r_2)}$$

$$T = \frac{2\pi r_1}{v_1} = \frac{2\pi\sqrt{r_1}(r_1 + r_2)}{\sqrt{Gm_2}} \quad \dots(1)$$

By using COM concept.

$$r_1 = \frac{m_2(r_1 + r_2)}{m_1 + m_2}$$

Put this value of r_1 in eqⁿ (1)

We get

$$T = \frac{2\pi(r_1 + r_2)^{3/2}}{\sqrt{G(m_1 + m_2)}}$$

Question: Tension in a spring is T_1 when length of the spring is L_1 and tension is T_2 when its length is L_2 . The natural length of the spring is

Options:

(a) $\frac{T_2 L_2 + T_1 L_1}{T_2 + T_1}$

(b) $\frac{T_2 L_2 - T_1 L_1}{T_2 - T_1}$

(c) $\frac{T_2 L_1 + T_1 L_2}{T_2 + T_1}$

(d) $\frac{T_2 L_1 - T_1 L_2}{T_2 - T_1}$

Answer: (d)

Solution:

Let the natural length of wire be l_0 .

Using Hooke's law, $Y = \frac{Tl_0}{A\Delta l}$

Where, $\Delta l = l - l_0$

We get $l - l_0 = \frac{Tl_0}{AY}$

Case 1: Tension is T_1 and length of wire $l = l_1$

$$\therefore l_1 - l_0 = \frac{T_1 l_0}{AY} \quad \dots(1)$$

Case 2: Tension is T_2 and length of wire $l = l_2$

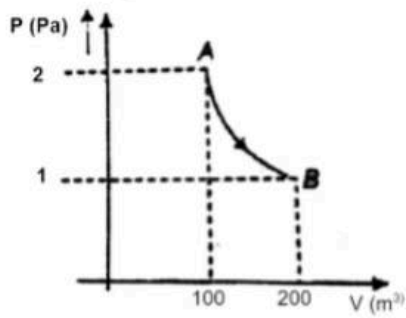
$$\therefore l_2 - l_0 = \frac{T_2 l_0}{AY} \quad \dots(2)$$

Dividing both equations

$$\frac{l_1 - l_0}{l_2 - l_0} = \frac{T_1}{T_2}$$

$$l_0 = \frac{l_1 T_2 - l_2 T_1}{T_2 - T_1}$$

Question: Find work done in the process $A \rightarrow B$ (isothermal) by gas?



Options:

- (a) $100 \ln 2$
- (b) $-100 \ln 2$
- (c) $200 \ln 2$
- (d) $-200 \ln 2$

Answer: (c)

Solution:

Work done by gas in isothermal process is $\Rightarrow W = nRT \ln \left(\frac{V_2}{V_1} \right)$

$$W = P_1 V_1 \ln \left(\frac{V_2}{V_1} \right)$$

$$W = 2 \times 100 \ln \left(\frac{200}{100} \right)$$

$$W_{\text{gas}} = 200 \ln 2$$

Question: A body rotating have an angular velocity of 300 rpm and its angular acceleration is $\frac{\pi}{20} (\text{rad} / \text{s}^2)$. Rotations done by this body in 10 sec is

Options:

- (a) $\frac{205}{4} (\text{rev})$
- (b) $\frac{307}{3} (\text{rev})$
- (c) $75 (\text{rev})$
- (d) $\frac{189}{2} (\text{rev})$

Answer: (a)

Solution:

$$\omega = 300 \text{ rpm} = 300 \times \frac{2\pi}{60} = 10\pi \text{ rad / sec}$$

$$\alpha = \frac{\pi}{20} \text{ rad / s}^2$$

$$\theta = \omega T + \frac{1}{2} \alpha T^2$$

$$\theta = 10\pi \times 10 + \frac{1}{2} \times \frac{\pi}{20} \times (10)^2 = 102.5 \pi \text{ rad}$$

$$\theta = \frac{102.5 \pi}{2\pi} \text{ rev} = \frac{205}{4} \text{ rev}$$

Question: A boy at the airport takes time t_1 to walk on escalator if the escalator is at rest and takes time t_2 if boy is at rest on moving escalator. Then find the time taken to walk on the escalator for same path?

Options:

(a) $|t_1 - t_2|$

(b) $\frac{t_1 + t_2}{2}$

(c) $\frac{2t_1 t_2}{t_1 + t_2}$

(d) $\frac{t_1 t_2}{t_1 + t_2}$

Answer: (d)

Solution:

Let distance to be traversed = x

$$\text{Speed of escalator} = \frac{x}{t_1}$$

$$\text{Speed of boy walking} = \frac{x}{t_2}$$

$$\text{When the boy is walking on a moving escalator, speed is } = x \left(\frac{1}{t_2} + \frac{1}{t_1} \right) = x \left(\frac{t_1 + t_2}{t_1 t_2} \right)$$

$$\text{Time taken is distance by speed} = \frac{x}{v} = \frac{t_1 t_2}{t_1 + t_2}$$

$$T = \frac{t_1 t_2}{t_1 + t_2}$$

Question: A particle is performing SHM along x-axis, such that its velocity is v_1 , when its displacement from mean position is x_1 and v_2 when its displacement from mean position is x_2 . Time period of oscillation is

Options:

$$(a) \frac{1}{2\pi} \sqrt{\frac{x_2 - x_1}{v_1 - v_2}}$$

$$(b) 2\pi \sqrt{\frac{(x_1^2 + x_2^2)}{(v_2^2 + v_1^2)}}$$

$$(c) 2\pi \sqrt{\frac{(x_2^2 - x_1^2)}{(v_1^2 - v_2^2)}}$$

$$(d) 2\pi \sqrt{\frac{(x_1 x_2 - x_1^2)}{(v_1 v_2 - v_1^2)}}$$

Answer: (c)

Solution:

$$v = \omega \sqrt{A^2 - x^2}$$

$$v_1 = \omega \sqrt{A^2 - x_1^2}$$

$$\Rightarrow v_1^2 = \omega^2 (A^2 - x_1^2) \quad \dots(i)$$

$$v_2 = \omega \sqrt{A^2 - x_2^2}$$

$$v_2^2 = \omega^2 (A^2 - x_2^2)$$

$$\Rightarrow \left(\frac{v_1^2}{\omega^2} + x_2^2 \right) = A^2 \quad \dots(ii)$$

From (i) and (ii)

$$v_1^2 = \omega^2 \left(\frac{v_2^2}{\omega^2} + x_2^2 - x_1^2 \right)$$

$$v_1^2 = v_2^2 + \omega^2 (x_2^2 - x_1^2)$$

$$\Rightarrow \omega^2 = \frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}$$

$$\Rightarrow \omega = \sqrt{\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}}$$

We know that

$$T = \frac{2\pi}{\omega}$$

$$\Rightarrow T = 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$$

Question: An electron ($9 \times 10^{-31} \text{ kg}$, $1.6 \times 10^{-19} \text{ C}$) is accelerated by a voltage of 40 kV. What is the wavelength?

$$h = 6.6 \times 10^{-34} \text{ SI units.}$$

Answer: 6.15×10^{-12}

Solution:

$$\lambda = \frac{h}{\sqrt{2m_e eV}}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9 \times 10^{-31} \times 1.6 \times 10^{-19} \times 40 \times 10^3}}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{1152 \times 10^{-47}}}$$

$$\lambda = 0.615 \times 10^{-34+23}$$

$$\lambda = 6.15 \times 10^{-12} \text{ m}$$

Question: For a medium, the magnetic susceptibility is 499. The permeability of free space is $4\pi \times 10^{-7}$ SI units. Then the permeability of the medium is?

Options:

(a) $2\pi \times 10^{-4}$ SI units

(b) $2\pi \times 10^{-7}$ SI units

(c) $\frac{5\pi}{4} \times 10^{-7}$ SI units

(d) $\frac{4\pi}{5} \times 10^{-4}$ SI units

Answer: (a)

Solution:

$$\chi_M = \mu_r - 1$$

$$\mu_r = 499 + 1 = 500$$

We know that

$$\mu = \mu_r \mu_0$$

$$\mu = 500 \times 4\pi \times 10^{-7}$$

$$\mu = 2\pi \times 10^{-4} \text{ SI units}$$

Question: A particle has 4 times its initial kinetic energy. Find the percentage change in momentum?

Options:

(a) 100%

(b) 200%

(c) 300%

(d) 400%

Answer: (a)

Solution:

Initial K.E. = k

Final K.E. = $4k$

$$k = \frac{P^2}{2m}$$

$$\Rightarrow P = \sqrt{2mk}$$

$$\Delta P = \sqrt{2m(4k)} - \sqrt{2mk}$$

$$= 2\sqrt{2mk} - \sqrt{2mk}$$

$$= \sqrt{2mk}$$

$$\% \text{ change} = \frac{\Delta P}{P} \times 100 = \frac{\sqrt{2mk}}{\sqrt{2mk}} \times 100 = 100\%$$

Question: Electrons with de-Broglie wavelength λ , fall on a target in an x-ray tube. The cut-off wavelength of emitted x-ray is

Options:

(a) $\frac{2mc\lambda^2}{h}$

(b) $\frac{2h}{mc}$

(c) $\frac{h}{mc}$

(d) None

Answer: (a)

Solution: de-Broglie wavelength = λ

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

$$\Rightarrow \frac{1}{2}mv^2 = \left(\frac{h}{\lambda}\right)^2 \times \frac{1}{2m}$$

Energy of corresponding to cut-off wavelength is equal to

$$\frac{hc}{\lambda_0} = \frac{1}{2}mv^2 = \frac{h^2}{\lambda^2} \times \frac{1}{2m}$$

$$\Rightarrow \lambda_0 = \frac{\lambda^2 (2m)c}{h}$$

$$\text{Hence, cut-off wavelength} = \frac{2mc\lambda^2}{h}$$

Question: An element has $\frac{1}{16}$ th of initial activity in 20 sec. Half life of the nuclei is

Options:

- (a) 5 sec
- (b) $\frac{4}{3}$ sec
- (c) 2.5 sec
- (d) 7.5 sec

Answer: (a)

Solution:

$$N = N_0 e^{-\lambda t}$$

$$\Rightarrow \frac{N_0}{16} = N_0 e^{-\lambda t}$$

$$\Rightarrow 2^{-4} = e^{-\lambda t}$$

$$\Rightarrow -4 \ln 2 = -\lambda t$$

$$\Rightarrow -4 \frac{\ln 2}{\lambda} = -t$$

$$\Rightarrow t = 4 \left(\frac{\ln 2}{\lambda} \right) = 4 \times t_{1/2}$$

$$\Rightarrow t_{1/2} = 5 \text{ sec.}$$

Question: A solid cylinder and ring are released from rest in top of inclined plane. Find ratio of their velocities when they reach bottom, assuming pure rolling

Options:

- (a) $\sqrt{\frac{3}{5}}$
- (b) $\sqrt{\frac{5}{3}}$
- (c) $\sqrt{\frac{7}{5}}$
- (d) $\sqrt{\frac{4}{3}}$

Answer: (d)

Solution: Loss in PE in gain in K.E

$$\Rightarrow mgh = \frac{1}{2} mv^2 + \frac{1}{2} I \frac{v^2}{R^2}$$

$$\Rightarrow v = \sqrt{\frac{2mgh}{m + \frac{I}{R^2}}}$$

$$\Rightarrow v_{cylinder} = \sqrt{\frac{2mgh}{m + \frac{mR^2}{2R^2}}} = \sqrt{\frac{4gh}{3}} \text{ and } v_{ring} = \sqrt{\frac{2mgh}{m + \frac{mR^2}{R^2}}} = \sqrt{gh}$$

$$\Rightarrow \frac{v_{cylinder}}{v_{ring}} = \sqrt{\frac{4}{3}}$$

Question: The angle of Dip in a plane at an angle of 30° with Geographical meridian is 45° . The value of true Dip is

Options:

(a) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

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

(c) 30°

(d) 60°

Answer: (a)

Solution:

Angle of dip

$$\tan \theta = \frac{V}{H} \quad \dots(1)$$

For 30° to meridian

$$\tan 45^\circ = \frac{V}{H \cos 30^\circ} \Rightarrow \frac{V}{H} = \cos 30^\circ \quad \dots(2)$$

$$\tan \theta = \cos 30^\circ \quad (\text{By comparing})$$

$$\tan \theta = \frac{\sqrt{3}}{2}$$

$$\theta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$$

JEE-Main-20-07-2021-Shift-2 (Memory Based)

CHEMISTRY

Question: Which gas retard the rate of photosynthesis?

Options:

- (a) CO
- (b) NO₂
- (c) CO₂
- (d) CFC

Answer: (b)

Solution: Higher concentration of NO₂ damage the leaves of plants and retard the rate of photosynthesis

Question: Sodium will not react normally with

Options:

- (a) Ammonia gas
- (b) Ethyne
- (c) But-2-yne
- (d) All of these

Answer: (c)

Solution: Sodium will not react with But-2-yne

Question: The hybridisation of NO₂⁻, NO₂⁺ and NH₄⁺ are respectively

Options:

- (a) sp², sp, sp³
- (b) sp, sp, sp³
- (c) sp², sp, sp
- (d) sp², sp², sp³

Answer: (a)

Solution:

Hybridisation of N in NO₂⁻ = sp²

Hybridisation of N in NO₂⁺ = sp

Hybridisation of N in NH₄⁺ = sp³

Question: What is added with HNO₃ in carius method?

Options:

- (a) Silver nitrate
- (b) Copper nitrate
- (c) Copper sulphate
- (d) None of these

Answer: (a)

Solution: In the Carius method, a known mass of the compound is heated with concentration nitric acid in the presence of silver nitrate in a hard glass tube. The hard glass is known as Carius tube.

Question: $4s^2 4p^1$: Diagonally next period in p-block. Identify element

Options:

- (a) Al
- (b) Sb
- (c) Cd
- (d) Sn

Answer: (d)

Solution: Ga has electronic configuration $4s^2 4p^1$

Sn is present diagonally to Ga in the next period in p-block.

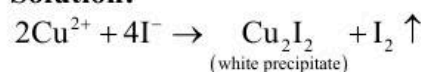
Question: Cu^{2+} salts reacts with KI and forms:

Options:

- (a) Cu_2I_2
- (b) CuI
- (c) CuI_2
- (d) None of these

Answer: (a)

Solution:



Question: In nitration, HNO_3 and H_2SO_4 act as:

Options:

- (a) Both acid
- (b) Both base
- (c) HNO_3 : Acid & H_2SO_4 : Base
- (d) HNO_3 : Base & H_2SO_4 : Acid

Answer: (d)

Solution: Nitration is an electrophilic substitution reaction, in its first step HNO_3 takes a proton from sulphuric acid and then forms $-\text{NO}_2^+$.

So, in the nitrating mixture HNO_3 acts as a base, and H_2SO_4 acts as an acid.

Question: The common monomer present in novolac and bakelite is:

Options:

- (a) Acetaldehyde
- (b) Methanal
- (c) Phenol
- (d) Ethylene glycol

Answer: (b)

Solution: Formaldehyde (Methanal) is the common monomer that is present in both novolac and bakelite.

Question: Rate of hydrolysis : Ester, Acid chloride, Acid anhydride

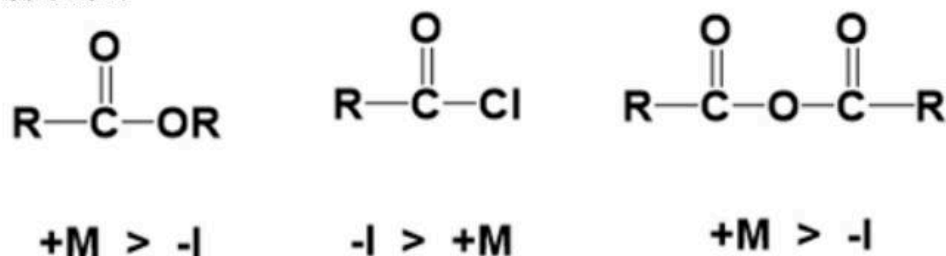
Options:

- (a) Acid chloride > Acid anhydride > Ester

- (b) Ester > Acid chloride > Acid anhydride
 (c) Acid anhydride > Ester > Acid chloride
 (d) Acid chloride < Acid anhydride < Ester

Answer: (a)

Solution:



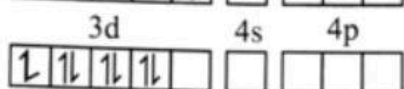
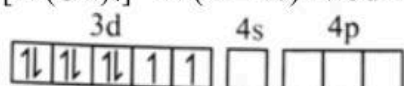
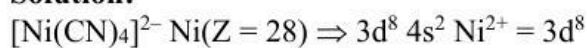
Question: What is the difference in the number of unpaired electrons in $[\text{NiCl}_4]^{2-}$ and $[\text{Ni}(\text{CN})_4]^{2-}$

Options:

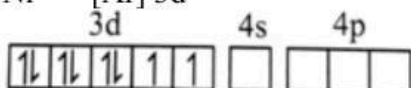
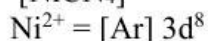
- (a) 4
 (b) 1
 (c) 0
 (d) 2

Answer: (d)

Solution:



Unpaired electrons = 0



Unpaired electrons = 2

Difference between unpaired electrons = 2

Question: Radioactive substance becomes 1/16th of original in 80 minutes, Find the half-life

Options:

- (a) 20 min
 (b) 40 min
 (c) 60 min
 (d) 80 min

Answer: (a)

Solution:

$$k = \frac{1}{t} \times 2.303 \log \frac{1}{1/16}$$

$$k = \frac{1}{80} \times 2.303 \log 16$$

$$k = \frac{1}{80} \times 2.303 \times 4 \log 2 = 0.035 \text{ min}^{-1}$$

$$t_{1/2} = \frac{0.693}{0.035 \text{ min}^{-1}} = 20 \text{ min}$$

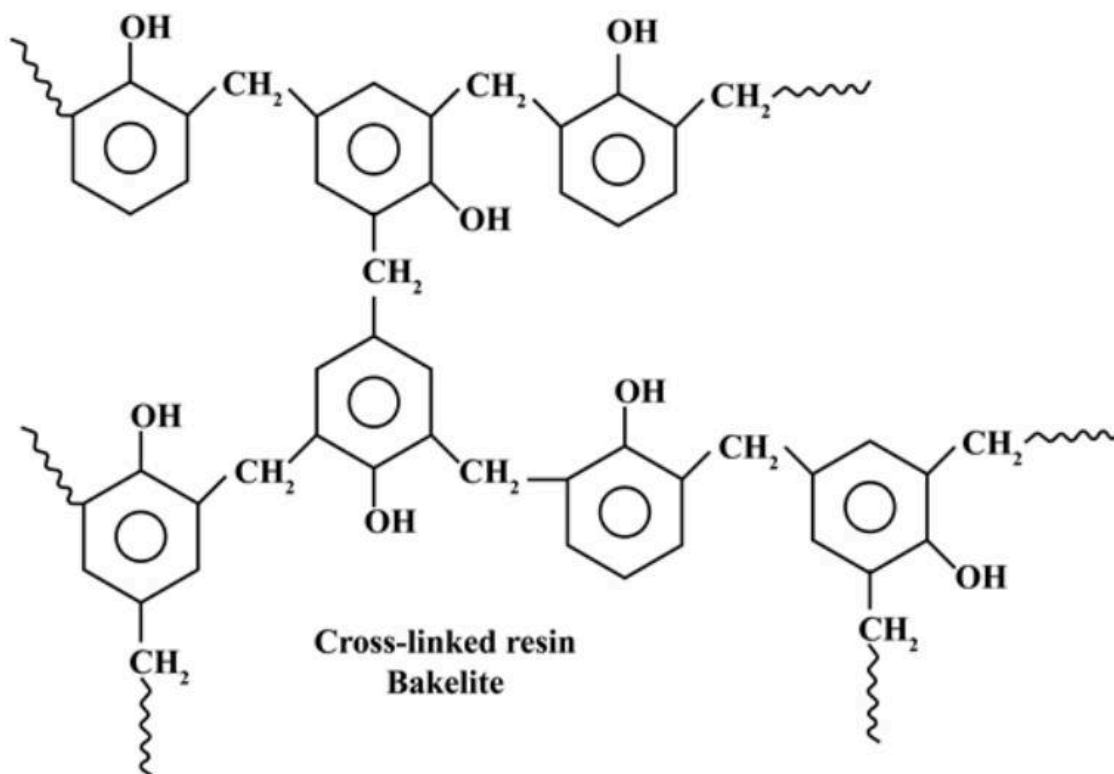
Question: Bakelite is formed by cross linking of which of the following?

Options:

- (a) Novolac
- (b) Buna-s
- (c) Dacron
- (d) PHBV

Answer: (a)

Solution:



(Formed by Novolac)

Question: In FCC, 50 % tetrahedral void is filled. Find the effective number of atoms in the cell if made using the same atoms?

Options:

- (a) 2
- (b) 4
- (c) 6
- (d) 8

Answer: (d)

Solution:

Number of atoms in FCC unit cell = 4

Total number of tetrahedral voids = 2 x 4 = 8

Given that 50% tetrahedral voids are occupied by atoms, i.e.,
Number of atoms present in tetrahedral voids = 50% of 8 = 4
Therefore, the effective number of atoms in the cell = 4 + 4 = 8

Question: Which of the following do not have magnetic moment of 1.73 B.M?

Options:

- (a) O_2^+
- (b) O_2^-
- (c) $[Cu(NH_3)_4]Cl_2$
- (d) CuI

Answer: (d)

Solution:

CuI : $Cu^+ : [Ar]3d^{10}$

No unpaired electrons

Question: If equimolar mixture of NaOH and Na_2CO_3 weight 4g then weight of NaOH is:

Options:

- (a) 1.595
- (b) 1.095
- (c) 2.904
- (d) 2.945

Answer: (b)

Solution:

Given equimolar mixture of NaOH and Na_2CO_3

Mass of mixture = 4g

Let mass of NaOH = w

$$\Rightarrow \frac{w}{40} = \frac{4-w}{106}$$

$$\Rightarrow w = \frac{160}{146} = 1.0958g$$

Question: $PCl_5 \rightarrow PCl_3 + Cl_2$

The above first order reaction has initial moles as 10 and after 20 min final moles are 2. Find the rate constant. (Given: $\log 5 = 0.693$)

Options:

- (a) 0.08 min^{-1}
- (b) 0.16 min^{-1}
- (c) 0.24 min^{-1}
- (d) 0.02 min^{-1}

Answer: (a)

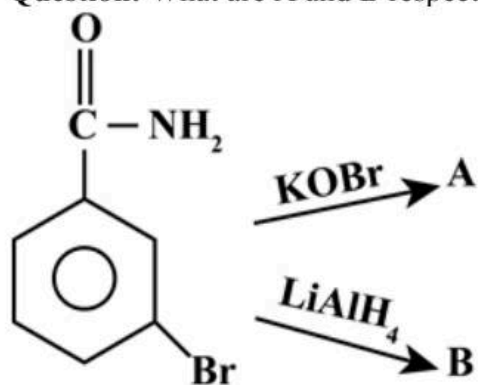
Solution:

$$K = \frac{1}{t} \times 2.303 \log \frac{[A_o]}{[A_t]}$$

$$K = \frac{1}{20} \times 2.303 \log \frac{10}{2}$$

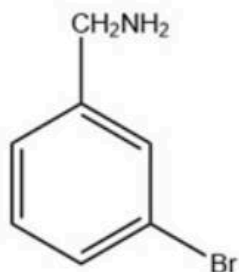
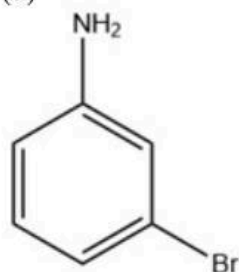
$$K = \frac{1}{20} \times 2.303 \log 5 = 0.08 \text{ min}^{-1}$$

Question: What are A and B respectively in the following reactions?

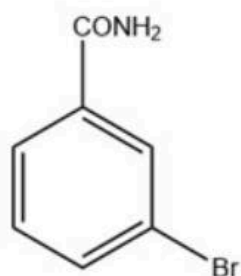
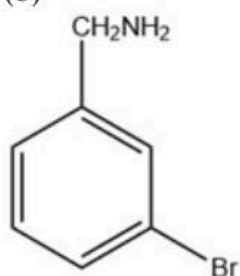


Options:

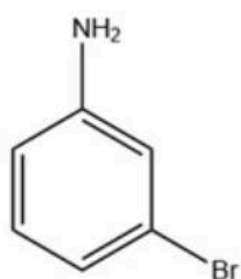
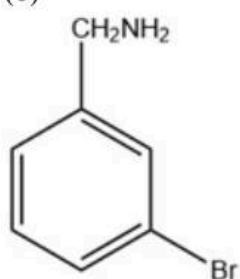
(a)



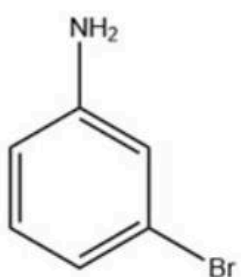
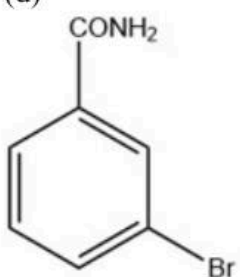
(b)



(c)

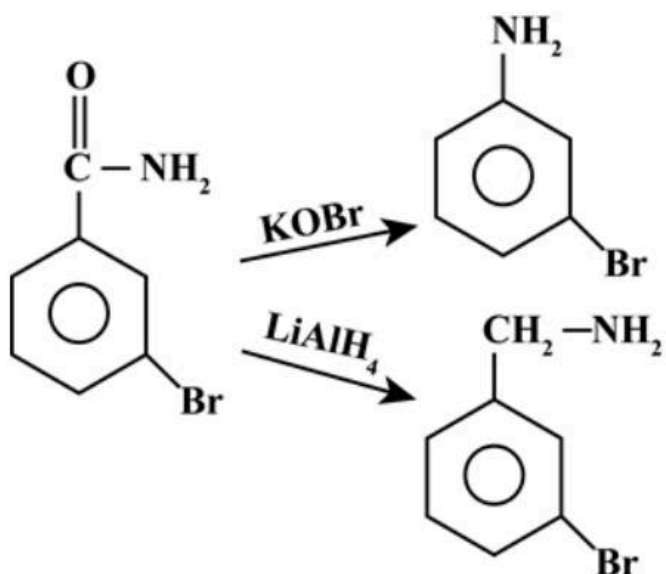


(d)



Answer: (a)

Solution:



Question: Spin only magnetic moment of Fe^{2+} with weak field ligand is

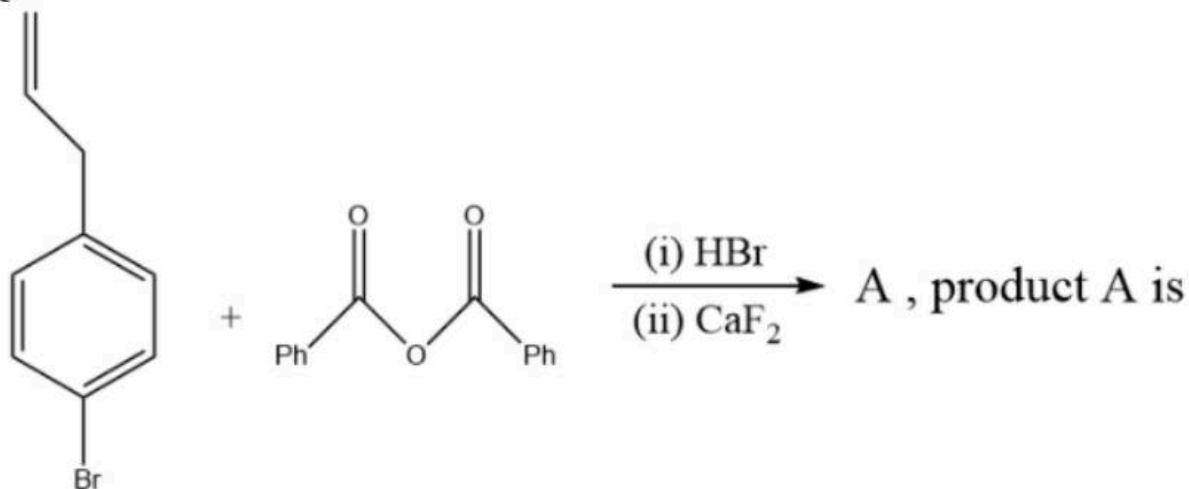
Options:

- (a) 4.90
- (b) 1.73
- (c) 2.80
- (d) 0

Answer: (a)

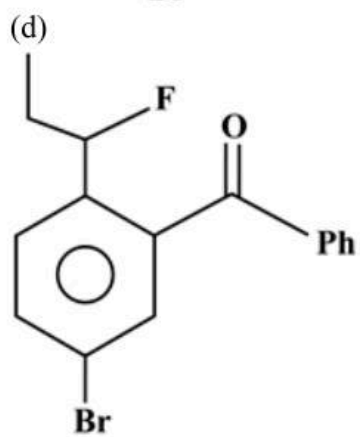
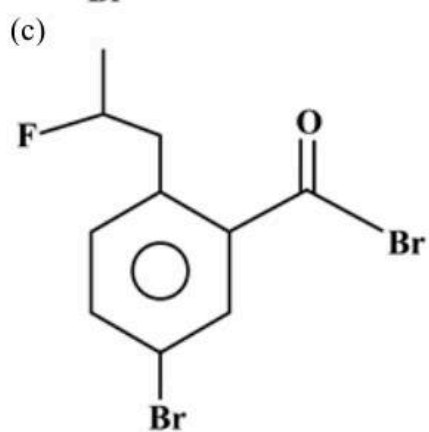
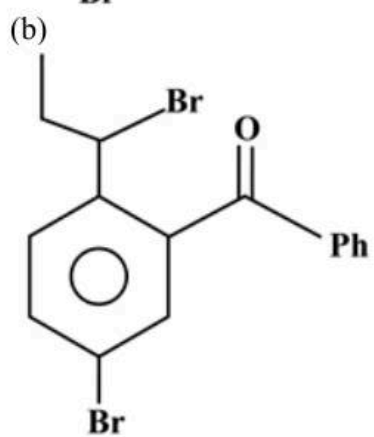
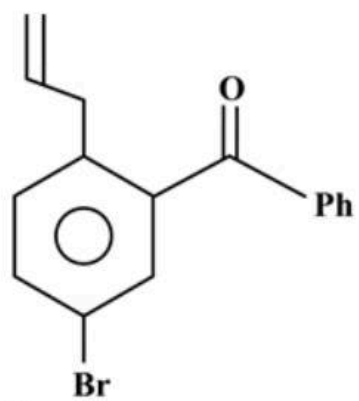
Solution: Fe^{2+} (with weak field ligand) has 4 unpaired electrons ($t_{2g}^4 e_g^2$), therefore spin only magnetic moment is 4.90 BM

Question:



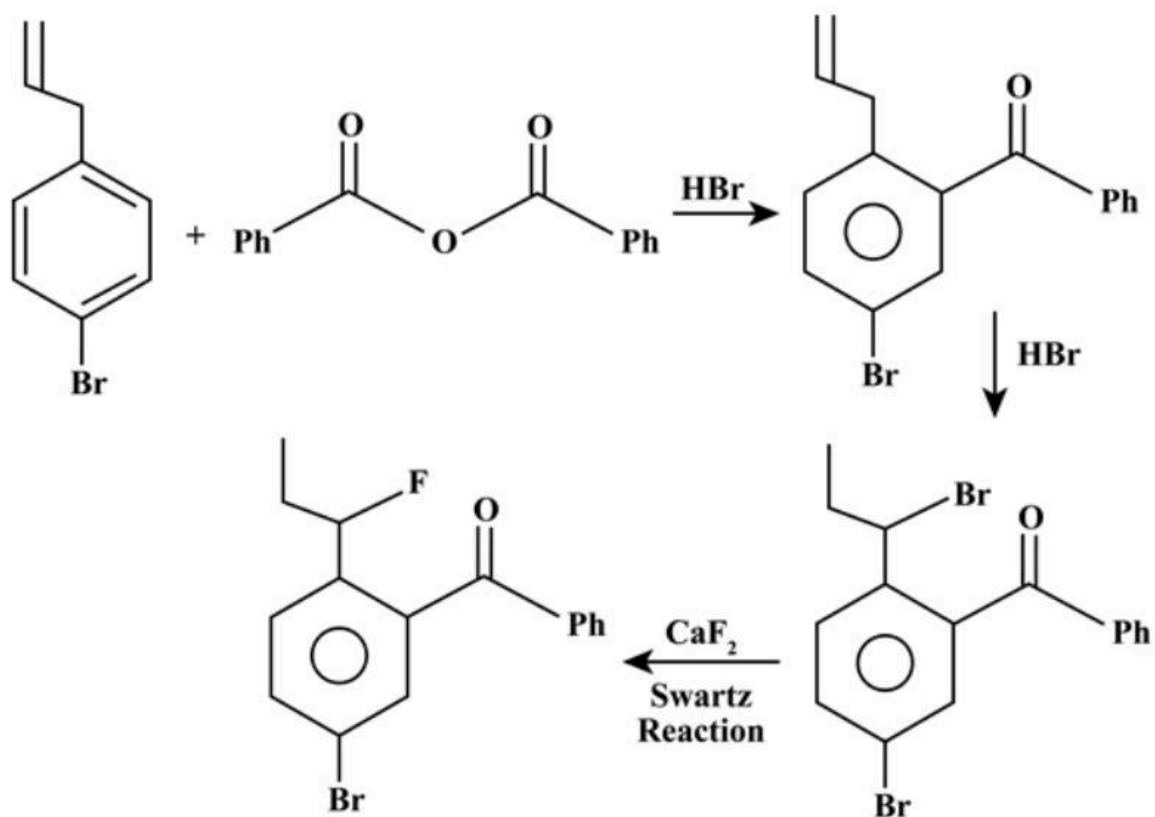
Options:

- (a)

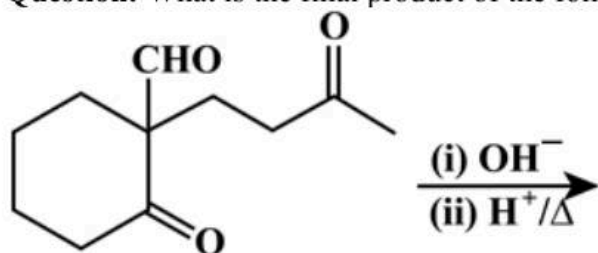


Answer: (d)

Solution:

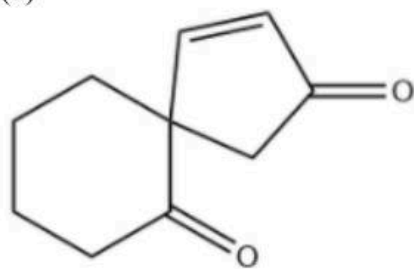


Question: What is the final product of the following reaction?

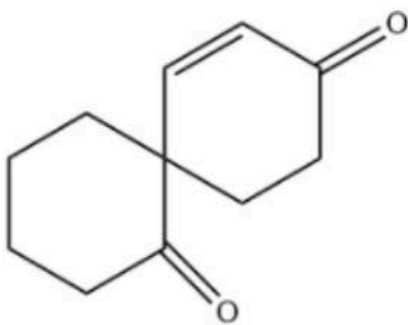


Options:

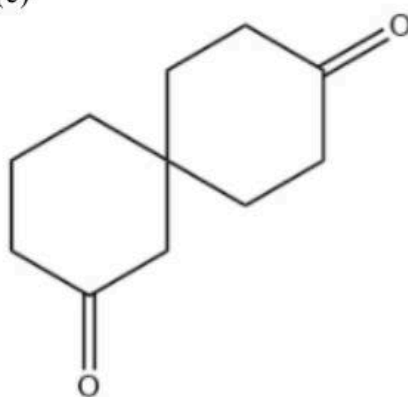
(a)



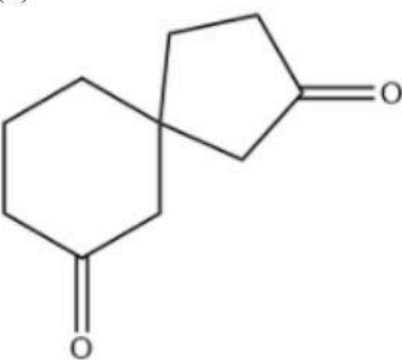
(b)



(c)

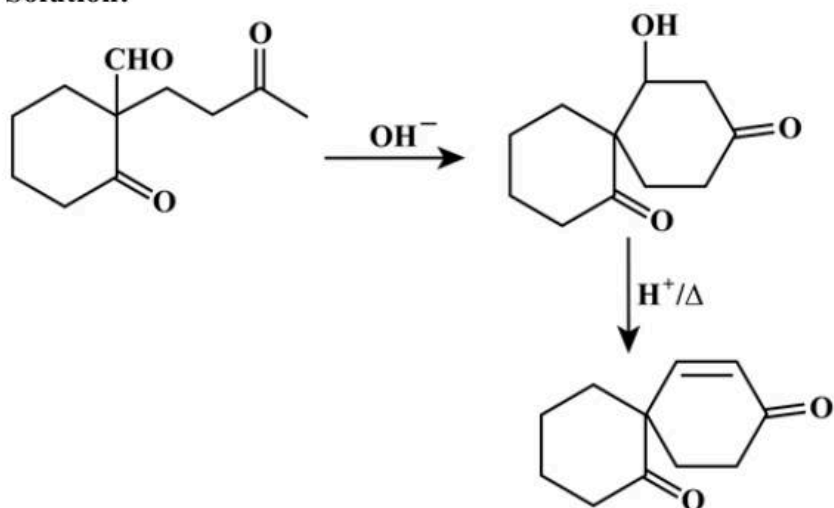


(d)



Answer: (b)

Solution:



JEE-Main-20-07-2021-Shift-2 (Memory Based)

MATHEMATICS

Question: Probability of only one of A and B is $1 - k$

Probability of only one of A and C is $1 - 2k$

Probability of only one of B and C is $1 - k$

$$P(A \cap B \cap C) = k^2, k \in (0, 1).$$

Find $P(A \cup B \cup C)$ is

Options:

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

(b) $\left[\frac{1}{8}, \frac{1}{4} \right]$

(c) $< \frac{1}{4}$

(d)

Answer: (a)

Solution:

$$P(A) + P(B) - 2P(A \cap B) = 1 - k \quad \dots(1)$$

$$P(A) + P(C) - 2P(A \cap C) = 1 - 2k \quad \dots(2)$$

$$P(B) + P(C) - 2P(B \cap C) = 1 - k \quad \dots(3)$$

$$P(A \cap B \cap C) = k^2$$

$$P(A \cap B \cap C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) + P(C \cap A) + P(A \cap B \cap C)$$

Add (1), (2) & 3

$$2(P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(C \cap A))$$

$$= 3 - 4k$$

$$P(A \cup B \cup C) = \frac{3 - 4k}{2} + k^2$$

$$= k^2 - 2k + \frac{3}{2}$$

$$= (k - 1)^2 + \frac{1}{2} > \frac{1}{2}$$

Question: If $a, b, 7, 10, 11, 15$, Mean = 10 and Variance = $\frac{20}{3}$. Find a and b .

Options:

- (a)
- (b)
- (c)
- (d)

Answer: 8, 9

Solution:

$$\frac{a+b+43}{6} = 10 \Rightarrow a+b = 17$$

$$\frac{a^2+b^2+495}{6} - 100 = \frac{20}{3} \Rightarrow a^2+b^2 = 145$$

$$\Rightarrow (a,b) = (9,8) \text{ or } (8,9)$$

Question: $g(t) = \begin{cases} \max(t^3 + 6t^2 + 9t - 3, 0); & t \in [0, 3] \\ 4 - t; & t \in (3, 4) \end{cases}$ Find points of non-differentiability.

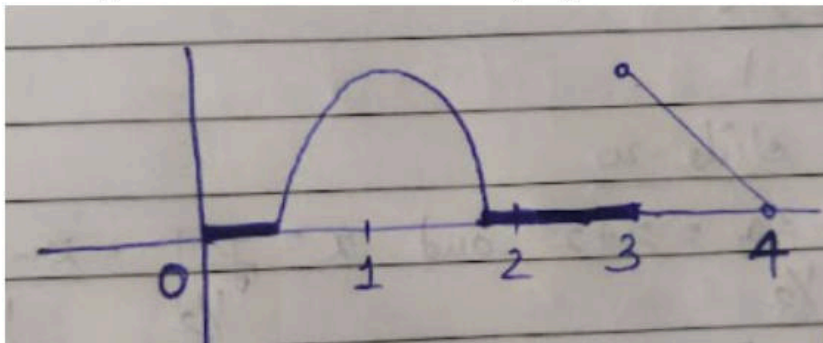
Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$g(t) = \begin{cases} \max(t^3 + 6t^2 + 9t - 3, 0); & t \in [0, 3] \\ 4 - t; & t \in (3, 4) \end{cases}$$



$\therefore$ Point of non-differentiability is 3

Question: If $\triangle ABC$ is right angled triangle with sides a, b and c and smallest angle θ . If

$\frac{1}{a}, \frac{1}{b}$ and $\frac{1}{c}$ are also the sides of right angled triangle, then find $\sin \theta$

Options:

- (a)
- (b)

(c)

(d)

Answer: ()

Solution:

Let a be smallest side & c be largest side

$$\therefore c^2 = a^2 + b^2 \text{ and } \frac{a}{\sin \theta} = c \dots (1)$$

$$\text{Also, } \frac{1}{a^2} = \frac{1}{b^2} + \frac{1}{c^2} \Rightarrow b^2 = \frac{a^2 c^2}{c^2 - a^2} = c^2 - a^2$$

$$\Rightarrow a^2 c^2 = (c^2 - a^2)^2 = a^4 + c^4 - 2a^2 c^2$$

$$\Rightarrow a^4 + c^4 - 3a^2 c^2 = 0$$

$$\Rightarrow \left(\frac{a}{c}\right)^4 - 3\left(\frac{a}{c}\right)^2 + 1 = 0$$

$$\Rightarrow \left(\left(\frac{a}{c}\right)^2 - 1\right)^2 = \left(\frac{a}{c}\right)^2$$

$$\Rightarrow \left(\frac{a}{c}\right)^2 - \left(\frac{a}{c}\right) - 1 = 0$$

$$\Rightarrow \frac{a}{c} = \frac{1 + \sqrt{5}}{2} = \sin \theta$$

Question: If $\log_x {}_9\left(\frac{1}{2}\right) + \log_x {}_9\left(\frac{1}{3}\right) + \dots$ upto 21 terms = 504. Find x .

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$$\log_x (2 + 3 + \dots 22) = 504$$

$$\log_x \left(\frac{21}{2}(4 + 20)\right) = 504$$

$$\log_x (21 \times 12) = 504$$

$$\log_x x = \frac{504}{21 \times 12} = 2$$

$$x = 9^2 = 81$$

Question: $\lim_{x \rightarrow 0} \frac{\alpha e^x + \beta \ln(1+x) + \gamma e^{-x}}{x \sin^2 x} = 10, \alpha + \beta + \gamma = ?$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$\lim_{x \rightarrow 0} \frac{\alpha e^x + \beta \ln(1+x) + \gamma e^{-x}}{x^2} = 10 \Rightarrow \alpha + \gamma = 0 \quad \dots(1)$$

$$\lim_{x \rightarrow 0} \frac{\alpha e^x + \frac{\beta}{1+x} - \gamma e^{-x}}{2x} = 10 \Rightarrow \alpha - \beta - \gamma = 0 \quad \dots(2)$$

$$\lim_{x \rightarrow 0} \frac{\alpha e^x - \frac{\beta}{(1+x)^2} + \gamma e^{-x}}{2} = 10 \Rightarrow \alpha - \beta + \gamma = 20 \quad \dots(3)$$

$$\therefore \beta = -20, \alpha = 10, \gamma = -10$$

$$\therefore \alpha + \beta + \gamma = -20$$

Question: $\operatorname{Re} \left[(1 + \cos \theta + 2 \sin \theta)^{-1} \right] = \frac{1}{5}$. Find θ .

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$\operatorname{Re}(1 + \cos \theta + 2 \sin \theta)^{-1} = \frac{1}{5}$$

$$\left(\frac{1}{1 + \cos \theta + 2 \sin \theta} \right) \frac{(1 + \cos \theta - 2i \sin \theta)}{(1 + \cos \theta - 2i \sin \theta)}$$

$$\operatorname{Real part} = \frac{1 + \cos \theta}{(1 + \cos \theta)^2 + 4 \sin^2 \theta} = \frac{1}{5}$$

$$\Rightarrow 5(1 + \cos \theta) = \left[(1 + \cos^2 \theta + 2 \cos \theta) + 4(1 - \cos^2 \theta) \right]$$

$$\Rightarrow 5 + 5 \cos \theta = 5 - 3 \cos^2 \theta + 2 \cos \theta$$

$$\Rightarrow 3 \cos^2 \theta + 3 \cos \theta = 0$$

$$\Rightarrow \cos \theta (\cos \theta + 1) = 0$$

$$\cos \theta = 0 \text{ or } -1$$

$$\theta = (2n+1)\frac{\pi}{2} \text{ or } (2n+1)\pi$$

Question: In a ΔABC , we have $AB = 3$, $AC = 7$, $BC = 5$ then find projection of $\overline{AC}$ on $\overline{BC}$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$\cos c = \frac{7^2 + 5^2 - 3^2}{2 \cdot 7 \cdot 5} = \frac{49 + 25 - 9}{70}$$

$$= \frac{65}{70} = \frac{13}{14}$$

$$\text{Projection} = AC \cos \theta = \frac{7 \times 13}{14} = \frac{13}{2}$$

Question: If $\tan \left(2 \tan^{-1} \left(\frac{3}{5} \right) + \sin^{-1} \left(\frac{5}{13} \right) \right) = ?$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$\tan \left[2 \tan^{-1} \left(\frac{3}{5} \right) + \sin^{-1} \left(\frac{5}{13} \right) \right]$$

$$= \tan \left[\tan^{-1} \left(\frac{\frac{6}{5}}{1 - \frac{9}{25}} \right) + \tan^{-1} \left(\frac{5}{12} \right) \right]$$

$$= \tan \left[\tan^{-1} \left(\frac{15}{8} \right) + \tan^{-1} \left(\frac{5}{12} \right) \right] = \frac{\frac{15}{8} + \frac{5}{12}}{1 - \left(\frac{15}{8} \right) \left(\frac{5}{12} \right)}$$

$$= \frac{180 + 40}{96 - 75} = \frac{220}{21}$$

Question: If $y = \frac{5x+3}{6x+a}$ and $f(f(x)) = x$ then find a .

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$f(f(x)) = \frac{5 \left(\frac{5x+3}{6x+a} \right) + 3}{6 \left(\frac{5x+3}{6x+a} \right) + a} = \frac{25x+15+18x+3a}{30x+18+6ax+a^2}$$

$$= \frac{33x+15+3a}{x(30+6a)+18+a^2}$$

For $a = -5$ above expression is x

Question: The lines $x = ay - 3 = z + 2$ and $x = 2y - 2 = bz - 2$ are coplanar, find a and b ?

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$x = \frac{y - \frac{3}{a}}{\frac{1}{a}} = z + 2 \text{ and } x = \frac{y - 1}{\frac{1}{2}} = \frac{z - \frac{2}{b}}{\frac{1}{b}}$$

$$\therefore \begin{vmatrix} 0 & 1-\frac{3}{a} & \frac{2}{b}+2 \\ 1 & \frac{1}{a} & 1 \\ 1 & \frac{1}{2} & \frac{1}{b} \end{vmatrix} = 0$$

$$\Rightarrow \left[\left(1-\frac{3}{a} \right) - \frac{1}{a} \left(\frac{2}{b}+2 \right) \right] = \left[\frac{1}{b} \left(1-\frac{3}{a} \right) - \frac{1}{2} \left(\frac{2}{b}+2 \right) \right]$$

$$\Rightarrow 1 - \frac{3}{a} - \frac{2}{ab} - \frac{2}{a} = \frac{1}{b} - \frac{3}{ab} - \frac{1}{b} - 1$$

$$\Rightarrow 2 - \frac{5}{a} + \frac{1}{ab} = 0$$

$$\Rightarrow 2ab - 5b + 1 = 0$$

Question: (α, β) is the point on $y^2 = 6x$, that is closest to $\left(3, \frac{3}{2}\right)$ find $2(\alpha, \beta)$

Answer: 9

Solution:

$$\beta^2 = 6\alpha \quad \dots(1)$$

$$\left(\frac{\frac{3}{2} - \beta}{3 - \alpha} \right) \times \left(\frac{3}{\beta} \right) = -1 \Rightarrow 2\alpha\beta = 9 \quad \dots(2)$$

From (1) and (2),

$$\beta^2 = \frac{27}{\beta}$$

$$\Rightarrow \beta = 3, \alpha = \frac{3}{2}$$

$$\therefore 2(\alpha + \beta) = 9$$

Question: $f(x) = x + 1$. Find $\lim_{x \rightarrow \infty} \frac{1}{n} \left(1 + f\left(\frac{5}{n}\right) + f\left(\frac{10}{n}\right) + \dots + f\left(\frac{5(n-1)}{n}\right) \right)$

Answer: $\frac{7}{2}$

Solution:

$$f(x) = x + 1$$

$$\begin{aligned}
&\therefore \lim_{n \rightarrow \infty} \frac{1}{n} \left[1 + f\left(\frac{5}{n}\right) + f\left(\frac{10}{n}\right) + \dots + f\left(\frac{5(n-1)}{n}\right) \right] \\
&= \lim_{n \rightarrow \infty} \frac{1}{n} \left[1 + 1 + \frac{5}{n} + 1 + \frac{10}{n} + \dots + 1 + \frac{5(n-1)}{n} \right] \\
&= \lim_{n \rightarrow \infty} 1 + \frac{5}{n^2} \{1 + 2 + \dots + (n-1)\} \\
&= \lim_{n \rightarrow \infty} 1 + \frac{5}{2} = \frac{7}{2}
\end{aligned}$$

Question: $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} [[x] + \sin x] dx = ?$

Answer: $-\pi$

Solution:

$$[[x] + \sin x] = [x] + [\sin x]$$

$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} [[x] + \sin x] dx = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} [x] dx + \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} [\sin x] dx$$

$$\int_{-\frac{\pi}{2}}^{-1} [x] dx + \int_{-1}^0 [x] dx + \int_0^1 [x] dx + \int_1^{\frac{\pi}{2}} [x] dx + \int_{-\frac{\pi}{2}}^0 [\sin x] dx + \int_0^{\frac{\pi}{2}} [\sin x] dx$$

$$= \int_{-\frac{\pi}{2}}^{-1} -2 dx + \int_{-1}^0 -dx + \int_0^1 0 dx + \int_1^{\frac{\pi}{2}} dx + \int_{-\frac{\pi}{2}}^0 -dx + \int_0^{\frac{\pi}{2}} 0 dx$$

$$= -2x \Big|_{-\frac{\pi}{2}}^{-1} - x \Big|_{-1}^0 + x \Big|_1^{\frac{\pi}{2}} - x \Big|_{-\frac{\pi}{2}}^0$$

$$= -2 \left(-1 + \frac{\pi}{2} \right) - (0 + 1) + \left(\frac{\pi}{2} - 1 \right) - \left(0 + \frac{\pi}{2} \right)$$

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

$$= -\pi$$