# UPSEE 2015 - Solved Paper

# Physics

## Question 1

**If *L*, *C* and *R* are the inductance, capacitance and resistance respectively, then which of the following does not represent the dimension of frequency?**

**Options:**

A. $\frac{R}{L}$

B. $\frac{C}{L}$

C. $\frac{1}{\sqrt{LC}}$

D. $\frac{1}{RC}$

**Answer: B**

**Solution:**

As we know that the resonant frequency for an LCR circuit is, $f = \frac{1}{2\pi\sqrt{LC}}$

Time constant for RL circuit is, $\frac{R}{L}$

Time constant for RC circuit is, $\frac{1}{RC}$

So $\frac{R}{L}$ and $\frac{1}{RC}$ have the dimension of frequency.

$\therefore \frac{C}{L}$ Does not represent the dimensions of frequency.

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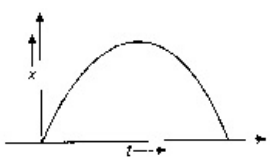
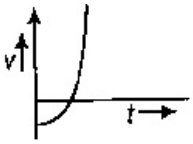
## Question 2

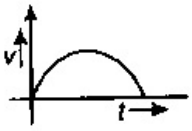
**The displacement-time (*x*-*t*) graph of a body is given as**

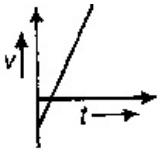


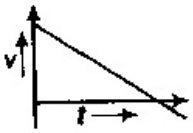

**The corresponding velocity-time (*v*-*t*) graph will be**

**Options:**

A. 


B. 


C. 

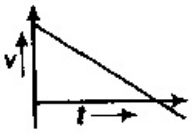

D. 


**Answer: D**

**Solution:**

As we know that, the velocity of a body is given by the slope of the displacement-time graph. So, initially slope of the graph is positive and after some time, it becomes zero and then will be negative.

Option A is incorrect because the velocity is initially zero.
Option B is also incorrect because the velocity is initially zero.
Option C is also incorrect because the velocity is initially negative.
Option D is correct is describe all the condition.

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# Question 3

**If the atom $^{257}_{100}\text{Fm}$ follows the Bohr model and the radius of $^{257}_{100}\text{Fm}$ is *n* times the Bohr radius, then the value of *n* is**

**Options:**

A. 4

B. $\frac{1}{4}$

C. 200

D. 100

**Answer: B**

**Solution:**

According to Bohr’s model

$$r_n = \frac{n^2}{Z} a_o$$

where n is the orbit number, $a_o$ is the Bohr's radius, Z is the atomic number.
Given that $Z = 100$, $m = 5$, and $r_n = na_o$

$$na_o = \frac{5^2}{100} a_o$$

$$n = \frac{1}{4}$$

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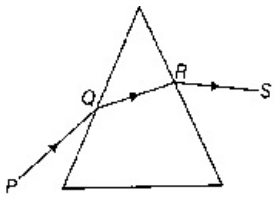
# Question 4

**A ray of light is incident on an equilateral glass prism placed on a horizontal table. For minimum deviation, which of the following is true?**




**Options:**

A. *QR* is horizontal

B. *PQ* is horizontal

C. Either *PQ* or *QS* is horizontal

D. *RS* is horizontal

**Answer: A**

**Solution:**

For minimum deviation, position of refracted ray inside the prism is parallel to the base of the prism.

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# Question 5

**A particle is thrown vertically upward with a speed of *u* from a tower of height *H*. The time taken by the particle to hit ground is *n* times that**

**taken by it to reach the highest point of its path. The relation between *H, u* and *n* is**

**Options:**

A. $gH = (n - 2)^2 u^2$

B. $\frac{nu^2(n-2)}{2} = gh$

C. $gH = \frac{n^2u^2}{2}$

D. $(n - 2) = \frac{gH}{u^2}$

**Answer: B**

**Solution:**

Time to reach maximum height, $t_1 = \frac{u}{g}$

Let $t_2$ be the time taken to hit the ground

$\therefore -h = ut_2 - \frac{1}{2}gt_2^2$

But, $t_2 = nt_1$ (given)

$$-h = u\frac{nu}{g} - \frac{1}{2}gn^2\frac{u^2}{g^2}$$

$$-2gh = 2nu^2 - n^2u^2$$

$$-gh = \frac{nu^2(2-n)}{2}$$

$$gh = \frac{nu^2(n-2)}{2}$$

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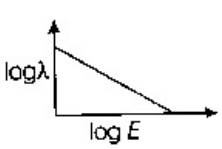
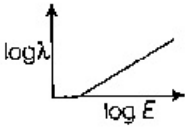
# Question 6

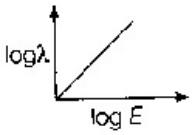
**The log-log graph between the energy *E* of an electron and its de-Broglie wavelength λ will be**

**Options:**

A. 

B. 


C. 


D. 


**Answer: A**

**Solution:**

de-Broglie wavelength is, $\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m}}\frac{1}{\sqrt{E}}$

Taking log on both the sides

$\text{Log } \lambda = \log \frac{h}{\sqrt{2m}} + \log \frac{1}{\sqrt{E}}$

($\because \log (AB) = \log A + \log B$)

$\text{Log } \lambda = \log\frac{h}{\sqrt{2m}} - \frac{1}{2} \log E$

$\text{Or Log } \lambda = -\frac{1}{2} \log E + \log\frac{h}{\sqrt{2m}}$

The equation of the straight line having the slope $\left(-\frac{1}{2}\right)$ and positive intercept on logλ axis.

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# Question 7

**In carnot engine, efficiency is 40% at hot reservoir temperature *T*. For efficiency 50%, what will be the temperature of hot reservoir?**

**Options:**

A. $\frac{2T}{5}$

B. $6T$

C. $\frac{6T}{5}$

D. $\frac{T}{5}$

**Answer: C**

**Solution:**

The efficiency of carnot engine is, $\eta = \frac{\text{work done}}{\text{heat input}} = \frac{W}{Q}$

$\eta = 1 - \frac{T_2}{T_1}$

Where $T_2$ = temperature of sink And $T_1$ = temperature of the hot reservoir
Given that the efficiency of Carnot engine is 40%.

$\frac{40}{100} = 1 - \frac{T_2}{T_1}$

$\frac{T_2}{T_1} = 0.6$
$T_2 = 0.6\ T_1$

when the efficiency is 50%

$$\frac{50}{100} = 1 - \frac{T_2}{T'_1}$$

$$0.5 = 1 - \frac{T_2}{T'_1}$$

$$\frac{T_2}{T'_1} = 0.5$$

$$\frac{0.6T_1}{T'_1} = 0.5$$

$$T'_1 = \frac{6}{5}T_1$$

$$T'_1 = \frac{6}{5}T$$

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# Question 8

**Fundamental frequency of a sonometer wire is *n*. If the length and diameter of the wire are doubled keeping the tension same, then the new fundamental frequency is**

**Options:**

A. $\frac{n}{2\sqrt{2}}$

B. $\sqrt{2n}$

C. $\frac{n}{4}$

D. $\frac{2n}{\sqrt{2}}$

**Answer: C**

## Solution:

Fundamental frequency of a sonometer wire is given by,

$F = \frac{1}{2l}\sqrt{\frac{T}{m}}$

where,
l = length of wire
T = Tension of the wire
m = mass per unit length
F = fundamental frequency
Given,
F = n

$\Rightarrow \quad n = \frac{1}{2l}\sqrt{\frac{T}{m}}$

mass per unit length (m) $= \frac{\rho V}{l}$

where,
ρ = density of the material of wire
V = Volume

mass per unit length (m) $= \frac{\rho \pi r^2 l}{l} = \rho \pi r^2$

Putting m in the formulae of fundamental frequency

$n = \frac{1}{2l}\sqrt{\frac{T}{\rho \pi r^2}}$

By doubling length and diameter of the wire,

$n' \frac{1}{2(2l)}\sqrt{\frac{T}{\rho\pi(2r)^2}} = \frac{1}{4}\left(\frac{1}{2l}\sqrt{\frac{T}{\rho\pi r^2}}\right) = \frac{1}{4}n$

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# Question 9

### A tank is filled with water of density 1 g $cm^{-3}$ and oil of density 0.9 g $cm^{-3}$. The height of water layer is 100 cm and of the oil layer is 400 cm. If $g$ = 980 cm $s^{-2}$, then the velocity of efflux from an opening in the bottom of the tank is

**Options:**

A. $\sqrt{920 \times 980}$ $cms^{-1}$

B. $\sqrt{900 \times 980}$ $cms^{-1}$

C. $\sqrt{1000 \times 980}$ $cms^{-1}$

D. $\sqrt{92 \times 980}$ $cms^{-1}$

**Answer: A**

**Solution:**

The pressure at the bottom of the tank must be equal to the pressure due to water of height $h$.

If $d_w$ and $d_0$ be the densities of water and oil respectively, then the pressure at the bottom of the tank

$P = h_w d_w g + h_0 d_0 g$

If this pressure is equivalent to pressure due to water of height $h$.

Then, $h d_w g = h_w d_w g + h_0 d_0 g$

$h = h_w + \frac{h_0 d_0}{d_w}$

$h = 100 + \frac{400 \times 0.9}{1}$

h = 100 + 360 = 460 cm

According to Torricelli's theorem

velocity, $V = \sqrt{2gh} = \sqrt{2 \times 980 \times 460}$

$v = \sqrt{920 \times 980}\, cms^{-1}$

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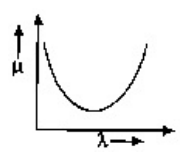
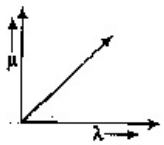
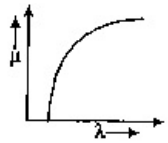
# Question 10

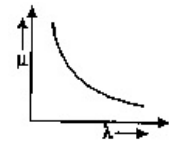
**The graph which represents the relation between refractive index μ with wavelength λ is**

**Options:**

A. 

B. 


C. 


D. 

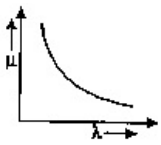

**Answer: D**

**Solution:**

According to the Cauchy's relation

$\mu = A + \frac{B}{\lambda^2}$
where A and B are constant

$\Rightarrow \mu \propto \frac{1}{\lambda^2}$
So the correct representation of the relation between refractive index μ with wavelength λ is

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# Question 11

**According to Bohr's model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionised Li atom (Z = 3) is**

**Options:**

A. 40.8

B. 13.6

C. 122.4

D. 1.51

**Answer: C**

**Solution:**

The doubly ionized Li atom is H-like atom since two electrons has been removed from outermost shell and only one electron is left.
The energy required to remove an electron from an atom is called ionization energy.
For hydrogen like atoms,

$$E_n = \frac{-13.6Z^2}{n^2}\text{eV}$$

where,
Z = atomic mass
n = number of electron
The energy of an electron in ground state of doubly ionized Li atom is

$$E_n = \frac{-13.6 \times 9}{1} = -122.4\,\text{eV}$$

Hence, the ionization energy for an electron inground state of doubly ionized Li atom = 122.4 eV

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# Question 12

**The moment of inertia of a rod about an axis through its centre and perpendicular to it is $\frac{1}{12}$ $ML^2$(where, $M$ is the mass and $L$ the length of the rod). The rod is bent in the middle to that the two halves make an angle of $60^0$. The moment of inertia of the bent rod about the same asix would be**

**Options:**

A. $\frac{ML^2}{48}$

B. $\frac{ML^2}{12}$

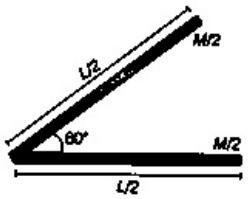
C. $\frac{ML^2}{24}$

D. $\frac{ML^2}{8\sqrt{3}}$

**Answer: B**

**Solution:**

The total length of the rod is $L$. Since, the rod is bent at the middle. So each part of it will have same length $\frac{L}{2}$ and $\frac{M}{2}$ mass.



Moment of inertia of each part about an axis passing through its one end

$$= \frac{1}{3}\left(\frac{M}{2}\right)\left(\frac{L}{2}\right)^2$$

Hence, net moment of inertia about an axis passing through its middle point $O$ is

$$I = \frac{1}{3}\left(\frac{M}{2}\right)\left(\frac{L}{2}\right)^2 + \frac{1}{3}\left(\frac{M}{2}\right)\left(\frac{L}{2}\right)^2$$

$$\mathrm{I} = \frac{1}{3}\left(\frac{ML^2}{8} + \frac{ML^2}{8}\right) = \frac{ML^2}{12}$$

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# Question 13

**If the ratio of the concentration of electrons to that of holes in a semiconductor is $\frac{7}{5}$ and the ratio of currents is $\frac{7}{4}$. Then, the ratio os their drift velocity is**

**Options:**

A. $\frac{4}{7}$

B. $\frac{4}{5}$

C. $\frac{5}{8}$

D. $\frac{5}{4}$

**Answer: D**

**Solution:**

As, $I = neAv_{\mathrm{d}}$

$$\Rightarrow \frac{I_e}{I_h} = \frac{en_eAV_e}{en_hAV_h} = \frac{n_eV_e}{n_hV_h}$$

$$\Rightarrow \frac{v_e}{v_h} = \frac{I_e}{I_h} = \frac{n_h}{n_e} = \frac{7}{4} \times \frac{5}{7} = \frac{5}{4}$$

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# Question 14

**How many NAND gates are used in an OR gate?**

**Options:**

A. Two

B. Three

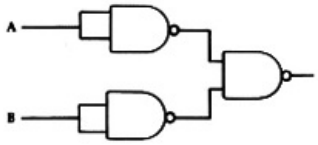
C. Four

D. Five

**Answer: B**

**Solution:**

Logic gate circuit is given below,




Here, three NAND gates are used to make an OR gate.

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# Question 15

**An object is placed on a smooth inclined plane of 1 in *I*. The horizontal acceleration to be imparted to inclined plane so that, the object is stationary relative to the inclined is given by**

**Options:**

A. $\frac{g}{I^2-1}$

B. $\frac{g}{\sqrt{I^2-1}}$

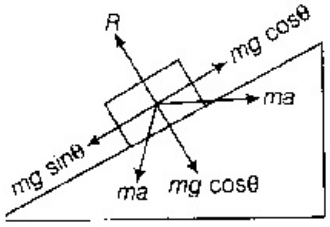
C. $g\sqrt{I^2-1}$

D. $g(I^2-1)$

**Answer: B**

**Solution:**

Consider the diagram




Here, $\sin\theta = \frac{1}{1} \Rightarrow \tan\theta = \frac{1}{\sqrt{l^2-1}}$

From free body diagram, we have

$ma\cos\theta = mg\sin\theta$

$a = g\tan\theta = g\frac{1}{\sqrt{l^2-1}}$

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# Question 16

**The population inversion in helium-neon laser is produced by**

**Options:**

A. photon excitation

B. chemical reaction

C. inelastic atomic collision

D. electron excitation

**Answer: D**

**Solution:**

The population inversion in He-Ne laser is created by electron excitation.

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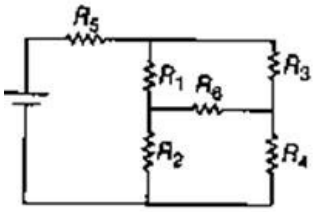
# Question 17

**For a given circuit, it is observed that the current $I$ is independent of the value of the resistance $R_6$. Then, the resistance values must satisfy**




**Options:**

A. $R_2R_3 = R_1R_4$

B. $R_3R_4\ R_6 = R_2R_1R_5$

C. $\frac{1}{R_3+R_4} = \frac{1}{R_5} + \frac{1}{R} - \frac{1}{R_1+R_2}$

D. $R_3\ R_1 = R_2R_4 = R_5R_6$

**Answer: A**

**Solution:**

As $I$ is independent of $R_6$, no current flows through $R_6$ this requires that the junction of $R_1$ and $R_2$ is at the same potential as the junction of $R_3$ and $R_4$. This must satisfy the condition $\frac{R_1}{R_2} = \frac{R_3}{R_4}$, as in the wheatstone bridge.

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# Question 18

**If eyeis kept at a depth *h* inside the water of refractive index and viewed outside, then the diameter of circle through which the outer objects become visible, will be**

**Options:**

A. $\frac{h}{\sqrt{\mu^2+1}}$

B. $\frac{h}{\sqrt{\mu^2-1}}$

C. $\frac{2h}{\sqrt{\mu^2-1}}$

D. $\frac{h}{\sqrt{2\mu^2-1}}$

**Answer: C**

**Solution:**

Let 2r be the diameter of circle through which the outer objects become visible. The ray of light must be incident at critical angle C.

$$\sin C = \frac{1}{\mu} = \frac{r}{\sqrt{r^2+h^2}}$$

$$\mu^2 r^2 = r^2 + h^2$$

$$\Rightarrow (\mu^2 - 1) r^2 = h$$

$$\Rightarrow r = \frac{h}{\sqrt{\mu^2 - 1}}$$

$$\therefore \text{Diameter} = 2r = \frac{2h}{\sqrt{\mu^2 - 1}}$$

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# Question 19

## If a vector A is given as $A = 4\hat{i} + 3\hat{j} + 12\hat{k}$, then the angle subtended with the *x*-axis is

**Options:**

A. $\sin^{-1}\left[\frac{4}{13}\right]$

B. $\sin^{-1}\left[\frac{3}{13}\right]$

C. $\cos^{-1}\left[\frac{3}{13}\right]$

D. $\cos^{-1}\left[\frac{4}{13}\right]$

**Answer: D**

## Solution:

In this question we have to find direction angle. Let α be the be the angle made by the given vector and x-axis.

Then, directional cosine cos α is given as :

$$\cos\alpha = \frac{A_x}{A} = \frac{4}{\sqrt{4^2+3^2+12^2}} = \frac{4}{13}$$

$$\alpha = \cos^{-1}\left[\frac{4}{13}\right]$$

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# Question 20

## A uniform chain of length *L* and mass *M* overhangs a horizontal table with its two-third part on the table. The friction coefficient between the table and the chain is μ. The work done by the friction during the period, the chain slips off the table is

**Options:**

A. $-\frac{2}{9}\mu MgL$

B. $-\frac{6}{7}\mu MgL$

C. $-\frac{1}{4}\mu MgL$

D. $-\frac{4}{9}\mu MgL$

**Answer: A**

## Solution:

Total mass of the chain = M
Linear mass density = L
Linear mass density $= \frac{M}{L}$

dW = - F.dx
Let dW be the small work done by friction when chain of length l slides a small distance dl

Frictional force applied during this period $= \mu\left[\frac{M}{L}\right]1g$

$dW = -\mu\left[\frac{M}{L}\right]gldl$

Length of the chain on the table $= \frac{2L}{3}$

Now, total work done

$W = \int_0^{2L/3} -\frac{\mu Mg}{L} l\, dl$

$= -\frac{\mu Mg}{L}\left[\frac{l^2}{2}\right]_0^{2L/3} = -\frac{\mu Mg}{L}\left[\frac{4L^2}{9} - 0\right]$

$\Rightarrow W = -\frac{2}{9}\mu MgL$

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# Question 21

### A disc of mass 2 kg and radius 0.2 m is rotating with angular velocity 30 rads$^{-1}$. What is angular velocity(in rad s$^{-1}$), if a mass of 0.25 kg is put on periphery of the disc?

**Options:**

A. 24

B. 36

C. 15

D. 26

**Answer: A**

## Solution:

According to law of conservation of angular momentum,
Angular momentum is conserved until external torque is not applied.

$\Rightarrow \quad I_1\omega_1 = I_2\omega_2 \qquad \ldots(i)$

Moment of inertia of thin disc $(I) = \frac{1}{2}MR^2$

$\omega_1 = 30 \text{ rads}^{-1}$

$\Rightarrow \quad \frac{1}{2} \times 2 \times (0.2)^2 \times 30 = \frac{1}{2} \times (2 + 2 \times 0.25)$

$(0.2)^2 \times \omega_2$

$\Rightarrow \quad 1.2 = 0.05\ \omega_2$

$\Rightarrow \quad \omega_2 = 24 \text{ rad s}^{-1}$

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# Question 22

**If a body have kinetic energy *T*, moving on a rough horizontal surface stops at distance *y*. The frictional force exerted on the body is**

**Options:**

A. $\frac{T}{\sqrt{y}}$

B. $\frac{\sqrt{T}}{y}$

C. $yT$

D. $\frac{T}{y}$

**Answer: D**

**Solution:**

A body of mass $m$ moving initially with velocity $u$ on a rough surface and due to friction, it comes to rest after covering a distance $s$, then the retarding force is given by

$ma = \mu mg$ or $a = \mu g$. ....(i)

Using, $v^2 = u^2 - 2as$, we have

$0 = u^2 - 2(\mu g)\ s$ .....(ii)

$T = \frac{1}{2}mu^2$ or $u^2 = \frac{2T}{m}$

we have from Eq. (ii).

$0 = -2(\mu g)\ s$

$\frac{2T}{m} = 2\mu g y$ [$\because\ s = y$].....(iii)

Frictional force, $f = \mu mg$ ....(iv)

From Eqs. (iii) and (iv), we get $f = \frac{T}{y}$

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# Question 23

**The escape velocity from the Earth is 11 $kms^{-1}$. The escape velocity from a planet having twice the radius and same mean density as that of Earth is**

**Options:**

A. 11 $kms^{-1}$

B. 5.5 $kms^{-1}$

C. 22 $kms^{-1}$

D. 10 $kms^{-1}$

**Answer: C**

**Solution:**

Escape velocity

$v_e = \sqrt{\frac{2GM}{R}} = R\sqrt{\frac{8}{3}\pi G\rho}$

$\therefore\ v_e \propto R$ if ρ=constant

Since, planet has double the radius in comparison to the Earth

$\therefore\ v_e = 22\ kms^{-1}$

---

# Question 24

**A body weighs 8 g when placed in one pan and 18 g when placed on the other pan of a false balance. If the beam is horizontal when both the**

**pans are empty, then the true weight of the body is**

**Options:**

A. 15 g

B. 13 g

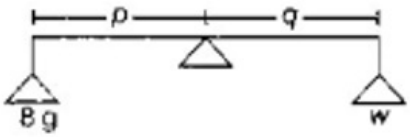
C. 10 g

D. 12 g

**Answer: D**

## Solution:

Let the true weight of body be w.
Case 1:
When body is placed in left pan




Since the balance is in equilibrium,
8p = wq

$\Rightarrow \frac{p}{q} = \frac{w}{8}$ ...(i)

Case 2:
When the body is placed in right pan


wp = 18q

$\Rightarrow \frac{p}{q} = \frac{18}{w}$ ...(ii)

From Eqs. (i) and (ii), we get

$\frac{p}{q} = \frac{w}{8} = \frac{18}{w}$

$w = \sqrt{18 \times 8} = 12g$

---

# Question 25

**If a ray travelling in the direction $\frac{1}{2}(\hat{i} + \sqrt{3}\hat{j})$ is incident on a plane mirror. After reflection, the ray travels along the direction $\frac{1}{2}(\hat{i} - \sqrt{3}\hat{j})$. The angle of incidence is**

**Options:**

A. 45 º

B. 75 º

C. 30 º

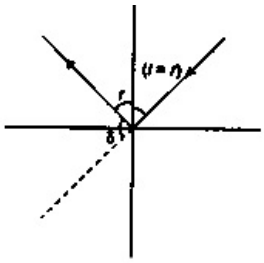
D. 60 º

**Answer: C**

**Solution:**

Abgle between incident ray and reflected ray

$\cos\delta = \frac{(\hat{i}+\sqrt{3}\hat{j}).(\hat{i}+3\hat{j})}{2.2}$



$\cos\delta = -\frac{1}{2}$ $\delta = 120^0$,

$180 - \angle i = 120$ $\angle i = 30^0$

---

# Question 26

**What will be the force acting on a particle moving along a circle of radius *R*, if its kinetic energy *k* depends on the distance covered as $k = as^2$?**

**Options:**

A. $2a\frac{R^2}{s}$

B. $2as\left[1+\frac{s^2}{R^2}\right]^{1/2}$

C. $\frac{2as^2}{R}$

D. $2\ as$

**Answer: B**

**Solution:**

We have,

$KE = \frac{1}{2}mv^2 = as^2$

$\Rightarrow \quad v = s\sqrt{\frac{2a}{m}}$ ...(i)

Let $a_R$ be the radial acceleration and $a_1$ be the tangential acceleration.

net accelerations $= \sqrt{a_R^2 + a_t^2}$ ...(ii)

$\therefore \quad a_R = \frac{v^2}{R}$

Putting the value of v from equation (i) we get,

$a_R = \frac{2as^2}{mR}$

$a_t = \frac{dv}{dt} = \frac{dv}{ds}.\frac{ds}{dt} = v\frac{dv}{ds}$ ...(ii)

Differencing equation with respect to s, we get

$\frac{dv}{ds} = \sqrt{\frac{2a}{m}}$

Putting the value of $\frac{dv}{ds}$ in equation (ii) we get

$a_t = \left[s\sqrt{\frac{2a}{m}}\right]\left[\sqrt{\frac{2a}{m}}\right] = \frac{2as}{m}$ ...(iii)

So, net accelerations $= \sqrt{a_R^2 + a_t^2}$

$$= \sqrt{\left[\frac{2as^2}{mR}\right]^2 + \left[\frac{2as}{m}\right]^2}$$

$$= \frac{2as}{m}\sqrt{1 + \left[\frac{s}{R}\right]^2}$$

Net force acting on the particle $= 2as\sqrt{1 + \left(\frac{s}{R}\right)^2}$

---

# Question 27

## A sample contains $10^{-2}$ kg each of the two substances *A* and *B* with half-lives 4 s and 8 s respectively. Their atomic weights are in the ratio of 1:2, the amounts of *A* and *B* after an interval of 16s are

**Options:**

A. $A$=0.625×$10^{-4}$ kg, $B$=0.25×$10^{-3}$ kg

B. $A$=0.25×$10^{-3}$ kg, $B$=0.625×$10^{-4}$ kg

C. $A$=2.5×$10^{-3}$ kg, $B$=6.25×$10^{-4}$ kg

D. $A$=6.25×$10^{-4}$ kg, $B$=2.5×$10^{-3}$ kg

**Answer: D**

## Solution:

The amount left after N half-lives

$N = N_0 \left[\frac{1}{2}\right]^n$

For $A$, $n = \frac{t}{T_1} = \frac{16s}{4s} = 4$

$N_A = 10^{-2}\ kg \left[\frac{1}{2}\right]^4 = 6.25 \times 10^{-4}\ kg$

For $B$, $n = \frac{16s}{8s} = 2$

$N_B = 10^{-2}\ kg \left[\frac{1}{2}\right]^2 = 2.5 \times 10^{-3}\ kg$

---

# Question 28

**Usually laser beams are used to measure long distance because**

**Options:**

A. they are coherent

B. they are monochromatic

C. they are highly polarised

D. they have high degree of parallelism

**Answer: D**

**Solution:**

Laser beams are perfectly parallel. So, that they are very narrow and can travel a long distance without spreading. Due to this feature, only lasers are used to measure long distances.

---

# Question 29

**Two tunning forks *P* and *Q* when set vibration, given 4 beats $s^{-1}$. If a prong of the fork *P* is filled, the beats are reduced to 2 $beats^{-1}$. What is frequency of *P*, if that of *Q* is 250 Hz?**

**Options:**

A. 250 Hz

B. 246 Hz

C. 252 Hz

D. 254 Hz

**Answer: B**

**Solution:**

There are four beats between $P$ and $Q$, therefore the possible frequencies of $P$ are 246 or 254 (i.e. 250$\pm$4) Hz.

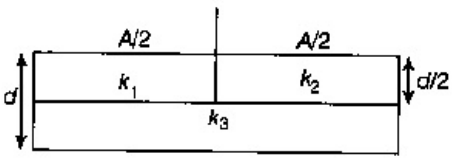
When the prong of $P$ is filled, its frequency becomes greater than the original frequency of $P$ is 254, then on filing its frequency will be greater than 254. The beats between $P$ and $Q$ will be more then 4. But it is given that the beats are reduced to 2, therefore, 254 is not possible.

The required frequency must be 246 Hz.

---

# Question 30

**A parallel plate capacitor of area $A$, plate separation $d$ and capacitance $C$ is filled with three dielectric materials having dielectric constants $k_1$, $k_2$ and $k_3$ as shown. If a single dielectric material is to be used to have the same capacitance $C$ in the capacitor, then its dielectric costant $k$ is given by**




**Options:**

A. $k = k_1 + k_2 + 2k_3$

B. $k = \frac{k_1 k_2}{k_1 + k_2} + 2k_3$

C. $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{2k_3}$

D. $\frac{1}{k} = \frac{1}{k_1 + k_2} + \frac{1}{2k_3}$

**Answer: D**

**Solution:**

The capacitances,

$C_1 = \frac{k_1\varepsilon_0 A/2}{[d/2]} = \frac{k_1\varepsilon_0 A}{d}$

$C_2 = \frac{k_2\varepsilon_0 A/2}{d/2} = \frac{k_0\varepsilon_0 A}{d}$

and $C_3 = \frac{k_3\varepsilon_0 A/2}{[d/2]} = \frac{2k_3\varepsilon_0 A}{d}$

The equivalent capacitance is given by

$$\frac{1}{C_{eq}} = \frac{1}{C_1 + C_2} + \frac{1}{C_3} = \frac{1}{\frac{\varepsilon_0 A}{d}(k_1 + k_2)} + \frac{1}{\frac{\varepsilon_0 A}{d} \times 2k_3}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1 + C_2} + \frac{1}{C_3} = \frac{1}{\frac{\varepsilon_0 A}{d}(k_1 + k_2)} + \frac{1}{\frac{\varepsilon_0 A}{d} \times 2k_3}$$

$$\frac{1}{C_{eq}} = \frac{d}{\varepsilon_0 A}\left[\frac{1}{k_1 + k_2} + \frac{1}{2k_3}\right]$$

$$C_{eq} = \left[\frac{1}{k_1 + k_2} + \frac{1}{2k_3}\right]^{-1} \cdot \frac{\varepsilon . A}{d}$$

$$\therefore \quad \frac{1}{k} = \left[\frac{1}{k_1 + k_2} + \frac{1}{2k_3}\right] \quad \left(\because C = \frac{k\varepsilon A}{d}\right)$$

---

# Question 31

**A ball is dropped from height *h* on the ground. If the coefficient of restitution is *e*, the height to which the ball goes up after it rebounds for the *n*th time is**

**Options:**

A. $\frac{h}{e^{2n}}$

B. $\frac{e^{2n}}{h}$

C. $he^{2\,n}$

D. $he^{n}$

**Answer: C**

**Solution:**

Let $v_0$ be the velocity with which the ball strikes the Earth first time and $v_n$ after the $n$th rebound.

The coefficient of restitution is

$$e = \frac{v_1}{v_0} = \frac{v_2}{v_1} = \frac{v_3}{v_2} = \ldots = \frac{v_n}{v_{n-1}}$$

$$\therefore e^n = \frac{v_1}{v_0} \times \frac{v_2}{v_1} \times \frac{v_3}{v_2} \times \ldots = \frac{v_n}{v_{n-1}} = \frac{v_n}{v_0}$$

Here, $v_0 = \sqrt{2gh}$ and $v_n = \sqrt{2gH}$

$$e^n = \frac{\sqrt{2gH}}{\sqrt{2gh}} = \frac{\sqrt{H}}{\sqrt{h}}$$

$$e^{2n} = \frac{H}{h} \Rightarrow H = he^{2n}$$

---

# Question 32

**Permanent magnet has properties retentivity and coercivity respectively,**

**Options:**

A. low-low

B. high-high

C. high-low

D. low-high

**Answer: B**

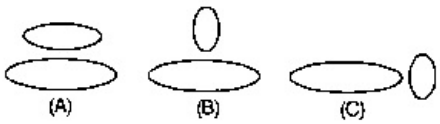
**Solution:**

The materials for a permanent magnet should have high retentivity and high coercivity.

---

# Question 33

**Two circular coils can be arranged in any of the three following situations as shown in figure. Their mutual inductance will be**




**Options:**

A. maximum in (B)

B. maximum in (A)

C. maximum in (C)

D. same in all conditions

**Answer: B**

## Solution:

Mutual inductance depends on their degree of flux linkage.

In (B) and (C) the flux linkage is less than A.

So, the mutual inductance of (A) will be maximum.

---

# Question 34

**A circular disc of radius $R$ rolls without slipping along the horizontal surface with constant velocity $v_0$, We consider a point $A$ on the surface of the disc. Then, the acceleration of the point $A$ is**

**Options:**

A. constant in magnitude

B. constant in direction

C. constant in magnitude as well as direction

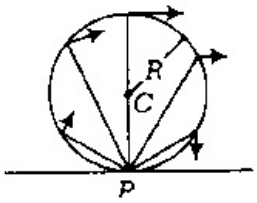
D. None of the above

**Answer: C**

## Solution:

The circular disc of radius $R$ rolls without slipping, and its centre of mass is $C$. $P$ is that point where the body is in contact with the surface at any instant. At this instant each particle (body) is moving at right angles to the line which joints the particle with point $P$ with velocity proportional to distance.

Therefore, the combined translational and rotational motion gives pure rolling and body moves with constant velocity in magnitudes as well as in direction.

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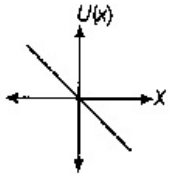
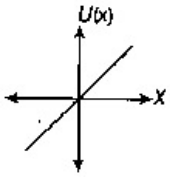
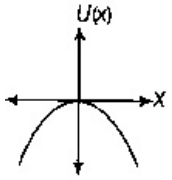
# Question 35

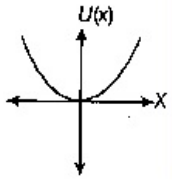
**The particle is placed at the origin and a force $F = kx$ is acting on it (where, $k$ is a positive constant.) If $U(0) = 0$, the graph of $U(x)$ versus $X$ will be, (where, $U$ is the potential energy function)**

**Options:**

A. 


B. 


C. 


D. 


**Answer: C**

**Solution:**

We know that,

$$F = -\frac{dU}{dx}$$

dU = - F dx

Given,

F = kx

$$U = \int_0^{U(x)} dU = -\int_0^x F dx$$

$$= -\int_0^x kx dx$$

$$= -k\int_0^x x dx$$

(k is constant)

$$U = -\frac{kx^2}{2}$$

So, the graph will be a downward parabola.

---

# Question 36

## Which of the following process represents γ–decay?

**Options:**

A. ${}^{A}_{z}X + {}^{1}_{0}n \rightarrow {}^{A-3}_{z-2}X + c$

B. ${}^{A}_{z}X + {}^{}_{-1}e \rightarrow {}^{A}_{z-1}X + g$

C. ${}^{A}_{z}X + r \rightarrow {}^{A}_{z-1}X + a + b$

D. ${}^{A}_{Z}X + r \rightarrow {}^{A}_{Z}X + a + b$

**Answer: D**

## Solution:

In a γ–decay atomic nucleus loses energy by emitting a gamma ray without a change in its atomic or mass numbers. So, during γ–decay there is no change in atomic or mass numbers.

In only option (d) atomic and mass numbers are unchanged.

So, the correct option is (d).

---

# Question 37

## In an *n-p-n* transistor circuit, the collector current is 10 mA. If 90% of the electrons emitted reach the collector

**Options:**

A. the base current will be 1 mA

B. the base current will be -1 mA

C. the emitter current will be 9 mA

D. the emitter current will be 15 mA

**Answer: A**

## Solution:

Given
$I_C$ = 90% of $I_E$
and $I_C$ = 10 mA

$$\Rightarrow \quad 10\text{mA} = \frac{90}{100} I_E$$

$$\Rightarrow \quad I_E = \frac{10 \times 10}{9} \approx 11 \text{ mA}$$

We know that,
$I_E = I_C + I_B$
$I_B = I_E - I_C$ = 11 mA − 10 mA = 1 mA

---

# Question 38

### The surface of the metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV, the work function of metal is

**Options:**

A. 1.51 eV

B. 1.42 eV

C. 3.0 eV

D. 1.68 eV

**Answer: B**

## Solution:

According to photoelectric equation,

$$\phi_o = \frac{hc}{\lambda} - E_k$$

where,
$\phi_o$ = work function
h = planck's constant ($6.634 \times 10^{-34}$ Js)
$\lambda$ = wavelength of light
$E_k$ = the maximum kinetic energy of the emitted electrons

$$\Rightarrow \quad \phi_o = \frac{1240\,\text{eV nm}}{400\text{nm}} - 1.68\,\text{eV}$$

$$= 3.1 - 1.68 = 1.42 \text{ eV}$$

---

# Question 39

### In an ideal double-slit experiment, when a glass-plate (μ=1.5) of thickness *t* is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is

**Options:**

A. λ

B. λ/3

C. 2λ/3

D. 2λ

**Answer: D**

## Solution:

In double-slit experiment,

$(\mu - 1)t = n\lambda$

where,
μ = refractive index
For minima put n = 1
So,

$(\mu - 1)t_{min} = \lambda$

$t_{min} = \frac{\lambda}{\mu - 1}$

$= \frac{\lambda}{1.5 - 1} = 2\lambda$

---

# Question 40

### An electromagnetic wave propagating along North has its electric field vector upwards. Its magnetic field vector point towards

**Options:**

A. East

B. North

C. West

D. downwards

**Answer: A**

## Solution:

According to thumb rule magnetic field will point towards the east.

---

# Question 41

### A charged particle moving in a magnetic field experiences a resultant force

**Options:**

A. in the direction opposite to the field

B. in the direction of field

C. in the direction perpendicular to both the field and its velocity

D. None of the above

**Answer: C**

## Solution:

We know that,
F = q (v × B)
We can see from the above equation that the direction of force is perpendicular to the direction of both velocity and magnetic field.
Hence the correct option is (c)

---

# Question 42

## If *g* is the acceleration due to gravity at the Earth's surface, the gain of the potential energy of an object of mass *m* raised from the surface of the Earth to height equal to the radius *R* of the Earth is

**Options:**

A. $\frac{mgR}{4}$

B. $\frac{mgR}{2}$

C. $mgR2^{2x}$

D. $2mgR$

**Answer: B**

## Solution:

Let the potential energy of an object at earth's surface be $U_1$

$$U_1 = -\frac{GMm}{R} \quad \text{...(i)}$$

where,
M = mass of earth
m = mass of object
R = radius of earth
Potential energy of the object at a height, h = R from the surface of the Earth.

$$U_2 = -\frac{GMm}{R+h} = -\frac{GMm}{R+R} = -\frac{GMm}{2R} \quad \text{...(ii)}$$

Gain in potential energy

$$\Delta U = U_2 - U_1 = -\frac{GMm}{2R} + \frac{GMm}{R} = \frac{1}{2}\frac{GMm}{R}$$

Also we know that,
$GM = gR^2$

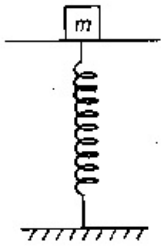
$$\Delta U = \frac{1}{2}\frac{gR^2m}{R} = \frac{mgR}{2}$$

---

# Question 43

**A mass of 2 kg is put on a flat pan attached to a vertical spring fixed on the ground as shown in figure. The mass of the spring and the pan is negligible. When pressed slightly and released the mass executes a SHM. The spring constant is 200 $Nm^{-1}$, What should be the minimum amplitude of motion, so that the mass gets detached from pan?**

**[Given, $g = 10\ m/s^2$]**




**Options:**

A. 10 cm

B. 4 cm

C. Less than 12 cm$2^{2x}$

D. 8 cm

**Answer: A**

**Solution:**

Restoring force on spring is given by

$F = ka$

As restoring force is balanced by weight $mg$ of block. For man to execute simple harmonic motion of amplitude $A$,

$kA = mg \Rightarrow A = \frac{mg}{k}$

Given $m = 2$ kg, $k = 200\ Nm^{-1}$

and $g = 10\ ms^{-2}$

$\therefore A = \frac{2 \times 10}{200} = \frac{10}{100} = 10$ cm

So, minimum amplitude of spring motion should 10 cm to detach the

mass from the pan.

---

# Question 44

## Bernoulli’s theorem is a consequence of the law of conservation of

**Options:**

A. angular momentum

B. mass

C. energy

D. momentum

**Answer: C**

## Solution:

Bernoulli’s theorem is the statement of the conservation of energy which is appropriate for flowing fluids.

$$p + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$$

So, the correct option is (c).

---

# Question 45

## The work of 146 kJ is performed in order to compress one kilomole of a gas adiabatically and in this process the temperature of the gas increases by 7 ºC. The gas is [$R$ =8.3 $Jmol^{-1}K^{-1}$]

**Options:**

A. diatomic

B. triatomic

C. a mixture of monoatomic and diatomic$2^{2x}$

D. None of the above

**Answer: A**

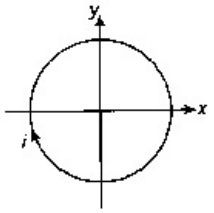
## Solution:

For adiabatic process,
dQ = 0
According to first law of thermodynamics during adiabatic process all the change in internal energy is in the form of work done
$\Rightarrow$ dU = - ΔW
$\Rightarrow$ $nC_v dT = + 146 \times 10^3$ J
where,
dT = change in temperature
$\Rightarrow \frac{nfR}{2} \times 7 = 146 \times 0^3$ J
where,
f is degree of freedom
n is number of mole of gas
$\Rightarrow \frac{10^3 \times f \times 8.3 \times 7}{2} = 146 \times 10^3$ J
$f = 5.02 \simeq 5$
Therefore, gas is diatomic.

---

# Question 46

**A conducting loop carrying a current *I* is placed in a uniform magnetic field pointing into the plane of the paper as shown. The loop will have a tendency to**




**Options:**

A. expand

B. move towards +ve *x* -axis

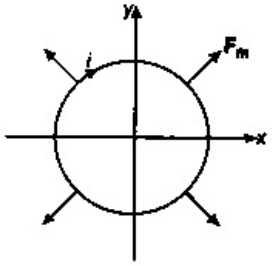
C. $2^{2x}$ contract

D. move towards – ve *x* –axis

**Answer: A**

## Solution:

Net force on a current carrying loop in uniform magnetic field is zero. Hence, the loop cannot translate.



From Fleming legt hand rule, we can see that if magnetic field is perpendicular to paper inwards and current in the loop is clockwise the magnetic force $F_m$ on each element of the loop is radially outwards or the loop will have the tendency of expand.

---

# Question 47

**Two springs are joined and attached to a mass of 16 kg. The system is then suspended vertically from a rigid support. The spring constant of the two springs are $k_1$ and $k_2$ respectively. The period of vertical oscillations of the system will be**

**Options:**

A. $8\pi \sqrt{\frac{k_1+k_2}{k_1k_2}}$

B. $\frac{\pi}{2}\sqrt{\frac{k_1}{k_2}}$

C. $\sqrt{\frac{k_1+k_2}{8\pi}}\ 2^{2x}$

D. $\frac{\pi\sqrt{k_1+k_2}}{2}$

**Answer: A**

## Solution:

From the question we can conclude that, the two springs are in series
When springs are in series their effective spring constant is given by,

$$\frac{1}{k}=\frac{1}{k_1}+\frac{1}{k_2}$$

where k is effective spring constant

$$\Rightarrow\ k=\frac{k_1k_2}{k_1+k_2}$$

Let T be the time period of oscillation.

$$T=2\pi\sqrt{\frac{m}{k}}$$

$$T=2\pi\sqrt{\frac{16}{\frac{k_1k_2}{(k_1+k_2)}}}$$

$$T=8\pi\sqrt{\frac{k_1+k_2}{k_1k_2}}$$

---

# Question 48

**If one mole of a monoatomic gas $\left(r_1=\frac{5}{3}\right)$ is mixed with one mole of a**

**diatomic gas $\left(r_2 = \frac{7}{5}\right)$, the value of *r* for the mixture is**

**Options:**

A. 3.07

B. 1.5

C. 1.402

D. 1.63

**Answer: B**

## Solution:

For the mixture of two gases,

$$r_{mix} = \frac{\frac{\mu_1 r_1}{r_1 - 1} + \frac{\mu_2 r_2}{r_2 - 1}}{\frac{\mu_1}{r_1 - 1} + \frac{\mu_2}{r_2 - 1}}$$

$\mu_1$ = no of mole of first gas
$\mu_2$ = no of mole of second gas
We have,
$\mu_1 = 1$, $\mu_2 = 1$

$$r_1 = \frac{5}{3}$$

$$r_2 = \frac{7}{5}$$

$$r_{mix} = \frac{\frac{1 \times \frac{5}{3}}{\left(\frac{5}{3} - 1\right)} + \frac{1 \times \frac{7}{5}}{\left(\frac{7}{5} - 1\right)}}{\left[\frac{1}{\left(\frac{5}{3} - 1\right)}\right] + \left[\frac{1}{\left(\frac{7}{5} - 1\right)}\right]}$$

$$r_{mix} = \frac{3}{2}$$

$$r_{mix} = 1.5$$

---

# Question 49

## The effect of rotation of the Earth on the value of acceleration due to gravity is

**Options:**

A. *g* is maximum at both poles

B. *g* is minimum at both poles

C. *g* is maximum at equator and minimum at the poles $2^{2x}$

D. *g* is minimum at the equator and maximum at the poles

**Answer: D**

## Solution:

Apparent value of gravity is, $g' = g - \omega^2 R \cos^2 \lambda$
Now, for poles $\lambda$– 90 º and for equator $\lambda$= 0º

(i) For $\lambda = 90^o$
$g'_{\text{pole}} = g - \omega^2 R \cos^2 90º = g$
$g' = g$

There is not effect on $g$ at the poles.

(ii) For $\lambda = 0$
$g_{\text{equator}} = g - \omega^2 R \cos^2 0º$
$g_{\text{equator}} = g - \omega^2 R$

The effect of rotation of the Earth on the value of $g$ at the equator is maximum. Therefore, g is minimum at the equator and maximum at the poles.

---

# Question 50

### A body floats in a liquid contained in a beaker. If the whole system falls under gravity, then the upthrust on the body due to liquid is

**Options:**

A. zero

B. equal to the weight of the immersed part of the body

C. equal to the weight of the body in liquid $2^{2x}$

D. equal to the weight of the body in air

**Answer: C**

### Solution:

There will be no change in the volume unimmersed in the liquid even if the system moves upward or downward with constant velocity or with same acceleration. Therefore, the thrust on the body due to liquid is equal to the weight of the body in air.

---

# Chemistry

# Question 51

### Which of the following is correct increasing order for the value of $\frac{e}{m}$?

**Options:**

A. $e < p < n < \alpha$

B. $n < p < e < \alpha$

C. $n < p < \alpha < e$

D. $n < \alpha < p < e$

**Answer: D**

### Solution:

$n < \alpha < p < e$

| | $n$ | $\alpha$ | $p$ | $e$ |
|---|---|---|---|---|
| $e$ | 0 | +2 | +1 | -1 |
| $m$ | 1 | 4 | 1 | 1/1836 |
| $\frac{e}{m}$ | 0 | $\frac{1}{2}$ | 1 | 1836 |

---

# Question 52

### What is the structure of $XeF_6$?

**Options:**

A. Tetrahedral

B. Distorted octahedral

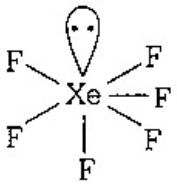
C. Octahedral

D. None of these

**Answer: B**

### Solution:

For $XeF_6$,




$H = \frac{1}{2}[V + Y - C + A]$

$= \frac{1}{2}[8 + 6 + 0 + 0] = 7$

Hybridisation = $sp^3d^3$

Due to the presence of one lone pair of electron, $XeF_6$ has distorted octahedral geometry.

---

# Question 53

### Lowering of vapour pressure is highest for

**Options:**

A. 0.1 M $Bacl_2$

B. 0.1 M glucose

C. 0.1 M $MgSO_4 2^2$

D. urea

**Answer: A**

**Solution:**

Lowering of vapour pressure is directly proportional to the van't Hoff factor ($i$). For $BaCl_2$, $i = 3$ (maximum) thus, $BaCl_2$ has highest value for relative lowering of vapour pressure.

---

# Question 54

**The set representing the correct order of ionic radius is**

**Options:**

A. $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$

B. $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$

C. $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$

D. $Mg^{2+} > Be^{2+} > Li^+ > Na^+$

**Answer: B**

**Solution:**

In general, the ionic radius increases on moving from top to bottom in group and decreases on moving from left to right in period So, the correct order is

$Na^+ > Li^+ > Mg^{2+} > Be^{2+}$

0.98Å 0.68Å 0.65Å 0.62Å

---

# Question 55

**During nuclear explosion one of the products is $^{90}Sr$ with half-life of 28.1 yr. If 1 μ g of of $^{90}Sr$ was absorbed in the bones of a newly born body instead of calcium, how much of it will remain after 60 yr, if it is not lost metabolically?**

**Options:**

A. 0.184 µg

B. 0.025 µg

C. 0.262 µg

D. 0.228 µg

**Answer: D**

**Solution:**

Half-life

$t_{1/2}$ = 28.1 yr

$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{28.1}$ $yr^{-1}$ For first order reaction,

$k = \frac{2.303}{k} \log \frac{a}{(a-x)}$

$a = 1\mu, t = 60$ yr, $k = \frac{0.693}{28.1} yr^{-1}$

$60 \text{ yr} = \frac{2.303}{0.693/28.1} \times \log \frac{a}{(a-x)}$

$\log \frac{a}{(a-x)} = \frac{(60 \text{ yr}) \times 0.693/28.1 \text{ yr}^{-1}}{2.303} = 0.642$

$\frac{a}{(a-x)}$ = antilog 0.642 = 4.385

$(a - x) = \frac{a}{4.385} = \frac{(1\mu g)}{4.385} = 0.2280$ µ g

Amount left after 60 yr = 0.2280 µ g

---

# Question 56

**NaOH is a strong base. What will be the pH of $5.0\times10^{-2}$ M NaOH solution? (log 2= 0.3)**

**Options:**

A. 14.00

B. 13.70

C. $13.002^2$

D. 12.70

**Answer: D**

**Solution:**

Given that,

$5.0\times10^{-2}$ M NaOH = $[OH^-] = 5 \times10^{-2}$ M

$[H^+][OH^-] = 1 \times 10^{-14}$

$[H^+]\ 5 \times 10^{-2} = 1 \times 10^{-14}$

$[H^+] = \frac{1 \times 10^{-14}}{5 \times 10^{-2}} = 2 \times 10^{-13}$

$pH = -\log[H^+] = -\log(2 \times 10^{-13})$

$= 12.69 = 12.70$

---

# Question 57

**The enthalpy of combustion for the $H_2$, cyclohexene and cyclohexane are -241, -3800 and -3920 kJ $mol^{-1}$, respectively. Heat of hydrogenation of cyclohexene is**

**Options:**

A. 121 kJ $mol^{-1}$

B. -121 kJ $mol^{-1}$

C. +242 kJ $mol^{-1}$

D. - 242 kJ $mol^{-1}$

**Answer: B**

**Solution:**

$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O,\ \Delta H$ = -241 kJ ....(i)

$C_6H_{10} + \frac{17}{2}O_2 \longrightarrow 6CO_2 + 5H_2O,$

$\Delta H$ = -3800 kJ ....(ii)

$C_6H_{12} + 9O_2 \longrightarrow 6CO_2 + 6H_2O,$

$\Delta H$ = -3920 kJ ....(iii)

Adding Eqs. (i) and (ii) then substracting Eq. (iii), we get

$\Delta H$ = -241 -3800- (-3920) = -121 kJ

---

# Question 58

**The $E^0_{M^{2+}/M^{3+}}$ values for Cr, Mn, Fe and Co are -0.41, +1.57, + 0.77 and 1.97 V, respectively. For which one of these metals the change in oxidation state from + 2 to + 3 is easiest?**

**Options:**

A. Cr

B. Mn

C. Fe $2^2$

D. Co

**Answer: A**

**Solution:**

$E^0_{Cr^{3+}/Cr^{2+}}$ = -0.41 V
$E^0_{Mn^{3+}/Mn^{2+}}$ = + 1.57 V
$E^0_{Fe^{3+}/Fe^{2+}}$ = + 0.77 V
$E^0_{Co^{3+}/Co^{2+}}$ = + 1.9
More negative value of $E^0_{Co^{3+}/Co^{2+}}$ indicates better reducing agent, thus easily oxidised. Thus oxidation of $Cr^{2+}$ to $Cr^{3+}$ is the easiest.

---

# Question 59

**The oxidation numbers of phosphorus in $Ba(H_2PO_2)_2$ and xenon in $Na_4XeO_6$ respectively are**

**Options:**

A. +3 and + 4

B. +2 and + 6

C. + 1 and +8 $2^2$

D. -1 and -6

**Answer: C**

**Solution:**

$Ba^{2+}(H_2\overset{+1}{P}\overset{x}{O}\overset{-2}{_2})_2$

$\therefore 2 + 2[2\times(+1) + x + 2\times(-2)] = 0$
Or $2 + 4 + 2x = 8 = 0$ or $x = +1$
And $Na_4\overset{+1}{X}\overset{x}{e}\overset{-2}{O_6}$
$\therefore 4\times1+x+6\times(-2) = 0$ or $x = +8$

---

# Question 60

**A colloidal system having a solid substance as a dispersed phase and a liquid as a dispersion medium is classified as**

**Options:**

A. solid sol

B. gel

C. emulsion

D. sol

**Answer: D**

**Solution:**

A colloidal system having a solid substance as a dispersed phase and a liquid as a dispersion medium is classified as sol.

---

# Question 61

**In a first reaction, the concentration of the reactant, decreases from 0.8 M to 0.4 M in 15 min. The time taken for the concentration to change from 0.1 M to 0.025 M is**

**Options:**

A. 30 min

B. 15 min

C. 7.5 min

D. 160 min

**Answer: A**

**Solution:**

Order = 1,
Concentration changes from 0.8 M to 0.4 M in (50%) 15 min, thus half-life = 15 min = $T_{50}$. A change from 0.1 M to 0.025 M is 75% and for first order reaction.
$T_{75} = 2 \times T_{50} = 2 \times 15 = 30$ min

---

# Question 62

**The value of $K_c$ for the dissociation reaction $H_2(g) \rightleftharpoons 2H(g)$ is $1.2 \times 10^{-42}$**

**Options:**

A. $H_2(g)$

B. H($g$) atom

C. 1 : 1molar mixture of $H_2$ and H $2^2$

D. 1 : 2 molar mixture of $H_2$ and H

**Answer: A**

## Solution:

Since, $K_c$ is very small, hence [$H_2$] is predominant.

---

# Question 63

## $K_{sp}$ of $CaSO_4$ is $4\times10^{-12}$. $CaSO_4$ is precipitated on mixing equal volumes of the following solutions.

**Options:**

A. $3 \times10^{-10}$ M $CaCl_2$ and $3 \times 10^{-6}$ M $(NH_4)_2$ $SO_4$

B. $4 \times10^{-6}$ M $CaCl_2$ and $3 \times 10^{-6}$ M $(NH_4)_2$ $SO_4$

C. $6 \times10^{-6}$ M $CaCl_2$ and $3 \times 10^{-16}$ M $(NH_4)_2$ $SO_4$

D. In all the above cases

**Answer: B**

## Solution:

A precipitate will form when two solutions are mixed if the ionic product is greater than the solubility product. This solution is called supersaturated solution.
$[Ca^{2+}]$ $[SO_4^{2-}] > K_{sp}$

In option B, the product of conc of the Ca2+ and $[SO_4^{2-}]$ is 12 x $10^{-12}$ which is more than the value of $K_{sp}$. Hence the correct answer is B.

---

# Question 64

## Which of the following is the correct decreasing order of oxidation state of nitrogen?

**Options:**

A. $HNO_3 > NO > NH_4Cl > N_2$

B. $HNO_3 > NO > N_2 > NH_4Cl$

C. $HNO_3 > NH_4Cl > NO > N_2$

D. NO > $HNO_3$ > $NH_4Cl$ > $N_2$

**Answer: B**

**Solution:**

Oxidation state of nitrogen decreasing as
$HNO_3$ =+5, NO=+2, $N_2$=0, $NH_4^+$=-3
$HNO_3$ > HO > $H_2$ > $NH_4Cl$

---

# Question 65

**Which of the following has highest electron affinity?**

**Options:**

A. N

B. O

C. F $2^2$

D. Cl

**Answer: D**

**Solution:**

The electron affinities of some of the elements of second period (i.e. N, O, F, etc) are however, lower then the corresponding elements (i.e. P, S, Cl, etc) of the third period. This is due to the reason that the elements of second period have the smallest stomic sizes amongst the elements in their respective groups. As a result, there are considerable electron-electron repulsion with the stom itself and hence, the additional electron is not accepted with the same case as compared to the remaining elements in the same group.

---

# Question 66

**The shape of $XeO_2F_2$ molecule is**

**Options:**

A. trigonal bipyramidal

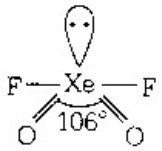
B. square planar

C. tetrahedral

D. see-saw

**Answer: D**

### Solution:




(See-saw, trigonal biphramidal)
The shape of $XeO_2F_2$ molecule in see-saw.

---

## Question 67

### The radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom?

**Options:**

A. $Li^{2+}$ ($n = 2$)

B. $Li^{2+}$ ($n = 3$)

C. $Be^{3+}$ ($n = 2$) $2^2$

D. $He^{+}$ ($n = 2$)

**Answer: C**

### Solution:

The expression for radii of stationary orbit is given by the expression:

$$r_n = 52.9\frac{n^2}{Z}\ pm$$

$$for\ H\ atom,\ n=1,\ Z=1$$

$$r_H = 52.9\frac{1^2}{1}\ pm$$

$$= 52.9\ pm$$

$$for\ Li^{2+},\ n=3,\ Z=3$$

$$r_{Li^{2+}} = 52.9\frac{3^2}{3}\ pm$$

$$= 3r_H$$

$$for\ Be^{3+}\ n=2,\ Z=4$$

$$r_{Be^{3+}} = 52.9\frac{2^2}{4}\ pm$$

$$= 52.9pm\ = r_H$$

$$for\ r_{He^+}\ n=2,\ Z=2.$$

$$r_{He^+} = 52.9\frac{2^2}{2}\ pm$$

$$= 2r_H$$

Thus, $Be^{3+}$($n$=2) has same radius as that of the first Bohr's orbit of H-atom. Hence, option (3) is correct.

---

# Question 68

**Calculate the osmotic pressure of 0.01 M solution of cane sugar at 300 K**
**($R$ = 0.08212 atm degree$^{-1}$ mol$^{-1}$)**

**Options:**

A. 0.3568 atm

B. 0.2463 atm

C. 0.1562 atm

D. 0.5623 atm

**Answer: B**

**Solution:**

Given,
$C$=0.01 M=0.01 mol/L
$R$= 0.0821 L atm/K/mol,
$T$= 300 K. π = $CRT$
π=0.01×0.0821×300=0.2463 atm

---

# Question 69

**van der waals' real gas, acts as an ideal gas at which condition?**

**Options:**

A. High temperature, low pressure

B. Low temperature, high pressure

C. High temperature, high pressure

D. Low temperature, low pressure

**Answer: A**

**Solution:**

At higher temperature and low pressure real gas acts as an ideal gas and obey $pV = nRT$ relation.

---

# Question 70

**Given, $E^0_{Cr^{3+}/Cr}$= -0.72 V, $E^0_{Fe^{2+}/Fe}$= -0.42 V. The potential for the cell $CrCr^{3}$+(0.1 M) $Fe^{2+}$ (0.01 M)Fe is**

**Options:**

A. 0.26 V

B. 0.399 V

C. - 0.399 V $2^2$

D. - 0.26 V

**Answer: A**

**Solution:**

$CrCr^{3}$+(0.1 M) $Fe^{2+}$ (0.01 M)Fe

Oxidation half-cell

$Cr \rightarrow Cr^{3+} + 3e^-]\times 2$

Reduction half-cell

$Fe^{2+} + 2e^- \rightarrow Fe]\times 3$

Net cell reaction

$2Cr + 3Fe^{2+} \rightarrow 2Cr^{3+} + 3Fe,\ n = 6$

$E^0_{cell} = E^0_{oxi} + E^0_{red}$

$= 0.72 - 0.42 = 0.30\ V$

$E^0_{cell} = E^0_{cell} - \frac{0.0591}{n} \log \frac{[Cr^{3+}]^2}{[Fe^{2+}]^3}$

$= 0.30 - \frac{0.0591}{6} \log \frac{(0.1)^2}{(0.01)^3}$

$= 0.30 - \frac{0.0591}{6} \log \frac{10^{-2}}{10^{-6}}$

$= 0.30 - \frac{0.0591}{6} \log 10^4$

$E_{cell} = 0.2606\ V$

---

# Question 71

**In a reaction, $A + B \longrightarrow C$, the rate expression is $R = k[A][B]^2$. If the concentration of both the reactant is doubled at constant volume, then the rate of the reaction will be**

**Options:**

A. eight times

B. double

C. quadruple

D. triple

**Answer: A**

**Solution:**

Given, $R = k[A][B]^2$

When $[A'] = [2A] \text{and} [B'] = [2B]$

$R' = k[2A][2B]^2$

$= k[2A]4[B]^2 = 8\ k[A][B]^2$

$R' = 8R$

Thus, the rate will become eight times.

---

# Question 72

**Ionisation energy in group 1A varies in the decreasing order as**

**Options:**

A. Li > Na > K > Cs

B. Na > Li > K > Cs

C. Li > Cs > K > Na

D. K > Cs > Na > Li

**Answer: A**

**Solution:**

Atomic size increases as we move from top to down in a group, therefore, the amount of energy required for ejection of an electron from atom decreases, i.e. ionisation energy decreases. Hence, the correct order of $IE_1$ is
Li > na > K > Cs

---

# Question 73

**Intramolecular hydrogen bond is present in**

**Options:**

A. water

B. *o*-nitrophenol

C. *p*-nitrophenol

D. methylamine

**Answer: B**

**Solution:**

Intramolecular H-bonding is present in ortho-nitrophenol.

---

# Question 74

**Which one of the following species acts as both Bronsted acid and base?**

**Options:**

A. $H_2PO_2^-$

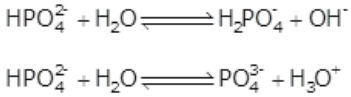
B. $HPO_3^{2-}$

C. $HPO_4^{2-}$ $2^2$

D. All of these

**Answer: C**

**Solution:**



$HPO_4^{2-}$ is a conjugate base of $H_3PO_2$ (a monobasic acid) and does not give $H^+$, $HPO_3^{2-}$ is a conjugate base of $H_2PO_3^-$ and does not ionise further. Since, $H_3PO_3$ is a dibasic acid.

---

# Question 75

**The reaction,**
**$SO_2 + O_2 \rightleftharpoons 2SO_3$ + Heat**
**The equilibrium reaction proceeds in forward direction by**

**Options:**

A. addition of $O_2$

B. removal of $O_2$

C. addition on inert gas

D. cannot proceed

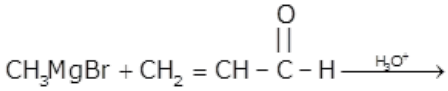
**Answer: A**

**Solution:**

According to Le-Chatelier's principle, equilibrium shift towards forward direction by addition of reactant.

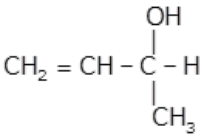
---

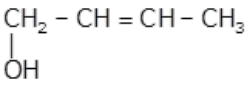
# Question 76



**Product It is (1 : addition)**

**Options:**

A. 

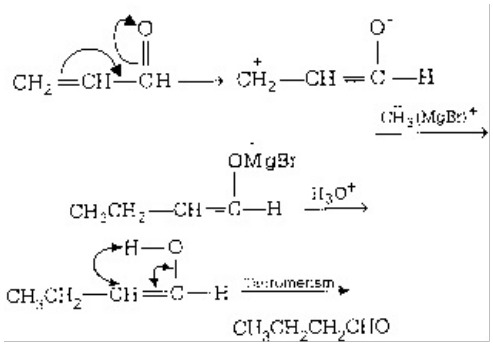
B. 

C. $CH_3CH_2CH_2CHO$

D. None of the above

**Answer: C**

## Solution:



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# Question 77

### Teflon is an example of polymer which is a/an

**Options:**

A. polyamide

B. addition polymer

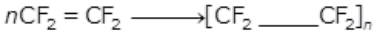
C. polyester

D. formaldehyde resin

**Answer: B**

## Solution:

Teflon is prepared by the combination of a large number of tetrafluoroethylene molecules, without the elimination of any small molecule. Therefore, it is an example of addition homopolymer.



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# Question 78

### Which of the following are addition polymers?

**Options:**

A. Nylon

B. Melamine formaldehyde resin

C. Orion

D. All of these

**Answer: C**

**Solution:**

Orlon is an addition polymer as its molecular mass is integral multiple of molecular mass of its monomer.

---

# Question 79

**Which one is least reactive in a nucleophilic substitution reaction?**

**Options:**

A. $CH_3CH_2Cl$

B. $CH_2 = CHCH_2Cl$

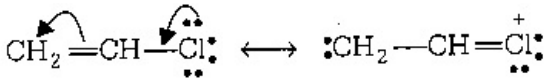
C. $CH_2 = CHCl$

D. $(CH_3)_3CCl$

**Answer: C**

**Solution:**

Vinyl chloride is least reactive for $S_N$ reaction due to resonance stabilisation of C____Cl bond.



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# Question 80

**Red lead is**

**Options:**

A. PbO

B. $Pb_3O_4$

C. $PbO_2$

D. $Pb_4O_3$

**Answer: B**

### Solution:

$Pb_3O_4$ or $PbO_2$ . 2PbO is called red lead.

---

# Question 81

### Setting of Plaster of Paris is

**Options:**

A. dehydration

B. oxidation with atmospheric oxygen

C. combination with atmospheric $CO_2$

D. hydration to yield another hydrate

**Answer: D**

### Solution:

Setting of plaster of Paris is exothermic process.

$$CaSO_4 \cdot \frac{1}{2}H_2O \xrightarrow{H_2O} \underset{\text{Orthorhombic}}{CaSO_4 \cdot 2H_2O} \xrightarrow{\text{Heating}} \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$$

---

# Question 82

### Benzaldehyde reacts with $CH_3NH_2$ forming

**Options:**

A. Schiff’s base

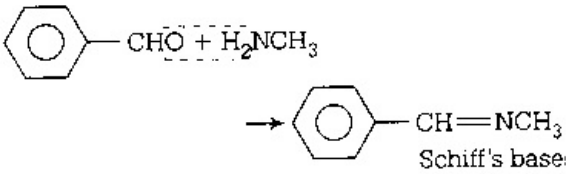
B. Hofmann base

C. Saytzeff base

D. None of these

**Answer: A**

### Solution:

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# Question 83

## Which is soluble in $NaNO_2$ and dil. HCl mixture and forming salt?

**Options:**

A. $(CH_3)_3CNH_2$

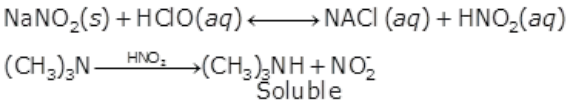
B. $(CH_3)_2CHNH_2$

C. $(CH_3)_2NH$

D. $(CH_3)_3N$

**Answer: D**

## Solution:

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# Question 84

## Which among the following will show anisotrophy?

**Options:**

A. Glass

B. Plastic

C. Barium chloride

D. Wood

**Answer: C**

## Solution:

Crystalline solids such as NaCl, $BaCl_2$, etc, will show anisotrophy.

---

# Question 85

**An example of a non-stoichiometric compound is**

**Options:**

A. PbO

B. $NiO_2$

C. $Al_2O_3$

D. $Fe_3O_4$

**Answer: D**

**Solution:**

$Fe_3O_4$ is a non-stochiometric compound because in it, the ratio of the cations to the anions becomes different from that indicated by the chemical formula.

---

# Question 86

**IA solution of D-glucose in water rotates the plane of polarised light**

**Options:**

A. to the left

B. to the right

C. to either side

D. None of these

**Answer: B**

**Solution:**

Natural glucose is *dextro*-rotatory (clockwise) and this glucose is also known as dextrose. Thus, it rotate the plane polatised light to the right.

---

# Question 87

**Which of the following pairs give positive Tollen’s test?**

**Options:**

A. Glucose, sucrose

B. Glucose, Fructose

C. Hexaual, acetophenone

D. Fructose, sucrose

**Answer: B**

**Solution:**

Only aldehyde give positive Tollen's test. However under the strongly basic condition of the test α -hydroxy ketones can isomerize to aldehydes (i.e. endiol rearrangement in fructose that inter convert ketones to aldoses.) so that's why will also gives a positive Tollen's test α -hydroxy ketones.

---

# Question 88

**Which pair of polymers have similar properties?**

**Options:**

A. Nylon, PVC

B. PAN, PTFE

C. PCTFE, PTFE

D. Bakelite, alkyle resin

**Answer: C**

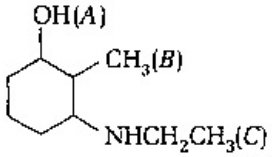
**Solution:**

PCTFE, PTFE both have same carbon backbone.
$[CIFC\_\_\_CF_2]_n$
$PCTFE[F_2C\_\_CF_2]_n$
(polymonochloro tetrafluoro ethylene)
PTFE (polytetrafluoro ethylene)

---

# Question 89

**In the following compound, groups designated as *A, B, C* will be numbered as**



**Options:**

A. 3, 2, 1

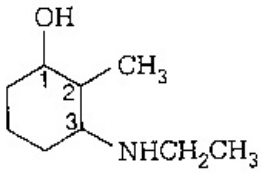
B. 6, 1, 2

C. 3, 1, 2

D. 1, 2, 3

**Answer: D**

## Solution:

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# Question 90

### Which of the following type of forces are present in vulcanised rubber?

**Options:**

A. Weakest intermolecular forces

B. Hydrogen bonding

C. Three dimensional network of bonds

D. Metallic bonding

**Answer: A**

## Solution:

Vulcanised rubber is highly elastic, so weakest intermolecular force present in it.

---

# Question 91

### Number of esters of the molecular formula $C_3H_6O_2$ can be

**Options:**

A. 4

B. 3

C. 2

D. 1

**Answer: C**

### Solution:

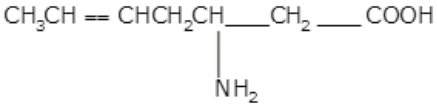
$CH_3COOCH_3.HCOOCH_2CH_3$

Thus, two esters

---

# Question 92

### The IUPAC name for



**Options:**

A. 5- amino-2-heptenoic acid

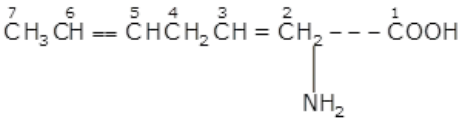
B. 5-amino hex-2-ene-carboxylic acid

C. 3-amino-5-heptenoic acid

D. β-amino-δ-heptenoic acid

**Answer: C**

### Solution:

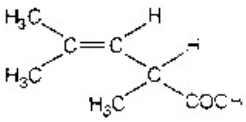


3 amino-5-heptenoic acid

---

# Question 93

### The following compound can exhibit



**Options:**

A. geometrical isomerism

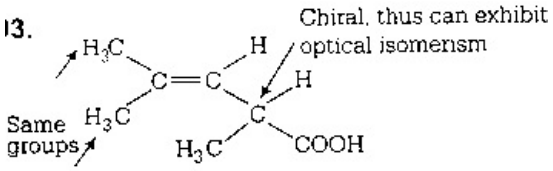
B. geometrical and optical isomerism

C. optical isomerism

D. tautomerism

**Answer: C**

**Solution:**




Hence, geometrical isomers are not possible.

---

# Question 94

### If $\Delta H_f$ ($H_2O$) is -286.20 kJ $mol^{-1}$, then $\Delta H_f^o$ ($OH^-$) is

**Options:**

A. -228.88 kJ $mol^{-1}$

B. +228.88 kJ $mol^{-1}$

C. -343.52 kJ $mol^{-1}$

D. +343.52 kJ $mol^{-1}$

**Answer: A**

**Solution:**

$H^+ + OH^- \rightarrow H_2O$, $\Delta H$ = -57.3 kJ $mol^{-1}$
(standard value)
$\Delta H = \Delta H_f^o = (H_2O) - \Delta H_f^o (H^+) - \Delta H_f^o (OH^-)$
$-57.3 = -286.2 - 0 - \Delta H_f^o (OH^-)$
$\Delta H_f^o (OH^-)$ = -228.9 kJ $mol^{-1}$

---

# Question 95

### 1 mole of gas occupying 3 L volume is expanded against a constant external pressure of 1 atm to a volume of 15 L. The work done by a system is equal to

**Options:**

A. - 1.215 × $10^3$ J

B. - 12.15 × $10^3$ J

C. +1.215 × $10^3$ J

D. + 12.15 × $10^3$ J

**Answer: A**

**Solution:**

$P_{ext}$= 1 atm
$V_1$= 3L $V_2$= 3L
As work is done against constant external pressure, the process is irreversible.
W = - $P_{ext}$ Δ $V$
= -1 atm [15 – 3]L = -12 atm L
= -12 × 101.3 J[11 atm = 1013 J]
= -1215.6 J = -1.2156 × $10^3$ J

---

# Question 96

**Which is not an electrophile?**

**Options:**

A. $\overset{+}{C}H_5$

B. $\overset{+}{C}H_3$

C. $BF_3$

D. $SO_3$

**Answer: A**

**Solution:**

$\overset{+}{C}H_5$has eight electrons (octet complete) on carbon. Thus, $\overset{+}{C}H_5$ is not an electrophile.

---

# Question 97

**Concentrated $HNO_3$ forms $NO_2^+$ in the presence of**

**Options:**

A. Conc. $H_2SO_4$

B. Fe

C. $FeBr_3$

D. $AlCl_3$

**Answer: A**

**Solution:**

Conc. $H_2SO_4$

---

# Question 98

### TEL is a compound used as

**Options:**

A. antibiotic

B. antiseptic

C. antiknocking

D. antioxidant

**Answer: C**

**Solution:**

Antiknocking compound are the chemicals which reduce knocking by improving the quality of gasoline, e.g. TEL (Tetra ethyl lead)

---

# Question 99

### Aldol condensation reaction is not given by

**Options:**

A. $C_6H_5CH_2CHO$

B. $C_6H_5CHO$

C. $CH_3CHO$

D. $CH_3COCH_3$

**Answer: B**

**Solution:**

$C_6H_5CHO$ has no H at α-carbon. Thus, no aldol condensation.

---

# Question 100

**Petroleum is obtained from water gas, name of the reaction involved ise**

**Options:**

A. Fischer-Tropsch

B. Benzoic

C. Dow’s

D. Kieldahl’s

**Answer: A**

**Solution:**

**Fischer-Tropsch Process**In this method carbon monoxide needed, is made by passing steam over red hot coke. The water gas thus obtained is mixed with hydrogen and passed at a pressure of 5-10 atm into a chamber containing a cobalt catalyst at 200 ºC.

$$n\mathrm{CO} + (2n + 1)\mathrm{H_2} \xrightarrow[200^\circ \mathrm{C}]{5\text{-}10\,\mathrm{atm}} \mathrm{C}_n\mathrm{H}_{2n+2} + 4\mathrm{H_2O}$$

The product is a mixture consisting mainly of liquid hydrocarbons.

---

## Maths

# Question 101

**Let Z denotes the set of all integers and $A = \{(a,b) : a^2 + 3b^2 = 28, a, b \in Z\}$ and $B = \{(a, b) : a < b, a, b \in Z\}$. Then, the number of elements in $AB$ is**

**Options:**

A. 2

B. 4

C. 6

D. 5

**Answer: C**

**Solution:**

$\because A = \{(a,b) : a^2 + 3b^2 = 28, a, b \in \mathrm{Z}\}$

$=\{(5, 1), (-5, -1), (5, -1), (-5, 1) (4, 2), (-4, -2), (4, -2), (-4, 2), (1, 3), (-1, -3), (1, -3), (-1, 3)\}$

And $B = \{(a, b) : a < b, a, b \in Z\}$
$\therefore AB = \{(1, 3), (-1, 3), (-4, -2), (-4, 2), (-5, -1), (-5, 1)\}$
$\therefore$The number of elements in $AB$ is 6.

---

# Question 102

**If two sets $A$ and $B$ are having 39 elements in common, then the number of elements common to each of the sets $A \times B$ and $B \times A$ are**

**Options:**

A. $2^{39}$

B. $39^2$

C. $782^{2x}$

D. 351

**Answer: B**

**Solution:**

The number of elements common to each set is $39 \times 39 = (39)^2$

---

# Question 103

**The domain of the function $f(x) = \frac{\sqrt{4 - x^2}}{\cos^{-1}(2 - x)}$ is**

**Options:**

A. [0, 2]

B. [0, 2)

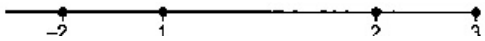
C. (1, 2]

D. [1, 2]

**Answer: C**

**Solution:**

Given, $f(x) = \frac{\sqrt{4 - x^2}}{\cos^{-1}(2 - x)}$
For, $f(x)$ to be defined $4 - x^2 \geq 0$, $-1 \leq 2 - x \leq 1$ and $2 - x \neq 1$
$-2 \leq x \leq 2$ and $-1 \leq 2 - x \leq 1$
$-2 \leq x \leq 2$ and $-3 \leq -x \leq -1$
$-2 \leq x \leq 2$ and $1 \leq x \leq 3$



∴Domain of $f(x)$ = (1, 2]

---

# Question 104

**If $a_1$, $a_2$, $a_3$, ....are terms of AP such that $a_1+a_5+a_{10}+a_{15}+a_{20}+a_{24}$ = 225, then the sum of first 24 terms is**

**Options:**

A. $9 \times 10^2$

B. $9 \times 10^3$

C. $10 \times 9^2 2^{2x}$

D. $10 \times 9^3$

**Answer: A**

**Solution:**

We know that the sum of terms of AP equidistant from the beginning and end is always same and it is always equal to the sum of first and last terms.

$a_1 + a_{24} = a_5 + a_{20} = a_{10} + a_{15}$

$\therefore a_1 + a_5 + a_{10} + a_{15} + a_{20} + a_{24} = 225$

$\therefore 3(a_1 + a_{24}) = 225$ $a_1 + a_{24} = 75$

$\therefore S_{24} = \frac{24}{2}(a_1 + a_{24})$

$\left[\because S_n = \frac{n}{2}(a_1 + a_n)\right]$

$= 12(75) = 900 = 9 \times 10^2$

---

# Question 105

**A cricket team plays $x$ number of matches in winter and wins $m$ matches. Further, it plays $y$ number of matches in summer and wins $n$ matches. Its winning probability in both the seasons is**

**Options:**

A. $\frac{m}{x} \cdot \frac{n}{y}$

B. $\frac{x}{m} - \frac{y}{n}$

C. $\frac{m+n}{x+y}$

D. $\frac{x+y}{m+n}$

**Answer: C**

**Solution:**

Total number of matches in both seasons = $x + y$
Number of winning matches = $m + n$
∴Required probability = $\frac{m+n}{x+y}$

---

# Question 106

**The probabilities that Mr. *A* and Mr. *B* will die within a year are $\frac{1}{2}$ and $\frac{1}{3}$ respectively, then the probability that only one of them will be alive at the end of the year, is**

**Options:**

A. $\frac{5}{6}$

B. $\frac{1}{2}$

C. $\frac{2}{3}2^{2x}$

D. None of the above

**Answer: B**

**Solution:**

Let $A$ be the event that Mr. $A$ will die and $B$ be the event that Mr. $B$ will die. Then, required probability = $P$ [($A$ will die and $B$ will alive) or ($B$ will die and $A$ alive)]
= $P$ [$AB'$) ($BA'$)]
= $P$ [$AB'$) + ($BA'$)]
[∵ these events are mutually exclusive]
= $P$ ($A$). $P$($B'$) + $P$($B$) . $P$($A'$)
[∵$A$and $B$ are independent]

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

$= \frac{2}{6}+\frac{1}{6}=\frac{3}{6}=\frac{1}{2}$

---

# Question 107

**The number of solutions of the system of equations $2x + y - z = 7$, $x - 3y + 2z = 1$ and $x + 4y - 3z = 5$ is**

**Options:**

A. 0

B. 1

C. $22^{2x}$

D. 3

**Answer: A**

**Solution:**

Consider the given system of equations
$2x + y - z = 7$ .....(i)
$x - 3y + 2z = 1$ .....(ii)
And $x + 4y - 3z = 5$ ....(iii)
From Eqs (i) and (ii), we get
$5x - y = 15$ .....(iv)
And from Eqs. (i) and (ii), we get
$5x - y = 16$ .....(v)
Since, Eqs (iv) and (v) shows that they are parallel and so solution does not exist.

---

# Question 108

**The maximum resultant of two forces is $2P$ and the minimum resultant is $2Q$, the two forces are at right angles, then the resultant is**

**Options:**

A. $P + Q$

B. $P - Q$

C. $\sqrt{\frac{P^2 + Q^2}{2}}\ 2^{2x}$

D. $\sqrt{2(P^2 + Q^2)}$

**Answer: D**

**Solution:**

Let the two forces be $F_1$ and $F_2$.
Then, maximum resultant = $2P = F_1 + F_2$
And minimum resultant = $2Q = F_1 - F_2$
Thus, $F_1 = P + Q$ and $F_2 = P - Q$
∴Resultant ($R$) = $\sqrt{F_1^2 + F_2^2}$

$= \sqrt{2P^2 + 2Q^2} = \sqrt{2(P^2 + Q^2)}$

---

## Question 109

**In a right angle Δ*ABC*, *A*= 90 º and sides *a, b, c* are respectively 10 cm, 8 cm, and 6 cm. If a force F has moments 0, 64 and 36 N-cm respectively about vertices *A, B* and *C*, then magnitude of F is**

**Options:**

A. 9

B. 4

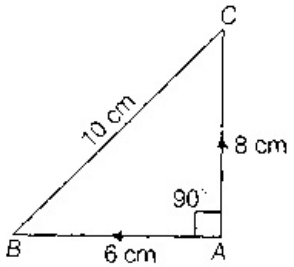
C. $102^{2x}$

D. 8

**Answer: C**

**Solution:**

Since, moment of **F** about $A$ is 0, therefore **F** passes through $A$. Let the components of **F** along $AB$ and $AC$ be $X$ and $Y$ respectively, then moment of **F** about $B$ = 36.




$6Y = 36$
$Y = 6$
Also, moment of **F** about $C$ = 64
$8X = 64$
$X = 8$

Hence, $F^2 = X^2 + Y^2$
$= 64 + 36 = 100$
$\therefore F = 10$

---

# Question 110

**The maximum horizontal range of a ball projected with a velocity of 40 m/s is (take $g$ = 9.8 m/s$^2$)**

**Options:**

A. 157 m

B. 127 m

C. 163 m$2^{2x}$

D. 153 m

**Answer: C**

**Solution:**

Maximum horizontal range
$= \frac{u^2}{g}$
$= \frac{(40)^2}{9.8}$ [$\because$ $u$ = 40 m/s]
$= \frac{1600}{9.8}$
$= 163.3 = 163$ m (approx.)

---

# Question 111

**A train of length 100 m travelling at 20 m/s overtakes another of length 200 m travelling at 10 m/s. The time taken by the first train to pass the second train is**

**Options:**

A. 30 s

B. 50 s

C. 10 s$2^{2x}$

D. 40 s

**Answer: A**

**Solution:**

Distance covered by the first train to pass the second train = (100 + 200)m = 300 m
[Since, both trains are travelling in the same direction.]
And velocity of first train relative to second train = (20-10) = 10 m/s
∴Time taken by the first train to pass the second train
$= \frac{300}{10} = 30$ s

---

# Question 112

**If $a \leq 3\cos x + 5\sin\left(x - \frac{\pi}{6}\right) \leq b$ for all $x$, then [a, b] is**

**Options:**

A. $\left[-\sqrt{19}, \sqrt{19}\right]$

B. (-17, 17)

C. $(-\sqrt{21}, \sqrt{21})2^{2x}$

D. None of these

**Answer: A**

**Solution:**

Let $f(x) = 3\cos x + 5\sin\left(x - \frac{\pi}{6}\right)$

$= 3\cos x + 5\left[\sin x.\frac{\sqrt{3}}{2} - \cos x.\frac{1}{2}\right]$

$= \frac{\cos x}{2} + \frac{5\sqrt{3}}{2}\sin x$

$\therefore -\sqrt{\left(\frac{1}{2}\right)^2 + \left(\frac{5\sqrt{3}}{2}\right)^2} \leq f(x) \leq \sqrt{\left(\frac{1}{2}\right)^2 + \left(\frac{5\sqrt{3}}{2}\right)^2}$

$-\sqrt{19} \leq f(x) \leq \sqrt{19}$

---

# Question 113

**If $\frac{1}{6}\sin^2\theta$, $\cos\theta$ and $\sec\theta$ are in GP, then $\theta$ is equal to ($nZ$)**

**Options:**

A. $2n\pi \pm \frac{\pi}{3}$

B. $2n\pi \pm \frac{\pi}{6}$

C. $n\pi + (-1)^n \frac{\pi}{3} 2^{2x}$

D. $n\pi + \frac{\pi}{3}$

**Answer: A**

**Solution:**

Since, $\frac{1}{6}\sin^2\theta$, $\cos\theta$ and $\sec\theta$ are in GP.

$\therefore \cos^2\theta = \frac{1}{6}\sin^2\theta . \sec\theta$

$6\cos^2\theta = \frac{\sin^2\theta}{\cos\theta}$

$6\cos^3\theta = (1 - \cos^2\theta)$

$6\cos^3\theta + \cos^2\theta - 1 = 0$

$(2\cos\theta - 1)(3\cos^2\theta + 2\cos\theta + 1) = 0$

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

$\theta = 2n\pi \pm \frac{\pi}{3}, n \in Z$

[$\because$ other factor gives imaginary roots]

---

# Question 114

**A house of height 100 m substends a right angle at the window of an opposite house. If the height of the window is 64 m, then the distance between the two houses is**

**Options:**

A. 48 m

B. 36 m

C. 54 $m 2^{2x}$

D. 72 m

**Answer: A**

**Solution:**

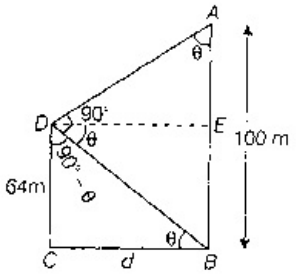
In $\Delta BCD$,

$64 \cot\theta = d$

$\tan\theta = \frac{64}{d}$ ....(i)

Also in $\Delta AED$,

$(100 - 64) \tan\theta = d$




$36\left(\frac{64}{d}\right) = d$ [From Eq. (i)]

$d^2 = 36 \times 64$

$d = 6 \times 8 = 48$ m

---

# Question 115

**If *A* and *B* are two fixed points, then the locus of a point which moves in such a way that the *APB* is a right angle, is**

**Options:**

A. a circle

B. an ellipse

C. a parabola$2^{2x}$

D. None of these

**Answer: A**

**Solution:**

Let $A(x_1 y_1)$ and $B(x_2 y_2)$ be two fixed points and $P(h, k)$ be a variable point such that

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

$\frac{k - y_1}{h - x_1} \times \frac{k - y_2}{h - x_2} = -1$

$(h - x_1)(h - x_2) + (k - y_1)(k - y_2) = 0$

Hence, locus of $(h, k)$ is

$(x - x_1)(x - x_2) + (y - y_1)(y - y_2) = 0$

Which is a circle having $AB$ as diameter.

Then, slope of $AP \times$ slope of $BP = -1$

---

# Question 116

**The point on the line $4x + 3y = 5$, which is equidistant from (1,2) and (3,4) is**

**Options:**

A. (7, -4)

B. (-10, 15)

C. $\left(\frac{1}{7}, \frac{8}{7}\right)$ $2^{2x}$

D. $\left(0, \frac{5}{4}\right)$

**Answer: B**

**Solution:**

Let the point $(x_1, y_1)$ be on the line $4x+3y = 5$

$\therefore 4x_1+3y_1 = 5$ ....(i)

Also, we have

$(x_1\text{-}1)^2 + (y_1 - 2)^2 = (x_1\text{-}3)^3+(y_1 - 4)^2$

$x_1^2+1 - 2x_1+y_1^2+4 -4y_1 = x_1^2 +9 - 6x_1$

$+ y_1^2+16 - 8y_1$

$4x_1 + 4y_1 = 20$

$x_1 + y_1 = 5$ ..(ii)

From Eqs. (i) and (ii), we get

$y_1 = 15$ and $= x_1 = -10$

---

# Question 117

**If *OA* and *OB* are the tangents to the circle $x^2 + y^2 - 6x - 8y + 21 = 0$ drawn from the origin *O*, then *AB* is equal to**

**Options:**

A. 11

B. $\frac{4}{5}\sqrt{21}$

C. $\sqrt{\frac{17}{3}}$ $2^{2x}$

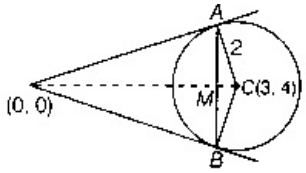
D. None of these

**Answer: B**

**Solution:**

Given equation of circle is

$x^2 + y^2 - 6x - 8y + 21 = 0$
whose centre = (3, 4)
and radius = $\sqrt{9+16-21} = 2$
Clearly, the line $AB$ is chord of contact and its equation is
$xx_1 + yy_1 + g(x+x_1)+f(y + y_1)+c = 0$
Here $(x_1, y_1) = 0\ (0, 0)$
$\therefore 0+0-3(x + 0) - 4(y + 0) + 21 = 0$
$3x + 4y - 21 = 0$ .....(i)




Now, perpendicular distance from (3, 4) to the line (i) is
$CM = \frac{3(3)+4(4)-21}{\sqrt{9+16}} = \frac{4}{5}$
$AM = \sqrt{AC^2 + CM^2} = \sqrt{4 - \frac{16}{25}} = \frac{2}{5}\sqrt{21}$
$\therefore AB = 2AM = \frac{4}{5}\sqrt{21}$

---

## Question 118

**The point of the contact of the tangent to the parabola $y^2 = 4ax$ which makes an angle of 30 º eith $X$-axis, if**

**Options:**

A. $(3a, 2\sqrt{3}\,a)$

B. $(2\sqrt{3}\,a, 3a)$

C. $(\sqrt{3}\,a, 6a)2^{2x}$

D. None of these

**Answer: A**

**Solution:**

We have, slope of tangent = tan 30 º = $\frac{1}{\sqrt{3}}$
Now, the equation of tangent at $(h, k)$ to $y^2 = 4ax$ is $yk = 2a(x + h)$.
On comparing the slopes, we get
$\frac{2a}{k} = \frac{1}{\sqrt{3}}$
Or $k = 2\sqrt{3}a$

And $h = 3a$

$\therefore (h, k) = (3a, 2\sqrt{3}a)$

---

# Question 119

**In an ellipse, if the joining focus to the extremities of the minor axis form an equilateral triangle with the minor axis, then the eccentricity of the ellipse is**

**Options:**

A. $\frac{\sqrt{3}}{2}$

B. $\frac{\sqrt{3}}{4}$

C. $\frac{1}{\sqrt{2}} 2^{2x}$

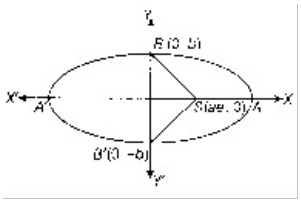
D. $\sqrt{\frac{2}{3}}$

**Answer: A**

**Solution:**

Consider, the horizontal ellipse

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, where $a^2 > b^2$




Since, $BB'S$ is an equilateral triangle.

$\therefore BS = BB'$

$\sqrt{(ae - 0)^2 + (0 - b)^2} = \sqrt{0 + (2b^2)}$

$a^2e^2 + b^2 = 4b^2$

$b^2 = \frac{a^2e^2}{3}$

Now, $e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{e^2}{3}}$

$e^2 = 1 - \frac{e^2}{3}$

$\frac{4e^2}{3} = 1$

$e = \frac{\sqrt{3}}{2}$

---

# Question 120

**The equations of the tangents drawn at the ends of the major axis of the ellipse $9x^2 + 5y^2 - 30y = 0$ are**

**Options:**

A. $y = \pm 3$

B. $x = \pm\sqrt{5}$

C. $y = 0$, $y = 6$

D. None of the above

**Answer: C**

**Solution:**

Given equation of ellipse is

$9x^2 + 5y^2 - 30y = 0$

The above equation can be reqritten as

$9x^2 + 5(y^2 - 6y) = 0$

$9x^2 + 5(y - 6y+9) = 45$

$9x^2 + 5(y - 3)^2 = 45$

$x^2/5 + (y - 3)^2 / 9 = 1$

Since, $a^2 < b^2$, so axis of ellipse if $Y$-axis.

To fine vertex at $Y$-axis, put = 0

$\therefore 5(y - 3)^2 = 45$

$(y - 3)^2 = 9$

$y - 3 = \pm 3$

$y = 0$ or $y = 6$

Therefore, tangents at vertex are $y = 0$, $y = 6$

---

# Question 121

**For the equation $10z^2 - 4iz - m = 0$, where $z$ is a complex variable and $i = \sqrt{-1}$, which of the following is true?**

**Options:**

A. Roots are purely imaginary for all negative real values of $m$

B. Roots are not real for all complex numbers $m$

C. Roots are purely imaginary for all positive real values of $m$

D. None of the above

**Answer: A**

**Solution:**

We have, $10z^2 - 4iz - m = 0$

$$z = \frac{4i \pm \sqrt{-16 + 40m}}{20}$$

$$= \frac{4i \pm 2\sqrt{-4 + 10m}}{20}$$

$$= \frac{2i \pm \sqrt{-4 + 10m}}{10}$$

The roots are either purely imaginary or complex

For purely imaginary roots,

$-4 + 10m < 0$

$-2 + 5m < 0$

$m < (2/5)$

If $m$ is a negative real number. Then $D$ is a negative real number.

So, option A. is true.

---

# Question 122

**The $n$th term of the series 5+7+13+31+85+....is**

**Options:**

A. $3^{n-1} + 2$

B. $3 + 3^{n-1}$

C. $4 + 3^{n-1}$

D. None of these

**Answer: C**

**Solution:**

Let

$S_n = 5+7+13+31+85+...+T_{n-1} + T_n$ ...(i)

$S_n = 5+7+13+31+...+T_{n-2} + T_{n-1} + T_n$ ...(ii)

On substracting Eq. (ii) from Eq. (i), we get

$0 = 5 + [2+6+18+...\text{to } (n-1)\text{terms}] - T_n$

$T_n = 5 + [2+6+18+...\text{to } (n+1)\text{terms}]$

$= 5 + \frac{2(3^{n-1}-1)}{3-1} \left[\because S^n = \frac{a(r^n-1)}{r-1}, r>1\right]$

$= 5 + 3^{n-1} - 1 = 4 + 3^{n-1}$

---

# Question 123

**The last two digits of the number $3^{400}$ are**

**Options:**

A. 81

B. 43

C. $292^{2x}$

D. 01

**Answer: D**

**Solution:**

Consider, $3^{400} = (3^4)^{100}$

$= (81)^{100} = (1+80)^{100}$

$= {}^{100}C_0 + {}^{100}C_1 80 + {}^{100}C_2 (80)^2$

$+....+ {}^{100}C_{100}(80)^{100}$

So, last two digits are 01.

---

# Question 124

**If** $\begin{vmatrix} x & 2 & 8 \\ 2 & 8 & x \\ 8 & x & 2 \end{vmatrix} = \begin{vmatrix} 3 & x & 7 \\ x & 7 & 3 \\ 7 & 3 & x \end{vmatrix} = \begin{vmatrix} 5 & 5 & x \\ 5 & x & 5 \\ x & 5 & 5 \end{vmatrix}$ **= 0 then $x$ is equal to**

**Options:**

A. 0

B. -10

C. $32^{2x}$

D. None of these

**Answer: B**

**Solution:**

On applying
$R_1 \rightarrow R_1 + R_2 + R_3$ in each determinant, we can take out $(x+10)$ common.
Then, we get $x+10 = 0$
$x = -10$

---

# Question 125

**Let $R$ = {(1,1) (1,3), (4,2), (2,4), (2,3),(3,1)} be a relation on the set $A$ = {1, 2, 3, 4}. The relation $R$ is**

**Options:**

A. a function

B. transitive

C. not symmetric

D. reflexive

**Answer: C**

**Solution:**

We have, $R$ = {(1,1) (1,3), (4,2), (2,4), (2,3),(3,1)} is a relation on $A$ = {1, 2, 3, 4} then
(a) Since, (2,4) and (2,3) $R$ so $R$ is not function.
(b) Since, (4,2) $R$ and (2,4) $R$ but (4,4) $R$ so $R$ is not transitive.
(c) Since, (2,3) $R$ but (3,2) $R$ so $R$ is not symmetric.
(d) Since, (4,4), (2,2), (3,3) $R$ so $R$ is not reflexive.

---

# Question 126

**If $\alpha = \sin^{-1}(\cos(\sin^{-1}x))$ and $= \beta = \cos^{-1}(\sin(\cos^{-1}x))$, then $\tan\alpha.\tan\beta$ is equal to**

**Options:**

A. 1

B. -1

C. 2

D. $\frac{1}{2}$

**Answer: A**

**Solution:**

We have, $\alpha = \sin^{-1}(\cos(\sin^{-1}x))$

$= \sin^{-1}\left[\cos\left(\frac{\pi}{2} - \cos^{-1}x\right)\right] = \sin^{-1}(\cos(\sin^{-1}x))$

And $\beta = \cos^{-1}(\sin(\cos^{-1}x))$

$\therefore \alpha + \beta = \sin^{-1}(\cos(\sin^{-1}x)) + \cos^{-1}(\sin(\cos^{-1}x)) = \frac{\pi}{2}$

Now consider

$\tan\alpha \tan\beta = \tan\alpha \cdot \tan\left(\frac{\pi}{2} - \alpha\right)$

$= = \tan\alpha \cdot \cot\alpha = 1$

---

# Question 127

**At which point the function $f(x) = \frac{x^2}{[x]'}$, where [.] is greatest integer function, is discontinuous?**

**Options:**

A. Only positive integers

B. All positive and negative integers and (0,1)

C. All rational numbers$2^{2x}$

D. None of the above

**Answer: B**

**Solution:**

Clearly, if $0 \le x < 1$, then $f(x)$ does not exist as $[x] = 0$

Also $\lim_{x \to a} f(x)$ does not exist for any integer $a$.

Thus, $f$ is discontinuous at all integers and also in (0, 1).

---

# Question 128

**The function $y = |2\sin x|$ is continuous for any $x$ but it is not differentiable at**

**Options:**

A. only $x = 0$

B. only $x = \pi$

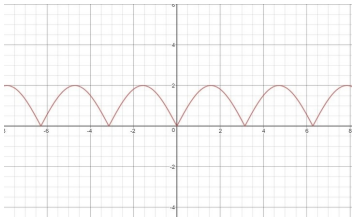
C. only $x = \frac{\pi}{2} 2^{2x}$

D. $x = k\pi$ ($k$ is an integer)

**Answer: D**

**Solution:**

The graph of $y = |2\sin x|$ is given below.



It can be easily seen from the graph of $f(x) = |2\sin x|$, it is continuous everywhere but not differentiable at integer multiples of π because of unequal limiting values of the derivative of the function at the multiples of π

---

# Question 129

**If $y = e^{\log (1+x+x2+x3+....)}$ , where $|x|<1$, then $\frac{dy}{dx}$ is equal to**

**Options:**

A. $\frac{-1}{(1-x)^2}$

B. $\frac{1}{(1-x)^2}$

C. $\frac{1}{(1+x)^2} 2^{2x}$

D. None of these

**Answer: B**

**Solution:**

We have,

$y = e^{\log (1+x+x2+x3+....)}$

$y = 1 + x + x^2 + x^3 + ....$

$y = \frac{1}{1-x} = (1 - x)^{-1} \left[\because S_\infty = \frac{a}{1-r}\right]$

$\frac{dy}{dx} = (-1)(1 - x)^2 (-1)$ $\frac{dy}{dx} = \frac{1}{(1-x)^2}$

---

# Question 130

**If two sides of a triangle are given, then the area of the triangle will be maximum, if the angle between the given sides is**

**Options:**

A. $\frac{\pi}{3}$

B. $\frac{\pi}{4}$

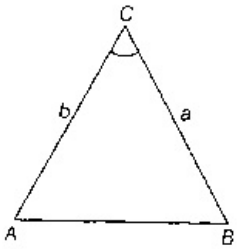
C. $\frac{\pi}{6} 2^{2x}$

D. $\frac{\pi}{2}$

**Answer: D**

**Solution:**

Let $a$ and $b$ be given, then area, $A = \frac{1}{2}\ ab\sin C$.




$\frac{dA}{dC} = \frac{1}{2} ab\cos\ C$

Hence, $A$ is maximum, when $\frac{dA}{dC} = 0$

$C = 90\ º = \frac{\pi}{2}$

---

# Question 131

**$\int \frac{dx^2}{\sqrt{x^4 + x^6}}$ is equal to**

**Options:**

A. $-\frac{\sqrt{1+x^2}}{x} + C$

B. $\frac{\sqrt{1+x^2}}{x} + C$

C. $-\frac{\sqrt{1-x^2}}{x} + C\, 2^{2x}$

D. $\int -\frac{\sqrt{x^2-1}}{x} + C$

**Answer: A**

**Solution:**

Let $I = \int \frac{dx^2}{\sqrt{x^4+x^6}}$

$= \int \frac{dx}{x^2\sqrt{x^2+1}}$

Put $x = \tan\theta$

$dx = \sec^2\theta d\theta$

$\therefore I = \int \frac{\sec^2\theta}{\tan^2\theta\sqrt{\tan^2\theta+1}} d\theta$

$= \int \frac{\sec^2\theta}{\tan^2\theta.\sec\theta} d\theta$

$= \int \operatorname{cosec}\theta\cot\theta \, d\theta$

$= -\operatorname{cosec}\theta + C = \frac{-\sqrt{x^2+1}}{x} + C$

---

# Question 132

**If $\sin^{-1}x\cos^{-1}x \, dx = f^1(x)$**

$\left[\frac{\pi}{2}x - x\, f^{-1}(x) - 2\sqrt{1-x^2}\right]$

$\frac{\pi}{2}\sqrt{1-x^2} + 2x + C$ **,then**

**Options:**

A. $f(x) = \sin x$

B. $f(x) = \cos x$

C. $f(x) = \tan x\, 2^{2x}$

D. None of these

**Answer: A**

**Solution:**

Let $I = \sin^{-1}x\cos^{-1}x \, dx$

$= \sin^{-1}x\left(\frac{\pi}{2} - \sin^{-1}x\right) dx$

$= \frac{\pi}{2} \sin^{-1}x dx - (\sin^{-1}x)^2 dx$

$= \frac{\pi}{2}[x\sin^{-1}x + \sqrt{1-x^2}] - [x.(\sin^{-1}x)^2$

$+2\sin^{-1}x\sqrt{1-x^2}-2x] + C$

[Using integration by parts]

$= \sin^{-1}x\left(\frac{\pi}{2}x - x\sin^{-1}x - 2\sqrt{1-x^2}\right)$

$+\frac{\pi}{2}\sqrt{1-x^2} + 2x + C$

$\therefore f^{1}(x) = \sin^{-1}x f(x) = \sin x$

---

# Question 133

**The slopes of the common tangents of the ellipse $\frac{x^2}{9}+\frac{y^2}{2}$ =1 and the circle $x^2 + y^2 = 3$ are**

**Options:**

A. $\pm\frac{1}{\sqrt{3}}$

B. $\pm\frac{1}{\sqrt{2}}$

C. $\pm\frac{1}{\sqrt{6}}$ $2^{2x}$

D. None of these

**Answer: C**

**Solution:**

Let $m$ be the slope of the common tangent, then

$\pm\sqrt{3}\sqrt{1+m^2} = \pm\sqrt{9m^2+2}$

$3(1+m^2) = 9m^2 + 2,$

$3+m^2 = 9m^2 + 2$

$6m^2 = 1$

$m^2 = \frac{1}{6}$

$m = \pm\frac{1}{\sqrt{6}}$

---

# Question 134

**If the vectors a and b are linearly independent satisfying ($\sqrt{3}$ tanθ +1) a + ($\sqrt{3}$ secθ -2)b =0, then the value of θ is**

**Options:**

A. $\frac{\pi}{2}$

B. $\frac{\pi}{6}$

C. $\frac{5\pi}{6}$

D. $\frac{11\pi}{6}$

**Answer: D**

**Solution:**

Since, the vectors **a** and **b** are linearly independent. Then,($\sqrt{3}$ tanθ +1) **a** + ($\sqrt{3}$ secθ -2)**b** =0 if and only if

$\sqrt{3}$ tanθ +1 = 0
and
$\sqrt{3}$ secθ -2 =0

$\Rightarrow \tan\theta = \frac{1}{\sqrt{3}}$
and
$\sec\theta = \frac{2}{\sqrt{3}}$

$\Rightarrow \theta = \frac{11\pi}{6}$

---

# Question 135

**If a and b are two unit vectors inclined at an angle $\frac{\pi}{3}$, then {a×(b+a×b)}. b is equal to**

**Options:**

A. $\frac{1}{4}$

B. $\frac{-3}{4}$

C. $\frac{3}{4}2^{2x}$

D. $\frac{1}{2}$

**Answer: B**

**Solution:**

Given, $|\mathbf{a}|=|\mathbf{b}|$ and $\mathbf{a.b} = \cos\frac{\pi}{3}$

Consider,

$\{\mathbf{a} \times(\mathbf{b}+\mathbf{a}\times\mathbf{b})\}.\mathbf{b}=(\mathbf{a}\times\mathbf{b}+\mathbf{a}\times(\mathbf{a}\times\mathbf{b})\}.\mathbf{b}$

$= (\mathbf{a}\times\mathbf{b}).\ \mathbf{b}+\{(\mathbf{a}.\mathbf{b}).\mathbf{a} -(\mathbf{a}.\mathbf{a}).\mathbf{b}\}.\mathbf{b}$

$= [\mathbf{a\ b\ b}]+ (\mathbf{a}.\mathbf{b})^2-|\mathbf{a}|^2\ |\mathbf{b}|^2$

$= 0 +\cos^2\frac{\pi}{3}- 1 = \frac{1}{4} -1 = \frac{-3}{4}$

---

# Question 136

**Let u, v and w be such that |u|=1, |v|=3 and |w|=2. If the projection of v along u is equal to that of w along u and vectors v and w are perpendicular to each other, then|u-v+w|equals**

**Options:**

A. 2

B. $\sqrt{7}$

C. $\sqrt{14}$

D. 14

**Answer: C**

**Solution:**

Given, $\mathbf{v.\ u} = \mathbf{w}$ and $\mathbf{v} \perp \mathbf{w}$ then, $\mathbf{v.w} = 0$

Now

$|u - v+w|^2= (u - v+w).(u - v+w)$

$=|\mathbf{u}|^2+|\mathbf{v}|^2 +|\mathbf{w}|^2- 2\mathbf{u}.\mathbf{v}-2\mathbf{w}.\mathbf{v}+ 2\mathbf{u}.\mathbf{w}$

$\mathbf{= 1 + 9 + 4}$

$\mathbf{= 14}$

$\mathbf{|u - v+w|=}\ \sqrt{14}$

---

# Question 137

**The solution of the differential equation $\frac{dy}{dx} = \frac{y(\log y - \log x + 1)}{x}$ is**

**Options:**

A. $x = ye^{cy}$

B. $y = xe^{cy}$

C. $x = ye^{xy}\, 2^{2x}$

D. None of these

**Answer: D**

## Solution:

We have,

$\frac{dy}{dx} = \frac{y}{x}\left(\log\left(\frac{y}{x}\right) + 1\right)$

Put $y = vx$

$\frac{dy}{dx} = v + x\frac{dv}{dx}$

$v + x\frac{dv}{dx} = v(\log v + 1)$

$v + x\frac{dv}{dx} = v\log v + v$

$\frac{dv}{v\log v} = \frac{dx}{x}$

$v = e^{Cx}$

$\frac{y}{x} = e^{Cx}$

$y = xe^{Cx}$

---

# Question 138

**The solution of the differential equation $\frac{dy}{dx} + \sin\left(\frac{y+x}{2}\right) - \sin\left(\frac{y-x}{2}\right) = 0$ is**

**Options:**

A. $\log \tan\left(\frac{y}{2}\right) = C - 2\sin x$

B. $\log \tan\left(\frac{y}{4}\right) = C - 2\sin\left(\frac{x}{2}\right)$

C. $\log \tan\left(\frac{y}{2} + \frac{\pi}{4}\right) = C - 2\sin x\, 2^{2x}$

D. $\log \tan\left(\frac{y}{2} + \frac{\pi}{4}\right) = C - 2\sin\left(\frac{x}{2}\right)$

**Answer: B**

**Solution:**

Given differential equation can be reqritten as

$\frac{dy}{dx} = \sin\left(\frac{x-y}{2}\right) - \sin\left(\frac{x+y}{2}\right)$

$= 2\cos\left(\frac{x}{2}\right)\sin\left(\frac{-y}{2}\right)$

$= -2\cos\left(\frac{x}{2}\right)\sin\left(\frac{y}{2}\right)$

$\frac{dy}{2\sin\left(\frac{y}{2}\right)} = -\cos\left(\frac{x}{2}\right)dx$

$\frac{1}{2}\operatorname{cosec}\left(\frac{y}{2}\right)dy = -\frac{\sin\left(\frac{x}{2}\right)}{\left(\frac{1}{2}\right)} + C$

$\frac{1}{2}\frac{\log\left(\operatorname{cosec}\left(\frac{y}{2}\right)-\cot\left(\frac{y}{2}\right)\right)}{\left(\frac{1}{2}\right)} = -\frac{\sin\left(\frac{x}{2}\right)}{\left(\frac{1}{2}\right)} + C$

$\log\tan\left(\frac{y}{4}\right) = -2\sin\left(\frac{x}{2}\right) + C$

---

# Question 139

**The part of straight line $y = x$ between $x = 1$ and $x = 2$ is revolved about $X$-axis, then the curved surface area of the solid thus generated is**

**Options:**

A. $2\sqrt{2\pi}$

B. $3\sqrt{2}$

C. $3\sqrt{2\pi}2^{2x}$

D. None of these

**Answer: C**

**Solution:**

Curved surface area

$= \int_a^b 2\pi y\sqrt{\left\{1+\left(\frac{dy}{dx}\right)^2\right\}}dx$

Here, $a = 1$, $b = 2$ and $y = x$,

Now, on differentiating $y$ $w.r.t.x$, we get

$\frac{dy}{dx} = 1$

$\therefore$Curved surface area

$= \int_1^2 2\pi x\sqrt{\{1\_1\}}\,dx$

$= 2\sqrt{2\pi}\int_1^2 x\,dx = 2\sqrt{2\pi}\left[\frac{x^2}{2}\right]_1^2$

$= \frac{2\sqrt{2\pi}}{2}\pi[4-1] = 3\sqrt{2\pi}$ sq unit

---

# Question 140

$\lim_{n\to\infty} n^{\left[\frac{1}{(n+1)(n+2)} + \frac{1}{(n+2)(n+4)} + \ldots\ldots + \frac{1}{6n^2}\right]}$ **is equal to**

**Options:**

A. $\log\left(\frac{3}{2}\right)$

B. $\log\left(\frac{5}{2}\right)$

C. $\log\left(\frac{1}{2}\right) 2^{2x}$

D. $\log\left(\frac{7}{4}\right)$

**Answer: A**

**Solution:**

Let

$L = \lim_{n\to\infty} n^{\left[\frac{1}{(n+1)(n+2)} + \frac{1}{(n+2)(n+4)} + \ldots\ldots + \frac{1}{6n^2}\right]}$

$= \lim_{n\to\infty} n^{\sum_{r=1}^{n} \frac{1}{(n+r)(n+2r)}}$

$= \lim_{n\to\infty} \frac{n}{n^2} \sum_{r=1}^{n} \frac{1}{\left(1+\frac{r}{n}\right)\left(1+\frac{2r}{n}\right)}$

$= \lim_{n\to\infty} \frac{1}{n} \sum_{r=1}^{n} \frac{1}{\left(1+\frac{r}{n}\right)\left(1+\frac{2r}{n}\right)}$

$\int_0^1 \frac{dx}{(1+x)(1+2x)} = \int_0^1 \left(\frac{1}{1+x} + \frac{2}{1+2x}\right) dx$

$= [-\log(1+x) + \log(1+2x)]_0^1$

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

---

# Question 141

**If** $\int_0^{\pi} x\, f(\sin^2 x + \sec^2 x)\, dx = k$
$\int_0^{\pi/2} x\, f(\sin^2 x + \sec^2 x)\, dx$**, then the value of** $k$ **is**

**Options:**

A. $\frac{\pi}{2}$

B. π

C. $-\frac{\pi}{2}$ $2^{2x}$

D. None of these

**Answer: B**

**Solution:**

We have,

$\int_0^{\pi} x\, f(\sin^2 x + \sec^2 x)\, dx$

$= k\int_0^{\frac{\pi}{2}} f(\sin^2 x + \sec^2 x)\, dx$

Let $I = \int_0^{\pi} xf(\sin^2 x + \sec^2 x)dx$ .....(i)

$= \int_0^{\pi} (\pi - x)\, f(\sin^2(\pi - x) + \sec^2(\pi - x))\, dx$

$= \int_0^{\pi} (\pi - x)\, f(\sin^2 x + \sec^2 x)\, dx$ ..(ii)

On adding Eqs. (i) and (ii), we get

$2I = \pi \int_0^{\pi} f(\sin^2 x + \sec^2 x)\, dx$

$2I = 2\pi \int_0^{\frac{\pi}{2}} f(\sin^2 x + \sec^2 x)\, dx$

$I = \pi \int_0^{\frac{\pi}{2}} f(\sin^2 x + \sec^2 x)\, dx$

On comparing with given integral, we get $k = \pi$

---

# Question 142

**A body of 6 kg rests in limiting equilibrium on an inclined plane whose slope is 30 º. If the plane is raised to slope of 60 º, then force (in kg-wt) along the plane required to support it is**

**Options:**

A. 3

B. 2 $\sqrt{3}$

C. $\sqrt{3}$ $2^{2x}$

D. 3 $\sqrt{3}$

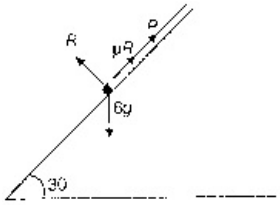
**Answer: B**

**Solution:**

Let $P$ be the force required to support the body and μ be the coefficient of friction.

**Case I**

When plane make inclination of 30 º



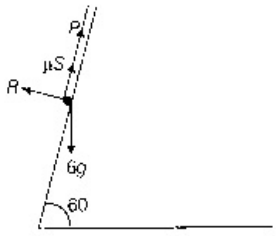

In this case, $R = 6g \cos 30$ º

$\mu R = 6\ g \sin 30$ º [limiting equilibrium]

$\therefore \mu = \tan 30$ º $= \frac{1}{\sqrt{3}}$

**Case II**

When plane raised to the slope of 60 º




In this case, $S = 6g \cos 60$ º,

$P + \mu S = 6\ g \sin 60$ º

$\therefore P + \frac{1}{\sqrt{3}}\ (6g \cos 60$ º$) = 6g \sin 60$ º

$P = 6g \left(\frac{\sqrt{3}}{2} - \frac{1}{2\sqrt{3}}\right) = 2\sqrt{3}\, g$

Hence, $P = 2\sqrt{3}$ kg-wt

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# Question 143

**If the line $x + 2ky + 3 = 0$ is a diameter of the circle $x^2 + y^2 - 6x + 2y = 0$, then $k$ is equal to**

**Options:**

A. 3

B. -5

C. $-12^{2x}$

D. 5

**Answer: A**

**Solution:**

Given equation of circle is
$x^2 + y^2 - 6x + 2y = 0$, whose
*centre = (3, -1) and*
*radius* = $\sqrt{9+1} = \sqrt{10}$
*Clearly, the centre lies on the line*
$x + 2ky + 3 = 0$
We have, $3+2k+3 = 0$
$6 - 2k = 0$
$\therefore k = 3$

---

# Question 144

**If the angles *A, B, C* of a triangle are in *AP* and the sides *a, b, c* opposite to these angles are in *GP*, then $a^2$, $b^2$, $c^2$ are in**

**Options:**

A. AP

B. GP

C. neither AP nor GP

D. HP

**Answer: A**

**Solution:**

Since, *A, B* and *C* are in AP.
Therefore, $B = 60$ º and as *a, b, c* are in GP,
Therefore $b^2 = ac$
By cosine rule Cos $B = \frac{a^2 + c^2 - b^2}{2ac}$
$\frac{1}{2} = \frac{a^2 + c^2 - b^2}{2b^2}$
$b^2 = a^2 + c^2 - b^2$
$2b^2 = a^2 + c^2$

Hence, $a^2$ ,$b^2$ and $c^2$ are in A.P.

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# Question 145

**The value of**
**$\cos\frac{\pi}{7} + \cos\frac{2\pi}{7} + \cos\frac{3\pi}{7} + \cos\frac{4\pi}{7} + \cos\frac{5\pi}{7} + \cos\frac{6\pi}{7} + \cos\frac{7\pi}{7}$ is**

**Options:**

A. 0

B. -1

C. $12^{2x}$

D. None of these

**Answer: B**

**Solution:**

We have,

$$\cos\frac{\pi}{7} + \cos\frac{2\pi}{7} + \cos\frac{3\pi}{7} + \cos\frac{4\pi}{7} + \cos\frac{5\pi}{7} + \cos\frac{6\pi}{7} + \cos\frac{7\pi}{7}$$

$$= \left(\cos\frac{\pi}{7}+\cos\left(\pi-\frac{\pi}{7}\right)\right)+\left(\cos\frac{2\pi}{7}+\cos\left(\pi-\frac{2\pi}{7}\right)\right) + \left(\cos\frac{3\pi}{7}+\cos\left(\pi-\frac{3\pi}{7}\right)\right)+(-1)$$

$$= 0 + 0 + 0 -1 = -1$$

---

# Question 146

**If $\sin x + \sin y = 0 = \cos x + \cos y$, then, $\cos 2x + \cos 2y$ is equal to**

**Options:**

A. $-2\sin(x+y)$

B. $-2s\cos(x+y)$

C. $2\sin(x+y)2^{2x}$

D. $2\cos(x+y)$

**Answer: B**

**Solution:**

Consider,

$$(\cos x + \cos y)^2 - (\sin x + \sin y)^2 = 0$$

$$(\cos^2 x + \cos^2 y + 2\cos x\cos y)$$

$$-(\sin^2 x + \sin^2 y + 2\sin x\sin y) = 0$$

$$\cos 2x + \cos 2y = -2(\cos x\cos y - \sin x\sin y)$$

$$\cos 2x + \cos 2y = -2\cos(x+y)$$

---

# Question 147

**If $f(x)=\frac{80}{3x^4+8x^3-18x^2+60}$, then the points of local maxima for the function $f(x)$ are**

**Options:**

A. 1, 3

B. -3, 1

C. -1, $32^{2x}$

D. -1, -3

**Answer: B**

**Solution:**

We have,

$f(x)=\frac{80}{3x^4+8x^3-18x^2+60}$

$f'(x)=\frac{-80(12x^3+24x^2-36x)}{(3x^4+8x^3-18x^2+60)^2}$

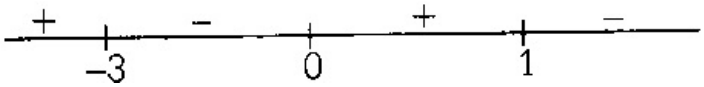
$=\frac{(-80)(12)(x)(x^2+24x-3)}{(3x^4+8x^3-18x^2+60)^2}$

$=\frac{-(80)(12)(x)(x-1)(x+3)}{(3x^4+8x^3-18x^2+60)^2}$

Put $f'(x)=0$

$x=0$, $x=1$ and $x=-3$

Clearly, the sign scheme of $f'(x)$ is




Hence, $x=-3$ and $x=1$ are the points of maxima.

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# Question 148

**The adjacent side of a rectangle with given parameter as 200 cm and enclosing maximum area are**

**Options:**

A. 20 cm and 80 cm

B. 40 cm and 60 cm

C. 50 cm and 50 cm

D. 30 cm and 70 cm

**Answer: C**

**Solution:**

Let $x$ and $y$ be the adjacent sides of the rectangle.
Then,
$2x + 2y = 200$
$x + y = 100$ ....(i)
Let area of rectangle be $A$.
$\therefore A = xy$
$A = x(100 - x)$ [using eq. (i)]
$A = 100x - x^2$

Differentiate area w.r.t. x
$\frac{dA}{dx} = 100 - 2x$

The second derivative of the area w.r.t x is
$\frac{d^2A}{dx^2} = -2$

For maximum area, $\frac{dA}{dx} = 0$ and $\frac{d^2A}{dx^2} < 0$
$100 - 2x = 0$
$x = 50$
$y = 50$ [using Eq. (i)]

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# Question 149

**All the value of $m$ for which both the roots of the equation $x^2 - 2mx + m^2 - 1 = 0$ are greater than -2 but less than 4, lie in the interval**

**Options:**

A. $-2 < m < 0$

B. $m > 3$

C. $-1 < m < 3$

D. $1 < m < 4$

**Answer: C**

**Solution:**

The given equation is
$x^2 - 2mx + m^2 - 1 = 0$

$(x - m)^2 - 1 = 0$
$(x - m - 1)(x - m + 1) = 0$
$x = m + 1$ or $x = m - 1$
According to the given condition,
$m - 1 > -2$ and $m + 1 < 4$
$m > -1$ and $m < 3$
Hence, $-1 < m < 3$

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# Question 150

**The value of $4+2(1+2)\log 2+\left(\frac{2(1+2^2)}{2!}\right)(\log 2)^3+\left(\frac{2(1+2^3)}{3!}\right)(\log 2)^3+\ldots$ is**

**Options:**

A. 10

B. 12

C. $\log (3^2.4^2)2^{2x}$

D. $\log (2^2.3^2)$

**Answer: B**

**Solution:**

$4+2(1+2)\log 2+\frac{2(1+2^2)(\log 2)^2}{3!}$
$+\frac{2(1+2^3)(\log 2)^3}{3!}+\ldots.$
$= 2\left(1+\log 2+\frac{(\log 2)^2}{2!}+\ldots\right)$
$+2\left(1+2\log 2+\frac{(2\log 2)^2}{2!}+\ldots\right)$
$= 2(e^{\log 2}) + 2(e^{2\log 2})$
$= 2 \times 2 + 2e^{\log 4} = 4 + 2 \times 4 = 12$

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