JEE-Main-27-06-2022-Shift-1 (Memory Based)

Physics

Question: A particle starts from mean position at t = 0 and at t = 3 sec its displacement is half the amplitude of particle. Find time period.

Options:

(a) 25 sec

(b) 30 sec

(c) 36 sec

(d) 24 sec

Answer: (c)

Solution:

$y = A\sin\omega t$

At $t = 3\,\text{sec}$,

$\frac{A}{2} = A\sin 3\omega$

$\Rightarrow \sin 3\omega = \frac{1}{2}$

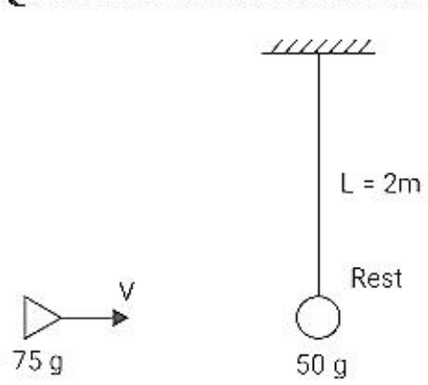
$3\omega = \frac{\pi}{6}$

$\omega = \frac{\pi}{18}$

$\frac{2\pi}{T} = \frac{\pi}{18}$

T = 36 sec

Question: A bullet of mass 75 g moving mM velocity v strikes a bob of mass 50 g as shown



If bullet emerges out from bob with velocity $\frac{v}{3}$ and bob just completes vertical circular motion. Find the velocity v of bullet.

Options:

(a) 10 m/s

(b) 7 m/s

(c) 12 m/s

(d) 5 m/s

Answer: (a)

Solution:

$$75\times10^{-3}\times v=50\times10^{-3}\times v^{1}+75\times10^{-3}\times\frac{v}{3}$$

$$75\times10^{3}v=50\times10^{-3}\times\sqrt{5rg}\times75\times10^{-3}\frac{v}{3}$$

A to Q

r = 2m

g = 10 m/s^2

$$75\times10^{-3}\times v=50\times10^{-3}\sqrt{5\times2\times10}+75\times10^{-3}\times\frac{v}{3}$$

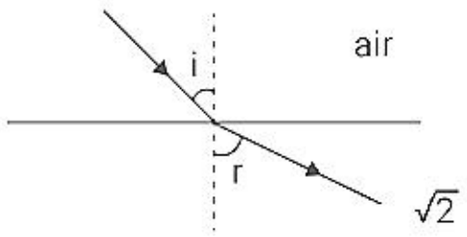
$$75\times10^{-3}\left(2\frac{v}{3}\right)=50\times10^{-3}\times10$$

$$15\times10^{-3}\times v=15^{\circ}\times10^{-2}$$

$$v=\frac{10^{-2}}{10^{-3}}$$

v = 10 m/s

Question: Find angle of incidence. Find angle of refraction is twice of angle of incidence.



Options:

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

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

(c) $\cos^{-1}\left(\frac{1}{2\sqrt{2}}\right)$

(d) $\sin^{-1}\left(\frac{2}{2\sqrt{1}}\right)$

Answer: (c)

Solution:

Snell's law

$$1\times\sin i=\sqrt{2}\sin(2i)$$

$$\sin i=\sqrt{2}(2\sin i\cos i)$$

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

$$\boxed{i=\cos^{-1}\left(\frac{1}{2\sqrt{2}}\right)}$$

Question: If susceptibility of a material is 99, the magnetic permeability is?

Options:

(a) $5\pi\times10^{-5}$

(b) $7\pi\times10^{-5}$

(c) $4\pi\times10^{-5}$

(d) $2\pi\times10^{-5}$

Answer: (c)

Solution:

$$\mu_R=1+x$$

$$\frac{\mu_m}{\mu_0}=1+99$$

$$\mu_m=100\times4\pi\times10^{-7}$$

$$\mu_m=4\pi\times10^{-5}$$

Question: If sources is at rest and observer is a approaching the source with $\frac{1}{5}m$ of velocity of sound. Find percentage change in frequency received by observer

Options:

(a) 25%

(b) 15%

(c) 30%

(d) 20%

Answer: (d)

Solution:

$$f'=f\left(\frac{v+v_0}{v-v_s}\right)$$

Here, $v_0=\frac{v}{5}\ \&\ v_s=0$

$$f'=f\left(\frac{v+v/s}{v}\right)=\frac{6}{5}f$$

$\therefore$ Change in frequency

$$f' - f = \left(\frac{6}{5} - 1\right) f$$

$$= \frac{1}{5} f = 20\%$$

Question: A body of mass m and density d_1 falls in a liquid of density d_2 and viscosity n. Find the terminal speed?

Options:

(a) $d_1 - d_2$

(b) $d_2 - d_1$

(c) $d_1 + d_1$

(d)) $d_2 + d_1$

Answer: (a)

Solution:

$$v_t = \frac{2}{9} \frac{r^2 g}{n} (d_1 - d_2)$$

$$m = \frac{4}{3} \pi r^3 . d_1$$

$$\therefore r^3 = \frac{3m}{4\pi d_1}$$

$$\therefore v_t = \frac{2g}{9n} \left(\frac{3m}{4\pi d_1}\right)^{2/3} (d_1 - d_2)$$

Question: Force on a charge between plates of a capacitor is 10 N. What will be the force if one of the plate is removed?

Options:

(a) 2 N

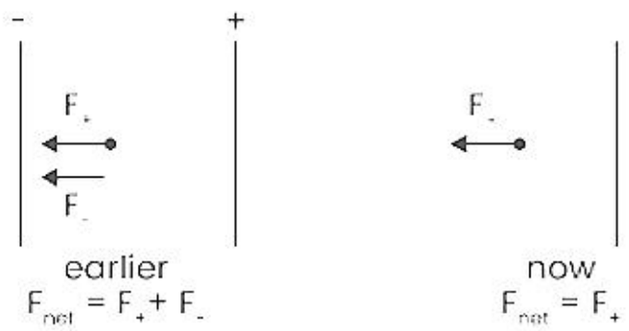
(b) 5 N

(c) 7 N

(d) 4 N

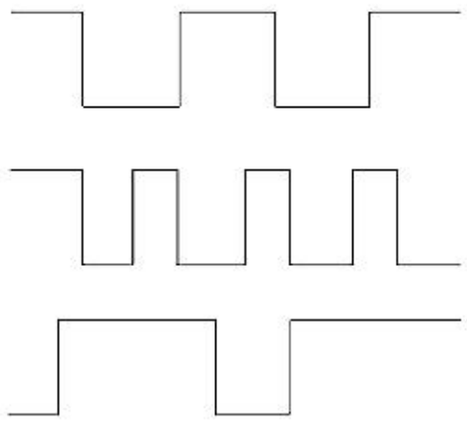
Answer: (b)

Solution:



$$\therefore \text{ New force } = \frac{1}{2} \text{old force} = \frac{1}{2} \times 10 = 5N$$

Question: Identify the logic gate for the following output inputs A and B



Options:

(a) AND gate

(b) NOR gate

(c) NAND gate

(d) XOR gate

Answer: (c)

Solution:

From the given diagram, we get

A	B	Output
1	1	0
0	0	1
0	1	1
1	0	1

This gives us a NAND gate.

Question: Find the dimensions of self inductance

Options:

(a) $\left[L^1M^2T^{-2}A^{-2}\right]$

(b) $\left[L^1M^1T^{-4}A^{-2}\right]$

(c) $\left[L^2M^1T^{-2}A^{-2}\right]$

(d) $\left[L^3M^1T^{-2}A^3\right]$

Answer: (c)

Solution:

$$e = L\frac{dI}{dt} \therefore L = \frac{edt}{dI} \therefore L = \frac{edt}{dI} = \frac{W}{q}\frac{dt}{dI}$$

$$= \frac{\left[L^2M^1T^{-2}\right]}{A\times T}\times\frac{T}{A}$$

[self inductance] $\left[L^2M^1T^{-2}A^{-2}\right]$

Question: Hydrogen in the ground state absorbs 10.2 ev. Find change in angular momentum.

Options:

(a) $\frac{h}{5\pi}$

(b) $\frac{h}{4\pi}$

(c) $\frac{h}{2\pi}$

(d) $\frac{h}{1\pi}$

Answer: (c)

Solution:

change in energy = 10.2 ev

i.e. transition is from n = 1 to n = 2

$\therefore$ change in momentum $= \frac{h}{2\pi}$

Question: Find the ratio of De Broglie wavelength of an α particle and carbon 12 for the same K.E.

Options:

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

(b) $\frac{\sqrt{6}}{1}$

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

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

Answer: (d)

Solution:

$$\lambda = \frac{h}{\sqrt{2mk}}$$

$$\lambda_\alpha = \frac{h}{\sqrt{2m_\alpha k_\alpha}}$$

$$\lambda_{c_{12}} = \frac{h}{\sqrt{2m_{c_{12}} k_{c_{12}}}}$$

$$\therefore \frac{\lambda_\alpha}{\lambda_{\alpha_{12}}} = \sqrt{\frac{m_{c_{12}}}{m_\alpha}} = \sqrt{\frac{12}{4}} = \frac{\sqrt{3}}{1}$$

Question: If rain falls vertically on girl when girl starts running with velocity of $15\sqrt{2}$, while standing she holds her umbrella at angle of 45° with vertical. Find the velocity of rain?

Options:

(a) 40 m/s

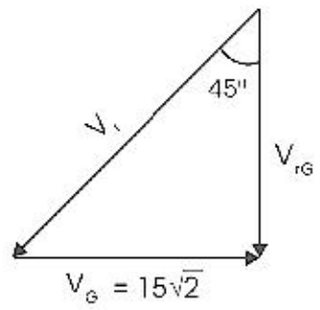
(b) 80 m/s

(c) 60 m/s

(d) 30 m/s

Answer: (b)

Solution:



From diagram

$$\sin 45° = \frac{v_g}{v_r}$$

$$v_r = \frac{15\sqrt{2}}{\sin 45°}$$

$$v_r = 80\, m/s$$

Question: Ball is projected with 20 m/s from horizontal at an angle α. After 10 sec, it makes an angle β with horizontal then find relation between α and β

Options:

(a) $1 - \frac{200}{10\sin\alpha}$

(b) $1 - \frac{300}{20\sin\alpha}$

(c) $1 + \frac{100}{30\sin\alpha}$

(d) $1 - \frac{100}{20\sin\alpha}$

Answer: (d)

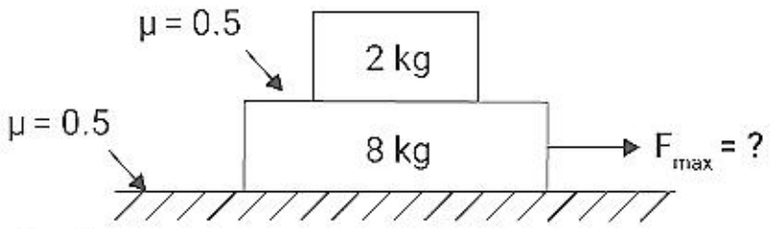
Solution:

$$\tan\alpha = \frac{u_y}{u_x} \quad \tan\beta = \frac{v_y}{v_x}$$

$$u_x = v_x \text{ and } v_y = u_y - gt = u_y - 100$$

$$\frac{\tan\beta}{\tan\alpha} = \frac{u_y - 100}{u_y} = 1 - \frac{100}{20\sin\alpha}$$

Question: Find Maximin force So that 100 m blocks move Together.



Options:

(a) 78 N

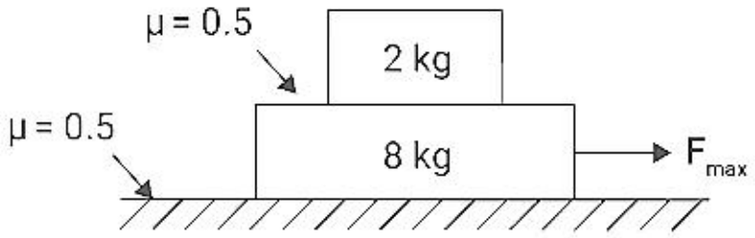
(b) 88 N

(c) 98 N

(d) 68 N

Answer: (c)

Solution:



for bath the block moving together

$a = \mu g$

So,

$a = 0.5 \times 9.8$

$a = 49\,\mathrm{m/s^2}$

Now Considering 2kgt 8kg as one body & drawing FBD.

$F_{max} - \mu_2 N = ma$

$F_{max} - 0.5 \times 10 \times 9.8 = 10 \times 4.9$

$F_{max} - 49 = 49$

$F_{max} = 98N$

Question: S-1Gravitation law holds good for any objects in universe.
S-2 Wt. of body at center of earth is 0.

Options:

(a) 1

(b) 0

(c) 3

(d) 5

Answer: (b)

Solution:

Both statements are correct.

$g' = g\left(1 - \frac{d}{R_e}\right)$; at center

$d = R_e$

$g' = 0$

Question: For a Carnot engine, source temperature $527^{\circ}C$ and sink at $200k$. If $12kJ$ of work is done then heat absorbed is?

Options:

(a) 16 KJ

(b) 13 KJ
(c) 15 KJ
(d) 19 KJ
Answer: (b)
Solution:

$$\eta = 1 - \frac{T_C}{T_H} = \frac{W}{Q_H}$$

$$\therefore 1 - \frac{200}{800} = \frac{12}{Q_A}$$

$$\therefore \frac{3}{4} = \frac{12}{Q_A}$$

$$\therefore Q_A = 16\text{KJ}$$

Question: A Transmitter Antenna has Height 49 m & Receiver Antenna has height 25 m. Find maximum distance through which signal con be Transmitted.
Options:
(a) 32.54
(b) 23.35
(c) 42.93
(d) 51.23
Answer: (c)
Solution:

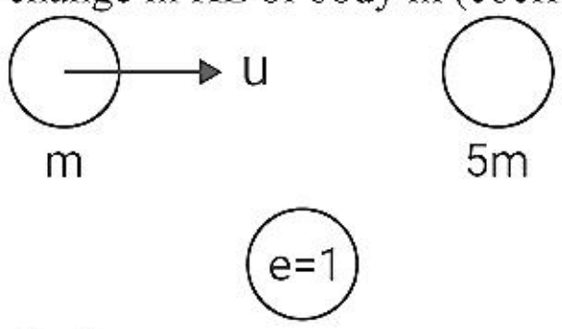
$$= \sqrt{2RG_T} + \sqrt{2RG_R}$$

$$= \sqrt{2\times 6400\times 10^3 \times 49} + \sqrt{2\times 6400\times 10^3 \times 25}$$

$$= 42.93\times 10^3 \text{ m}$$

$$= 42.93\text{km}$$

Question: If bodies with masses m and 5 m collide as shown in the figure, then find out \% change in KE of body m (coefficient of restitution e =1)



Options:
(a) 32.65%
(b) 74.93%
(c) 43.85%
(d) 55.56%
Answer: (d)
Solution:

$$m u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$mu + 5m \times 0 = mv_1 + 5mv_2 \ldots (1)$$

Again,

$$e = 1 = \frac{V_2 - V_1}{u_1 - u_2}$$

$$1 = \frac{v_2 - v_1}{4 - 0}$$

$$v_2 - v_1 = u$$

$$v_2 = u + v_1 ...(1)$$

$$mu = mv_1 + 5m\left(u + v_1\right)$$

$$mu = mv_1 + 5mu + 5mv_1 - 4mu = 6mv_1$$

$$v_1 = -\frac{2}{3}u$$

So,

$$k_i = \frac{1}{2}mu^2$$

$$k_f = \frac{1}{2}mv_1^2$$

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

$$= \frac{1}{2} \times \frac{4}{9}m4^2$$

$$= \frac{4}{9}k_i$$

So % Change in $k\varepsilon$

$$\frac{K_f - K_i}{K_r} \times 100 = \frac{\frac{4}{9}K_i - K_1^1}{K_i} \times 100$$

$$= \frac{-5}{9} \times 100$$

$$= \frac{-500}{9}$$

$$= -55.56\%$$

If decreases by 55.56%

Question: A body of mars m density d_1 falls on liquid of density d_2 and attains terminal velocity. Find viscous force.

Options:

(a) $mg\left[1 - \frac{d_2}{d_1}\right]$

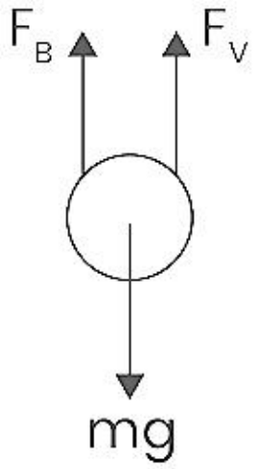
(b) $mg\left[1 + \frac{d_2}{d_1}\right]$

(c) $mg\left[1 < \frac{d_2}{d_1}\right]$

(d) $mg\left[1 > \frac{d_2}{d_1}\right]$

Answer: (a)

Solution:



After attaining terminal velocity $F_{net} = 0$

$$mg = F_B + F_V$$

$$mg = \left(\frac{m}{d_1}\right) d_2 g + F_v$$

$$F_v = mg\left[1 - \frac{d_2}{d_1}\right]$$

Question: Find λ of emitted photon for transition in $L_i + 2$ from 3^{rd} orbit to 1^{st} orbit.

Options:

(a) 1.13×10^{-8} m

(b) 1.12×10^{-8} m

(c) 1.14×10^{-8} m

(d) 1.10×10^{-8} m

Answer: (c)

Solution:

$$\lambda = 1.14 \times 10^{-8} \text{ m}$$

$$\frac{1}{\lambda} = Rz^2\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

$$\frac{1}{\lambda} = R(3)^2\left[\frac{1}{12} - \frac{1}{3^2}\right]$$

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

$$\frac{1}{\lambda} = 9R \times \frac{8}{9}$$

$$\lambda = \frac{1}{8R} = 0.114 \times 10^{-7}$$

$$\lambda = 1.14 \times 10^{-8} \text{ m}$$

Question: In YDSE $D = 0.8\,\text{m} d = 0.6\,\text{mm}$ First dark band is formed in front of the slit. $\lambda = ?$

Options:

(a) 450 nm

(b) 750 nm

(c) 650 nm

(d) 350 nm

Answer: (a)

Solution:

$$y_{\text{dard}} = \frac{d}{2}$$

$$\text{odd } \frac{\lambda 0}{2d} = \frac{d}{2}$$

$$\therefore \lambda = \frac{d^2}{0} = \frac{\left(6\times10^{-4}\right)^2}{0.8} = \frac{36\times10^{-8}}{8\times10^{-1}}$$

$$= 4.5\times10^{-7}\ \text{m}$$

$$= 450\,\text{nm}$$

Question: An infinite solid cylinder has radius 4 mm & current density is $4\times10^{6}\,\text{Am}^{-2}$. Find current in Region $\frac{R}{2}$ to R

Options:

(a) 150.79

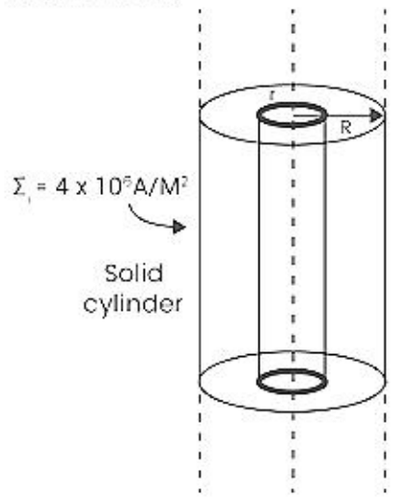
(b) 168.87

(c) 140.67

(d) 130.32

Answer: (a)

Solution:



$$O_i = \frac{i}{A} = 4\times10^6\ \mathrm{A/M^2}$$

$$(dV)_{cylinder} = 2\pi r dr \cdot l$$

$$di = \int ri \cdot \left(\frac{dV}{l}\right)$$

$$\int_0^i di = \int_{R/2}^{R} 4\times10^6 2\pi r dr \cdot l$$

$$\left(\frac{i}{l}\right) = \theta\pi\times10^6 \int_{R/2}^{R} r \cdot dr$$

$$\left(\frac{i}{l}\right) = \theta\pi\times10^6 \times \left|\frac{R^2}{2}\right|_{R/2}^{R}$$

$$= \theta\pi\times10^6 \times \left(\frac{R^2}{4} - \frac{R^2}{8}\right)$$

$$= \frac{\theta\pi\times10^6}{\theta}\left(\frac{2R^2 - R^2}{1}\right)$$

$$= \frac{\theta\pi\times10^6}{\theta}\times R^2$$

$$\left(\frac{i}{l}\right) = \frac{\theta\pi\times10^6}{\theta}\times\left(4\times10^{-3}\right)^2$$

$$= 150.79\ A$$

Question: Find fraction of current passing through galvanometer.

Given $R_g = 720$ and $R_s = 80$

Options:

(a) 0.3

(b) 0.2

(c) 0.1

(d) 0.0

Answer: (c)

Solution:

$$I = I_g + I_s$$

$$I = \frac{I_g}{I} + \frac{I_s}{I}$$

$$= \frac{I_g}{I} + \frac{I_g R_g}{R_s I}$$

$$1 = \frac{I_g}{I}\left(1 + \frac{R_g}{R_s}\right)$$

$$1 = \frac{I_g}{I}\left(1 + \frac{72}{8}\right)$$

$$1 = \frac{I_g}{I}(9 + 1)$$

$$\Rightarrow \frac{I_g}{I} = \frac{1}{10}$$

Question: Match the correct column

	Colum I		Colum II
(a)	X rays	(p)	sterilize
(b)	IR rays	(q)	study cubic lattice
(c)	UV rays	(r)	greenhouse effect

Options:

(a) (a) r, (b) q, (c) p

(b) (a) q, (b) r, (c) p

(c) (a) r, (b) p, (c) q

(d) (a) q, (b) p, (c) r

Answer: (b)

Solution:

X rays - study cubic lattice

IR rays – Green House Effect

UV rays - sterilize

equipment

Question: 2 block the mass 10 kg and 30 kg coordinate (0,0) and at (x, 0) A block of 10 kg is moved a distance of 6 cm towards 30 kg Find the distance moved by Mass of 30 kg

Options:

(a) -3cm

(b) -4cm

(c) -2cm

(d) -1cm

Answer: (c)

Solution:

We know

$$x_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

also

$$dx_{com} = \frac{m_1 dx_1 + m_2 dr_2}{m_1 + m_2}$$

Now to keep com at sanc position (i.e. $dx_{com}=0$)

$$0 = m_1 (dx_1) + m_2 dx_2 ...(1)$$

A to d

$$m_1 = 10k\,\text{g}, \quad m_2 = 80\,\text{kg}$$

$$dx_1 = 6\,\text{cm}, \quad dx_2 = ?$$

From eq (1)

$$0 = 10(6) + 30(dx_2)$$

$$dx_2 = -\frac{60}{30}$$

$$dx_2 = -2\,\text{cm}$$

So the m_2 mass will be moved 2cm towards 10kg mass

Question: The current flowing through on ac circuit is given by I =5 \sin (120 at)A. How long will the current take to reach the peak value starting from O

Options:

(a) 1 / 60 S

(b) 605

(c) 1 / 1205

(d) 1 / 240 S

Answer: (d)

Solution:

$i = 5\sin(120\pi t)$

A to Q

$5 = 5\sin(120\pi t)$

$\sin(120\pi t) = 1$

$\sin(120\pi t) = \sin\frac{\pi}{2}$

$120\pi t = \frac{\pi}{2}$

$t = \frac{1}{240}s$

JEE-Main-27-06-2022-Shift-1 (Memory Based)

Chemistry

Question: What is the product formed in the given reaction?
Options:
(a) H_2O_2
(b) H_2
(c) No reaction
(d) Both (a) and (b)
Answer: (a)
Solution:
$BaO_2 . 8H_2O + H_2SO_4 \rightarrow BaSO_4 + H_2O_2 + 8H_2O$

Question: What's the most stable oxidation state of Co?
Options:
(a) +2
(b) +5
(c) +6
(d) +7
Answer: (a)
Solution: The most common oxidation state for Cobalt is + 2 and +3.

Question: NaCN is used as a froth stabilizer for purification of which ore?
Options:
(a) ZnS which contain PbS
(b) Cu_2S which contain Fe_2S_3
(c) PbS which contain ZnS
(d) PbS which contain SiO_2
Answer: (b)
Solution: In the case of an ore containing ZnS and PbS, the froth stabilizer used is NaCN

Question: Calculate Λ^o_m for AgI given that Λ^o_m for $AgNO_3$, NaI and $NaNO_3$ 13.3, 12.07, 12 S cm^2 mol^{-1} respectively?
Options:
(a) 13.37
(b) 10.28
(c) 17.25
(d) 32.17
Answer: (a)
Solution:

$$\Lambda^o_{m(AgI)} = \Lambda^o_{AgNO_3} + \Lambda^o_{NaI} - \Lambda^o_{NaNO_3}$$
$$= 13.3 + 12.07 - 12 = 13.37 \text{ S cm}^2 \text{ mol}^{-1}$$

Question: White P $\xrightarrow{\text{Conc.HNO}_3}$?

Options:

(a) $H_3PO_3 + N_2$

(b) $NO_2 + PH_3$

(c) $H_3PO_4 + NO_2$

(d) $H_3PO_3 + NO_2$

Answer: (c)

Solution: $P_4 + HNO_3 \rightarrow H_3PO_4 + NO_2 + H_2O$

Question: 2 g of solute is dissolved in two different solvent A and B having 200 g mass each. Given that $K_b(A) : K_b(B) = 1:2$. Calculate the ratio of $\Delta T_b(A) : \Delta T_b(B)$.

Options:

(a) 1 : 2

(b) 2 : 3

(c) 3 : 1

(d) 3 : 4

Answer: (a)

Solution:

Mass of solute = 2g

Mass of solvent A = 200 g

Mass of solvent B = 200 g

$K_b(A) : K_b(B) = 1 : 2$ (given)

As we know $\Delta T_b = \dfrac{1000 \times K_b \times w_2}{M_2 \times w_1}$

$$\therefore \frac{\Delta T_b(A)}{\Delta T_b(B)} = \frac{\dfrac{1000 \times K_b(A) \times 2}{M_2 \times 200}}{\dfrac{1000 \times K_b(B) \times 2}{M_2 \times 200}}$$

$$\frac{\Delta T_b(A)}{\Delta T_b(B)} = \frac{K_b(A)}{K_b(B)} = \frac{1}{2}$$

$$\therefore \Delta T_b(A) = \Delta T_b(B) = 1:2$$

Question: Match the following.

Column I	Column II
A) Cationic detergent	i) Toothpaste
B) Anionic detergent	ii) Soap
C) Sodium Rosinate	iii) Dish wash
D) Nonionic detergent	iv) Hair conditioner

Options:

(a) (A) → (i); (B) → (ii); (C) → (iii); (D) → (iv)

(b) (A) → (iv); (B) → (i); (C) → (ii); (D) → (iii)

(c) (A) → (ii); (B) → (iii); (C) → (i); (D) → (iv)

(d) (A) → (iii); (B) → (i); (C) → (iv); (D) → (ii)

Answer: (b)
Solution:
A) Cationic detergent ⇒ Hair conditioner
B) Anionic detergent ⇒ Toothpaste
C) Sodium Rosinate ⇒ Soap
D) Nonionic detergent ⇒ Dish washer

Question: Statement-1: $\Delta T_f = km$
Statement-2: Molality is independent of temperature.
Options:
(a) Both statements are correct
(b) Statement 1 is correct, statement 2 is incorrect
(c) Both statements are incorrect
(d) Statement 2 is correct, statement 1 is incorrect
Answer: (a)
Solution: Both statements are correct

Question: $KMnO_4$ reacts with oxalic acid, the oxidation no. of Mn in the product formed.
Options:
(a) +7
(b) +5
(c) +2
(d) +3
Answer: (c)
Solution:

$$K\overset{+7}{M}nO_4 + H_2C_2O_4 + H_2SO_4 \rightarrow K_2SO_4 + \overset{-2}{M}nSO_4 + CO_2 + 8H_2O$$

Question: Correct uses of polymers

Column-I	Column-II
A) Bakelite	i) Switches
B) Glyptal	ii) Paints
C) PVC	iii) Raincoats

Options:
(a) A → (i); B → (ii); C → (iii)
(b) A → (iii); B → (ii); C → (i)
(c) A → (ii); B → (iii); C → (i)
(d) A → (ii); B → (i); C → (iii)
Answer: (a)
Solution:
Bakelite ⇒ Switches
Glyptal ⇒ Paints
PVC ⇒ Raincoats

Question: Hydrogen in ground state absorbs photon of energy 10.2 eV find change in angular momentum.
Options:

(a) $2.15 \times 10^{-34}\ Js^{-1}$
(b) $3.45 \times 10^{-34}\ Js^{-1}$
(c) $0.05 \times 10^{-34}\ Js^{-1}$
(d) $1.05 \times 10^{34}\ Js^{-1}$
Answer: (d)
Solution:
n = 1, n = 2

$$L_1 = \frac{h}{2\pi},\ L_2 = \frac{2h}{2\pi}$$

$$\Delta L = \frac{h}{2\pi} = \frac{6.6\times10^{-34}}{6.28} = 1.05\times10^{-34}\ Js^{-1}$$

Question: What is correct match?

Column I	Column II
A) BF_3	(i) See-saw
B) ClF_3	(ii) Square planar
C) XeF_4	(iii) T-shape
D) SF_4	(iv) Trigonal Planar

Options:
(a) A → (iv); B → (iii); C → (ii); D → (i)
(b) A → (iii); B → (i); C → (ii); D → (iv)
(c) A → (i); B → (ii); C → (iii); D → (iv)
(d) A → (ii); B → (iii); C → (iv); D → (i)
Answer: (a)
Solution:
A) BF_3 ⇒ Trigonal Planar
B) ClF_3 ⇒ T-shape
C) XeF_4 ⇒ Square planar
D) SF_4 ⇒ See-saw

Question: The product formed when $LiAlH_4$ reacts with $BeCl_2$
Options:
(a) BeH_2
(b) Be_2H_6
(c) HCl
(d) None
Answer: (a)
Solution: $2BeCl_2 + LiAlH_4 \rightarrow 2BeH_2 + LiCl + AlCl_3$

Question: Statement - 1: Mg^{2-} and O^{2-} have same ionic radius
Statement - 2: Mg^{2+} and O^{2-} are isoelectronic species
Options:
(a) Statement - 1 is false, Statement - 2 is true.
(b) Statement - 1 is false, Statement - 2 is false.
(c) Statement - 1 is true, Statement - 2 is true.
(d) Statement - 1 is true, Statement - 2 is false.

Answer: (a)
Solution: Statement 1 is false and statement 2 is true
$Mg^{2-} < O^{2-}$

Question: Statement I: Classical smog is formed in cold and humid environment.
Statement II: Photochemical smog contains O_3 and PAN.
The correct statements are:
Options:
(a) Both statements are correct
(b) Statement 1 is correct
(c) Statement II is correct
(d) Both statements are incorrect
Answer: (a)
Solution: (a) Classical smog occurs in cool humid climate. It is a mixture of smoke, fog and sulphur dioxide. Chemically it is a reducing mixture and so it is also called as reducing smog.
(b) Photochemical smog occurs in warm, dry and sunny climate. The main components of the photochemical smog result from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides produced by automobiles and factories. Photochemical smog has high concentration of oxidizing agents and is, therefore, called as oxidizing smog.

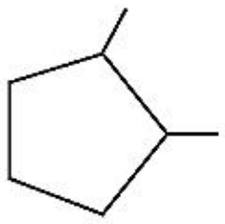
$$3CH_4 + 2O_3 \longrightarrow \underset{\text{Formaldehyde}}{3CH_2=O} + 3H_2O$$

$\underset{\text{Acrolein}}{CH_2=CHCH=O}$ $\qquad$ $\underset{\text{Peroxyacetyl nitrate (PAN)}}{CH_3COONO_2}$ (with $=O$ on the second O)

Question: Hydrogen and oxygen gas are present in a container of vol 2000 cm^3 at 300 K and 100 Kpa. Total mass of mixture is 0.76 g what is the ratio of their moles.
Options:
(a) 3 : 1
(b) 1 : 3
(c) 1 : 4
(d) 3 : 2
Answer: (a)
Solution:
$PV = nRT$
$1 \times 2 = n \times 0.0821 \times 300 \Rightarrow n = 0.08$
$H_2 \rightarrow x\text{mol}, O_2 \rightarrow (0.08 - x)\text{mol}$
$2x + (0.08 - x)32 = 0.76 \Rightarrow x = 0.06$

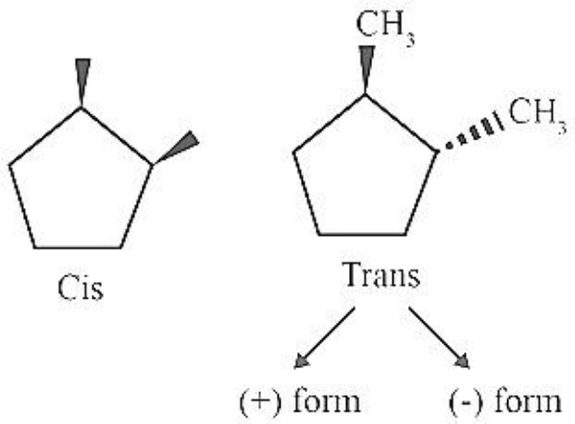
$$\frac{n_{H_2}}{n_{O_2}} = \frac{3}{1}$$

Question: Find out the number of stereoisomers formed by:



Answer: 3.00

Solution:



Total stereoisomers = 3

Question: $Fe_{0.93}O$ has metal deficiency defect. Calculate the percentage of Fe^{2+} ions in $Fe_{0.93}O$ compound. (Round off to the nearest integer)

Answer: 85.00

Solution:

$Fe^{+2} \rightarrow x$

$Fe^{+3} \rightarrow y$

$x + y = 0.93$ …(1) × 2

charge balance

$+2x + 3y = 2$ …(2)

solving (1) and (2)

$y = 0.14$

$$\% \, y = \frac{0.14}{0.93} \times 100 = 15 \, \%$$

$x = 100 - 15.85 \, \%$

$Fe^{+2} = 85\%$

Question: How many of the following statement is correct?

Statement I. Cu II → Paramagnetic

Statement II. Cu I → Colourless

Statement III. Cu I → Can be oxidised

Statement IV. Cu I → Used as reactant in Fehling's solution.

Answer: 3.00

Solution: I) II) and III) are correct

Statement IV) is false, Cu (II) is used as a reactant in Fehling's solution.

Question: How many of the following statement is correct?

Statement 1: Lyophilic ⇒ Protective colloid

Statement 2: Positive sol ⇒ $FeCl_3$ + NaOH

Statement 3: Negative sol ⇒ $FeCl_3$ + hot water

Statement 4: Emulsion ⇒ liq - liq

Answer: 2.00
Solution:
Statement I and IV are correct match
Statement II and III are false
Positive solution: $FeCl_3$ + hot water
Negative solution: $FeCl_3$ + hot NaOH

Question: When electron makes transition from 3rd state to ground state in Li^{2+} ion. The wavelength of photon emitted is (Round of to the nearest integer)
Answer: 114.00
Solution:
$E_3 - E_1 = 12.1 \times 9$ eV

$$\frac{12400}{\lambda} = 108.9 \text{ eV}$$

$\lambda = 113.8$ Å

JEE-Main-27-06-2022-Shift-1 (Memory Based)

MATHEMATICS

Question: $x=\sum_{n=0}^{\infty}a^n, y=\sum_{n=0}^{\infty}b^n, z=\sum_{n=0}^{\infty}c^n, |a|,|b|,|c|<1$ & a,b,c are in A.P. then

Options:

(a) x,y,z are in AP

(b) x,y,z are in GP

(c) $\frac{1}{x},\frac{1}{y},\frac{1}{z}$ are in AP

(d) $\frac{1}{x},\frac{1}{y},\frac{1}{z}=1-(a+b+c)$

Answer: (c)

Solution:

$$x=\sum_{n=0}^{\infty}a^n=\frac{1}{1-a}$$

$$y=\frac{1}{1-b},\ z=\frac{1}{1-c}$$

$a,b,c \Rightarrow$ AP

$1-a,1-b,1-c \Rightarrow$ AP

$$\Rightarrow \frac{1}{1-a},\frac{1}{1-b},\frac{1}{1-c} \Rightarrow \text{HP}$$

$$\Rightarrow x,y,z \Rightarrow \text{HP}$$

$$\Rightarrow \frac{1}{x},\frac{1}{y},\frac{1}{z} \Rightarrow AP$$

Question: Find number of distinct real roots of $x^4-4x-1=0$

Answer: 2.00

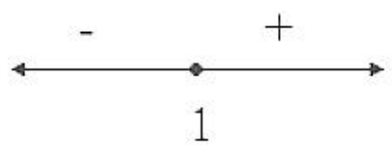
Solution:

Let $f(x)=x^4-4x-1$

$$f'(x)=4x^3-4$$

$$\Rightarrow x^3-1=0$$

$$x=1$$



Thus $f(x)$ will take only one minimum at $x=1$, thus, number of real roots will be '2'.

Question: $\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{6\pi}{7}=$

Answer: $\frac{-1}{2}$

Solution:

Given, $\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{6\pi}{7}$

$$\Rightarrow \frac{\sin 3\frac{\left(\frac{2\pi}{7}\right)}{2}}{\sin\left(\frac{\frac{2\pi}{7}}{2}\right)}\cos\left\{\frac{2\pi}{7}+\left(\frac{3-1}{2}\right)\frac{2\pi}{7}\right\}$$

$$\Rightarrow \frac{\sin\left(\frac{3\pi}{7}\right)}{\sin\frac{\pi}{7}}\cos\left\{\frac{4\pi}{7}\right\}$$

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

Question: $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ satisfies $\left(4\sqrt{\frac{2}{5}},3\right)$ & $e=\frac{1}{4}$. Find $3a^2-b^2$.

Answer: 31.00

Solution:

Given, $e=\frac{1}{4}$

$$\Rightarrow b^2=a^2\left(1-e^2\right)$$

$$=a^2\left(1-\frac{1}{16}\right)$$

$$b^2=\frac{15}{16}a^2$$

Now, $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ satisfy $\left(4\sqrt{\frac{2}{5}},3\right)$

$$\Rightarrow \frac{16\left(\frac{2}{5}\right)}{a^2}+\frac{9}{b^2}=1$$

$$\frac{32}{5a^2}+\frac{9\times 16}{15a^2}=1$$

$$\Rightarrow \frac{32+48}{5a^2}=1$$

$$\Rightarrow 5a^2=80$$

$$\Rightarrow a^2=16$$

$$\therefore b^2=\frac{15}{16}\times 16=15$$

Thus, $a^2+b^2=16+15=31$

Question: $\lim\limits_{x\to 7}\frac{\left(18-\left[1-x\right]\right)}{\left(\left[x\right]-3a\right)}$ exists, find a.

Answer: -6.00

Solution:

$$\frac{17-\left[-x\right]}{\left[x\right]-3a}$$

$$\text{LHL}=\frac{17-\left(-7\right)}{6-3a}=\frac{24}{6-3a}$$

$$\text{RHL}=\frac{17-\left(-8\right)}{7-3a}=\frac{25}{7-3a}$$

$$\text{LHL}=\text{RHL}\Rightarrow\frac{24}{6-3a}=\frac{25}{7-3a}$$

$$\Rightarrow 168-72=150-75a$$

$$\Rightarrow 18=-3a$$

$$\Rightarrow a=-6$$

Question: $f\left(x\right)=\frac{2e^{2x}}{e^{2x}+e}$, $f\left(\frac{1}{100}\right)+f\left(\frac{2}{100}\right)+\ldots+f\left(\frac{99}{100}\right)=?$

Answer: 99.00

Solution:

$$f\left(x\right)=\frac{2e^{2x}}{e^{2x}+e}$$

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

$$\Rightarrow\frac{2e^2}{e^2+e\cdot e^{2x}}=\frac{2e}{e+e^{2x}}$$

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

$$\Rightarrow f\left(\frac{1}{100}\right)+f\left(\frac{91}{100}\right)=2$$

$$f\left(\frac{2}{100}\right)+f\left(\frac{98}{100}\right)=2$$

$$\vdots$$

$$f\left(\frac{49}{100}\right)+f\left(\frac{51}{100}\right)=2$$

$$f\left(\frac{50}{100}\right)=f\left(\frac{1}{2}\right)=\frac{2e}{e+e}=1$$

$\therefore$ Required answer $=2\times 49+1$

Question: $\frac{1}{5}+\frac{2}{65}+\frac{3}{325}+\frac{4}{102}+\ldots.$ up to 10 terms?

Answer: $\frac{55}{221}$

Solution:

$$t_r=\frac{r}{4r^4+1}$$

$$\Rightarrow t_r=\frac{r}{4r^4+1+4r^2-4r^2}$$

$$\Rightarrow t_r=\frac{4r}{4\left(2r^2+1\right)^2-\left(2r\right)^2}$$

$$\Rightarrow t_r=\frac{1}{4}\times\frac{4r}{\left(2r^2+1-2r\right)\left(2r^2+1+2r\right)}$$

$$\Rightarrow t_r=\frac{1}{4}\left(\frac{1}{\left(2r^2+1-2r\right)}-\frac{1}{\left(2r^2+1+2r\right)}\right)$$

$$\Rightarrow t_r=\frac{1}{4}\left(\frac{1}{2r^2+1-2r}-\frac{1}{2\left(r+1\right)^2-2\left(r+1\right)+1}\right)$$

$$\Rightarrow \sum_{r=1}^{\infty}t_r=\frac{1}{4}\sum_{r=1}^{\infty}\left(\frac{1}{2r^2+1-2r}-\frac{1}{2\left(r+1\right)^2-2\left(r+1\right)+1}\right)$$

$$\Rightarrow \sum_{r=1}^{\infty}t_r=\left(\frac{1}{4}\right)\left[\left(\frac{1}{1}-\frac{1}{5}\right)+\left(\frac{1}{5}-\frac{1}{13}\right)+\left(\frac{1}{13}-\frac{1}{25}\right)+\ldots\right]$$

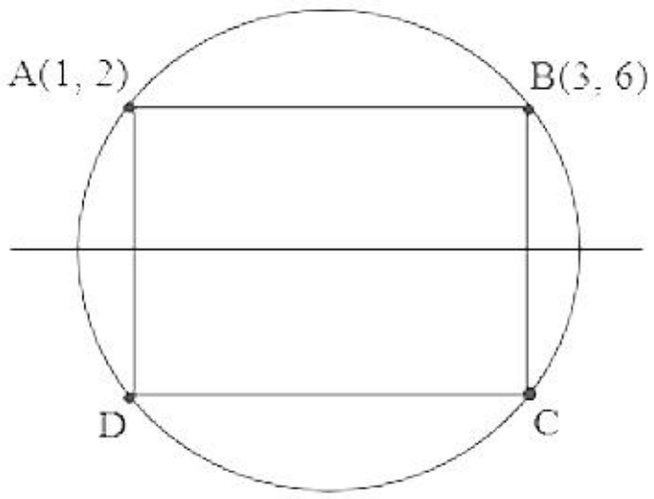
$$\Rightarrow \sum_{r=1}^{\infty}t_r=\frac{1}{4}(1)=\frac{1}{4}=\frac{m}{n}$$

$\therefore m+n=1+4=5$

Question: Rectangle having vertices (1, 2) & (2, 6) is circumscribed by circle with one of its diameter along $2x-y+4=0$ find area.

Answer: 16.00

Solution:



$$AB=\sqrt{(6-2)^2+(3-2)^2}=\sqrt{4^2+2^2}=\sqrt{20}$$

$$OB=\left|\frac{2\times3-6\times4}{\sqrt{2^2+1^2}}\right|=\frac{4}{\sqrt{5}}$$

$$BC=2OB=\frac{8}{\sqrt{5}}$$

$$\text{Area}=AB\times BC=\sqrt{20}\times\frac{8}{\sqrt{5}}=16$$

Question: $\int\frac{(x^2+1)e^x}{(x+1)^2}=f(x)e^x$. Find $\frac{d^3f}{dx^3}$ at $x=1$.

Answer: $\frac{3}{4}$

Solution:

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

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

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

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

$$\int g(x)=\int\left(\frac{x}{1+x}+\frac{1}{(1+x)^2}\right)e^x+\left(\frac{-1}{1+x}+\frac{1}{(1+x)^2}\right)e^x$$

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

$$\Rightarrow f(x)=\frac{x-1}{x+1}$$

$$f'(x)=\frac{(x+1)-(x-1)}{(x+1)^2}=\frac{2}{(x+1)^2}$$

$$f''(x)=\frac{-4}{(x+1)^3}$$

$$f'''(x)=\frac{12}{(x+1)^4}$$

$$f'''(1)=\frac{12}{2^4}=\frac{3}{4}$$

Question: $\begin{vmatrix}14 & 28 & -14\\ -14 & 14 & 28\\ 28 & -14 & 14\end{vmatrix}=\left|aadj\left(adj\left(A\right)\right)\right|$ then $|A|=?$

Answer: ± 14

Solution:

Given, $\begin{vmatrix}14 & 28 & -14\\ -14 & 14 & 28\\ 28 & -14 & 14\end{vmatrix}=\left|aadj\left(adj\left(A\right)\right)\right|$

$$|A|^{(3-1)^2}=14(196+392)-28(-196-784)-14(196-329)$$

$$=8232+27440+1862$$

$$|A|^4=38416=14^4$$

$$|A|=14$$

Question: Find area of polygon formed by non-real roots of $\overline{z}=iz^2$.

Answer: $\frac{\left(3\sqrt{3}\right)}{4}$

Solution:

Let $z=x+iy$

$$x-iy=i\left(x+iy\right)^2$$

$$x-iy=i\left(x^2-y^2+2ixy\right)$$

$$x-iy=-2xy+i\left(x-y^2\right)$$

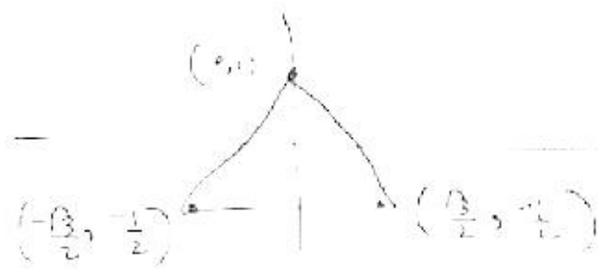
$\Rightarrow x=-2xy$ and $-y=x^2-y^2$

$\Rightarrow x=0$ or $y=\dfrac{1}{2}$

When $x=0$, $y=0$ and 1

When $y=\dfrac{-1}{2}$, $x=\pm\sqrt{\dfrac{3}{2}}$

$x=(0,0),(0,1),\left(\dfrac{\sqrt{3}}{2},\dfrac{-1}{2}\right),\left(\dfrac{-\sqrt{3}}{2},\dfrac{-1}{2}\right)$



Area $=\dfrac{1}{2}\left(\sqrt{3}\right)\left(\dfrac{3}{2}\right)=\dfrac{3\sqrt{3}}{4}$

Question: $\dfrac{dy}{dx}=\dfrac{2^{x-y}\left(2^y-1\right)}{2^{x-1}}$, $y(1)=1$. Find $y(2)$.

Answer: ()

Solution:

$\dfrac{dy}{dx}=\dfrac{2^{x-y}\left(2^y-1\right)}{2^{x-1}}$

$\Rightarrow \dfrac{dy}{dx}=\dfrac{2^{-y}\left(2^y-1\right)}{2^{-1}}$

$\Rightarrow \dfrac{dy}{1-2^{-y}}=2\,dx$

$\Rightarrow \int\dfrac{2^y\,dy}{2^y-1}=\int 2\,dx$

$\Rightarrow \dfrac{1}{\ln 2}\ln\left(2^y-1\right)=2x+C$

$y(1)=1$

$\Rightarrow \dfrac{\ln 1}{\ln 2}=2+C\Rightarrow C=-2$

$\Rightarrow \dfrac{1}{\ln 2}\ln\left(2^y-1\right)=2x-2$

At $x=2$

$\Rightarrow \ln\left(2^y-1\right)=(\ln 2)(2\times 2-2)$

$\Rightarrow \ln\left(2^y - 1\right) = 2\ln 2$

$\Rightarrow \ln\left(2^y - 1\right) = \ln 4$

$\Rightarrow 2^y - 1 = 4$

$\Rightarrow 2^y = 5$

$\Rightarrow y = \log_2 5$

Question: $x_1, x_2, x_3, x_4, x_5 \in \{1, 2, ..., 18\}$ are arranged such that $x_1 > x_2 > x_3 > x_4 > x_5$ then find probability of $x_2 = 7$ & $x_4 = 11$.

Answer: $\dfrac{126}{{}^{18}C_5}$

Solution:

Total number of cases $= {}^{18}C_5$

$$\underline{\quad} \quad \underset{\downarrow}{7} \quad \underline{\quad} \quad \underset{\downarrow}{11} \quad \underline{\quad}$$

$${}^{6}C_1 \qquad {}^{3}C_1 \qquad {}^{7}C_1$$

Favourable number of cases $= 6 \times 3 \times 7 = 126$

Probability $= \dfrac{126}{{}^{18}C_5}$

Question: Find coefficient of x^{10} in $\left(\dfrac{\sqrt{x}}{5^{\frac{1}{4}}} + \dfrac{\sqrt{5}}{x^{\frac{1}{3}}}\right)^{60}$ is $5^n \times l$, then $n = ?$

Answer: 6.00

Solution:

Given, $\left(\dfrac{\sqrt{x}}{5^{\frac{1}{4}}} + \dfrac{\sqrt{5}}{x^{\frac{1}{3}}}\right)^{60}$

$$T_{r+1} = {}^{60}C_r \left(\frac{\sqrt{x}}{5^{\frac{1}{4}}}\right)^{60-r} \left(\frac{\sqrt{5}}{x^{\frac{1}{3}}}\right)^{r}$$

$$= {}^{60}C_r \, 5^{\frac{r-60}{4}} x^{\frac{60-r}{2}} 5^{\frac{r}{2}} x^{-\frac{r}{3}}$$

$$= {}^{60}C_r \, 5^{\frac{3r-60}{4}} \cdot x^{\frac{180-5r}{6}}$$

Now, we need x^{10},

$$\therefore \frac{180-5r}{6}=10$$

$$180-5r=60$$

$$120=5r$$

$$r=24$$

$\therefore$ coefficient of x^{10} will be $={}^{60}C_{24}\,5^3$

$$=\frac{60!}{24!36!}\cdot 5^3$$

Now, exponent of 5 in $60!=\left[\frac{60}{5}\right]+\left[\frac{60}{5^2}\right]+\left[\frac{60}{5^3}\right]+\ldots$

$$=12+2+0=14$$

Exponent of 5 in $24!=\left[\frac{24}{5}\right]+\left[\frac{24}{5^2}\right]=4$

Exponent of 5 in $36!=\left[\frac{36}{5}\right]+\left[\frac{36}{5^2}\right]=7$

$\therefore$ Coefficient of x^{10} will be $=1\times 5^6$

$\therefore n=6$

Question: We have 11 identical blue balls & 5 red balls. Find number of ways to arrange these 16 balls such that minimum 2 balls are kept in between 2 red balls.

Answer: ${}^8C_5\cdot 5!$

Solution:

Number of ways to arrange blue ball

$$x_1+x_2+x_3+x_4+x_5+x_6=11$$

$$x_1\geq 0,\ x_2\geq 2, x_3\geq 2,\ x_4\geq 2,\ x_5\geq 2,\ x_6\geq 0$$

$$t_2=x_2-2,\ t_3=x_3-2,\ t_4=x_4-2$$

$$\Rightarrow x_1+t_2+t_3+t_4+t_5+x_6\geq 3$$

$$\Rightarrow {}^{3+6-1}C_{6-1}={}^8C_5$$

Ways to arrange red ball $=5!$

Total number of ways $={}^8C_5\cdot 5!$

Question: $\int_{-2}^{2}\frac{|x^3-x|}{e^{|x|x}+1}=?$

Answer: 6.00

Solution:

$$I=\int_{-2}^{2}\frac{|x|\left(x^2+1\right)}{1+e^{x|x|}}dx \qquad \ldots.(\mathrm{i})$$

$$I=\int_{-2}^{2}\frac{|x|\left(x^2+1\right)}{1+e^{-x|x|}}dx \qquad ....(\text{ii})$$

Adding (i) & (ii),

$$2I=\int_{-2}^{2}\frac{|x|\left(x^2+1\right)\left(1+e^{x|x|}\right)}{1+e^{x|x|}}dx$$

$$\Rightarrow 2I=2\int_{0}^{2}\left(x^3+x\right)dx$$

$$\Rightarrow I=\left[\frac{x^4}{4}+\frac{x^2}{2}\right]_0^2=4+2=6$$