Physical World

EXERCISE-I

Q.1 (4)
Q.2 (2)
Q.3 (3)
Q.4 (3)
Q.5 (4)
Q.6 (4)
Q.7 (2)
Q.8 (4)
Q.9 (2)
Q.10 (2)
Q.11 (4)
Q.12 (4)
Q.13 (4)
Q.14 (4)
Q.15 (1)

EXERCISE-II

Q.1 (3)
Q.2 (2)
Q.3 (3)
Q.4 (4)
Q.5 (1)
Q.6 (4)
Q.7 (2)
Q.8 (4)
Q.9 (3)
Q.10 (4)
Q.11 (4)
Q.12 (4)
Q.13 (1)
Q.14 (4)
Q.15 (1)

Units and Measurement

EXERCISE-I (MHT CET LEVEL)

Q.1 (1)
Q.2 (3)
Q.3 (3)
Q.4 (1)
Q.5 (4)
Q.6 (3)

$$\frac{h}{I} = \frac{\frac{E}{v}}{MR^2} = \frac{\frac{[ML^2T^{-2}]}{[T^{-1}]}}{[ML^2]}$$

= $[T^{-1}]$ = frequency

Q.7 (3)

Angular Frequency (f) $= \frac{1}{T} = M^oL^oT^{-1}$

So, here dimension in length is zero

Q.8 (2)
P = mvm $\rightarrow$ mass
v $\rightarrow$ velocity
Dimesion of [P] = $[MLT^{-1}]$

Q.9 (1)
Q.10 (1)
Q.11 (1)

$\frac{\alpha z}{k\theta}$ must be dimensionless

$$\Rightarrow \frac{\alpha z}{k\theta} = [M^0L^0T^0]$$

$$\alpha = \frac{k\theta}{z} = \frac{[ML^2T^{-2}K^{-1}][K]}{[L]}$$

$= [MLT^{-2}]$

$$P = \frac{\alpha}{\beta} = [ML^{-1}T^{-2}]$$

$$\Rightarrow B = \frac{[MLT^{-2}]}{[ML^{-1}T^{-2}]} = [M^0L^2T]$$

Q.12 (3)

$$T = 2\pi\sqrt{\frac{ML^3}{3Yq}},$$

writting dimensions of both the sides,

we get $[T] = \left[\frac{ML^3}{ML^{-1}T^{-2}q}\right]^{\frac{1}{2}} \Rightarrow [T^2] = \frac{[L^4T^2]}{q}$

or $q = [L^4]$

Q.13 (2)
Dimension of at = Dimension of F

$$[at] = [F] \Rightarrow [a] = \left[\frac{F}{t}\right]$$

$$[b] = \left[\frac{MLT^{-2}}{T}\right] \Rightarrow [a] = [MLT^{-3}]$$

Dimension of bt^2 = Dimension of F

$$[bt^2] = [F] \Rightarrow [b] = \left[\frac{F}{t^2}\right]$$

$$[b] = \left[\frac{MLT^{-4}}{T^2}\right] \Rightarrow [b] = [MLT^{-4}]$$

Q.14 (3)

$$\upsilon = \frac{p}{2\ell}\left[\frac{F}{m}\right]^{1/2}$$

$$\upsilon^2 = \frac{p}{4\ell^2}\frac{F}{m} \Rightarrow m = \frac{p^2F}{4\ell^2\upsilon^2}$$

Now, dimensional formula of R.H.S.

$$= \frac{[MLT^{-2}]}{[L^2][T^{-1}]^2} = [ML^{-1}T^0]$$

[P will have no dimension as it is an integer = $ML^{-1}T^0$]

Q.15 (3)

Dimensions of $Y = \frac{\text{dimensions of } X}{\text{dimensions of } Z^2}$

$$= \frac{M^{-1}L^{-2}T^4A^2}{(MT^{-2}A^{-1})^2}$$

$= [M^{-3}L^{-2}T^8A^4]$

Q.16 (4)

$P = \frac{I}{C} = [ML^{-1}T^{-2}]$

$C = [LT^{-1}]$

$Q = \frac{\text{Energy}}{\text{Area} \times \text{time}} = \frac{[ML^2T^{-2}]}{[L^2][T]}$

$= [MT^{-3}]$

$P^x Q^y C^Z = [M^0L^0T^0]$

$[ML^{-1}T^{-2}]^X [MT^{-3}]^y [LT^{-1}]^Z = [M^0L^0T^0]$

$x + y = 0 \Rightarrow x = -y$

$-x + z = 0 \Rightarrow x = z = -y$

$-2x - 3y - z = 0$

$x = 1$

$\Rightarrow$ $y = -1$

$z = 1$

Q.17 (1)

Let $V = kT^aA^b\rho^c$

$k =$ dimensionless constant Writing dimension on both side we get

$[LT^{-1}] = [MLT^{-2}]^a [L^2]^b [ML^{-3}]^c$

$= [M^{a+c}L^{a+2b-3c}T^{-2a}]$

Comparing power on both sides we have

$a + c = 0, a + 2b - 3c = 1, -2a = -1$

$a = \frac{1}{2}, c = -\frac{1}{2} \Rightarrow b = -\frac{1}{2} \therefore V = k\sqrt{\frac{T}{A\rho}}$

Q.18 (1)

$[MLT^{-2}] = [L^{2a}] \times [L^bT^{-b}][M^cL^{-3c}]$

$= [M^cL^{2a+2-3c}T^{-b}]$

comparing powers of M, L and T, on both side, we get

C=1, 2a+b-3C = 1, -b = -2 or b=2

Also, 2a+2-3(1) = 1 $\Rightarrow$ 2a = 2 or a =1

$\therefore$ This is 1,2, 1

Q.19 (1)

Since unit of energy = (unit of force). (unit of length) so if we increase unit of length and force, each by four times, then unit of energy will increases by sixteen times.

Q.20 (1)

Given

$P = 10^6$ dyne/cm^2

$n_1u_1 = n_2u_2$

$n_1[M_1^1L_1^{-1}T_1^{-2}] = 10^6[M_2^1L_2^{-1}T_2^{-2}]$

$n_1 = 10^6\left[\frac{M_2}{M_1}\right]^1\left[\frac{L_2}{L_1}\right]^{-1}\left[\frac{T_2}{T_1}\right]^{-2}$

$= 10^6\left[\frac{1}{1000}\right]^1\left[\frac{1}{100}\right]^{-1}$

$\Rightarrow 10^6 \times \frac{10^2}{10^3} = 10^5 \text{ N/m}^2$

Q.21 (4)

$\frac{C^2}{g} = \frac{L^2T^{-2}}{LT^{-2}} = [L]$

Q.22 (1)

Least count for A $(L.C.)_A = 0.001$ mm

Least count for B $(L.C.)_B = \frac{1}{50}$ mm = 0.02 mm

Least count for C $(L.C.)_C = 0.01$ mm

Least count for D $(L.C.)_D$ = 1 MSD – 1VSD

$= 1\text{MSD} - \frac{19}{20}\text{MSD} = \frac{1}{20}\text{MSD}$

= 0.05 mm

$\therefore (L.C.)_A$ is smallest.

Hence more accurate.

Q.23 (2)

$g = \frac{GM}{R^2} \Rightarrow \frac{dg}{g} = -2\frac{dR}{R}$

$\frac{dR}{R} = -1\% \Rightarrow \frac{dg}{g} = 2\%$

Q.24 (3)

Q.25 (1)

Q.26 (3)

Q.27 (4)

EXERCISE-II (NEET LEVEL)

Q.1 (3)

PARSEC is a unit of distance.

It is used in astronomical science.

Q.2 (2)

SI unit of universal gravitational constant G is -

We know $F = \frac{GM_1M_2}{R^2}$

Here M_1 and M_2 are mass

R = Distance between them M_1 and M_2

F = Force

$$G = \frac{FR^2}{M_1M_2} = \frac{N-m^2}{kg^2}$$

So, Unit of G = $N–m^2\ kg^{-2}$

Q.3 (1)

$$F = \eta\left(\frac{dv}{dx}\right)A$$

$$\frac{kgm}{sec^2} = \eta.\frac{m/sec}{m} \times m^2$$

$$\Rightarrow \eta = kg\,m^{-1}\,S^{-1}$$

Q.4 (4)

Here ρ is specific resistance.

$$R = \frac{\rho l}{A} \Rightarrow ohm = \frac{\rho m}{m^2} \qquad \Rightarrow \rho = ohm \times m$$

Q.5 (1)

Here i = current

A = crossectional Area

M = iA

= Amp. m^2

Q.6 (4)

Stefan-Constant(σ)

Unit → $w/m^2\text{-}k^4 = wm^{-2}k^{-4}$

Q.7 (3)

S.I. unit of the angular acceleration is rad/s^2.

α = angular velocity/time

Q.8 (2)

AM = mvr

$[AM] = [MLT^{-1}\,L] = [ML^2\,T^{-1}]$

Q.9 (2)

$$\text{magnetic flux density} = \frac{weber}{metre^2} = \frac{ML^2T^{-2}A^{-1}}{L^2}$$

Q.10 (2)

Dimension of Pressure = $M^1L^{-1}T^{-2}$

= Force/Area

It is same as energy per unit volume

$$= \frac{Energy}{Volume} = \frac{M^1L^2T^{-2}}{L^3} = M^1L^{-1}T^{-2}$$

Q.11 (4)

$$\frac{VT}{I \times \frac{V}{I} \times \frac{Q}{V} \times V} = \frac{T}{Q} = \frac{T}{AT} = A^{-1}$$

Q.12 (3)

All the terms in the equation must have the dimension of force

$\therefore\ [A \sin C t] = MLT^{-2}$

$\Rightarrow\ [A][M^0L^0T^0] = MLT^{-2}$

$\Rightarrow\ [A] = MLT^{-2}$

Similarly, $[B] = MLT^{-2}$

$$\therefore\ \frac{[A]}{[B]} = M^oL^oT^o$$

Again $[Ct] = M^oL^oT^o \qquad \Rightarrow [C] = T^{-1}$

$[Dx] = MLT^o \Rightarrow [D] = L^{-1}$

$$\Rightarrow\ \frac{[C]}{[D]} = M^oL^1T^{-1}.$$

Q.13 (1)

$$[\alpha] = \left[\frac{2ma}{\beta}\right] \text{ and } \left[\frac{2\beta\ell}{ma}\right] = 1$$

$$[\alpha] = \left[\frac{ma}{\beta}\right] \qquad \left[\frac{ma}{\beta}\right] = \ell$$

$[\alpha] = L$

Q.14 (2)

It is obvious

Q.15 (4)

By checking each option.

$$\frac{V^2}{rg} = \frac{\left[L^1T^{-1}\right]^2}{[L^1][L^1T^{-2}]}$$

$$= \frac{L^2T^{-2}}{L^2T^{-2}} = [M^oL^oT^o]$$

Q.16 (1)

$G = 6.67 \times 10^{-11}\ N\,m^2\,(kg)^{-2}$

$= 6.67 \times 10^{-11} \times 10^5\ dyne \times 100^2\ cm^2 / (10^3)^2\ g^2 = 6.67 \times 10^{-8}\ dyne\text{-}cm^2\text{-}g^{-2}$

Q.17 (4)

We know $n_1\,u_1 = n_2u_2$

when $n_1 > n_2$ then $u_1 < u_2$

So, we can say $n \propto \frac{1}{u}$

Q.18 (3)

$P = \frac{W}{t}$

Watt = Joule/sec.
Joule = Watt-sec.
One watt-hour = 1 watt×60×60 sec
1 Hour=60×60sec. = 3600 watt-sec
= 3600 Joule
= 3.6×10^3 Joule

Q.19 (1)

$$n_2 = 13600\left[\frac{M_1}{M_2}\right]^1\left[\frac{L_1}{L_2}\right]^{-3}$$

$$= 13600\left[\frac{1000}{1}\right]^1\left[\frac{100}{1}\right]^{-3}$$

$n_2 = 13.6\ gcm^{-3}$

Q.20 (2)

$\therefore E = \frac{1}{2}mv^2$

$\therefore$ % Error in K.E.

= % error in mass + 2 × % error in velocity

= 2 + 2 × 3 = 8 %

Q.21 (2)

$\because V = \frac{4}{3}\pi r^3$

$\therefore$ % error is volume $= 3 \times \%$ error in radius

$= 3 \times 1 = 3\%$

Q.22 (3)

% error in velocity = %error in L + %error in t

$= \frac{0.2}{13.8} \times 100 + \frac{0.3}{4} \times 100$

= 1.44 + 7.5 = 8.94 %

Q.23 (1********)

$\frac{1}{20} = 0.05$

$\therefore$ Decimal equivalent upto 3 significant figures is 0.0500

Q.24 (1)

Since percentage increase in length = 2 %

Hence, percentage increase in area of square sheet

$= 2 \times 2\% = 4\%$

Q.25 (1)

As we know $F = qvB = \frac{mv^2}{r}$

$\therefore r = \frac{mv}{Bq}$

And $KE = k = \frac{1}{2}mv^2$

$\therefore mv = \sqrt{2km}$

$\therefore r = \frac{mv}{qB} = \frac{\sqrt{2km}}{qB}$

$\Rightarrow r \propto \sqrt{k}$ or $r = c^{1/2}$ (c is a constant)

$\frac{dr}{dr} = c\frac{dk^{-1}}{dr}$ or $\frac{c\Delta k}{\Delta r} = 2\sqrt{k}$

or $\frac{\Delta r}{r} = \frac{c\Delta k}{2\sqrt{kc}\sqrt{k}} = \frac{\Delta k}{2r}$

Therefore percentage changes in radius of path,

$\frac{\Delta r}{r} \times 100 = \frac{\Delta k}{2r} \times 100 = 2\%$

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (2)

Unit of impulse = $\Rightarrow$ Impulse = Force × time

$= kg\ \frac{m}{sec^2}sec = kg\frac{m}{sec} = mv$

The unit is same as the unit of linear momentum.

Q.2 (4)

Energy W = f × d = Nm
W = eV = electron-volt
W = p × t = Watt hour
So, kg × m/sec^2 is not the unit of energy.

Q.3 (3)

They Can't e added or Substracted in Same expression.

Q.4 (4)

Plank Const. (h) $\rightarrow$

$E = hf \qquad \Rightarrow \quad h = \frac{ML^2T^{-2}}{\frac{1}{T}}$

Unit $\rightarrow$ J-S
Dimension = $M^1L^2T^{-2} \times T^1 = M^1L^2T^{-1}$
This is also a dimension of Angular momentum.
= mvr
= MLT^{-1} L=$M^1L^2T^{-1}$

Q.5 (2)

$P = P_o\ Exp\ (-\alpha t^2)$
Here Exp $(-\alpha t^2)$ is a dimensionless
So, dimension of $[\alpha t^2] = M^oL^oT^o$

So, $[\alpha] = \frac{M^oL^oT^o}{T^2}$

$[\alpha] = M^oL^oT^{-2}$

Q.6 (4)

Action = Energy × Time = $M^1L^2T^{-2} \times T^1$

$= M^1L^2T^{-1}$

It is same as dimension of Impulse × distance

$= MLT^{-1} \times L^1 = M^1L^2T^{-1}$

Q.7 (3)

By checking the dimension in all options

[Pressure] = $M^1L^{-1}T^{-2}$

Q.8 (3)

$$v = at + \frac{b}{t+c}$$

Same physical quantity can be added or substracted.

Dimension of a

[v] = [at]

$$[a] = \frac{[v]}{[t]} = \frac{L^1T^{-1}}{T^1} = L^1T^{-2}$$

Here t + c is also a Time (t)

$$[v] = \left[\frac{b}{t}\right]$$

$[b] = [v]\,[t] = L^1T^{-1} \times T^1$

$[b] = L^1$

Q.9 (3)

$$x(t) = \frac{v_o}{\alpha}[1 - e^{-\alpha t}]$$

Dimension of v_o and α

Here $e^{-\alpha t}$ is dimensionless so,

$[\alpha]\,[t] = M^oL^oT^o$

$$[\alpha] = \frac{M^oL^oT^o}{T^1} = T^{-1}$$

$[\alpha] = M^oL^oT^{-1}$

Here$1-e^{-\alpha t}$ is a number

$$[x(t)] = \frac{V_o}{\alpha}$$

$[V_o] = [L^1]\,[T^{-1}]$

$[V_o] = M^oL^1T^{-1}$

Q.10 (4)

Y = a sin (bt – cx)

Dimension of b

Here bt is dimensionless

$[bt] = M^oL^oT^o$

$$[b] = \frac{M^oL^oT^o}{[T^1]} = M^oL^oT^{-1}$$

It is a dimension of wave frequency.

Q.11 (4)

$$\alpha = \frac{F}{V^2}\sin(\beta t)$$

Here sin (βt) is dimensionless.

$[\beta t] = M^oL^oT^o$

$$\beta = \frac{M^oL^oT^o}{T^1} = \left[T^{-1}\right]$$

$$[\alpha] = \left[\frac{F}{V^2}\right]$$

$$= \frac{M^1L^1T^{-2}}{[L^1T^{-1}]^2} = \frac{M^1L^1T^{-2}}{L^2T^{-2}}$$

$[\alpha] = [M^1L^{-1}T^o]$

Q.12 (4)

L α FAT

$L = K\,F^aA^bT^c$

.... (1)

$M^oL^1T^o = K[M^1L^1T^{-2}]\,[L^1T^{-2}]^b[T]^c$

$M^oL^1T^o = K[M^a]\,[L^{a+b}]\,[T^{-2a-2b+c}]$

By comparesion and solving we find

[a = 0] [b = 1] [c = 2]

Put these value in Equa. (1)

$[L = F^oA^1T^2]$

Q.13 (2)

F α Avρ

$F = KA^a\,v^b\,\rho^c$

$= K[L^2]^a\,[L^1T^{-1}]^b\,[M^1L^{-3}]^c$

$F = K[M^cL^{2a+b-3c}\,T^{-b}]$

$M^1L^1T^{-2} = K[M^c\,L^{2a+b-3c}\,T^{-b}]$

c = 1

$-2 = -b \Rightarrow b = 2$

and

2a + b – 3c = 1

$2a + 2 - 3 = 1 \Rightarrow a = 1$

So $F = A^1\,v^2\,q^1$

$\therefore\ F = Av^2\rho$

Q.14 (2)

$V = g^p\,h^q$

$V = Kg^p\,h^q$

$[L^1T^{-1}] = [L^1T^{-2}]^p\,[L^1]^q$

$L^1T^{-1} = L^{p+q}\,T^{-2p}$

By comparing both sides

p+q=1, -2p=-1

p = 1/2, q=1/2

Q.15 (1)

$n_1u_1 = n_1u_1$

$$n_1\left[M_1^1L_1^2T_1^{-3}\right] = 1\left[M_2^1L_2^2T_2^{-3}\right]$$

$$n_1 = \left[\frac{M_2}{M_1}\right]^1\left[\frac{L_2}{L_1}\right]^2\left[\frac{T_2}{T_1}\right]^{-3}$$

$= \left[\frac{20}{1}\right]^1 \left[\frac{10}{1}\right]^2 \left[\frac{5}{1}\right]^{-3}$

$= \frac{20 \times 100}{5 \times 5 \times 5} = 16$

$n_1 = 16$

Unit of power in new system = 16 Watt.

Q.16 (4)

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

$n_1 u_1 = n_2 u_2$

$10[L_1]^1 [T_1]^{-2} = n_2 [L_2]^1 [T_2]^{-2}$

$n_2 = 10\left[\frac{L_1}{L_2}\right]^1 \left[\frac{T_1}{T_2}\right]^{-2}$

$n_2 = 10\left[\frac{1}{1000}\right]^1 \left[\frac{1}{3600}\right]^{-2}$

$n_2 = 129600$

Q.17 (3)

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

Dimension = $M^1L^2T^{-2}$

Now M.L are doubled

$= (2M)^1 (2L)^2 (T^{-2}) = 8\ M^1L^2T^{-2}$

So, K.E. will become 8 times.

Q.18 (1)

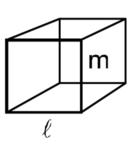
$A = \ell b \quad = 10.0 \times 1.00 = 10.00$

$\frac{\Delta A}{A} = \frac{\Delta \ell}{\ell} + \frac{\Delta b}{b}$

$\frac{\Delta A}{10.00} = \frac{0.1}{10.0} + \frac{0.01}{1.00} \quad \Rightarrow \quad \Delta A = 10.00$

$\left(\frac{1}{100} + \frac{1}{100}\right) \quad = 10.00\left(\frac{2}{100}\right) = \pm 0.2\ cm^2.$

Q.19 (2)



$\rho = \frac{m}{V} = \frac{m}{\ell^3}$

Given : $\frac{\Delta m}{m} = \pm\ 2\% = \pm 2 \times 10^{-2} \qquad \frac{\Delta \ell}{\ell} = \pm 1\% = \pm 1 \times 10^{-2}$

$\frac{\Delta \rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta \ell}{\ell}$

$= 2 \times 10^{-2} + 3 \times 10^{-2} = 5 \times 10^{-2} = 5\%$

Q.20 (1)

(1) $g = 4\pi^2 \frac{\ell}{T^2}$

$\frac{\Delta \ell}{\ell} = 2\% = \pm 2 \times 10^{-2}$

$\frac{\Delta T}{T} = \pm 3\% = \pm 3 \times 10^{-2}$

$\Rightarrow \frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + \frac{2\Delta T}{T} = 2 \times 10^{-2} + 2 \times 3 \times 10^{-2} = 8 \times 10^{-2} = \pm 8\,\%$

Q.21 (4)

$\frac{\Delta x}{x} = 1\% = 10^{-2}$

$\frac{\Delta y}{y} = 3\% = 3 \times 10^{-2}$

$\frac{\Delta z}{z} = 2\% = 2 \times 10^{-2}$

$t = \frac{xy^2}{z^3}$

$\frac{\Delta t}{t} = \frac{\Delta x}{x} + \frac{2\Delta y}{y} + \frac{3\Delta z}{z}$

$= 10^{-2} + 2 \times 3 \times 10^{-2} + 3 \times 2 \times 10^{-2}$

$= 13 \times 10^{-2}\ \therefore \qquad \%\text{ error in } t = \frac{\Delta t}{t} \times 100 = 13\%$

Q.22 (2)

m = 1.76 kg

M = 25 m

= 25 × 1.76

= 44.0 kg

Note : Mass of one unit has three significant figures and it is just multiplied by a pure number (magnified). So result should also have three significant figures.

Q.23 (2)

$R_1 = (24 \pm 0.5)\ \Omega$

$R_2 = (8 \pm 0.3)\ \Omega$

$R_S = R_1 + R_2$

$= (32 \pm 0.8)\ \Omega$

Q.24 (2)

$\Delta \ell = 0.5$ mm

N = 100 divisions

zero correction = 2 divisions

Reading = Measured value + zero correction

$= (8 \times 0.5)\ mm + (83 - 2) \times \frac{0.5}{100}.$

$= 4\ mm + 81 \times \frac{0.5}{100}\ mm$

= 4.405 mm

Q.25 (1)

$$D = 2\times1+5\times\frac{10-9}{100} = 2.05\ \text{cm}$$

EXERCISE-IV

INTEGER TYPE

Q.1 [1]
Q.2 [3]
Q.3 [4]
Q.4 [1]
Q.5 [0]
Q.6 [10.76]
Q.7 [2.6]
Q.8 [5]
Q.9 [43.7]
Q.10 [9]
Q.11 (2)
Q.12 (3)
Q.13 (3)
Q.14 (3)
Q.15 (1)
Q.16 (1)

PREVIOUS YEAR'S

MHT_CET

Q.1 (4)
Q.2 (2)
Q.3 (1)
Q.4 (1)
Q.5 (4)
Q.6 (1)
Q.7 (3)
Q.8 (3)
Q.9 (2)
Q.10 (4)
Q.11 (2)
Q.12 (1)
Q.13 (1)
Q.14 (4)
Q.15 (3)
Q.16 (2)
Q.17 (4)

Previous Year's_NEET-JEE

Q.1 (4)

$$H = \frac{(k)A(T_2-T_1)}{\ell}$$

$$(k) = (H)\left(\frac{\ell}{A}\right)\frac{1}{[T_2-T_1]}$$

$$k = w\frac{1}{m}\frac{1}{k}$$

$$K = wm^{-1}k^{-1}$$

Q.2 (3)
Q.3 (4)
Q.4 (1)
Q.5 (3)

Area = Length ×Breadth
$= 55.3\times25$
$= 1382.5$
$= 14\times10^2$
Resultant should have 2 significant figures

Q.6 (2)
$[MLT^{-2}A^{-2}]$ = Magnetic permeability

Q.7 (4)
Plane angle and solid angle are dimensionless but have units.

Q.8 (4)
Diameter of the ball = MSR + CSR × (Least count) – Zero error
$= 5\ \text{mm} + 25\times0.001\ \text{cm} - (-0.004)\ \text{cm}$
$= 0.5\ \text{cm} + 25\times0.001\ \text{cm} - (-0.004)\ \text{cm} = 0.529\ \text{cm}.$

Q.9 (2)

$$x = \frac{A^2B^{1/2}}{C^{1/3}D^3}$$

$$\ell nx = 2\ell n A + \frac{1}{2}\ell nB - \frac{1}{3}\ell nC - 3\ell nD$$

Differenting

$$\left(\frac{dx}{x}\right)_{max} = 2\frac{dA}{A} + \frac{1}{2}\frac{dB}{B} + \frac{1}{3}\frac{dC}{C} + \frac{3dD}{D}$$

$$\text{error } x_{max} = 2\times1+\frac{2}{2}+\frac{1}{3}\times3+3\times4 = +16\%$$

Q.10 (2)
Q.11 (1)
Q.12 (3)

JEE MAIN

Q.1 (4)
S.I. unit of specific heat capacity = $Jkg^{-1}K^{-1}$
S.I. unit of latent heat = Jkg^{-1}
so dimensions will be different

Q. 2 (1)
Pascal second

$$\frac{F}{A}t = \frac{MLT^{-2}}{L^2}T = ML^{-1}T^{-1}$$

Q. 3 (4)

$\left(\frac{L}{C}\right)$ does not have dimension of time.

$RC, \frac{L}{R}$ are time constant while $\sqrt{LC}$ is reciprocal of angular frequency or having dimension of time.

Q.4 (3)

$$\left[P+\frac{a}{V^2}\right][V-b]=RT$$

Dimensionally $[P]=\left[\frac{a}{V^2}\right]$ $[V]=[b]$

$\therefore a=PV^2 \qquad \frac{a}{b}=\frac{PV^2}{v}=PV$

Q.5 (3)

Q.6 (5)

Q.7 (3)

e^2 : induced emf in secondary coil

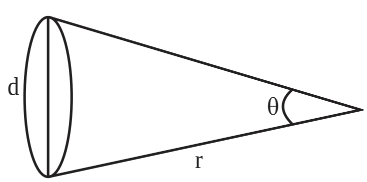
i_1 : Current in primary coil

M : Mutual inductance

$$e_2=-M\frac{di_1}{dt}, \qquad M=-\frac{e_2}{\frac{di_1}{dt}}$$

$$[M]=\frac{[e_2]}{\left[\frac{di_1}{dt}\right]}=\frac{\left[\frac{W}{q}\right]}{\left[\frac{di_1}{dt}\right]}=\frac{\frac{[ML^2T^{-2}]}{[AT]}}{[AT^{-1}]}=[ML^2T^{-2}A^{-2}]$$

Q.8 (3)



$$\theta=\frac{d}{r}$$

$$\frac{2000}{60\times60}\times\frac{\pi}{180}=\frac{d}{1.5\times10^{11}}$$

$$\Rightarrow d=\frac{2000}{60\times60}\times\frac{\pi}{180}\times1.5\times10^{11}$$

$$\Rightarrow \frac{\pi\times1.5}{3\times6\times18}\times10^{11}=1.45\times10^{9}$$

Q.9 (1)

$\eta\propto P^aA^bT^c$

$[\eta]=[P]^a[A]^b[T]^c$

$[ML^{-1}T^{-1}]=[MLT^{-1}]^a[L^2]^b[T]^c$

$[M^1L^{-1}T^{-1}]$ $[M^aL^{a+2b}T^{-a+c}]$

a = 1, a + 2b = - 1, - a + c = - 1

b = -1 & C = 0

$\eta\propto P^1A^{-1}T^0$

Q.10 (1)

Electric displacement - $D=\varepsilon E$

Q.11 (4)

Here $\frac{\alpha x}{Kt}=1$ (is an angle)

$$\alpha=\frac{KT}{x}$$

$$\alpha=\frac{PV}{x}=F$$

Now $\frac{E}{v}=\frac{F}{\beta}$

So, $\beta=\frac{FV}{E}=\frac{L^3}{L}=L^2$

Q.12 (3)

$$u=\frac{B^2}{2\mu_0}$$

u = Energy per unit volume

$$\left[\frac{B^2}{\mu_0}\right]=[u]=\frac{[ML^2T^{-2}]}{[L^3]}=[ML^{-1}T^{-2}]$$

Q.13 (4)

$$\eta=\frac{\alpha\beta}{\sin\theta}\log\left(\frac{\beta x}{kT}\right)$$

k – Boltzmann constant

T – temperature

Dim of K = $[M^1L^2T^{-2}K^{-1}]$

or Dim of $\frac{\beta x}{kT}=M^0L^0T^0$

$$\frac{\beta[L]}{[ML^2T^{-2}K^{-1}][K]}=[M^0L^0T^0]$$

$\beta=[MLT^{-2}]$ = Force

(b) Dim of $\alpha^{-1}x$ = Dim of βx

$=(MLT^{-2})[L]=[ML^2T^{-2}]$[Energy]

(c) η is dimensionless, $\sin\theta$ is also dimensionless from expression dimension of $\eta^{-1}\sin\theta=\alpha\beta$

So, Dim of $\eta^{-1}\sin\theta - \alpha\beta$
(d) Dim of $\alpha\beta = M^0L^0T^0$

So, Dim of α = dim of $\frac{1}{\beta}$

Q.14 (4)

$$T = K\sqrt{\frac{\rho r^3}{S^{\frac{3}{2}}}}$$

$$\text{Dimensions of RHS} = \frac{\left[M^{\frac{1}{2}}L^{-\frac{3}{2}}\right]\left[L^{\frac{3}{2}}\right]}{[MT^{-2}]^{\frac{3}{4}}} = M^{\frac{1}{8}}L^0T^{\frac{3}{2}}$$

Dimensions of L.H.S. $\neq$ Dimensions of R.H.S.

Q.15 (2)

Torque = F x r $\perp$ Nm

Stress = $\frac{\text{Force}}{\text{Area}}$ N/m^2

Latent Heat = $\frac{\text{Energy}}{\text{Mass}}$ Jkg^{-1}

Power = $\frac{\text{Work}}{\text{Time}}$ Nms^{-1}

Q.16 (4)

Here $\frac{\alpha x}{Kt} = 1$ (is an angle)

$$\alpha = \frac{KT}{x}$$

$$\alpha = \frac{PV}{x} = F$$

Now $\frac{E}{v} = \frac{F}{\beta}$

So,

$$\beta = \frac{FV}{E} = \frac{L^3}{L} = L^2$$

Motion in a Straight Line

EXERCISE-I (MHT CET LEVEL)

Q.1 (2)
Total time of motion is 2 min 20 sec = 140 sec.
As time period of circular motion is 40 sec so in 140 sec. athlete will complete 3.5 revolution i.e., He will be at diametrically opposite point i.e., Displacement = 2R.

Q.2 (2)
Q.3 (2)
Q.4 (2)
When the mass increases by a factor of 4 the acceleration must decrease by a factor of four if the same force is applied. The question asks about position so we need to ralate acceleration and time to position. We want the change in position to stay the same. The initial velocity is zero so in order for the change in position to remain constant the term $\left(\frac{1}{2}\right)$ at^2 must remain the same. If the acceleration is reduced by a factor of 4 you can see that the time must be increased by a factor of 2 in order for the term to remain the same.

Q.5 (2)
(i) $V = u + at_1$

$40 = 0 + a \times 20$

$a = 2\ m/s^2$

$v^2 - u^2 = 2as$

$40^2 - 0 = 2 \times 2s_1$

$s_1 = 400m$

(ii) $s_2 = v \times t_2 = 40 \times 20 = 800m$

(iii) $v = u + at$

$0 = 40 + a \times 40$

$a = -1\ m/s^2$

$0^2 - 40^2 = 2(-1)s_3$

$s_3 = 800m$

Total distance travelled = $s_1 + s_2 + s_3$
$= 400 + 800 + 800 = 2000m$
Total time taken = 20+20+40 = 80s

Average velocity = $\frac{2000}{80} = 25m/s$

Q.6 (3)
Displacement of the particle will be zero because it comes back to its starting point

Average Speed = $\frac{\text{Total distance}}{\text{Total time}} = \frac{30m}{10sec} = 3m/s.$.

Q.7 (2)
Q.8 (3)
Acceleration of body along AB is g cos θ Distance travelled in time t sec =

$$AB = \frac{1}{2}(g\cos\theta)\,t^2$$

From $\triangle$ ABC, AB = 2R cos θ

Thus, 2 R cos $\theta = \frac{1}{2} g \cos\theta t^2$

$$\Rightarrow t^2 = \frac{4R}{g} \Rightarrow t = 2\sqrt{\frac{R}{g}}$$

Q.9 **(2)**
Distance between two cars leaving from the station A is,

$$d = \frac{1}{6} \times 60 = 10\,km$$

Man meets the first car after time,

$$t_1 = \frac{60}{60+60} = \frac{1}{2}h$$

He will meet the next car after time,

$$t_2 = \frac{10}{60+60} = \frac{1}{12}h$$

In the remaining half an hour, the number of cars he will meet agian is, $n = \frac{1/2}{1/12} = 6$

$\therefore$ Total number of cars would be meet on route will be 7.

Q.10 (1)
Q.11 (4)
$x \propto t^3 \therefore x = Kt^3$

$\Rightarrow v = \frac{dx}{dt} = 3Kt^2$ and $a = \frac{dv}{dt} = 6Kt$

i.e. $\alpha \propto t$..

Q.12 (2)

$$x = 4(t-2) + a(t-2)^2$$

At $t = 0, x = -8 + 4a = 4a - 8$

$v = \frac{dx}{dt} = 4 + 2a(t-2)$ $\quad a = \frac{dv}{dt} = 2a$

At $t = 0, v = 4 - 4a = 4(1-a)$.

Q.13 **(3)**

Q.14 (2)

Time taken by same ball to return to the hands of juggler

$= \frac{2u}{g} = \frac{2\times 20}{10} = 4s.$ So he is throwing the balls after each 1s. Let at some instant he is throwing ball number 4. Before 1s of it he throws ball. So height of ball 3:

$h_3 = 20\times 1 - \frac{1}{2}10(1)^2 = 15m$

Before 2s, he throws ball 2. So height of ball 2:

$h_2 = 20\times 2 - \frac{1}{2}10(2)^2 = 20m$

Before 3s, he throws ball 1. So height of ball 1:

$h_1 = 20\times 3 - \frac{1}{2}10(3)^2 = 15m$

Q.15 (1)

Q.16 (2)

Q.17 (4)

Q.18 (3)

Q.19 (3)

Q.20 (3)

Given that $x = At^2 - Bt^3$

$\therefore$ velocity $= \frac{dx}{dt} = 2At - Bt^2$

and acceleration $= \frac{d}{dt}\left(\frac{dx}{dt}\right) = 2A - 6Bt$

For acceleration to be zero $2A - 6Bt = 0$.

$\therefore t = \frac{2A}{6B} = \frac{A}{3B}$

Q.21 (3)

An object is said to be moving with a uniform accleration, if its velocity changes by equal amount in equal intervals of time. The velocity-time graph of uniformly accelerated motion is a straight line inclined to time axis. Acceleration of an object in a uniformly accelerated motion in one dimension is equal to the slope of the velocity-time graph with time exis.

Q.22 (4)

Q.23 (4)

Q.24 (3)

EXERCISE-II (NEET LEVEL)

Q.1 (1)

$\vec{r} = 20\hat{i} + 10\hat{j}$

$\therefore r = \sqrt{20^2 + 10^2} = 22.5m$

Q.2 (3)

Distance average speed $= \frac{2v_1v_2}{v_1 + v_2}$

$= \frac{2\times 30\times 50}{30+50} = \frac{75}{2} = 37.5 km/hr.$

Q.3 (4)

Average speed $= \frac{\text{Total distance travelled}}{\text{Total time taken}}$

$= \frac{x}{\frac{2x/5}{v_1} + \frac{3x/5}{v_2}} = \frac{5v_1v_2}{3v_1 + 2v_2}.$

Q.4 (2)

As $S = ut + \frac{1}{2}at^2 \therefore S_1 = \frac{1}{2}a(10)^2 = 50a$

.....(i)

As $v = u + at$

velocity acquired by particle in 10 sec $v = a \times 10$

For next 10 sec , $S_2 = (10a)\times 10 + \frac{1}{2}(a)\times(10)^2$

$S_2 = 150a$

.....(ii)

From (i) and (ii) $S_1 = S_2/3$

Q.5 (2)

Q.6 (2)

$v = 4t^3 - 2t$ (given) $\therefore a = \frac{dv}{dt} = 12t^2 - 2$

and $x = \int_0^t v\,dt = \int_0^t (4t^3 - 2t)dt = t^4 - t^2$

When particle is at 2m from the origin $t^4 - t^2 = 2$

$\Rightarrow t^4 - t^2 - 2 = 0 (t^2 - 2)(t^2 + 1) = 0 \Rightarrow t = \sqrt{2}$ sec

Acceleration at $t = \sqrt{2}$ sec given by,

$a = 12t^2 - 2 = 12 \times 2 - 2 = 22 m/s^2$.

Q.7 (1)

$$\frac{dt}{dx} = 2\alpha x + \beta \Rightarrow \nu = \frac{1}{2\alpha x + \beta}$$

$$\because \alpha = \frac{d\nu}{dt} = \frac{d\nu}{dx}.\frac{dx}{dt}$$

$$\alpha = \nu\frac{d\nu}{dx} = \frac{-\nu.2\alpha}{(2\alpha x + \beta)^2} = -2\alpha.\nu.\nu^2 = -2\alpha\nu^3$$

$\therefore$ Retardation $= 2\alpha\nu^3$.

Q.8 (2)

From $n^2 = u^2 + 2aS$

$\Rightarrow 0 = u^2 + 2aS$

$$\Rightarrow a = \frac{-u^2}{2S} = \frac{-(20)^2}{2 \times 10} = -20 m/s^2.$$

Q.9 (3)

If particle starts from rest and moves with constant acceleration then in successive equal interval of time the ratio of distance covered by it will be

$1 : 3 : 5 : 7 ..... (2n - 1)$

i.e. ratio of x and y will be 1 : 3 i.e. $\frac{x}{y} = \frac{1}{3} \Rightarrow y = 3x$

Q.10 (4)

S µ u^2 If u becomes 3 times then S will become 9 times i.e. $9 \times 20 = 180 m$.

Q.11 (1)

Velocity acquired by body in 10sec

$\nu = 0 + 2 \times 10 = 20 m/s$

and distance travelled by it in 10 sec

$$S_1 = \frac{1}{2} \times 2 \times (10)^2 = 100m$$

then it moves with constant velocity (20 m/s) for 30 sec

$S_2 = 20 \times 30 = 600m$

After that due to retardation $(4m/s^2)$ it stops

$$S_3 = \frac{\nu^2}{2a} = \frac{(20)^2}{2 \times 4} = 50m. ; D = 100 + 600 + 50 = 750 m$$

Q.12 (4)

Let t be the time of flight of the first body after meeting, then $(t-4)$ sec will be the time of flight of the second body. Since $h_1 = h_2$

$$\therefore 98t - \frac{1}{2}gt^2 = 98(t-4) - \frac{1}{2}g(t-4)^2$$

On solving, we get t = 12 seconds

Q.13 (3)

Let the body is projected vertically upward from A with a speed μ_0.

Using equation, $s = ut + \frac{1}{2}at^2$

For case (1) $-h = u_0 t_2 - \frac{1}{2}gt_1^2$ ...(1)

For case (2) $-h = u_0 t_2 - \frac{1}{2}gt_1^2$ ...(2)

Subtraacting eq (2) from (1), we get

$$0 = u_0(t_2 + t_1) + \frac{1}{2}g(t_2^2 - t_1^2)$$

$$\Rightarrow u_0 = \frac{1}{2}g(t_1 - t_2) \quad ...(3)$$

Putting the value of u_0 in eq (2), we get

$$-h = -\left(\frac{1}{2}\right)g(t_1 - t_2)t_2 - \left(\frac{1}{2}\right)gt_2^2$$

$$\Rightarrow h = \frac{1}{2}g(t_1 t_2) \quad ...(4)$$

For case 3, $u_0 = 0$, t = ?

$$-h = 0 \times t - \left(\frac{1}{2}\right)gt^2$$

$$h = \left(\frac{1}{2}\right)gt^2$$

Comparing. eq. (4) and (5), we get

$$\frac{1}{2}gt^2 = \frac{1}{2}gt_1t_2 \therefore t = \sqrt{t_1t_2}$$

Q.14 (3)

$$h = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{2h/g}$$

$$t_a = \sqrt{\frac{2a}{g}} \text{ and } t_b = \sqrt{\frac{2b}{g}} \Rightarrow \frac{t_a}{t_b} = \sqrt{\frac{a}{b}}$$

Q.15 (1)

$$h = \frac{1}{2}gt^2 = \frac{1}{2}\times 10\times(4)^2 = 80\text{m.}$$

Q.16 (3)

Force down the plane = mg sin θ

∴ Acceleration down the plane = g sin θ

Since $l = 0 + \frac{1}{2}g\sin\theta t^2$

$$\therefore t^2 = \frac{2l}{g\sin\theta} = \frac{2h}{g\sin^2\theta} \Rightarrow t = \frac{1}{\sin\theta}\sqrt{\frac{2h}{g}}.$$

Q.17 (3)

$$h = ut + \frac{1}{2}gt^2 \Rightarrow 81 = -12t + \frac{1}{2}\times 10\times t^2 \Rightarrow t = 5.4 \text{ sec.}$$

Q.18 (4)

Given $a = 19.6\ m/s^2 = 2g$

Resultant velocity of the rocket after 5 sec

$\nu = 2g \times 5 = 10g$ m/s

Height achieved after 5 sec, $h_1 = \frac{1}{2}\times 2g\times 25 = 245$m

On switching off the engine it goes up to height h_2 where its velocity becomes zero.

$0 = (10g)^2 - 2gh_2 \Rightarrow h_2 = 490$ m

∴ Total height of rocket = 245 + 490 = 735 m.

Q.19 (2)

$$t = \sqrt{\frac{2h}{g}} \Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}}.$$

Q.20 (3)

Speed of the object at reaching the ground $\nu = \sqrt{2gh}$.

Q.21 (1)

Acceleration of the particle a =2t – 1

The particle retards when acceleration is opposite to velocity.

$$\Rightarrow a, v = 0 \Rightarrow (2t-1)t^2 - t < 0$$
$$\Rightarrow t(2t-1)(t-1) < 0$$

Now t is always positive

$$\Rightarrow (2t-1)(t-1) < 0$$

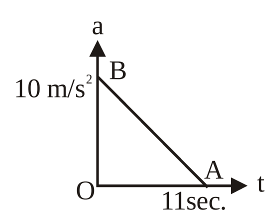
Or $2t-1<0$ and $t-1>0 \Rightarrow t<\frac{1}{2}$ and $t>1$.

This is not possible

Or $2t-1>0$ & $t-1<0 \Rightarrow 1/2<t<1$

Q.22 (2)

The area under acceleration time graph gives change in velocity. As acceleration is zero at the end of 11 sec



i.e. v_{max} Area of ΔOAB

$$= \frac{1}{2} \times 11 \times 10 = 55\,m/s$$

Q.23 (2)

Region OA shows that graph bending toward time axis i.e. acceleration is negative.

Q.24 (4)

Maximum acceleration means maximum change in velocity in minimum time interval.

In time interval t =30 to t = 40 sec

$$a = \frac{\Delta v}{\Delta t} = \frac{80-20}{40-30} = \frac{60}{10} = 6\,cm/sec^2.$$

Q.25 (3)

Area of trapezium $= \frac{1}{2} \times 3.6 \times (12+8) = 36.0\ m$ ..

Q.26 (1)

For the given condition initial height h = d and velocity of the ball is zero. When the ball moves downward its velocity increases and it will be maximum when the ball hits the ground & just after the collision it becomes half and in opposite direction. As the ball moves upward its velocity again decreases and becomes zero at height d/2. This explanation match with graph (1).

Q.27 (3)

For upward motion

Effective acceleration = $-(g+a)$

and for downward motion

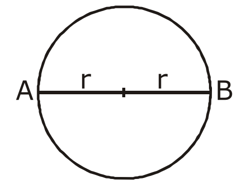
Effective acceleration = $(g-a)$

But both are constants. So the slope of speed-time graph will be constant.

Q.28 **(3)**

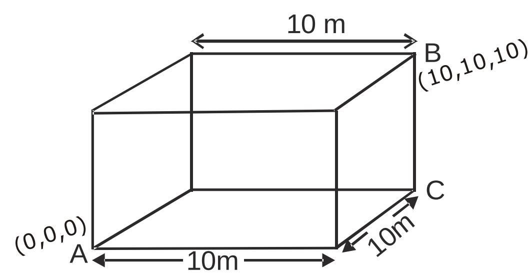
EXERCISE-III (JEE MAIN LEVEL)

Q.1 (2)

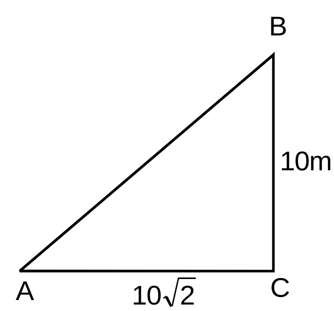


Displacement = 2r
distance = πr

Q.2 (2)



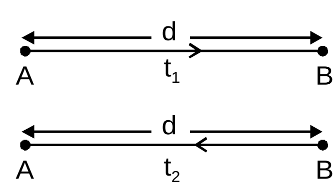
Fly start from A and reaches at B.



$$\therefore\ AB = \sqrt{\left(10\sqrt{2}\right)^2 + 10^2} = 10\sqrt{3}m$$

Q.3 (2)

From A to B $t_1 = \frac{d}{20}$ hr $\Rightarrow$ From B to A $t_2 = \frac{d}{30}$ hr



$\therefore$ Average Speed $= \frac{\text{Total Distance}}{\text{Total Time}}$

$= \frac{2d}{t_1 + t_2} = \frac{2d}{\frac{d}{20} + \frac{d}{30}} \Rightarrow \quad v = 24 \text{ km/hr}$

Q.4 (2)

Average velocity $= \frac{\text{Total Distance}}{\text{Total time}}$

$48 = \frac{2000}{\frac{1000}{40} + \frac{1000}{V}} = \frac{80V}{40 + V} \Rightarrow V = 60$

Q.5 (2)

$t = 62.8$ sec

in each lap car travel a distance $= 2\pi R$

$= 2 \times 3.14 \times 100 = 628$ m

In each lap displacement of the car = 0

Average speed

$= \frac{\text{Total Distance}}{\text{Total Time}} = \frac{628}{62.8} = 10 \text{ m/s}$

Average Velocity $= \frac{\text{Total Displacement}}{\text{Total Time}} = 0$

Q.6 (1)

$2s = gt^2 \Rightarrow s = \frac{1}{2}gt^2$

$v = \frac{ds}{dt} = gt$

Q.7 (3)

$V_{inst} = \frac{dx}{dt}$ (slop of x-t graph)

At C $\tan\theta$ =+ve At E $\theta > 90^o(-\text{ve slop})$

At D $\theta = 0^o$ At F $\theta < 90^o(+\text{ve slope})$ $\therefore$ At E v_{inst} is negative

Q.8 (3)

let the acceleration of the body is a and $u = 0$

then $x_1 = \frac{1}{2}at^2 = \frac{1}{2}a(10)^2$

$x_2 = \frac{1}{2}a(20)^2 - x_1 \Rightarrow x_2 = \frac{1}{2}a(20)^2 - \frac{1}{2}a(10)^2$

$= \frac{1}{2}a(10)(30) \Rightarrow x_3 = \frac{1}{2}a(30)^2 - \frac{1}{2}a(20)^2$

$= \frac{1}{2}a(10)(50) \Rightarrow \therefore x_1 : x_2 : x_3 = 1:3:5$

Q.9 (1)

$u = 10$m/sec $\quad a = -2$m/sec^2

Total time taken when final is zero.

$a = 10$m/sec^2

10m/sec

$v = 0$

$0 = 10-2t$

$t = 5$ sec

$S = ut + \frac{1}{2}at^2$

$S_{t=5} = 10 \times 5 - \frac{1}{2} \times 2 \times 25 = 25$

$S_{t=4\text{ sec.}} = 10 \times 4 - \frac{1}{2} \times 2 \times 16 = 24$

$S_{t=5} - S_{t=4} = 25 - 24 = 1$ m

Q.10 (2)

$S_2 = \frac{1}{2} \times a \times 4$

$S_3 = \frac{1}{2} \times a \times 9$

$S_4 = \frac{1}{2} \times a \times 16$

$S_5 = \frac{1}{2} \times a \times 25$

distance travelled by body in 3rd see $= \frac{1}{2}a[7]$

distance travelled by body in 4th see $= \frac{1}{2}a[9]$

ratio = 7 : 9

Q.11 (4)

Let constant acceleration = a

$S = \frac{1}{2}at^2$

$S_1 = \frac{1}{2}a \times 10^2 = 50a$

$S_2 = \frac{1}{2}a \times 20^2 - \frac{1}{2}a \times 10^2 = 150a$

$S_2 = 3S_1$

Q.12 (2)

In inclined initial u = 0

$S = \frac{1}{2}at^2$ and $a = g\sin\theta$

$l = \frac{1}{2}g\sin\theta\, x \times (4)^2$

...(i)

$\frac{\ell}{4} = \frac{1}{2}g\sin\theta\, t^2$

...(ii)

From (i) and (ii)

t = 2 sec

Q.13 (3)

$\frac{h}{2} = \frac{1}{2}gt_1^2$

....(1)

$h = \frac{1}{2}g(t_1 + t_2)^2$

....(2)

From equation (1) and (2)

$2t_1^2 = (t_1 + t_2)^2$

$\sqrt{2}t_1 = t_1 + t_2$

$(\sqrt{2} - 1)t_1 = t_2$

$t_1 = \frac{t_2}{\sqrt{2}-1} \times \frac{\sqrt{2}+1}{\sqrt{2}+1}$

$t_1 = \left(\sqrt{2}+1\right) t_2$

Q.14 (4)

At H_{max}, v = 0

Acceleration constant & it is due to gravity

$|a| = g$

Q.15 (4)

$v = \frac{ds}{dt} = 3t^2 - 12t + 3$

$a = \frac{dv}{dt} = 6t - 12$

$a = 0 \Rightarrow t = 2\,sec$

$V_{2sec} = 3(2)^2 - 12(2) + 3 = +12 - 24 + 3$

= – 9 m/s

Q.16 (3)

$\frac{dv}{dt} = 6 - 3v \Rightarrow \frac{dv}{6-3v} = dt$

Integrating both sides, $\int \frac{dv}{6-3v} = \int dt$

$\Rightarrow \frac{\log_e(6-3v)}{-3} = t + K_1$

$\Rightarrow \log_e(t - 3v) = -3t + K_2$

…(i)

At t = 0, v = 0 $\therefore \log_e 6 = K_2$

Substituting the value of K_2 in equation (i)

$\log_e(t - 3v) = -3t + \log_e 6$

$\Rightarrow \log_e\left(\frac{6-3v}{6}\right) = -3t \Rightarrow e^{-3t} = \frac{6-3v}{6}$

$\Rightarrow t - 3v = 6e^{-3t} \Rightarrow 3v = 6(1 - e^{-3t})$

$\Rightarrow v = 2(1 - e^{-3t})$

$\therefore v_{trminal} = 2$ m/s (When $t = \infty$)

Acceleration $a = \frac{dv}{dt} = \frac{d}{dt}\left[2\left(1 - e^{-3t}\right)\right] = 6e^{-3t}$

Initial acceleration = 6 m/s^2.

Q.17 (3)

From graph it is clear that velocity is always positive during its motion

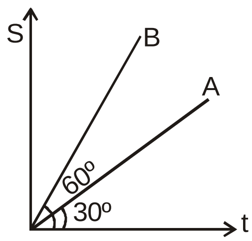
so displacement = distance

displacement = Area under V-t curve

$$= \frac{1}{2} \times 20 \times 1 + 20 \times 1 + \frac{1}{2} \times 1 \times 30 + 1 \times 10$$

$\Rightarrow$ 55 m

Q.18 **(4)**



$$\frac{V_A}{V_B} = \frac{\tan 30^o}{\tan 60^o} \Rightarrow \therefore \frac{V_A}{V_B} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$$

Q.19 (2)

Distance = Total Area

= 105 m

Displacement = 90 - 15 = 75m

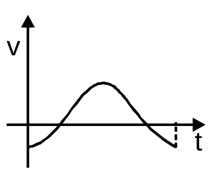
(-ve y asxis area) - (-ve y axis area)

Q.20 (3)

Equation of given sin curve is

$x = -A \sin t$

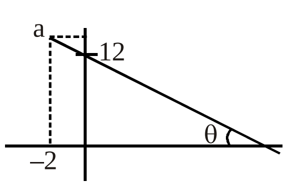
$$V = \frac{dx}{dt} = -A \cos t$$

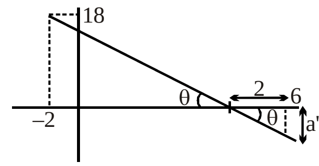


EXERCISE-IV

Q.1 [0055]

ΔV = area under graph





$$\tan \theta = \frac{12}{4} = 3$$

$$\frac{a}{6} = 3 \quad \Rightarrow a = 18$$

$$\frac{a'}{2} = \tan \theta \qquad \Rightarrow a' = 6$$

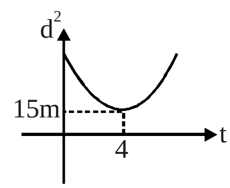
$$\text{Area} = \frac{1}{2} \times 18 \times 6 - \frac{1}{2} \times 6 \times 2$$

$V_6 - 7 = 54 - 6 = 48$

$V_6 = 55$ m/s

Q.2 [0015]

$d^2 = x^2 + y^2 = (3t)^2 + (25 - 4t)^2$



$= 625 - 200\,t + 25t^2$

$d^2 = 625 - 200 \times 4 + 25 \times 16 = 1025 - 800 = 225$

$d = 15$ m

Q.3 [0400]

$\ell = ct^2$

$2000 = c \times 10^2$

$c = 20$ m/s^2

$$v = \frac{d\ell}{dt} = 2ct = 2 \times 20 \times 10 = 400 \text{ m/s}]$$

Q.4 [0008]

$$v = \frac{1}{3}(3t^2 + 2t) \text{ or } \frac{ds}{dt} = \frac{1}{3}(3t^2 + 2t)$$

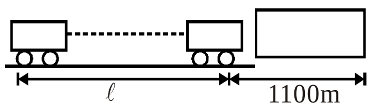
$$\Rightarrow \quad s \quad = \quad \int ds = \frac{1}{3} \quad = \quad \left[\int_2^3 (3t^2 + 2t)\, dt\right] \quad =$$

$$\frac{1}{3}\left[\left(t^3+t^2\right)\right]_2^3$$

$$= \frac{1}{3}[(3^3-2^3)+(3^2-2^2)] = \frac{1}{3}[19+5] = 8\text{ m}$$

Q.5 [0006]

Q.6 [100]



total distance moved by car

$$= (\ell + 1100) = \frac{72\times 1000}{3600}\times 60$$

$\ell + 1100 = 1200$
$\ell = 100$ m

Q.7 [0004]

$$\frac{vdv}{dx} = 4-2x$$

$$\int_0^v vdv = \int_0^x (4-2x)dx \Rightarrow \frac{v^2}{2} = 4x - x^2$$

when $v = 0$, $4x - x^2 = 0$
$x = 0, 4$
$\therefore$ At $x = 4$, the particle will again come to rest.

Q.8 [00 10]

$$s = vt = \frac{1}{2}at^2 \qquad \therefore t = \frac{2v}{a}$$

$v_f = at = 2v = 10$ m/s

Q.9 [0025]

$$\text{Average speed} = \frac{\text{dis tan ce travelled}}{\text{time taken}}$$

$$b = \frac{\text{total area}}{\text{total time}} = \frac{10+20}{6} = \frac{30}{6} = 5\text{ m/s}$$

$$\text{Average acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$C = \frac{10-(-10)}{4} = \frac{20}{4} = 5\text{ m/s}^2$$

$bc = (5)(5) = 25\text{ m}^2/\text{s}^3$

Q.10 [0075]

$$l = \frac{1}{2}g\sin 45\, t^2$$

$$\frac{1}{2}(g\sin 45 - \mu g\cos 45)(2t)^2$$

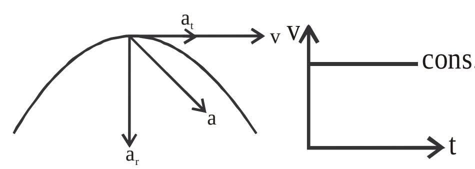
$$\Rightarrow 4(1-\mu) = 1 \Rightarrow \mu = \frac{3}{4}$$

$100\,\mu = 75$

Q.11 (2)

Q.12 (2)

$\vec{a}$ = rate of change of $\vec{V}$
i.e. (magnitude + direction)



$$\vec{a} = 0 \Rightarrow \frac{\Delta\vec{V}}{\Delta t} = 0$$

$a_t = 0 \Rightarrow |\vec{V}| = \text{cons.}$

$a_r \Rightarrow$ change direction

$\Rightarrow |\vec{V}| = \text{cos.}$

$\Rightarrow \vec{a} \neq 0$

Q.13 (2)

Q.14 (3)

Q.15 (3)
$a = 2t + 1$ $\quad$ $u = 0$
$t = 0$ $\quad$ $a = 1$
$t = 3$sec $\quad$ $a = 7$

$$a = \frac{dV}{dt} = 2t+1 \Rightarrow \int_0^v dv \int_0^t (2t+1)dt$$

$v = t^2 + t$, $t = 2$ Þ $v = 6$

$$\int_0^{\pi} dr = \int_0^{t}\left(t^2+t\right)at \Rightarrow r = \frac{t^3}{3}+\frac{t^2}{2}$$

$$t = 1\text{sec} \quad \pi = \frac{1}{3}+\frac{1}{2} = \frac{5}{6}$$

Q.16 (1)

PREVIOUS YEAR'S

MHT CET

Q.1 (4)
Q.2 (2)
Q.3 (3)
Q.4 (3)
Q.5 (2)

For no collision, the speed of car A should be reduced to v_B before the cars meet, i.e. final relative velocity of car A with respect to car B is zero, i.e.

$v_{relative} = 0$

Here, initial relative velocity, $u_r = v_A - v_B$

Relative acceleration, a_r = -a - 0 = -a

Let relative displacement be s_r.

Thus, from third equation of motion, we get

$$V^2_{relative} = u_r^2 + 2a_r s_r = \left(v_A - v_B\right)^2 - 2as_r$$

$$\Rightarrow s_r = \frac{\left(v_A - v_B\right)^2}{2a}$$

For no collision, $s \le s_r$

i.e., $s_r \le \dfrac{\left(v_A - v_B\right)^2}{2a}$

Q.6 (4)

Given, acceleration, a = (6t + 5) m/s^2

$$a = \frac{dv}{dt} = 6t + 5$$

$\Rightarrow dv = (6t + 5)dt$

$\Rightarrow \int dv = \int (6t+5)dt$

$\Rightarrow v = 3t^2 + 5t + c$

where, c is constant of integration.

When t = 0, v = 0, so c = 0

Therefore, v= $3t^2 + 5t$

$\Rightarrow ds = (3t^2+5t)dt \left[\because v = \frac{ds}{dt}\right]$

From 0 to 2s, we have

$$\int_0^s ds = \int_0^s \left(3t^2+5t\right)dt$$

$$s = \left(t^3 + \frac{5}{2}t^2\right)_0^2 = 8 + 10 = 18m$$

Q.7 (1)

The distance travelled in nth second is given by

$s = u = \frac{1}{2}a(2n-1) \Rightarrow s = \frac{g}{2}\left(2n-1\right)$ [here, u = 0, a = g]

According to the question,

$$\frac{11}{36}h = \frac{9.8}{2}\left(2n-1\right) \qquad ....(i)$$

From second equation of motion

$$n = \frac{1}{2}gn^2 \ [\because u = 0] \qquad .....(ii)$$

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

$\frac{11}{36}\times\frac{9.8}{2}\times n^2 = \frac{9.8}{2}\times\left(2n-1\right)$ [here, g = 9.8 m/s^2]

$\Rightarrow 2n - 1 = \frac{11}{36}n^2$

$\Rightarrow 11n^2 - 72n + 36 = 0 \qquad \Rightarrow 11n^2 - 66n - 6n + 36 = 0$

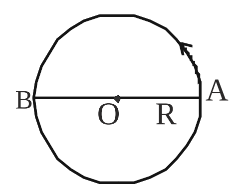
$\Rightarrow 11n(n-6)-6(n-6) = 0 \qquad \Rightarrow n = 6$

(rejecting fractional values)

Therefore, $h = \frac{1}{2}\times 10\times 6\times 6 = 180m$

Q.8 (4)

For a particle, performing uniform circular motion. In half revolution i.e., from A to B,



Displacement = AB = Length of diameter = 2R

$$\text{Distance} = \frac{\text{Circumference}}{2} = \pi R$$

Q.9 (3)

The initial relative velocity of body A wrt body B,

$v_{AB} = u - 0 = u$

The relative acceleration of A wrt B,

$a_{aB} = 0 - a = - a$

According to question, velocity of A and B becomes equal, then

$v_{AB} = 0$

$$\Rightarrow V_{AB}^2 - u_{AB}^2 = 2a_{AB}s \Rightarrow s = \frac{0-u^2}{2(-a)} = \frac{u^2}{2a}$$

NEET/AIPMT

Q.1 (3)

Net force on the particle is zero

$\therefore \vec{a} = 0$

$\vec{v}$ = remains constant

Q.2 (3)

Q.3 (2)

$$S_{nth} = u + \frac{a}{2}(2n-1)$$

$$= 0 + \frac{a}{2}(2n-1)$$

$S_{nth} \propto (2n-1)$

$\Rightarrow S_{1st}, \quad S_{2nd}, \quad S_{3rd}, \quad S_{4th}$

$= [2(1)-1] : [2(2)-1] : [2(3)-1] : [2(4)-1]$

$= 1 : 3 : 5 : 7$

Q.4 (3)

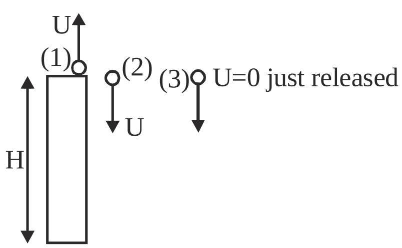
Velocity is slope of x-t graph

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

$$\frac{V_1}{V_2} = \frac{\tan\theta_1}{\tan\theta_2} = \frac{\tan 30^o}{\tan 45^o} = \frac{1}{\sqrt{3}}$$

JEE MAIN

Q.1 (3)



$\Rightarrow$ In first case $-H = U(6) - \frac{1}{2}g(6)^2$ ....(1)

In second case $-H = -U(1.5) - \frac{1}{2}(1.5)^2$ ....(2)

In third case $-H = -\frac{1}{2}gt^2$ ....(3)

$1.5 \times (-H) = U(6) \times 1.5 - \frac{1}{2}(6)^2 \times (1.5)$

$6 \times (-H) = -U(1.5) \times 6 - \frac{1}{2}(1.5)^2 \times 6$ ....(4)

equation (2) multiply by (6)

equation (3) + (4) $\Rightarrow -7.5H = \frac{1}{2}g \times 1.5 \times 6(6 + 1.5)$

$H = 45\,m$

equation (3) to $-H = -\frac{1}{2}gt^2$

$-45 = -\frac{1}{2} \times 10\,t^2$

$t = 3$ sec

M – II

for same height

$$t = \sqrt{t_1 t_2} = \sqrt{6 \times 1.5} = 3 \text{ sec.}$$

Q.2 (4)

$x_p = \alpha t + \beta t^2$ ...(1)

$x_Q = ft - t^2$ ...(2)

$V_P = \alpha + 2\beta t$ ...(3)

$V_Q = f - 2t$ ...(4)

$V_P = V_Q$ (according to question)

$\alpha + 2\beta t = f - 2t$

$$2t(1+\beta) = f - \alpha \Rightarrow t = \frac{(f-\alpha)}{2(1+\beta)}$$

Q.3 (1)

Q.4 [6]

Let they meet at t = t

So first ball gets to sec.

& 2nd gets (t – 2) sec. & they will meet at same height

$$h_1 = 50t - \frac{1}{2}gt^2$$

$$h_2 = 50(t-2) - \frac{1}{2}g(t-2)^2$$

$h_1 = h_2$

$$50t - \frac{1}{2}gt^2 = 50(t-2) - \frac{1}{2}g(t-2)^2$$

$$100 = \frac{1}{2}g\left[t^2 - (t-2)^2\right]$$

$$100 = \frac{10}{2}[4t - 4]$$

$5 = t - 1$

$t = 6$ sec.

Q.5 (1)

Given data:

$$v_2 = \frac{n}{m^2}v_1 \Rightarrow \frac{v_2}{v_1} = \frac{n}{m^2}$$

$$a_2 = \frac{a_1}{mn} \Rightarrow \frac{a_2}{a_1} = \frac{1}{mn}$$

We know that

$$\frac{v}{a} = T$$

Hence

$$\frac{T_2}{T_1} = \frac{v_2}{v_1} \times \frac{a_1}{a_2}$$

By putting the values of $\frac{v_2}{v_1}$ and $\frac{a_1}{a_2}$ in above equation

$$\frac{T_2}{T_1}=\frac{n}{m^2}\times mn=\frac{n^2}{m}\Rightarrow T_2=\frac{n^2}{m}T_1$$

We know that

Length=Velocity × Time

L = V × T

$$\therefore \frac{L_2}{L_1}=\frac{V_2}{V_1}\times\frac{T_2}{T_1}$$

$$\frac{L_2}{L_1}=\frac{n}{m^2}\times\frac{n^2}{m}=\frac{n^3}{m^3}$$

$$\therefore L_2=\frac{n^3}{m^3}L_1$$

∴ Correct option-A

Q.6 (18)

$$\langle\vec{V}\rangle=\frac{\text{Displacement}}{\text{time}}$$

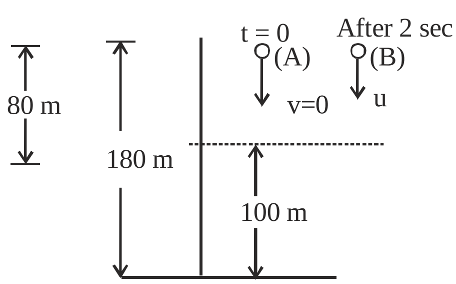
(Let displacement be *l*)

$$=\frac{\ell}{\left(\frac{\ell}{V_3}+\frac{\ell}{V_2}+\frac{\ell}{V_1}\right)\frac{1}{3}}$$

$$=\frac{3}{\frac{1}{V_1}+\frac{1}{V_2}+\frac{1}{V_3}}=\frac{3}{\frac{1}{11}+\frac{1}{22}+\frac{1}{33}}$$

=18m/s

Q.7 (4)



For A ball.

$s=ut+\frac{1}{2}at_A^2$ $\quad$ $a=g=10\ m/s^2$

$$80=\frac{1}{2}(10)t_A^2$$

$t_A = 4$ sec

For B

$t_B = t_A - 2$sec $\quad$ $v_B = 0$

$t_B = 2$ sec. $\quad$ $s = 80$ m

$$s=u_Bt_B+\frac{1}{2}at_B^2$$

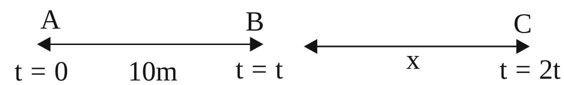
$$80=2u+\frac{1}{2}g(2)^2$$

$$\boxed{u=30\,m/s}$$

Q.8 (3)

Acceleration is constant

$u = 0$ $\quad$ $v = u + at$



Let in initial t seconds it goes from A to B and in another t seconds it goes from B to C.

For A to B

Using $\vec{S}=\vec{u}t+\frac{1}{2}\vec{a}t^2$

$$\Rightarrow 10=\frac{1}{2}at^2\ (u=0)$$

$$\Rightarrow a=\frac{20}{t^2}$$

For B to C again

Using $\vec{S}=\vec{u}t+\frac{1}{2}\vec{a}t^2$

From A to B particle has attained

Velocity $\vec{V}=\vec{u}+\vec{a}t$

V = at (u = 0)

For B to C using

$$\vec{S}=\vec{u}t+\frac{1}{2}\vec{a}t^2$$

$$\Rightarrow x=(at)t+\frac{1}{2}at^2=\frac{3}{2}at^2$$

$$\Rightarrow x=\frac{3}{2}\times\frac{20}{t^2}\times t^2$$

$\Rightarrow x = 30$ m

Q.9 [3]

Using $V^2 = u^2 + 2a\,\Delta x$

$0 = (150)^2 - 2a(27)$

$(150)^2 = 2a(27)$ $\quad$ ......(1)

If the speed $=\frac{150}{3}=50$km /h

$(50)^2 = 2a(\Delta x)$ ......(2)

$9 = \frac{27}{\Delta x} \Rightarrow \Delta x = 3m$

Q.10 [100]

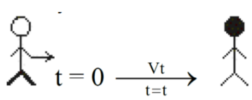
$\frac{dv}{dx} = 5$

$a = v\frac{dv}{dx}$

$a = (20)(5) = 100$ m/sec

Q.11 (1)

Monkey

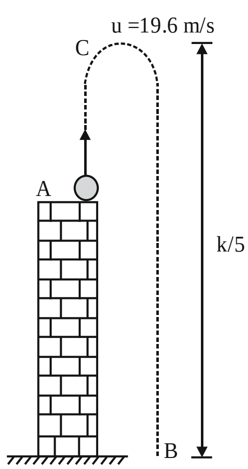


Time taken by mango = $\sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 19.6}{9.8}}$ = 2 second

Distance = vt

$= 9 \times \frac{5}{18} \times 2 = 5$ m

Q.12 [392]



time taken to reach from A to B = 6 sec

$g = 9.8$ m/s^2

height of tower H

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

$-H = 19.6 \times 6 - \frac{1}{2} \times 9.8 \times 62$

$= 117.6 - 176.4$

$H = 58.8$ m

Height form A to C = y

$v^2 = u^2 + 2as$

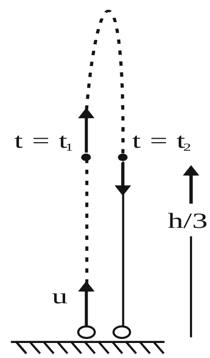
$0 = (19.6)^2 - 2 \times 9.8 \times y \Rightarrow y = 19.6$ m

So, height from ground = $H + y = \frac{k}{5}$

$58.8 + 19.6 = \frac{k}{5}$

$K = 392$

Q.13 (2)



Max. height = $h = \frac{u^2}{2g}$

$\Rightarrow u = \sqrt{2gh}$

$S = ut + \frac{1}{2}at^2$

$\frac{h}{3} = \sqrt{2gh}t + \frac{1}{2}(-g)t^2$

$\frac{gt^2}{2} - \sqrt{2gh}t + \frac{h}{3} = 0$ (Roots are t_1 & t_2)

$$\frac{t_2}{t_1} = \frac{\sqrt{2gh} + \sqrt{2gh - 4 \times \frac{g}{2} \times \frac{h}{3}}}{\sqrt{2gh} - \sqrt{2gh - 4 \times \frac{g}{2} \times \frac{h}{3}}}$$

$$= \frac{\sqrt{2gh} + \sqrt{\frac{4gh}{3}}}{\sqrt{2gh} - \sqrt{\frac{4gh}{3}}} = \frac{\sqrt{3} + \sqrt{2}}{\sqrt{3} - \sqrt{2}}$$

Q.14 (4)

For first $\frac{h}{2}$

$\frac{h}{2} = \frac{1}{2}gt_1^2$

For total height h

$$h = \frac{1}{2}g\left(t_1 + t_2\right)^2$$

$$\frac{1}{\sqrt{2}} = \frac{t_1}{t_1 + t_2}$$

$$1 + \frac{t_2}{t_1} = \sqrt{2}$$

$$\frac{t_1}{t_2} = \frac{1}{\sqrt{2} - 1}$$

$$t_2 = \left(\sqrt{2} - 1\right)t_1$$

Motion in a Plane

EXERCISE-I (MHT CET LEVEL)

Q.1 (3)

$$\cos\theta = \frac{R^2 - A^2 - B^2}{2AB} = \frac{R^2 - R^2}{2AB} = 0$$

$$\Rightarrow \cos\theta = 90^o = \frac{\pi}{2}$$

Q.2 (3)

$R^2 = [A^2 + B^2 + 2AB\cos\theta]$

$R^2 = R^2 + R^2 + 2R^2\cos\theta$

$-R^2 = 2R\cos\theta$ or $\cos\theta = -1/2$

$\theta = 2\pi/3$.

Q.3 (2)

$$\left|\vec{P}+\vec{Q}\right| = \left|2\hat{i} - 3\hat{j} + 4\hat{k} + \hat{j} - 2\hat{k}\right| = \left|2\hat{i} - 2\hat{j} + 2\hat{k}\right|$$

$$= \sqrt{2^2 + 2^2 + 2^2} = 2\sqrt{3}$$

Q.4 (4)

Q.5 (4)

Q.6 **(4)**

Q.7 **(1)**

Q.8 (4)

$C^2 = A^2 + B^2 + 2AB\cos\theta$

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

If $\theta = 90^o$

$$0 = \frac{C^2 - A^2 + B^2}{2AB}$$

$C^2 = A^2 + B^2$

If $\theta > 90° \Rightarrow \cos\theta < 0$

$\rightarrow C^2 - A^2 + B^2 < 0 \Rightarrow C^2 < A^2 + B^2$

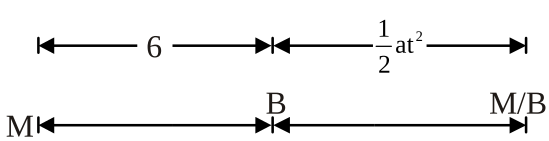
If $\theta < 90^o \Rightarrow \cos\theta > 0$

$\Rightarrow C^2 > A^2 + B^2$

Q.9 **(1)**

Q.10 (1)

Let us draw the figure for given situation,



$$\Rightarrow \quad 4t = 6 + \frac{1}{2}\times 1.2 \times t^2$$

$$\Rightarrow \quad 4t = 6 + 0.6t^2$$

Q.11 (1)

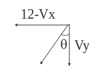
$\vec{V}_{B,g} = 8\hat{i}\ \vec{V}_{R,g} = V_x\hat{i} + V_y\hat{j}$

$\vec{V}_{R,B} = \vec{V}_{R,g} - \vec{V}_{B,g} = \left(v_x - 8\right)\hat{i} + V_y\hat{j}$

Given, rain falling vertically

$\therefore V_x - 8 = 0 \Rightarrow \boxed{V_x = 8}$

When $\vec{V}_{B,g} = 12\hat{i}$

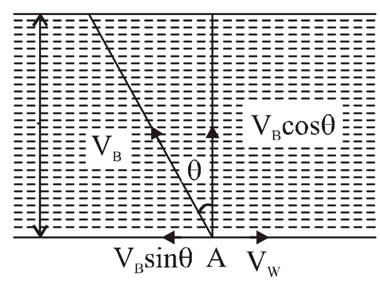


$$\tan 30^o = = \frac{12 - V_x}{V_y} = \frac{4}{V_y}$$

$$\Rightarrow \boxed{V_y = 4\sqrt{3}} \Rightarrow \left|\vec{V}_{R,g}\right| = \sqrt{8^2 + \left(4\sqrt{3}\right)^2}$$

$$= 4\sqrt{7}\,\text{km/h}$$

Q.12 **(1)**



From figure, $V_B \sin\theta = V_W$

$$\sin\theta = \frac{V_w}{V_B} = \frac{1}{2} \Rightarrow \theta = 30°\left[\because V_B = 2V_W\right]$$

Time taken to cross the river.

$$t = \frac{D}{V_B\cos\theta} = \frac{D}{V_B\cos 30°} = \frac{2D}{V_B\sqrt{3}}.$$

Q.13 (2)

Q.14 **(3)**

Q.15 **(1)**

Q.16 (1)

Range of projectile $= \dfrac{u^2\sin 2\theta}{g}$

$\sin 2\theta$ must remain same for θ_1 and θ_2.

$\sin 2\theta_1 = \sin(180 - 2\theta_1)$

$= \sin 2(90 - \theta_1)$

$= \sin 2\theta_2$

$\Rightarrow \boxed{\theta_2 = 90 - \theta_1}$

$\therefore$ for complimentary angles, the range of projectile is same.

Q.17 (1)

$T = \frac{2u\sin\theta}{g}$, lesser is the value of θ, lesser is $\sin\theta$ and hence lesser will be the time taken.
Hence A will fall earlier.

Q.18 (1)

$t_1 = \frac{2u\sin\theta}{g}$ and

$t_2 = \frac{2u\sin(90-\theta)}{g} = \frac{2u\cos\theta}{g}$

$\therefore t_1 t_2 = \frac{4u^2\cos\theta\sin\theta}{g^2} = \frac{2}{g}\left[\frac{u^2\sin 2\theta}{g}\right]$

$= \frac{2}{g}R,$
where R is the range.
Hence $t_1 t_2 \propto R$

Q.19 (2)
for θ = 15°

$R = \frac{u^2\sin 2(15°)}{g} = \frac{u^2\sin 30°}{g}$

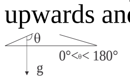
$1.5 = \frac{u^2}{2g}$

For θ = 45°

$R = \frac{u^2\sin 2(45°)}{g} = \frac{u^2}{g}$

$= 1.5 \times 2 = 3\text{km}$

Q.20 (4)
Here velocity is acting upwards when projectile is going upwards and acceleration is



downwards. The angle θ between $\vec{v}$ and $\vec{a}$ is more than 0° and less than 180° avoid skidding.

Q.21 (3)

Initially $u = \cos\theta\,\hat{i} + u\sin\theta\,\hat{j}$

At highest point $v = u\cos\theta\,\hat{i}$

$\therefore$ difference is $u\sin\theta$

Q.22 (3)
From question,
Horizontal velocity (initial),

$u_x = \frac{40}{2} = 20 \text{ m/s}$

Vertical velocity (initial), $50 = u_y t + \frac{1}{2}gt^2$

$\Rightarrow u_y \times 2 + \frac{1}{2}(-10)\times 4$
or, $50 = 2u_y - 20$
or, $u_y = \frac{70}{2} = 35 \text{ m/s}$

$\therefore \tan\theta = \frac{u_y}{u_x} = \frac{35}{20} = \frac{7}{4}$

$\Rightarrow$ Angle $\theta = \tan^{-1} = \frac{7}{4}$

Q.23 (3)
For projectile A

Maximum height, $H_A = \frac{u_A^2\sin^2 45°}{2g}$

For projectile B

Maximum height, $H_B = \frac{u_B^2\sin^2\theta}{2g}$

As we know, $H_A = H_B$

$\frac{u_A^2\sin^2 45°}{2g} = \frac{u_B^2\sin^2\theta}{2g}$

$\frac{\sin^2\theta}{\sin^2 45°} = \frac{u_A^2}{u_B^2}$

$\sin^2\theta = \left(\frac{u_A}{u_B}\right)\sin^2 45°$

$\sin^2\theta = \left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{1}{4}$

$\sin\theta = \frac{1}{2} \Rightarrow \theta = \sin^{-1}\left(\frac{1}{2}\right) = 30°$

Q.24 (3)
Since range on horizontal plane is

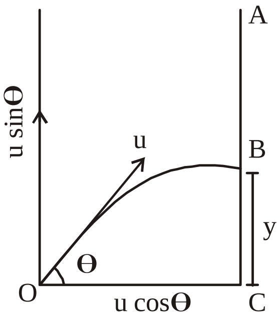
$R = \frac{u^2\sin 2\theta}{g}$

so, it is maximum when, $\sin 2\theta = 1$

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

Q.25 (2)

$t = \frac{OC}{u\cos\theta} = \frac{x}{u\cos\theta}$



$AC = x\tan\theta$

BC = distance travelled by bullet in t, vertically.

$$y = u\sin\theta t - \frac{1}{2}gt^2$$

$$AB = x\tan\theta - \left(u\sin\theta t - \frac{1}{2}gt^2\right)$$

$$= x\tan\theta - \left(u\sin\theta \times \frac{x}{u\cos\theta} - \frac{1}{2}gt^2\right)$$

$$\Rightarrow x\tan\theta - x\tan\theta + \frac{1}{2}gt^2 = \frac{1}{2}gt^2$$

($\therefore$ bullet will always hit the monkey)

Q.26 (1)
Q.27 (3)
Q.28 (1)
Q.29 (2)
Q.30 (1)
Q.31 (4)
Q.32 (4)
Q.33 (3)
Body moves with constant speed it means that tangential acceleration a_t=0 & only centripetal acceleration a_c exists whose direction is always towards the centre or inward (along the radius of the circle).

Q.34 (1)
It can be observed that component of acceleration perpendicular to velocity is $a = 4\,\text{m/s}^2$

$\therefore$ radius $= \frac{v^2}{a_c} = \frac{(2)^2}{4} = 1$ metre

Q.35 (2)
Q.36 (2)
Since surface (ice) is frictionless, so the centripetal force required for skating will be provided by inclination of boy with the vertical and that angle is given as $\tan\theta = \frac{v^2}{rg}$, where v is speed of skating & r is radius of circle in which he moves.

Q.37 (1)
Q.38 (1)

EXERCISE-II (NEET LEVEL)

Q.1 (2)
$|P - Q| \le R \le |P + Q|$
If P = 10N & Q = 6N
$4 \le R \le 16$

Q.2 (4)
Initial & final position are coincide.

Q.3 (1)
$R_{max} = (P + Q)$
When angle between P & Q is 0º

Q.4 (3)
$R^2 = P^2 + Q^2 + 2PQ\cos\theta$
R = 13
P = 5
Q = 12
$\cos\theta = 0$

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

Q.5 (4)

$$\vec{P} + \vec{Q} = \vec{P} - \vec{Q}$$

$$\overrightarrow{2Q} = 0$$

$$\vec{Q} = 0$$

$$|\vec{Q}| = 0$$

Q.6 (4)

$\therefore\ \vec{A} \perp \vec{B}\ \&\ |\vec{A}| = |\vec{B}|$

$\therefore$ Parallelogram formed by these two vectors is a square. The sum & difference vector give two diagonals of the above parallelogram.

Q.7 (3)

$$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$$

$$= 2\hat{i} - 3\hat{j} + 4\hat{k} - \hat{i} - \hat{j} + \hat{k}$$

$$= \hat{i} - 4\hat{j} + 5\hat{k}$$

Q.8 (1)

$\boxed{2\hat{i} - 3\hat{j}}$ $\boxed{\vec{F} = F_x\hat{i} + F_y\hat{j}}$

Q.9 (4)

$\vec{A}.\vec{B} = 0$ – $\vec{A} \perp \vec{B}$

$\vec{A}.\vec{C} = 0$ – $\vec{A} \perp \vec{C}$

If may be possible

$\therefore$ $\vec{A}$ is parallel to any vector $\perp$ to the plane containing $\vec{B}$ & $\vec{C}$.

Q.10 (2)

Relative velocity of bird w.r.t train= 25 + 5 = 30 m/s

time taken by the bird to cross the train

$$t = \frac{210}{30} = 7 \text{ sec}$$

Q.11 (4)

At t = 3 sec, 1st stone will have speed of 30 m/s

$$h_1 = \frac{1}{2} \times 10 \times 9 = 45\text{m}$$

$$h_2 = \frac{1}{2} \times 10 \times 1^2 = 5\text{m}$$

$$h_1 - h_2 = 40\text{m}$$

Q.12 (2)

$$\left(\vec{V}_{bc}\right)_x = \left(\vec{V}_b\right)_x - \left(\vec{V}_c\right)_x$$

$$20\cos 60° = \left(\vec{V}_b\right)_x - 30$$

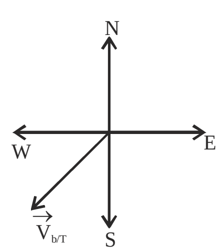
$$\left(\vec{V}_b\right)_x = 40; \left(\vec{V}_{bc}\right)_y = \left(\vec{V}_b\right)_y - \left(\vec{V}_c\right)_y$$

$$20\sin 60° = \left(\vec{V}_b\right)_y - 0$$

$$\left(\vec{V}_b\right)_y = 10\sqrt{3}\ ;$$

$$\tan\theta = \frac{\left(\vec{V}_b\right)_y}{\left(\vec{V}_b\right)_x} = \frac{10\sqrt{3}}{40} = \frac{\sqrt{3}}{4}$$

Q.13 (3)



$$\vec{V}_b = -40\hat{j}$$

$$\vec{V}_T = +40\hat{i}$$

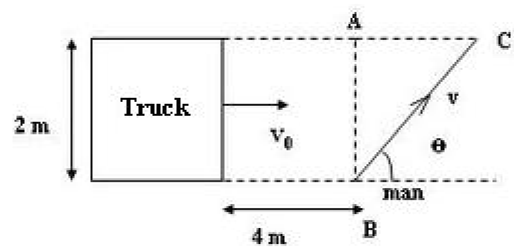
$$\vec{V}_{b/T} = \vec{V}_b - \vec{V}_T$$

$$= -40\hat{i} - 40\hat{j}$$

$$\left|\vec{V}_{b/T}\right| = 40\sqrt{2}\text{km / hr.}$$

Q.14 (3)

Let the men starts crossing the road a an angle θ as shown in fjigure. For safe crossing the condition is that man must cross the road by teht the man must cross the road by the time the truck describes thedistance $4 + AC$ or $4 + 2\cot\theta$.



$$\therefore \frac{4 + 2\cot\theta}{8} = \frac{2/\sin\theta}{v} \text{ or } v = \frac{8}{2sion\theta + \cos\theta} \text{ ....(i)}$$

For minimum $v, \frac{dv}{d\theta} = 0$

$$\text{or } \frac{-8(2\cos\theta - \sin\theta)}{(2\sin\theta + \cos\theta)^2} = 0 \text{ or } 2\cos\theta - \sin\theta = 0$$

or tan θ = 2

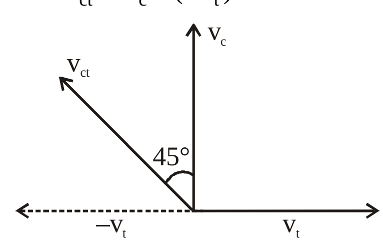
From eqution (i),

$$v\min = \frac{2}{2\left(\frac{2}{\sqrt{2}}\right) + \frac{1}{\sqrt{5}}} = \frac{8}{\sqrt{5}} = 3.57\text{m/s}$$

Q.15 (2)

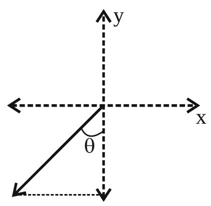
$$\vec{v}_{ct} = \vec{v}_c - \vec{v}_t$$

$$\vec{v}_{ct} = \vec{v}_c + (-\vec{v}_t)$$



Velocity of car w.r.t. train (v_{ct}) is towards West – North

Q.16 (1)



$\vec{V}_b = V\hat{i}$

$\vec{V}_R = -u\hat{j}$

$\vec{V}_{R/b} = \vec{V}_R - \vec{V}_b$

$= -u\hat{j} - V\hat{i}$

$$\tan\theta = \frac{(V_{R/b})_x}{(V_{R/b})_y} = \frac{v}{u}$$

$$\theta = \tan^{-1}\left(\frac{v}{u}\right)$$

Q.17 (2)

$$\tan 30^\circ = \frac{(V_R)_x}{(V_R)_y}$$

$$\Rightarrow (V_R)_y = \sqrt{3}(V_R)_x \quad ...(1)$$

For moving man, $(V_{R/m})_x = 0$ { As rainfall appears vertically}

$\Rightarrow (V_R)_x = (V_m)_x = 10$km/hr

$\therefore$ from eq^n (1)

$(V_R)_y = 10\sqrt{3}$km / hr

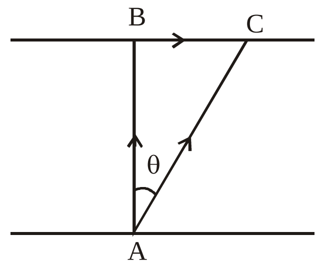
Now, $\vec{V}_{R/M} = (V_{R/M})_x\,\hat{i} + (V_{R/m})_y\,\hat{j}$

$= 0 + \left[(V_R)_y - (V_m)_y\right]\hat{j}$

$|\vec{V}_{R/m}| = (V_R)_y = 10\sqrt{3} \quad \left[\because (V_m)_y = 0\right]$

Q.18 (3)

Given $\overrightarrow{AB}$ = Velocity of boat = 8 km/hr



$\overrightarrow{AC}$ = Resultant velocity of boat = 10 km/hr

$\overrightarrow{BC}$ = Velocity of river = $\sqrt{AC^2 - AB^2}$

$= \sqrt{(10)^2 - (8)^2} = 6$ km / hr

Q.19 (2)

The relative velocity of boat w.r.t. water

$= v_{boat} - v_{water} = (3\hat{i} + 4\hat{j}) - (-3\hat{i} - 4\hat{j}) = (6\hat{i} + 8\hat{j})$

Q.20 (1)

Due north will take himcross in shortest time.

Q.21 (4)

For I body $\rightarrow h = 98t - \frac{1}{2}gt^2$

For II body $\rightarrow h = 98(t-4) - \frac{1}{2}g(t-4)^2$

$98t - \frac{1}{2}gt^2 = 98(t-4) - \frac{1}{2}g(t-4)^2$

Solving, we get $\boxed{t = 12s}$

Q.22 (3)

$v_x = \frac{dx}{dt} = 6$ and $v_y = \frac{dy}{dt} = 8 - 10t$

$= 8 - 10 \times 0 = 8$

$\therefore\ v = \sqrt{v_x^2 + v_y^2} = \sqrt{6^2 + 8^2} = 10\ ms^{-1}$

Q.23 (1)

Range $= \frac{u^2 \sin 2\theta}{g}$; when $\theta = 90^\circ$, $R = 0$ i.e the body will fall at the point of projection after completing one dimensional motion under gravity.

Q.24 (3)

$$v_y = \frac{dy}{dt} = 8 - 10t, v_x = \frac{dx}{dt} = 6$$

at the time of projection i.e. $v_y = \frac{dy}{dt} = 8$ and $v_x = 6$

$$\therefore \; v = \sqrt{v_x^2 + v_y^2} = \sqrt{6^2 + 8^2} = 10 m/s$$

Q.25 (1)

For vertical upward motion $h = ut - \frac{1}{2}gt^2$

$$5 = (25 \sin\theta) \times 2 - \frac{1}{2} \times 10 \times (2)^2$$

$$\Rightarrow 25 = 50 \sin\theta \Rightarrow \sin\theta = \frac{1}{2} \Rightarrow \theta = 30°.$$

Q.26 (2)

Range is given by $R = \frac{u^2 \sin 2\theta}{g}$

On moon $g_m = \frac{g}{6}$. Hence $R_m = 6R$.

Q.27 (1)

$$H_1 = \frac{u^2 \sin^2\theta}{2g} \text{ and } H_2 = \frac{u^2 \sin^2(90-\theta)}{2g} = \frac{u^2 \cos^2\theta}{2g}$$

$$H_1 H_2 = \frac{u^2 \sin^2\theta}{2g} \times \frac{u^2 \cos^2\theta}{2g} = \frac{(u^2 \sin 2\theta)^2}{16g^2} = \frac{R^2}{16}$$

$$\therefore R = 4\sqrt{H_1 H_2}$$

Q.28 (3)

$$v_y = \frac{dy}{dt} = 8 - 10t, v_x = \frac{dx}{dt} = 6$$

at the time of projection i.e. $v_y = \frac{dy}{dt} = 8$ and $v_x = 6$

$$\therefore \; v = \sqrt{v_x^2 + v_y^2} = \sqrt{6^2 + 8^2} = 10 m/s$$

Q.29 (2)

Q.30 (2)

Q.31 (3)

Due to constant velocity along horizontal and vertical downward force of gravity stone will hit the ground following parabolic path.

Q.32 (4)

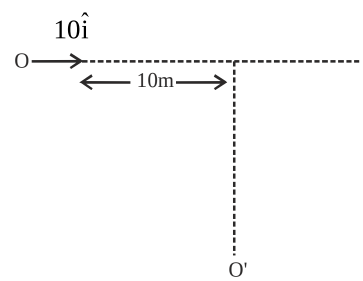
$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 396.9}{9.8}} \simeq 9$ sec and $u = 720$ km/hr $= 200$ m/s

$\therefore \; R = u \times t = 200 \times 9 = 1800$ m

Q.33 (3)

$$T = \frac{2u \sin 45^o}{g \cos 45^o} = 2 \sec$$

Q.34 (2)



$$\vec{V}_{O/O'} = \vec{V}_O - \vec{V}_{O'}$$

$$= 10\cos 60\hat{i} + 10\sin 60\hat{j} - [-10\cos 60\hat{i} + 10\sin 60\hat{j}]$$

$$= 20\cos 60\hat{i} = 10\hat{i}$$

$$t = \frac{10}{10} = 1 \text{ sec}$$

Q.35 (3)

$$\omega_{min} = \frac{2\pi}{60} \frac{Rad}{min} \text{ and } \omega_{hr} = \frac{2\pi}{12 \times 60} \frac{Rad}{min}$$

$$\therefore \frac{\omega_{min}}{\omega_{hr}} = \frac{2\pi / 60}{2\pi / 12 \times 60}$$

Q.36 (1)

$$\omega = \frac{v}{r} = \frac{100}{100} = 1 rad/s$$

Q.37 (3)

$\omega = 80$ rad/sec, $t = 5$ sec, $\omega_0 = 0$

$\theta = ?$

If α constant, then

$$\theta = \left(\frac{\omega+\omega_0}{2}\right) t = \left(\frac{80+0}{2}\right) 5 = 200 \text{ rad } \textbf{Ans.}$$

Q.38 (3)

Centripetal acceleration $= \frac{v^2}{r}$ = constant. Direction keeps changing.

Q.39 (1)

Centripetal force $= \frac{mv^2}{r}$ and is directed always towards the centre of circle. Sense of rotation does not affect magnitude and direction of this centripetal force.

Q.40 (4)

Radial force $\frac{mv^2}{r} = \frac{m}{r}\left(\frac{p}{m}\right)^2 = \frac{p^2}{mr}$ [As $p = mv$]

Q.41 (1)

$\omega^2 . r = a_r \Rightarrow \omega^2 = 9.8/20 \times 10^{-2}$, $\omega = 7$ rad/s

Q.42 (2)

$F = K\frac{1}{r}$ $\qquad \frac{k}{r} = \frac{mv^2}{r}$ $v = \sqrt{\frac{k}{m}}$

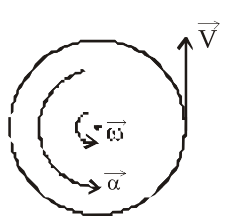
so independent of r

Q.43 (1)

Force is perpendicular to $\vec{v}$

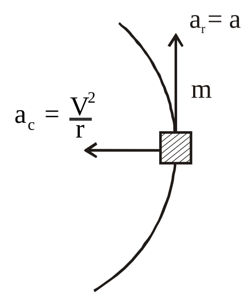
$R = \frac{v^2}{a_\perp} \Rightarrow R = \frac{mv^2}{F}$ **Ans.**

Q.44 (2)



Q.45 (2)

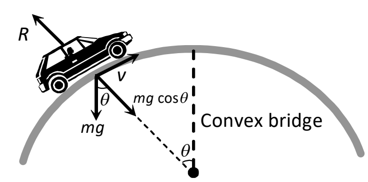
$$|\vec{a}| = \sqrt{a_c^2 + a_t^2} = \sqrt{\left(\frac{v^2}{r}\right)^2 + a^2}$$



$$a = \sqrt{\frac{v^4}{r^2} + a^2}$$

Q.46 (1)

$$R = mg\cos\theta - \frac{mv^2}{r}$$



when θ decreases cos θ increases i.e., R increases.

Q.47 (1)

$$T = \frac{mv^2}{r} \Rightarrow 25 = \frac{0.25 \times v^2}{1.96} \Rightarrow v = 14 \text{ m/s.}$$

Q.48 (3)

$$F = KR^{-n} = MR\omega^2 \Rightarrow \omega^2 = KR^{-(n+1)}$$

$$\text{or } \omega = K'R^{\left(\frac{-(n+1)}{2}\right)}$$

$$\left[\text{where } K' = K^{\frac{1}{2}}, \text{a constant}\right]$$

$$\frac{2\pi}{T} \alpha R^{\left(\frac{-(n+1)}{2}\right)} \quad \therefore T \,\alpha\, R^{\left(\frac{(n+1)}{2}\right)}$$

Q.49 (4)

$$F = mg - \frac{mv^2}{r}.$$

Q.50 (4)

$p = mv$, & $F = mv^2/r \Rightarrow F = m\left(\frac{p}{m}\right)^2/r \Rightarrow F = p^2/mr$

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3)

$R^2 = P^2 + Q^2 + 2PQ\cos 60°$

$7Q^2 = P^2 + Q^2 + PQ \Rightarrow P^2 - 6Q^2 + PQ = 0$

$$\left(\frac{P}{Q}\right)^2 + \left(\frac{Q}{Q}\right) - 6 = 0$$

$$\Rightarrow \left(\frac{P}{Q} + 3\right)\left(\frac{P}{Q} - 2\right) = 0 \Rightarrow \frac{P}{Q} = 2$$

Q.2 (4)

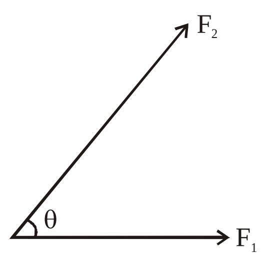
$\vec{A} = \hat{i} - 2\hat{j} + 3\hat{k}$

$\vec{B} = 4\hat{i} + 2\hat{j} + 3\hat{k} \Rightarrow \overrightarrow{AB} = 3\hat{i} + 4\hat{j}$

$$\hat{AB} = \frac{3\hat{i} + 4\hat{j}}{5} \Rightarrow \vec{V} = 10\left(\frac{3\hat{i} + 4\hat{j}}{5}\right) = 6\hat{i} + 8\hat{j}$$

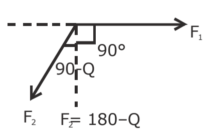
Q.3 (1)

$P^2 = F_1^2 + F_2^2 + 2F_1F_2\cos\theta$



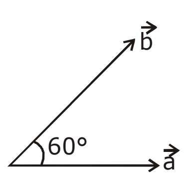
$Q^2 = F_1^2 + F_2^2 - 2F_1F_2\cos\theta$

$P^2 + Q^2 = 2(F_1^2 + F_2^2)$



Q.4 (2)

$|\hat{a} - \hat{b}| = \sqrt{a^2 + b^2 - 2ab\cos\theta}$



$\theta = 60° \Rightarrow |\hat{a} - \hat{b}| = 1$

Q.5 (1)

$\bar{A} - \bar{B} = 3\hat{i} - \hat{k}$

$$A - B = \frac{\bar{A} - \bar{B}}{|A - B|} = \frac{3\hat{i} - \hat{k}}{\sqrt{10}}$$

Q.6 (2)

$\vec{B} = x\vec{a}$

on multiplying with the scalar magnitude will change

if x is –ve direction of $\vec{B}$ change

if x is +ve direction of $\vec{B}$ same as $\vec{a}$

$\vec{B}$ & $\vec{a}$ are colinear vector

Q.7 (2)

$\vec{A} = 2\hat{i} + 3\hat{j}$

$\vec{B} = \hat{j} \Rightarrow \vec{A}.\vec{B} = |\vec{A}||\vec{B}|\cos\theta$

$$\cos\theta = \frac{3}{\sqrt{13}} \Rightarrow \tan\theta = 2/3 \Rightarrow \theta = \tan^{-1}(2/3)$$

Q.8 (1)

$\vec{A} = a_1\hat{i} + a_2\hat{j}$

$\vec{B} = 4\hat{i} - 3\hat{j}$

$|\hat{A}| = 1 \Rightarrow a_1^2 + a_2^2 = 1$

...(i)

$\vec{A}.\vec{B} = 0$

$4a_1 - 3a_2 = 0$

$4a_1 = 3a_2$

...(ii)

$$\text{(i) (ii)} \rightarrow a_1^2 + \frac{16}{9}a_1^2 = 1$$

$$a_1^2 = \frac{9}{15},\ a_1 = \frac{3}{5} = 0.6,\quad a_2 = 0.8$$

Q.9 (1)

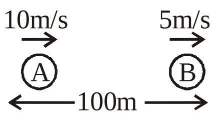
By the defination of equal vector.

Q.10 (4)

$(\bar{A} \times \bar{B}) \perp A$

$(\bar{A} \times \bar{B}) \perp B$

Q.11 (3)

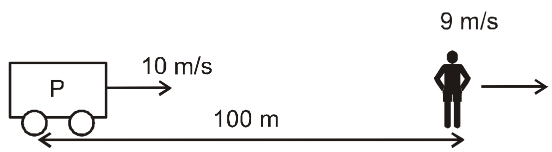


$V_{AB} = 10 - 5 = 5 \text{ m/s}$

$t = \frac{100}{5} = 20 \text{ sec}$

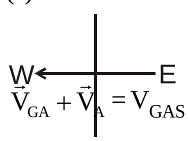
Q.12 (4)

$\vec{V}_{PT} = \vec{V}_P - \vec{V}_T = 10 - 9 = 1 \text{ m/s}$



So time taken $t = \frac{100}{\vec{V}_{PT}} = \frac{100}{1} = 100$ sec.

Q.13 (1)



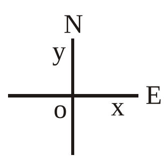
$\vec{V}_{GA} + \vec{V}_A = V_{GAS}$

$\vec{V}_A = -500\,\hat{i} \Rightarrow$

$\vec{V}_{GA} = 1500\,\hat{i} \Rightarrow$

$1500\,\hat{i} - 500\,\hat{i} = 1000\,\hat{i}$

Q.14 (4)



$\vec{V}_r = 50\,(-\hat{j}) - 50\,\hat{i} = 50\,(-\hat{i} - \hat{j})$ i.e., in south west

Q.15 (4)

$\vec{V}_{12} = \vec{V}_1 - \vec{V}_2$

$|\vec{V}_{12}| = \sqrt{V_1^2 + V_2^2 - 2V_1V_2\cos\theta}$

If $\cos\theta = -1$

$|\vec{V}_{12}|_{max} = \sqrt{V_1^2 + V_2^2 + 2V_1V_2}$

$|\vec{V}_{12}|_{max} = (V_1 + V_2)$

So $|\vec{V}_{12}|$ is maximum when $\cos\theta = -1$ and $\theta = \pi$

Q.16 (1)

$\vec{V}_r = \upsilon_y\,\hat{j}$

$\vec{\upsilon}_m = 5\hat{i}$

$\vec{V}_r - \vec{V}_m = (-5)\,\hat{i} + \upsilon_y\,\hat{j}$

$\tan\theta = 1 = \frac{\upsilon_y}{5}$

so $\upsilon_y = 5$ km/hr

Q.17 (2)

$\vec{V}_r = 10\,\hat{j}$

$\vec{V}_c = \upsilon\,\hat{i}$

$\vec{V}_r - \vec{V}_c = 10\,\hat{j} - \upsilon\hat{i}$

$|\vec{V}_r - \vec{V}_c| = \sqrt{10^2 + \upsilon^2} = 20$

$\upsilon = 10\sqrt{3}$

Q.18 (2)

$T_0 = \frac{d}{V} + \frac{d}{V} = \frac{2d}{V}$

$T = \frac{d}{V+u} + \frac{d}{V-u} = \frac{2Vd}{V^2 - u^2}$

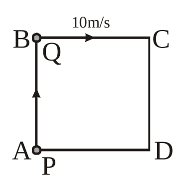
$T = \frac{V^2\,T_0}{V^2 - u^2} = \frac{T_0}{1 - \frac{u^2}{V^2}}$

$\frac{T}{T_0} = \frac{1}{1 - \frac{u^2}{V^2}}$

Q.19 (1)

Due north will take him cross in shortest time.

Q.20 (2)



a = 8 m

They meet when Q displace 8 × 3 m more than p $\Rightarrow$ relative displacement = relative velocity × time.

8 × 3 = (10 – 2) t

t = 3 sec

Ans. 3 sec

Q.21 (2)

$V_x = 2at$

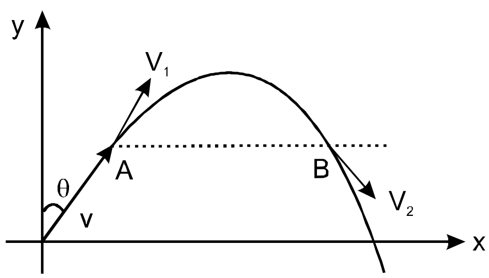
$V_y = 2bt$

$V = 2t\sqrt{a^2 + b^2}$

Q.22 (4)
Horizontal Component of velocity
Because there is no acceleration in horizontal Direction

Q.23 (3)
In projectile motion Horizontal accelereation $a_x = o$ & Vertical acceleration $a_y = g = 10m/s^2$ $a_x = o$
$a_x = 0$
$a_y = 10$ (down)
$\Rightarrow$ only "C" is correct **Ans**

Q.24 (1)



Avg. vel. b/w A & B $= \dfrac{\vec{V}_1 + \vec{V}_2}{2}$ ($\because$ Acceleration is constant = g)

Now, if $\vec{V}_1 = V_{1x}\,\hat{i} + V_{1y}\,\hat{j}$

Thans $\vec{V}_2 = V_{1x}\,\hat{i} - V_{1y}\,\hat{j}$ ($\because$ both A & B are at same lavel)

$\therefore \dfrac{\vec{V}_1 + \vec{V}_2}{2} = V_{1x}\,\hat{i} = V\sin\theta\,\hat{i}$ ($\because$ θ is from vertical)
" B " **Ans.**

Q.25 (3)
Range of θ and 90-θ is same
If $\theta = 30°$
So $90 - \theta = 60°$

Q.26 (3)
For both particles $u_y = 0$ and $a_y = -g$

$h = \dfrac{1}{2}gt^2 \Rightarrow h \rightarrow \text{same} \Rightarrow t \rightarrow \text{same}$

Q.27 (4)

$(Y_{max}) \Rightarrow \dfrac{dY}{dt} = 0$

$\Rightarrow \dfrac{d}{dt}(10\,t - t^2) = 10 - 2\,t \Rightarrow t = 5$

$\Rightarrow Y_{max} = 10(5) - 5^2 = 25$ m **Ans** "D"

Q.28 (4)
(i)
For θ and 90-θ
Range is ssame
$\theta = 15^0$
$90\text{-}\theta = 75^0$

(ii) $R = \dfrac{u\sin\theta . u\cos\theta}{g}$

$\therefore \sin(90 - \theta) = \cos\theta$
$\therefore \cos(90 - \theta) = \sin\theta$

Q.29 (2)

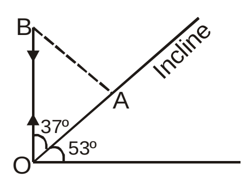
$E = \dfrac{1}{2}mv^2$

At Highest Point
vel = vcos θ

$KE = \dfrac{1}{2}mv^2\cos^2\theta = E\cos^2\theta = \dfrac{E}{2}$ ($\therefore \theta = 45°$)

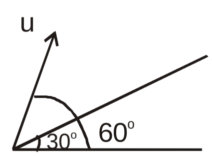
Q.30 (1)

$OB = \dfrac{u^2}{2g} = 5m$



$\therefore$ AB = OB sin37° = 3m.

Q.31 (3)



$u = 10\sqrt{3}$ m/s

Time of flight on the incline plane

$$T=\frac{2u\sin\alpha}{g\cos\beta}$$

given $\alpha=30^o$ & $\beta=30^o$ & $u=10\sqrt{3}$ m/s

$$T=\frac{2\times 10\sqrt{3}\,\sin 30^o}{10\cos 30^o}$$

so T= 2 sec .

Q.32 (2)

At maximum height v = u cosθ

$$\frac{u}{2}=v\Rightarrow\frac{u}{2}=u\cos\theta$$

$$\Rightarrow\ \cos\theta=\frac{1}{2}\qquad\Rightarrow\theta=60°$$

$$R=\frac{u^2\sin 2\theta}{g}=\frac{u^2\sin(120°)}{g}$$

$$=\frac{u^2\cos 30°}{g}=\frac{\sqrt{3}u^2}{2g}$$

Q.33 (3)

$r=\frac{20}{\pi}$ m, a_t = constant

n = 2nd revolution

v = 80 m/s

$$\omega_0=0,\ \omega_f=\frac{v}{r}=\frac{80}{20/\pi}=4\pi\ \text{rad/sec}$$

$\theta=2\pi\times 2=4\pi$

from 3rd equation

$\omega^2=\omega_0^{\,2}+2\alpha\theta$

$\Rightarrow\quad (4\pi)^2=0^2+2\times\alpha\times(4\pi)$

$\alpha=2\pi$ rad/s^2

$$a_t=\alpha r=2\pi\times\frac{20}{\pi}=40\ \text{m/s}^2$$

Q.34 (4)

$$\omega_{second}=\frac{2\pi}{T}=\frac{2\pi}{60}\ \text{rad/sec.}$$

$$v=\omega.r=\frac{2\pi}{60}\times 0.06\ \text{m/s}=2\pi\ \text{mm/s}$$

$$\Delta\vec{v}=\vec{v}_f-\vec{v}_i=\sqrt{2}\,v=2\sqrt{2}\,\pi\ \text{mm/s}$$

Q.35 (1)

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

where $t=1\text{Day}=24\times 60\times 60$ second

because earth complete one

revolution is 24 hours about its own axis

$$w=\left(\frac{2\pi}{60\times 60\times 24}\right)\text{rad/s}$$

Q.36 (1)

$$\text{Given }\omega_0=0,\ \omega=2\pi n=2\pi\times\frac{210}{60}\frac{\text{rad}}{\text{sec}}$$

from t = 5

$\omega=\omega_0+\alpha t$

$$2\pi\times\frac{210}{60}=0+\alpha\times 5\Rightarrow\ \alpha=1.4\pi\frac{\text{rad}}{\text{sec}^2}$$

Q.37 (2)

$$a_c=\omega^2R=\frac{4\pi^2}{T^2}R=\frac{4\times 3.14^2\times 6400\times 10^5}{(24\times 60\times 60)^2}$$

$$\omega^2R=\frac{4\pi^2}{T^2}R=\frac{4\times 3.14^2\times 6400\times 10^5}{(24\times 60\times 60)^2}=3.4\text{cm/sec}^2$$

Q.38 (3)

Given

$\omega=\theta^2+2\theta$

$$\frac{d\omega}{d\theta}=2\theta+2\Rightarrow\left.\frac{d\omega}{d\theta}\right|_{t=1}=2\theta+2=4$$

$$\alpha=\frac{\omega d\omega}{d\theta}=(\theta^2+2\theta).(2\theta+2)=12\ \text{rad/sec}^2$$

Q.39 (2)

We know that

$\nu\le\sqrt{\mu r g}$

$\nu\le\sqrt{0.64\times 20\times 9.8}$

$\nu\le 11.2\,\text{m/s}$

Q.40 (4)

r = 144 m, m = 16 kg, T_{max} = 16 N

$$T=\frac{mv^2}{r}$$

$$v=\sqrt{\frac{Tr}{M}}=\sqrt{\frac{16\times 144}{16}}=12\ \text{m/s}$$

Q.41 (4)

$T = m\omega^2 r$

$\Rightarrow T^1 = 2T = m\omega_1^2 r$

$\omega_1 = \sqrt{2}\ \omega = \sqrt{2} \times 5 = \sqrt{50} \sim 7$ rev/min

Q.42 (2)

We know the Tension provides necessary centripetal force

So $T = m\omega^2\ell$

Given $m = 0.1, \omega = 2\pi \times \frac{19}{\pi}$

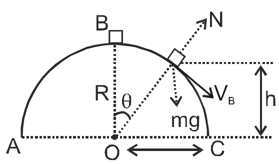
$\ell = 1 \quad \Rightarrow T = m\omega^2\ell$

$T = 0.1 \times \left(2\pi\times\frac{10}{\pi}\right)^2 \times 1$

$= 0.1 \times 4\pi^2 \times \frac{100}{\pi^2} \times 1 = 40$ N

Q.43 (2)

Let the car looses the contact at angle θ with vertical



$$mg\cos\theta - N = \frac{mv^2}{R} \Rightarrow N = mg\cos\theta - \frac{mv^2}{R}$$

During descending on overbridge θ is incerese. So cos θ is decrease therefore normal reaction is decrease.

Q.44 (1)

$T - mg = \frac{mv^2}{r}$ (centripetal force at lowest point)

$T = \frac{mv^2}{r} + mg$

Q.45 (1)

The maximum bearable Tension

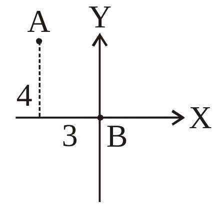
$T = \frac{mv^2}{l}$

$T_{max} = 10$ N, $m = 1$,
$v = ?$, $l = 1$

$\upsilon = \sqrt{\frac{Tl}{m}} = \sqrt{\frac{100\times1}{1}} = 10$ m/s

EXERCISE-IV

Q.1 [0036]



$\vec{r}_f - \vec{r}_i = \vec{v}t$

$\vec{r}_f - \left[3(\hat{i}) + 4(\hat{j})\right] = 2\left(\frac{3\hat{i}+4\hat{j}}{5}\right)\times5$

$\vec{r}_f + 3\hat{i} - 4\hat{j} = 6\hat{i} + 8\hat{j}$

$\therefore \vec{r}_f = 3\hat{i} + 12\hat{j}$

Q.2 [0003]

$a^2 - 2a - 3 = 0$

$a^2 - 3a + a - 3 = 0$

$a(a-3) + 1(a-3) = 0$

$\therefore a = 3$

Q.3 [0008]

$c^2 - 5c - 24 = 0$

$c = \frac{5 \pm \sqrt{25+96}}{2} = \frac{6\pm11}{2} = -3, 8$

Q.4 [0001]

$\omega^2 R = 2R\alpha$

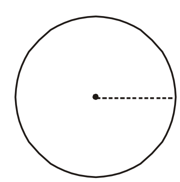
$\omega^2 = 2\alpha = 2\alpha\theta$

$\theta = 1$ rad.

Q.5 [0625]

$v = wR$

$v' = w(R-5) = \frac{\omega R}{5}$



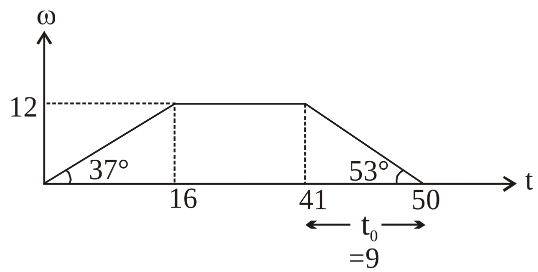
$5R - 25 = R$

$R = \frac{25}{4}$ m $= 6.25$ m

Q.6 [0009]

$$<\omega> = \frac{\int \omega\,dt}{\int dt} = \frac{\text{Area under graph}}{\text{time}}$$

$$= \frac{\frac{1}{2}\times 12[25+50]}{50} = 9 \text{ r/s.}$$



Q.7 [0005]

$T = mg$

$m r_{max}\,\omega^2 = T + \mu mg$

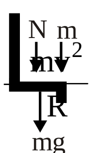
$m r_{min}\,\omega^2 = T - \mu mg$

$m(r_{max} + r_{min})\omega^2 = 2mg$

$$\therefore\ r_{max} + r_{min} = \frac{2g}{\omega^2} = 5\text{ m}$$

Q.8 [0200]

$$N_b - mg = \frac{mv^2}{R}$$



$$N_b = mg + \frac{mv^2}{R}$$

$$N_T + mg = \frac{mv^2}{R}$$

$$N_T = \frac{mv^2}{R} - mg = \frac{1}{3}\left(mg + \frac{mv^2}{R}\right)$$

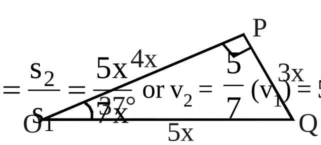
$$\frac{2}{3}\,\frac{mv^2}{R} = \frac{4}{3}\,mg$$

$$v = \sqrt{2gR} = \sqrt{20\times 2000} = 200 \text{ m/s}$$

Q.9 [0005]

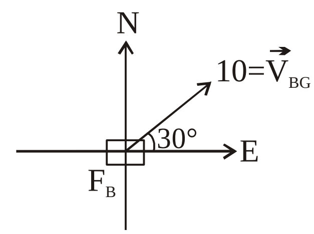
Bird (1) travels 7x and Bird (2) travels 5x in same time,

$$\text{so } \frac{v_2}{v_1} = \frac{s_2}{s_1} = \frac{5x}{7x} \text{ or } v_2 = \frac{5}{7}(v_1) = 5 \text{ km/hr}$$

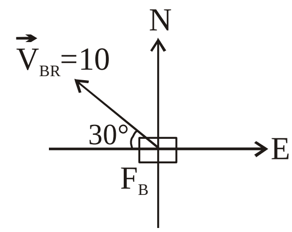


Q.10 [0017]

Ground frame :



River frame :



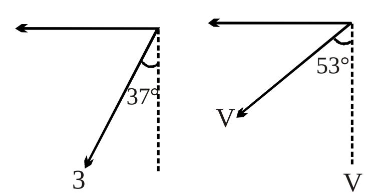
$$\vec{V}_{BG} = \vec{V}_{BR} + \vec{V}_{RG} \quad \Rightarrow$$

$$5\sqrt{3}\,\hat{i} + 5\hat{j} = -5\sqrt{3}\,\hat{i} + 5\hat{j} + \vec{V}_{RG}$$

$$\therefore\ \vec{V}_{RG} = 10\sqrt{3}\,\hat{i}$$

$\therefore\ V_{RG} = 17.3$ m/s

Q.11 [0007]



$$\frac{3V}{5} = \frac{12}{5}$$

$V = 4$

$$\frac{4V}{5} = \frac{9}{5} + V_C = \frac{7}{5}$$

$V_C = 0 + a_C t$

$a_C = 7$

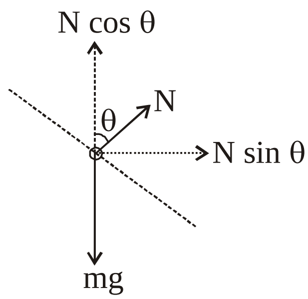
Q.12 [0004]

$N\cos\theta = mg \ \mid\ a = g\tan\theta$

$$N\sin\theta = ma \ \mid \tan\theta = \frac{dy}{dx}$$

$y = x^2$

$$\frac{dy}{dx} = 2x = 2\times 0.2 = 0.4$$



$a = 10 \times 0.4 = 4\ m/s^2$

Q.13 [0025]

$$y = x\tan\theta - \frac{1}{2} g \frac{x^2}{v^2\cos^2\theta}$$

$x = 38 + 2 = 40$
$y = 18$
$\theta = 60°$ $\Rightarrow v = 25\ m/s$

Q.14 [0007]

$R = \dfrac{u^2 \sin(2\theta)}{g}$ $\therefore R \propto \sin(2\theta)$ (for same speed of projection)

$$\therefore \frac{R'}{R} = \frac{\sin(2\times 45°)}{\sin(2\times 15°)}$$

$$\therefore R' = 3.5 \times \frac{1}{0.5} = 7\ m$$

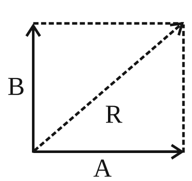
Q.15 [0020]

$$-20 = 40\tan 0 - \frac{1}{2}\frac{g\times 40^2}{u^2\cos^2 0°}$$

$$u^2 = \frac{1600}{4} = 400$$

$u = 20\ m/s$

Q.16 (1)



$\vec{R} = \vec{A} + \vec{B}$

$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$
If $\theta > 90°$

$R = \sqrt{A^2 + B^2 - 2AB\cos\theta}$
R may less than either vector if θ = obtuse

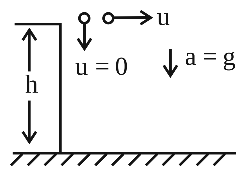
Q.17 (3)

$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$

$v_{AB} = \sqrt{v_A^2 + v_B^2 - 2v_A v_B\cos\theta}$

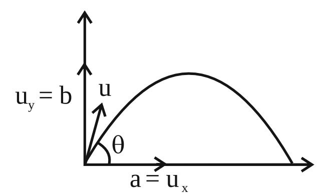
$\theta = 0$ $v_{AB} = v_A - v_B$
$v_{AB} < v_A$
$\theta = 180°$ $v_{AB} = v_A + v_B$
$v_{AB} > v_A$

Q.18 (1)



$t = \sqrt{\dfrac{2h}{g}}$

Q.19 (1)



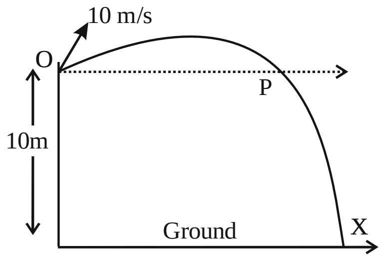
$R_{max} = \dfrac{u^2}{g}$ at $\theta = 45°$ $a = b$

Q.20 (1)
Q.21 (4)

PREVIOUS YEAR'S

MHT CET

Q.1 (1)
Q.2 (2)
Q.3 (4)
Q.4 (1)
Q.5 (4)
Q.6 (3)
Q.7 (1)
Q.8 (4)
Q.9 (4)
Q.10 (4)
Q.11 (1)
Q.12 (2)
Q.13 (1)
Q.14 (3)
Q.15 (2)



The ball will be at a point P when it is at a height of 10m from the ground. So, we have to find the distance OP, which can be calculated directly by considering it as a projectile on a levelled plane OX.

Therefore, maximum range, $OP = R = \frac{u^2 \sin 2\theta}{g}$

$$= \frac{10^2 \times \sin(2\times 30^\circ)}{10} = \frac{10\sqrt{3}}{2} = 5\sqrt{3} = 8.6\text{m}$$

Q.16 (2)

Q.17 (2)

Given, at maximum height, $u\cos\theta = \frac{1}{2}u$

$$\Rightarrow \quad \cos\theta = \frac{1}{2} \text{ or } \theta = 60^\circ$$

$\therefore$ Maximum height, $H_{max} = \frac{u^2 \sin^2\theta}{2g}$

$$= \frac{u^2 \times \sin^2 60^\circ}{2g} = \frac{3u^2}{8g} \qquad \left[\because \sin 60^\circ = \frac{\sqrt{3}}{2}\right]$$

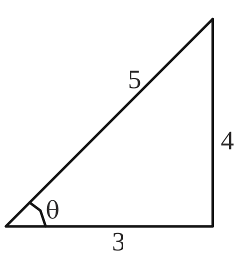
Q.18 (2)

Given, $u = 3\hat{i} + 4\hat{j}$

$$\therefore \quad u = |u| = \sqrt{3^2 + 4^2}$$

$$\Rightarrow \quad v = 5\,\text{m/s}$$

From figure,



$\sin\theta = \frac{4}{5}$ and $\cos\theta = \frac{3}{5}$

$$\therefore \quad R = \frac{u^2 \sin 2\theta}{g} = \frac{v^2 .2\sin\theta.\cos\theta}{g}$$

$$= \frac{5\times 5\times 2\times \frac{4}{5}\times\frac{3}{5}}{10} = 2.4\text{m}$$

Q.19 (3)

Q.20 (1)

Q.21 (3)

Q.22 (2)

Q.23 (4)

Q.24 (3)

Q.25 (1)

Q.26 (2)

Q.27 (2)

Q.28 (1)

Q.29 (4)

Q.30 (3)

Q.31 (1)

Q.32 (3)

Q.33 (2)

Q.34 (Bouns)

Q.35 (2)

Q.36 (1)

Q.37 (1)

Q.38 (4)

Q.39 (1)

Q.40 (1)

Q.41 (1)

Q.42 (4)

Q.43 **(2)**

The maximum tension in the string will be at lowest point i.e., $T_{max} = \frac{mv_1^2}{l} + mg$

and minimum tension in the string will be the highest point i.e., $T_{min} = \frac{mv_2^2}{l} - mg$

Therefore, $\frac{T_{max}}{T_{min}} = \frac{\frac{mv_1^2}{l} + mg}{\frac{mv_2^2}{l} - mg} = 4$

$$\Rightarrow \frac{v_1^2 + gl}{v_2^2 - gl} = 4$$

As we know, $v_1^2 = v_2^2 + 4gl$

So from Eqs. (i) and (ii), we get

$$v_2^2 + 4gl + gl = 4v_2^2 - 4gl$$

$$\Rightarrow \quad 3v_2^2 = 9gl$$

$$v_2^2 = 3gl = 3\times 10\times\frac{10}{3}$$

$$v_2^2 = 100 \Rightarrow v_2 = 10 \text{ m/s}$$

Q.44 **(3)**

Given, r = 20 cm = 0.2 m,t = 0.5 s, v = 4t and m = 5kg

Radial acceleration, $a_r = \frac{v^2}{r} = \frac{(4t)^2}{0.2} = \frac{16t^2}{0.2} = 80t^2$

$= 80 \times (0.5)^2$

At, = 20 ms^{-2}

Tangential acceleration of particle,

$a_t = \frac{dv}{dt} = \frac{d}{dt}(4t) = 4ms^{-2}$

$\therefore$ Net acceleration

$a_n = \sqrt{a_r^2 + a_t^2} = \sqrt{(20)^2 + (4)^2} = 4\sqrt{26}ms^{-2}$

So, net force, $F_n = ma_n = 5 \times 4\sqrt{26}$

$= 20\sqrt{26}N$

Q.45 **(2)**

Let original length be x cm.

Initial angular velocity be ω.

Elongation, dx = 1cm

According to Newton's law $F = -kdx = \frac{mv^2}{r}$

$\Rightarrow -kdx = m\omega^2 r$

Since, r = (x+1) and dx = 1 cm

Therefore, $-k(1) = m\omega^2(x+1)$ ....(i)

Again angular velocity is doubled and elongation produced is 5 cm.

There, $-k(5) = m(2\omega)^2(x+5)$

$-5k = 4m\omega^2(x+5)$ ....(ii)

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

$\frac{5k}{k} = \frac{4m\omega^2(x+5)}{m\omega^2(x+1)}$

$\Rightarrow (x+1)5 = 4(x+5)$

$\Rightarrow 5x+5 = 4x+20$

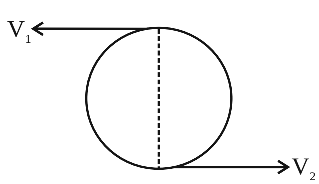
$\Rightarrow 5x - 4x = 20 - 5$

$\Rightarrow x = 15$ cm

Q.46 **(2)**

For half revolution, the position of the particle is given below,

Let velocity be v.



Change in velocity = $v_2 - v_1$ = v-(-v) = 2v

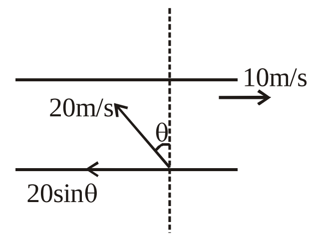
Time taken by the particle to cover half revolution

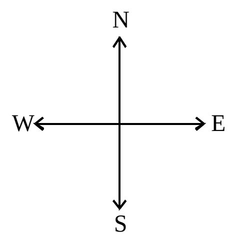
$t = \frac{\pi R}{v}$

$\therefore$ Average acceleration $= \frac{\text{Velocity}}{\text{Time}} = \frac{2v}{\frac{\pi R}{v}} = \frac{2v^2}{\pi R}$

NEET / AIPMT

Q.1 (1)





For shortest path, velocity along river flow is zero.

$20 \sin\theta = 10 \quad \Rightarrow \sin\theta \frac{10}{20} = \frac{1}{2}$

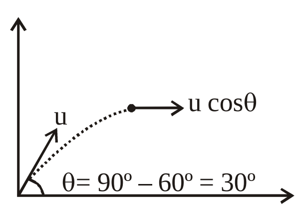
θ = 30° West

Q.2 (1)

Q.3 (1)

Q.4 (1)

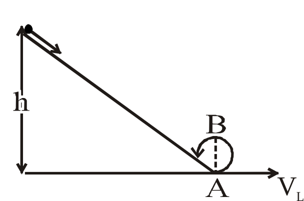
At highest point only horizontal component of velocity remains $\Rightarrow u_x = u \cos\theta$



$u_x = u \cos\theta = 10 \cos 30°$

$= 5\sqrt{3}ms^{-1}$

Q.5 (4)



As track is frictionless, so total mechanical energy will remain constant

$T.M.E_I = T.M.E_F$

$$0 + mgh = \frac{1}{2}mv_L^2 + 0$$

$$h = \frac{v_L^2}{2g}$$

For completing the vertical circle, $v_L \geq \sqrt{5gR}$

$$h = \frac{5gR}{2g} = \frac{5}{2}R = \frac{5}{4}D$$

Q.6 (3)

In vertical circular motion, tension in wire will be maximum at lower most point, so the wire is most likely to break at lower most point.

Q.7 (3)

Q.8 (4)

$$\text{Time period (T)} = \frac{2\pi}{\omega}$$

ω = angular speed

$T_1 = T_2$ (given)

$$\frac{2\pi}{\omega_1} = \frac{2\pi}{\omega_2}$$

$\omega_1 = \omega_2$

$\omega_1 : \omega_2 = 1 : 1$

JEE MAIN

Q.1 (3)

$$|\vec{A}| \neq 0$$

$$\vec{A}.\vec{A} = |\vec{A}||\vec{A}|\cos 0° \Rightarrow \vec{A}.\vec{A} = |\vec{A}|^2$$

$$\vec{A} \times \vec{A} = |\vec{A}||\vec{A}|\sin 0°\hat{n} = 0$$

Q.2 (2)

$$|\hat{A} + \hat{B}| = \sqrt{|\hat{A}|^2 + |\hat{B}|^2 + 2|\hat{A}||\hat{B}|\cos\theta}$$

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

$$= \sqrt{2(1+\cos\theta)} \qquad \{|\hat{A}| = |\hat{B}| = 1\}$$

$$= \sqrt{2 \times 2\cos^2\frac{\theta}{2}}$$

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

$$|\hat{A} - \hat{B}| = \sqrt{|\hat{A}|^2 + |\hat{B}|^2 - 2|\hat{A}||\hat{B}|\cos\theta}$$

$$= \sqrt{2 - 2\cos\theta}$$

$$= 2\sin\frac{\theta}{2}$$

$$\frac{|\hat{A} + \hat{B}|}{|\hat{A} - \hat{B}|} = \cot\frac{\theta}{2} \Rightarrow |\hat{A} - \hat{B}| = |\hat{A} + \hat{B}|\tan\frac{\theta}{2}$$

Q.3 (3)

$|\vec{A}| = |\vec{B}| = A$

$|\vec{A} + \vec{B}| = 2(|\vec{A} - \vec{B}|)$

$A^2 + A^2 + 2A^2\cos\theta = 4(A^2 + A^2 - 2A^2\cos\theta)$

$2A^2(1 + \cos\theta) = 2A^2(4 - 4\cos\theta)$

$5\cos\theta = 3$

$$\cos\theta = \frac{3}{5}, \ \theta = \cos^{-1}\left(\frac{3}{5}\right)$$

Q.4 [2]

magnitude of component of $\vec{A}$ along

Q.5 (5)

$\vec{a}.\vec{b} = 0$

$\therefore\ \vec{a}.\vec{b} = 0$

$\therefore\ 2 \times 1 + 4 \times 2 - 2 \times \alpha = 0$

$\therefore\ \alpha = 5$

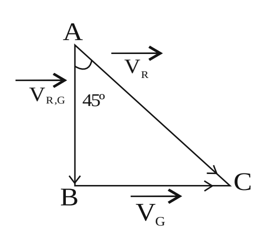
Q.6 (3)

$$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} i & j & k \\ 2 & 2 & 1 \\ 5 & 3 & -7 \end{vmatrix}$$

$$= \hat{i}(-14-3) - \hat{j}(-14-5) + \hat{k}(6-10)$$

$$= -17\hat{i} + 19\hat{j} - 4\hat{k}$$

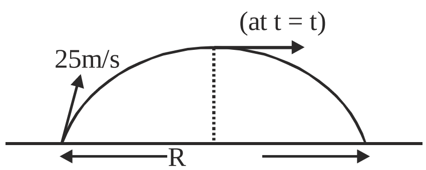
Q.7 (3)



$$V = \tan\theta \frac{V_G}{V_{RG}}$$

$$1 = \frac{V_G}{V_{RG}} \Rightarrow 15\sqrt{2} = V_{RG}$$

Q.8 (4)



According to question

at t = t, $x = \frac{R}{2}, T = \frac{2u\sin\theta}{g}$

$t = \frac{T}{2} = \frac{u\sin\theta}{g}$ ....(1)

R = u cos θ (2t) ....(2)

divide (1) by (2)

$$\frac{R}{t} = \frac{g \times u\cos\theta(2t)}{u\sin\theta} = 2gt \times \cot\theta$$

$$\frac{R}{t} = 20t\cot\theta$$

$$\cot\theta = \frac{R}{20t^2}$$

$$\theta = \cot^{-1}\left(\frac{R}{20t^2}\right)$$

Q.9 (20m)

$$V_y = \frac{u}{\sqrt{2}} - 10 \times 2 = \frac{u}{\sqrt{2}} - 20$$

$$\sqrt{V_y^2 + \left(\frac{u}{\sqrt{2}}\right)^2} = 20$$

$$\left(\frac{u}{\sqrt{2}} - 20\right)^2 + \left(\frac{u}{\sqrt{2}}\right)^2 = 400$$

$$\frac{u^2}{2} + 400 - \frac{40u}{\sqrt{2}} + \frac{u^2}{2} = 400$$

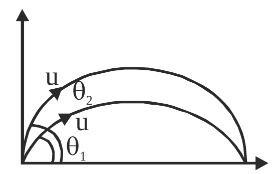
$$u^2 = \frac{40u}{\sqrt{2}}$$

$u = \frac{40}{\sqrt{2}} = 20\sqrt{2}$ $\quad u_y = 20\sqrt{2} \times \frac{1}{2} = 20$

$$H_{max.} = \frac{u_y^2}{2g} = \frac{(20)^2}{2 \times 10} = \frac{400}{20} = 20\,m$$

$H_{max.} = 20m$

Q.10 **(1)**



Ball A and B both have same velocity and same range then

$\theta_1 + \theta_2 = 90$

$\theta_1 = \theta$ and $\theta_2 = 90 - \theta$

$h_1 = \frac{u^2 \sin^2}{2g}$ ....(1) $\quad h_2 = \frac{u^2 \sin^2(90 - \theta)}{2g}$

$h_2 = \frac{u^2}{2g}\cos^2\theta$ ....(2)

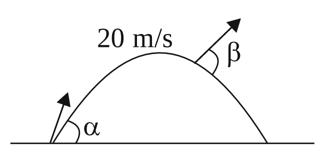
$$h_1 h_2 = \frac{u^2 \sin^2\theta}{2g} \cdot \frac{u^2\cos^2\theta}{2g}$$

$$h_1 h_2 = \frac{(u^2 \sin\theta.\cos\theta)^2}{(2g)^2}$$

$$4h_1h_2 = \left(\frac{2u^2\sin\theta\cos\theta}{2g}\right)^2 \left(\frac{u^2 \sin 2\theta}{2g}\right)^2 = \left(\frac{R}{2}\right)^2$$

$4.h_1.h_2 \times 4 = R^2$ $\boxed{R = 4\sqrt{h_1.h_2}}$

Q.11 (2)



$v_x = u_x = 20\cos\alpha$

$v_y = 20\sin\alpha - 10 \times 10$

$$\tan\beta = \frac{v_y}{v_x} = \frac{20\sin\alpha - 100}{20\cos\alpha}$$

$= \tan\alpha - 5\sec\alpha$

Q.12 (60)

Q.13 (1)

$x = 4\sin\left(\frac{\pi}{2} - \omega t\right)$ $y = 4\sin\omega t$

$x = 4\cos\omega t$

Eliminate 't' to find relation between X and Y

$x^2 + y^2 = 4^2\cos^2\omega t + 4^2\sin^2\omega t$

$x^2 + y^2 = 16(\sin^2\omega t + \cos^2\omega t)$

$x^2 + y^2 = 16 \rightarrow$ Equation of circle

Q.14 (2)

$$\text{Range} = \frac{u^2\sin 2\theta}{g}$$

$$(\text{Range})_{max} = \frac{u^2}{g}(\theta = 45^\circ)$$

$$\frac{u^2}{g} = 100 \Rightarrow u^2 = 100g$$

$$\text{Height} = \frac{u^2\sin^2\theta}{2g}$$

$$(\text{Height})_{max} = \frac{u^2}{2g}(\theta = 90^\circ)$$

$$= \frac{100g}{2g} = 50\,m$$

Q.15 (4)

$$\frac{R}{H} = \left(\frac{2U^2\sin\theta\cos\theta}{g}\right)\left(\frac{2g}{U^2\sin^2\theta}\right)$$

$$1 = \frac{4}{\tan\theta}$$

$\tan\theta = 4$

Q.16 (3)

$h_{1max} = h_{2\,max}$

$$\frac{u_{1y}^2}{2g} = \frac{u_{2y}^2}{2g}$$

$u_{1y} = u_{2y}$

$u_1 \sin 30 = u_2 \sin 45$

$$\frac{u_1}{2} = \frac{u_2}{\sqrt{2}}$$

$$\frac{u_1}{u_2} = \frac{2}{\sqrt{2}} = \sqrt{2}:1$$

Q.17 [5]

$y = 5x - 5x^2$

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta} \ldots \tan\theta = 5$$

$\vec{u}_x = \hat{i} \rightarrow u_x = 1$

$u\cos\theta = 1$

$$\tan\theta = \frac{u_y}{u_x} = \frac{u_y}{1}$$

$$5 = \frac{u_y}{1}$$

$\boxed{u_y = 5} \rightarrow \vec{u}_y = 5\hat{j}$

Q.18 (3)

Let initial velocity of both the projectiles be u.

Then for ground-to-ground projectile, horizontal range is given by $R = \frac{u^2\sin 2\theta}{g}$.

now, according to question,

$$\frac{R_A}{R_B} = \frac{\frac{u^2\sin 2\theta_A}{g}}{\frac{u^2\sin 2\theta_B}{g}} = \frac{\sin 90^\circ}{\sin 60^\circ} = \frac{2}{\sqrt{3}}$$

Q.19 [1]

For 1st ball

$v = u + at$

at max ht. $v = 0$

so

$0 = v_1 - gt_1$

$$t_1 = \frac{v_1}{g} \qquad \text{---------(1)}$$

For 2nd ball

$$t_2 = \frac{v_2\cos\theta}{g} \qquad \text{---------(2)}$$

Given

$t_1 = t_2$

From (1) and (2)

$$\frac{v_1}{g} = \frac{v_2\cos\theta}{g}$$

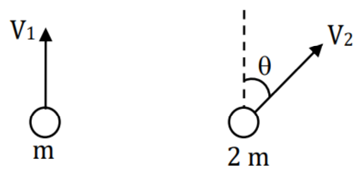
$\boxed{v_1 = v_2\cos\theta}$

$$h_1 = \frac{v_1^2}{2g} \text{ and } h_2 = \frac{v_2^2\cos^2\theta}{2g}$$

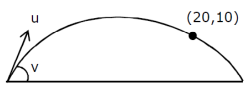
Now

$$\frac{h_1}{h_2} = \left(\frac{v_1^2}{2g}\right) \times \frac{2g}{v_2^2\cos^2\theta} = \frac{v_2^2\cos^2\theta}{v_2^2\cos^2\theta} = 1$$

$\frac{h_1}{h_2} = 1$



Q.20 (4)



By $y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$

$10 = 20\tan 45° - \frac{1\times10\times20^2}{2u^2(\cos 45°)^2}$

Solving $u = 20$

Now time of flight $T = \frac{2u\sin\theta}{g} = \frac{2\times20\times\sin 45°}{10} = 2\sqrt{2}$

Momentum of $t = \frac{T}{\sqrt{2}} = 2\sec$

$P = mu\cos\theta\ \hat{i} + m(u\sin\theta - gt)\hat{j}$

$= 10[20\cos 45°]\hat{i} + 10(20\sin 45° - 10\times2)\hat{j}$

$= 100\sqrt{2}\hat{i} + (100\sqrt{2} - 200)\hat{j}$

Q.21 (2)

$x = 3t\,\hat{i}$ $\quad y = 5t^3\,\hat{y}$ $\quad z = 7\,\hat{j}$

$v_x = \frac{dx}{dt} = 3\,\hat{x}$ $\quad y_x = \frac{dy}{dt} = 15t^2$ $\quad v_z = \frac{dz}{dt} = 0$

$a_x = \frac{dv_x}{dt} = 0$ $\quad a_y = \frac{dv_y}{dt} = 30t\ \hat{y}$ $\quad a_z = 0$

$a_{net} = \vec{a}_x + \vec{a}_y + a_z$

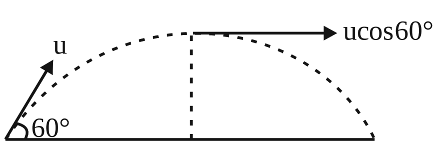
$= 30t\,\hat{y}$

at t = 1 sec

$a_{net} = 30\,\hat{y}$

Q.22 (3)

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



At highest point, velocity $V = u\cos 60° = \frac{u}{2}$

$\therefore$ K.E. at topmost point $= \frac{1}{2}m\left(\frac{u}{2}\right)^2 = \frac{E}{4}$

Q.23 (15)

$R_{max} = \frac{u^2\sin 2(45°)}{g} = \frac{u^2}{g}$

$\frac{R}{2} = \frac{u^2}{2g} = \frac{u^2\sin 2\theta}{g}$

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

$2\theta = 30°, 150°$

$\theta = 15°, 75°$

Q.24 (4)

Time taken by ball to reach highest point $= \frac{u}{g}$

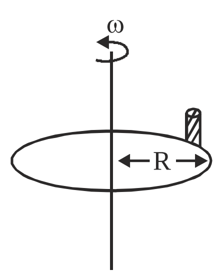
Frequency of throw $= \frac{g}{u} = n$

$\Rightarrow u = \frac{g}{n}$

$H_{max} = \frac{u^2}{2g} = \frac{\left(\frac{g}{n}\right)^2}{2g}$

$\frac{g}{2n^2}$

Q.25 **(2)**



$f_r = m\omega^2R$

Now

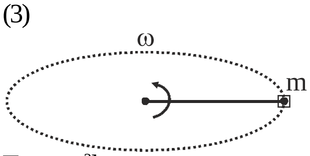
$f_r \le \mu N$

$m\omega^2R \le \mu mg$

$\omega^2R \le \mu g$

$\boxed{R \le \frac{\mu g}{\omega^2}}$

Q.26 (3)



$T = m\omega^2 l$

$80 = 0.1 \times \omega^2 \times 2$

$\omega^2 = \frac{80}{0.2} = 400$

$\omega = 20$ rad/s

$= 20 \times \frac{60}{2\pi}$ rev / min

$= \frac{600}{\pi}$

$K = 600$

Q.27 (2)

According to theory :

$T + mg = \frac{mv^2}{R}$.....(at highest point)

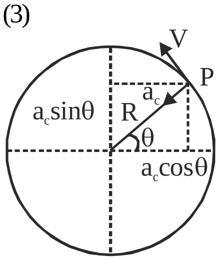
$T = \frac{mv^2}{R} - (mg)$

$\therefore$ Tension is minimum at highest point.

$T = \frac{mv^2}{r} + mg$....(At lowest point)

$\therefore$ Tension is maximum at lowest point.

Q.28 (3)



$v \rightarrow$ uniform speed

So tangential acc. will be zero $a_t = 0$

$\vec{a} = \vec{a}_t + \vec{a}_c$

So $\boxed{\vec{a} = \vec{a}_c}$

$\vec{a}_c = -\frac{v^2}{R}(\hat{R})$

$$\boxed{\vec{a}_c = -\frac{v^2}{R}\cos\theta\hat{i} - \frac{v^2}{R}\sin\theta\hat{j}}$$

Q.29 (24)

$V = \sqrt{\mu rg}$

$\frac{v_2}{v_1} = \sqrt{\frac{r_2}{r_1}} \Rightarrow \frac{v_2}{30} = \sqrt{\frac{48}{75}} = \sqrt{\frac{16\times 3}{25\times 3}}$

$\frac{v_2}{30} = \frac{4}{5} \Rightarrow \boxed{V_2 = 24 m/s}$

Q.30 (3)

$a = k^2 r t^2$ power delivered = ??

$a_c = \frac{v^2}{r} = k^2rt^2$

$v^2 = k^2 r^2 t^2$

$v = k r t$

Tangential acceleration $a = \frac{dv}{dt} = kr$

So tangential force $f_t = ma_t$

$F_t = mkr$

Power delivered

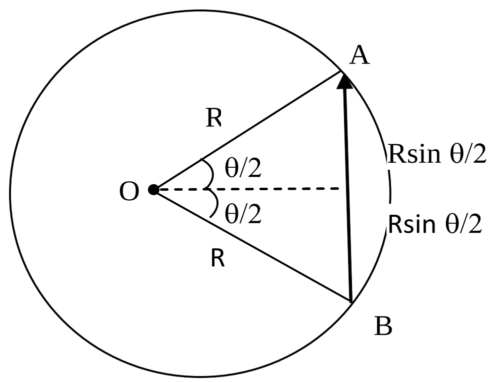
$P = Fv$

$P = mkr \times krt$

$P = m k^2 r^2 t$

Q.31 (2)

Distance travelled $S = R\theta$ (R = radius)



$R = \frac{5}{\theta} \Rightarrow R\frac{60}{\frac{3\pi}{4}} \Rightarrow R = \frac{80}{\pi}m$

Displacement $|\Delta\vec{r}| = 2R\sin\frac{\theta}{2}$

$|\Delta\vec{r}| = R\sqrt{2(1-\cos\theta)}$

$= \frac{80}{\pi}\sqrt{2(1+0.7)}\left\{\begin{matrix}\theta = 135^\circ \\ \cos 135^\circ = -0.7\,(\text{given})\end{matrix}\right\}$

Given $\cos 135^\circ = -0.7$

$\approx 47\,m$

Q.32 (1)

$N = \frac{mv^2}{r}$

Curve is parabola

$Y = kx^2$

Laws of Motion

EXERCISE-I (MHT CET LEVEL)

Q.1 (2)

$\vec{F} = \frac{d\vec{p}}{dt} =$ Rate of change of momentum

As balls collide elastically hence, rate of change of momentum of ball = n [mu– (mu)] = 2 mmu i.e. F = 2 mnu.

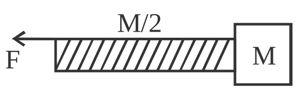
Q.2 (3)
If momentum remains constant then force will be zero

because $F = \frac{dp}{dt}$.

Q.3 (1)
For exerted by ball on wall
= rate of change in momentum of ball

$= \frac{m\nu - (-m\nu)}{t} = \frac{2mu}{t}$.

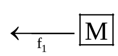
Q.4 (3)



Acceleration, $a = \frac{F}{M + \frac{M}{2}} = \frac{2F}{3M}$

for block,

$f_1 = ma$



$= m\left(\frac{2f}{3M}\right)$

$= \frac{2f}{3} = \frac{2(2Mg)}{3} = \frac{4Mg}{3}$

Q.5 (4)
For equilibrium of all 3 masses,

$$a = \frac{T_3}{m_1 + m_2 + m_3}$$

For equilibrium of m_1 & m_2

$T_2 = (m_1 + m_2).a$ and $T_2 = \frac{(m_1 + m_2)T_3}{m_1 + m_2 + m_3}$

Given $m_1 = 10kg, m_2 = 6kg, m_3 = 4kg$

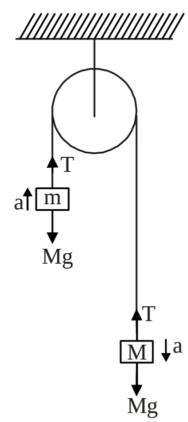
$T_3 = 40N$

$$\therefore T_2 = \frac{(10+6).40}{10+6+4} = 32N$$

Q.6 (3)

Given $m = 0.36\,kg, M = 0.72\,kg$

The figure shows the forces on m and M When the system is released, let the acceleration be a. Then



T-mg = ma
Mg-T= Ma

$$a = \frac{(M-m)g}{M+m} = g/3$$

and $T = 4mg/3$

For block m :
u=0, a=g / 3, t=1, s=?
Work done by the string on m is

$$\vec{T}\vec{s} = Ts = 4\frac{mg}{3} \times \frac{g}{6} = \frac{4 \times 0.36 \times 10 \times 10}{3 \times 6} = 8\,J$$

Q.7 (4)
Net sliding force or pulling
force = 2mg sin45° – mg sin 45°

$= \frac{mg}{\sqrt{2}}$

Maximum resistance by

friction = $f_{A_1L} + f_{B_1L}$

$= \mu_A N_A + \mu_B N_B$

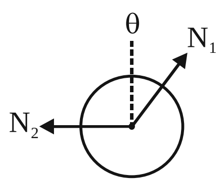
$= \frac{2}{3} mg\cos 45° + \frac{1}{3} 2mg\cos 45°$

$= \frac{4}{3}\frac{mg}{\sqrt{2}} >$ pulling force $\left(\frac{mg}{\sqrt{2}}\right)$

Thus the system will not slide and acceleration of system will be zero.

Q.8 (3)

$\sin\theta = \frac{1}{3}$



Thus, $N_1 \sin\theta = N_2$

$\therefore \quad \frac{N_1}{N_2} = \frac{1}{\sin\theta} = 3$

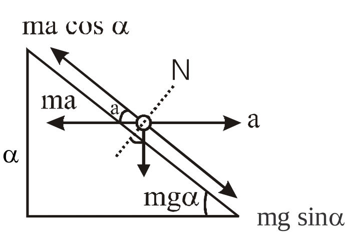
Q.9 (1)
After the stone is thrown out of the moving train, the only force acting on it is the force of gravity i.e. its weight.

$\therefore F = mg = 0.05 \times 10 = 0.5N$.

Q.10 (3)
Q.11 (1)
Q.12 (3)
5N force will not produce any tension in spring without support of other 5N force. So here the tension in the spring will be 5N only.

Q.13 (3)
From free body diagram,
For block to remain stationary,

mg sin α = ma cos α



$\Rightarrow a = g\tan\alpha$

Q.14 (4)
Q.15 (2)

Q.16 (1)
T = m (g + a) = 500 (10 + 2) = 6000 N

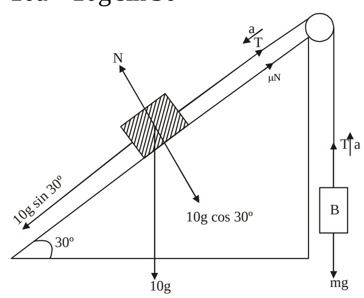
Q.17 (2)
Rate of flow will be more when lift will move in upward direction with some acceleration because the net downward pull will be more and vice-versa.
$F_{upward} = m(g + a)$ and $F_{downward} = m(g - a)$ F_{upward}

Q.18 (4)

$\mu = \frac{F}{R} = \frac{F}{mg} = \frac{98}{100\times 9.8} = \frac{1}{10} = 0.1$

Q.19 (1)
for block A to move the limiting friction at block A must be exceeded by the weight of block B.
At the limitting condition
than, $M_B g = \mu M_A g$
$\Rightarrow M_B = \mu M_A = 0.2 \times 10$
= 2 kg

Q.20 (2)
Considering the equilibrium of A, we get
10a = 10g sin 30º



$\therefore 10a = \frac{10}{2}g - T - \mu\times 10g\cos 30^o$

but $a = 0, T = m_B g$

$0 = 5g - m_B g - \frac{0.2\sqrt{3}}{2}\times 10\times g$

$\Rightarrow m_B = 3.268 \simeq 3.3\,kg$

Q.21 (3)
Q.22 (3)

a = g (sin θ – μ cos θ) = 10 (sin 60º – 0.25 cos 60º)

a = 7.4 m/s^2.

Q.23 (2)

$a = \frac{\text{Applied force} - \text{Kinetic friction}}{\text{mass}}$

$$= \frac{100 - 0.5 \times 10 \times 10}{10} = 5\,m/s^2$$

Q.24 (2)

Q.25 (4)

Q.26 (2)

EXERCISE-II (NEET LEVEL)

Q.1 (3)

Acceleration $\alpha = \frac{F}{m} = \frac{100}{5} = 20\ cm/s^2$

Now $v = \alpha t = 20 \times 10 = 200$ cm/s

Q.2 (3)

Thrust $F = u\left(\frac{dm}{dt}\right) = 5 \times 10^4 \times 40 = 2 \times 10^6\,N$

Q.3 (4)

Force $= m\left(\frac{dv}{dt}\right) = \frac{0.25 \times [(10) - (-10)]}{0.01} = 25 \times 20 = 500$ N.

Q.4 (1)

$F = m\left(\frac{v - u}{t}\right) = \frac{5(65 - 15) \times 10^{-2}}{0.2} = 12.5$ N.

Q.5 (2)

$F = ma = \frac{m(u - v)}{t} = \frac{2 \times (8 - 0)}{4} = 4$ N.

Q.6 (3)

$\vec{F} - = \frac{d\vec{p}}{dt} = \frac{d}{dt}(\alpha + bt^2) = 2bt$ i.e. $F \propto t$

Q.7 (1)

Change in momentum = Impulse

$\Rightarrow \Delta p = F \times \Delta t \Rightarrow \Delta t = \frac{\Delta p}{F} = \frac{125}{250} = 0.5$ sec.

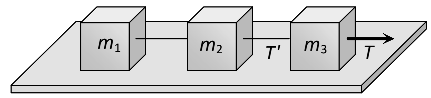
Q.8 (2)

$F = \sqrt{(F)^2 + (F)^2 + 2F.F\cos\theta} \Rightarrow \theta = 120°$.

Q.9 (4)

Range of resultant of F_1 and F_2 varies between (3 + 5) = 8N and (5 – 3) = 2N. It means for some value of angle (θ), resultant 6 can be obtained. So, the resultant of 3N, 5N and 6N may be zero and the forces may be in equilibrium.

Q.10 (3)



$T' = (m_1 + m_2) \times \frac{T}{m_1 + m_2 + m_3}$.

Q.11 (4)

$T = \frac{2m_1m_2}{m_1 + m_2}g = \frac{2 \times 10 \times 6}{10 + 6} \times 9.8 = 73.5\,N.$

Q.12 (3)

If monkey move downward with acceleration a then its apparent weight decreases. In that condition Tension in string = m (g – a)

This should not be exceed over breaking strength of the rope i.e. $360 \geq m(g - a) \Rightarrow 360 \geq 60(10 - a)$

$\Rightarrow a \geq 4\,m/s^2$.

Q.13 (1)

For jumping he presses the spring platform, so the reading of spring balance increases first and finally it becomes zero.

Q.14 (3)

Net force on bird , $F_{Net} = 0.5 \times 2 = 1N$

$\therefore$ Reading increases by 1 N

Q.15 (2)

Since downward force along the inclined plane

= mg sin θ = 5 × 10 × sin 30º = 25 N.

Q.16 (3)

As the spring balances are massless therefore the reading of both balance should be equal.

Q.17 (4)

In stationary lift man weighs 40 kg i.e. 400 N.

When lift accelerates upward it's apparent weight = m(g + a) = 40 (10 + 2) = 480 N i.e. 48 kg

For the clarity of concepts in this problem kg-wt can be used in place of kg.

Q.18 (4)

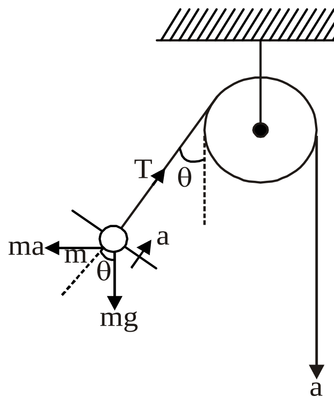
As the apparent weight increase therefore we can say that acceleration of the lift is in upward direction.

$R = m(g + a) \Rightarrow 4.8\,g = 4(g + a)$

$\Rightarrow a = 0.2g = 1.96\ m/s^2$

Q.19 (3)

Applying Newton's law along string



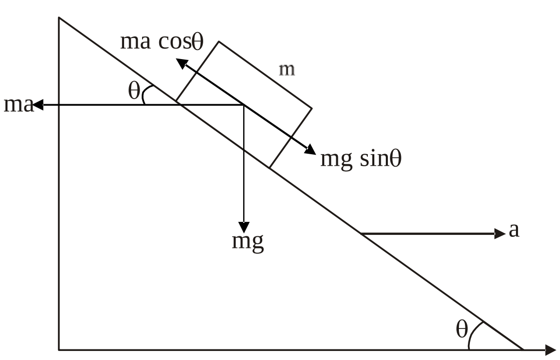
$$\Rightarrow T - m\sqrt{g^2 + a^2} = ma$$

$$\text{or } T = m\sqrt{g^2 + a^2} + ma$$

Q.20 (3)

the mass of block is m. It will remains Let the mass if forces acting on it are in stationary i.e., ma cos θ = mg sin θ

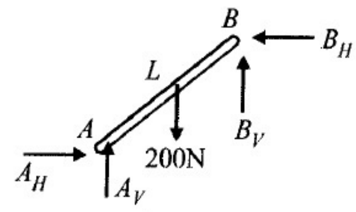
$$\Rightarrow a = g\tan\theta$$



Here ma = Pseudo force on block,
mg = weight

Q.21 (1)

Conder FBD of structure.

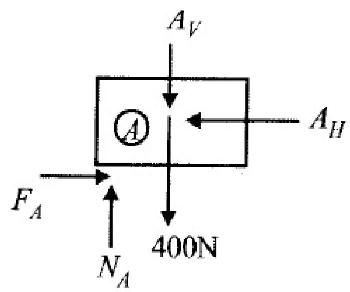


Applying equilibrium sequations,

$Av + Bv = 200\ N$ ...(i)

$A_H = B_H$ ...(ii)

From FBD of block *B*,



$B_H + F_B \cos 60° - N_B \sin 60° = 0$

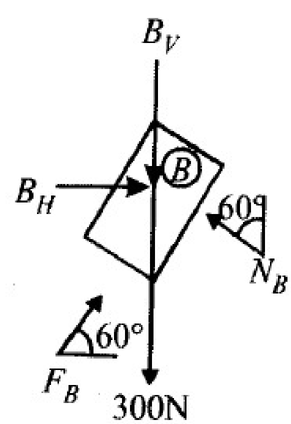
$N_B \cos 60° - B_V - 300 + F_B \sin 60° = 0$

$F_B = 0.25\ N_B$

$B_H - 0.74\ N_B = 0$ ...(iii)

$-B_V + 0.71\ N_B = 300$ ...(iv)

FBD of block *A*



$F_A - A_H = 0$

$N_A - A_V = 400$ ...(v)

$F_A = \mu_A N_A$

$\therefore \mu_A N_A - A_H = 0$ ...(vi)

On solving above equations, we get

$N_A = 650\ N,\ F_A = 260N,\ F_A = \mu_A N_A$

$\therefore \mu_A = \frac{260}{250} = 0.4$

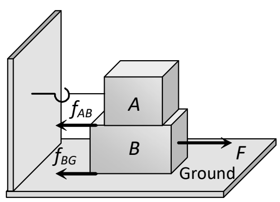
Q.22 (3)

$F_l = \mu_s R = 0.4 \times mg = 0.4 \times 10 = 4N$ i.e. minimum 4N force is required to start the motion of a body. But applied force is only 3N. So the block will not move.

Q.23 (2)

$$F = \frac{W}{\mu} = \frac{1 \times 9.8}{0.2} = 49\,N.$$

Q.24 (3)



$F = f_{AB} + F_{BG}$

$= \mu_{AB} m_A g + \mu_{BG}(m_A + m_B)g$

$= 0.2 \times 100 \times 10 + 0.3\,(300) \times 10$

$= 200 + 900 = 1100\,N$

Q.25 (1)

$$\mu_s = \frac{m_B}{m_A} \Rightarrow 0.2 = \frac{m_B}{10} \Rightarrow m_B = 2\,kg.$$

Q.26 (1)

Retarding force $F = ma = \mu R = \mu\ mg \therefore \alpha = \mu g$

Now from equation of motion $v^2 = u^2 - 2\alpha s$

$$\Rightarrow 0 = u^2 - 2as \Rightarrow s = \frac{u^2}{2a} = \frac{u^2}{2\mu g}.$$

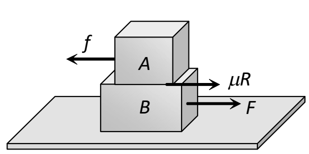
Q.27 (1)

There is no friction between the body B and surface of the table. If the body B is pulled with force F then

$F = (m_A + m_B)\,a$

Due to this force upper body A will feel the pseudo force in a backward direction.

$F = m_A \times a$



But due to friction between A and B, body will not move. The body A will start moving when pseudo force is more than friction force.

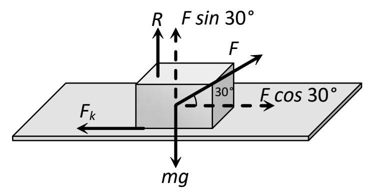
i.e. for slipping, $m_A a = m_A g \therefore a = \mu g$

Q.28 (2)

From the relation $F - \mu mg = ma$

$$\alpha = \frac{F - \mu mg}{m} = \frac{129.4 - 0.3 \times 10 \times 9.8}{10} = 10\,m/s^2. ...$$

Q.29 (1)



Kinetic friction $= \mu_k R = 0.2\,(mg - F\sin 30^o)$

$$= 0.2\left(5 \times 10 - 40 \times \frac{1}{2}\right) = 0.2(50 - 20) = 6N$$

Acceleration of the block

$$= \frac{F\cos 30^o - \text{Kinetic friction}}{\text{Mass}}$$

$$= \frac{40 \times \frac{\sqrt{3}}{2} - 6}{5} = 5.73\,m/s^2.$$

Q.30 (1)

Limiting friction between block and slab $= \mu_s m_A g$

$= 0.6 \times 10 \times 9.8 = 58.8\,N$

But applied force on block A is 100 N. So the block will slip over a slab.

Now kinetic friction works between block and slab FK $= \mu_k m_A g = 0.4 \times 10 \times 9.8 = 39.2\,N$

This kinetic friction helps to move the slab

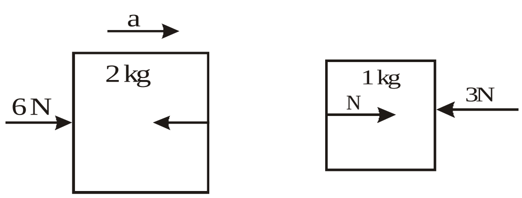
$$\therefore \text{ Acceleration of slab} = \frac{39.2}{m_B} = \frac{39.2}{40} = 0.98\,m/s^2.$$

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (4)
Experimental fact.

Q.2 (2)
Action and Reaction are equal and opposite

Q.3 (3)



Both blocks are constrained to move with same acceleration.

6 – N = 2a [Newtons II law for 2 kg block]

N – 3 = 1a [Newtons II law for 1 kg block]

⇒ N = 4 Newton

Q.4 (1)

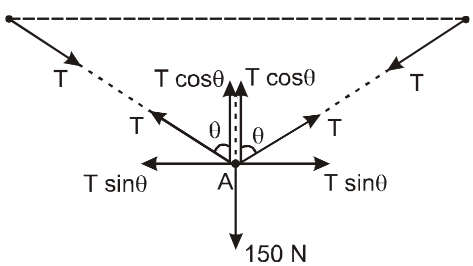
$\vec{F} = m\vec{a}$

Q.5 (3)

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

Q.6 (2)
In free fall gravitation force acts.

Q.7 (4)



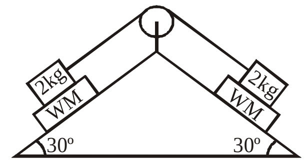
$T\cos\theta + T\cos\theta - 150 = 0$ [Equilibrium of point A]

$2T\cos\theta = 150$ $\qquad T = \dfrac{75}{\cos\theta}$

When string become straight θ becomes 90°

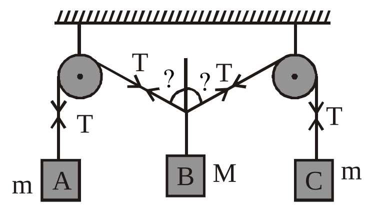
$\Rightarrow T = \infty$

Q.8 (1)
Weighing Machine
always Measure
Normal froce



$N = 20\cos 30° = 10\sqrt{3}$

Q.9 (2)



T = mg ...(i)

2T cos θ = Mg ...(ii)

From equation (i) and (ii)

⇒ 2mg cos θ = Mg

θ always > 0 so M < 2 m

Q.10 (1)
Relative acceleration Man and car is zero during the journey
N = 0

Q.11 (1)

At t = 2 sec ⇒ $a = \dfrac{10}{2} = 5\ m/s^2$

So, $F = ma = \dfrac{50}{1000} \times 5 = 0.25\ N$

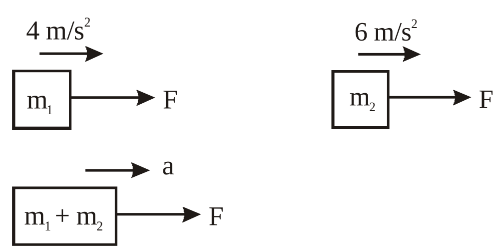
At t = 4 sec

a = 0 So F = 0

⇒ At t = 6 sec,

⇒ $a = -5\ m/s^2$ ⇒ $F = -0.25\ N$

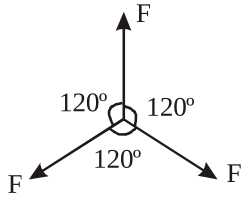
Q.12 (3)



$F = m_1 4$ [Newton's II law for m_1]
$F = m_2 6$ [Newton's II law for m_2]
$F = (m_1 + m_2)a$ [Newton's II law for $(m_1 + m_2)$]

$\Rightarrow \quad F = \left[\frac{F}{4}+\frac{F}{6}\right]a \Rightarrow 1 = \left[\frac{1}{4}+\frac{1}{6}\right]a \Rightarrow a = 2.4\ m/s^2.$

Q.13 (4)



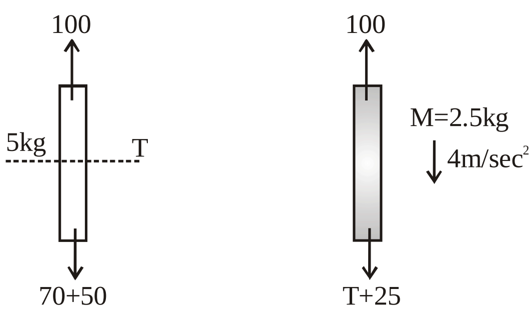
Due to symmetry we can say net force on body M is O.
$\therefore$ acceleration is O.

Q.14 (3)

$mg - \frac{3}{4}mg = ma$ [Newton's II law for man]

$\Rightarrow \quad a = \frac{g}{4}$

Q.15 (2)



$120 - 100 = 5a$ ....(i)

$a = \frac{20}{5} \Rightarrow a = 4 m/s^2$

$T + 25 - 100 = 2.5 \times 4$ ....(ii)
$T = 85\ N$

Q.16 (4)

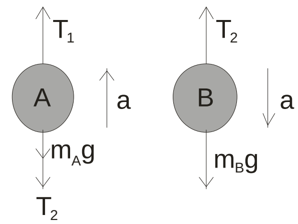
$$\upsilon^2 = \upsilon_0^2 + 2as = 1^2 + 2\frac{F}{m}x$$

$$x = \frac{-m}{2F}\ \upsilon^2 = \upsilon_0^2 + 2as$$

$$O^2 = 3^2 + \frac{2F^1}{m} \times \quad 0 = 9 + \frac{2F^1}{m}\left(\frac{-m}{2F}\right)$$

$\Rightarrow F^1 = 9F$

Q.17 (1)



$T_1 - T_2 - m_A g = m_A a$

$T_2 - m_B g = m_B a$

$T_1 - (m_A + m_B)g = (m_A + m_B)$

$T_2 = m_B(a + g)$

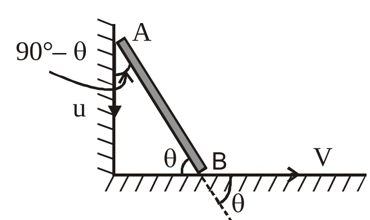
$\frac{T_1}{T_2} = \frac{m_A + m_B}{m_B}$

Q.18 (1)
$\theta = \downarrow \Rightarrow \sin\theta \downarrow$
$mg \sin\theta \downarrow$

Q.19 (1)
$-v_A - v_A - v_A + v_B = 0$
From constrained
$-5 - 5 - 5 + v_B = 0$
$v_B = 15\ m/s \downarrow$

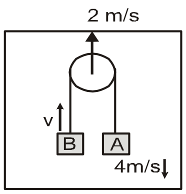
Q.20 (1)
From constrained
$+2 - v_B - v_B + 1 = 0$
$v_B = 3/2\ m/s \uparrow$

Q.21 (3)



From constrained Motion - (along the rod vel of each particle is same so component of the velocity in the direction of rod is)
$v \cos\theta = u \sin\theta$
$v = u \tan\theta$

Q.22 (4)



V = (velcoity of B w.r.t ground)

$\frac{V-4}{2} = 2V = 8$ m/s (velcoity of B w.r.t ground)

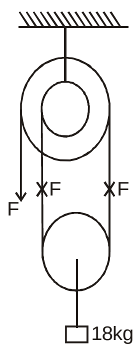
V' = 6 m/s (velcoity of B w.r.t lift)

Q.23 (2)

18kg at rest => 180 = 2F

F = 90N

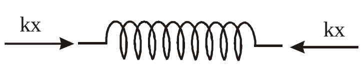
Q.24 (3)



(a) T = mg + ma (2) T = mg – ma

T = mg

Q.25 (4)



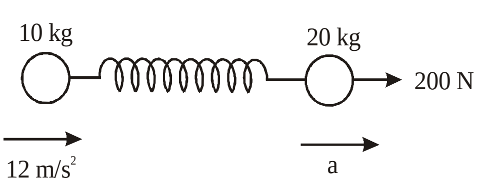
$F - kx = m_1 a_1$ [Newton's II law for M_1]

$kx = m_2a_2$ [Newton's II law for M_2]

By adding both equations.

$F = m_1a_1 + m_2a_2 \Rightarrow a_2 = \frac{F - m_1 a_1}{m_2}$

Q.26 (2)



$F = m_1a_1 + m_2a_2$ [Newton's law for system]

$200 = 10 \times 12 + 20 \times a$

$a = 4$ m/s^2.

Q.27 (2)

$T = \frac{2m_1m_2g}{(m_1 + m_2)} \Rightarrow T = \frac{2 \times 5 \times 1 \times 10}{6} = \frac{50}{3}$

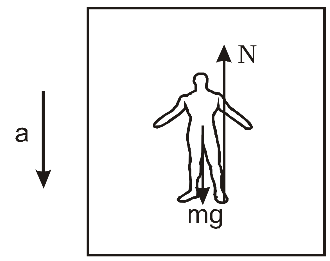
$2T = \frac{100}{3} \approx 33.3$kg

The spring balance reads

2T = 33.33kgwt < 60kgwt

Q.28 (4)

Weight of man in stationary lift is mg.



mg – N = ma [Newton's II law for man]

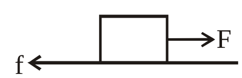
$\Rightarrow$ N = m (g – a)

Weight of man in moving lift is equal to N.

$\Rightarrow \frac{mg}{m(g-a)} = \frac{3}{2} \Rightarrow a = \frac{g}{3}$

Q.29 (1)

$F < f_{smax}$



friction=F

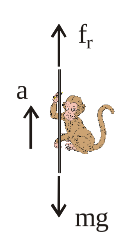
For $F > f_{max}$

friction constant

Q.30 (1)

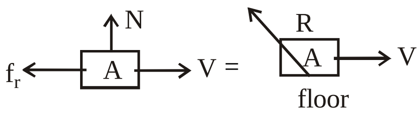
Q.31 (1)

Monkey is moving up due to friction force



$f_r - mg = ma$
$f_r = m(a+g)$
towards up.

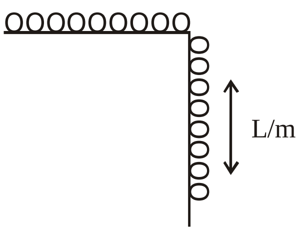
Q.32 (3)
Floor will provide the normal force and friction force the net reaction is provide by the floor is R.



Q.33 (4)
$m_A g\sin 30 = \mu m_A\, g\cos 30$
$m_B\, g\sin 40 = \mu m_B g\cos 40$
Does not depend on mass so all three are possible.

Q.34 (2)

$$\mu\lambda L\left(1-\frac{1}{n}\right)g = \lambda\frac{L}{n}g$$



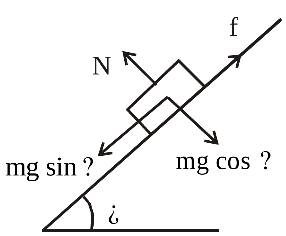
$$\mu = \frac{1}{n-1}$$

Q.35 (2)
$f_{max} = \mu\, mg\cos\theta$

$$f_{s_{max}} = 0.7\times 2\times 9.8\times\frac{\sqrt{3}}{2} = 7\sqrt{3}$$

$mg\sin\theta = 9.8$
As $mg\sin\theta < f_{smax}$ so friction requird is $mg\sin\theta$.

Q.36 (1)
$N = mg\cos\theta$
$f_s \le \mu N$
$mg\sin\theta \le \mu\, m\, g\cos\theta$



$\mu \ge 1$

Q.37 (1)
Friction not depend on surface Area so angle remain same.
$\therefore$ Angle = 30°

Q.38 (3)
$v = u + at \Rightarrow a_A = -\mu g$
$a_B = -\mu g \Rightarrow a = \text{same} \Rightarrow u = \text{same}$
Time taken to stop is also same
Does not depend on mass.

Q.39 (1)
move with a constant velocity
So $ma = m\mu g$ (in negative direction)
$a = \mu g$
$\Rightarrow v^2 - u^2 = 2as \quad v_f^2 = v_i^2 + 2as$
$v = \sqrt{2\mu gs}$ here $v_f = 0$, $v_i = v$

Q.40 (1)

$$V^2 = 2\times g\sin\theta\times l$$

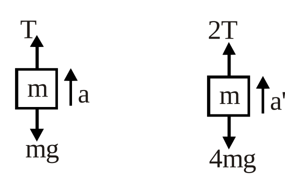
$$\frac{v^2}{n^2} = 2\times(g\sin\theta - \mu g\cos\theta)$$

$$\sin\theta\left(1-\frac{1}{n^2}\right) = \mu\cos\theta$$

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

EXERCISE-IV

Q.1 [0005]
$T - mg = ma$ .... (i)



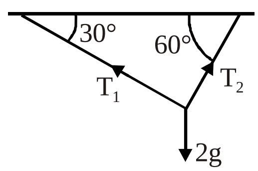
$4mg - 2T = 4ma' \Rightarrow 2mg - T = 2ma'$ ..... (ii)
constraint relation : $Ta - 2Ta' \Rightarrow a' = a/2$
$\therefore$ from equation (ii) we get
$2mg - T = 2m\,(a/2)$ .... (iii)

solving (i) and (ii), we get

$a = \frac{g}{2} = 5\ m/s^2$

Q.2 [0010]

$T_1 \sin 30° + T_2 \sin 60° = 20$



$T_1 \cos 30° = T_2 \cos 60°$

$T_2 = T_1\sqrt{3} \quad \Rightarrow \quad \frac{4T_1}{2} = 20$

$T_1 = 10\ N$

Q.3 [0050]

$100 = k \times (40 - \ell_0)$

$200 = k \times (60 - \ell_0)$

$2 = \frac{60 - \ell_0}{40 - \ell_0}$

$80 - 2\ell_0 = 60 - \ell_0$

$20 = \ell_0 \quad \Rightarrow \quad 20k = 100$

$\Rightarrow \quad k = 5$

$x = k \times (30 - 20) = 50\ N$

Q.4 [0360]

$a = \frac{90-50}{5} = 8$, after 2 sec

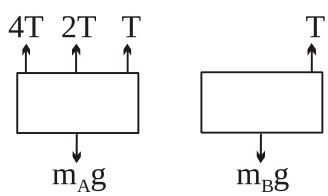
S = 16m, V = 16 m/s

3 kg part hits the ground t = 4 sec.

remaining 2 kg has a = 35

$S_{rel} = 360$]

Q.5 [0070]



$7T = m_Ag \qquad T = m_Bg$

$\therefore\ m_A = 7m_B = 70$

Q.6 [0270]

$F = 2 \times 75 \cos 37° + 150$

$= 150 \times \frac{4}{5} + 150 = 270$

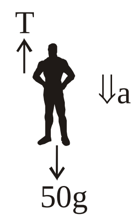
Q.7 [0880]

m = 16, M = 80, x = 6, L = 12

$T = \left(\frac{mx}{L} + M\right)g$

$\Rightarrow \left[\frac{16 \times 6}{12} + 80\right] \times 10 = 880\ N$]

Q.8 [4]



$50g - T = 50a$

$a = 10 - \frac{300}{50} = 4\ m/s^2$

Q.9 [0002]

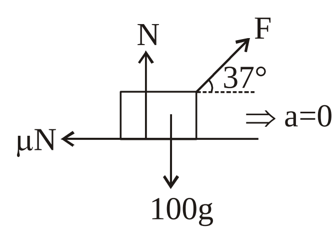
$a_{max} = \mu g = 0.2 \times 10 = 2 m/sec^2$

v = u + at

0 = 4 – 2t

t = 2sec

Q.10 [0200]



$F \cos 37° = \mu N$

$F \sin 37° + N = 100\ g$

$F = \frac{\mu mg}{\cos\theta + \mu \sin\theta} = 200\ N$

Q.11 (4)
Q.12 (3)
Q.13 (2)
Q.14 (1)
Q.15 (4)
Q.16 (1)

PREVIOUS YEAR'S

MHT CET

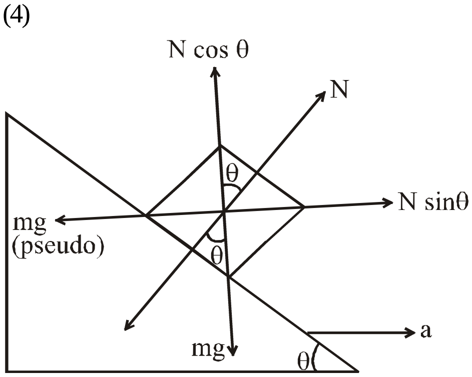
Q.1 (2)
Q.2 (1)
Q.3 (2)
Q.4 (3)
Q.5 (1)
Q.6 (2)
Q.7 (4)
Q.8 (2)
Q.9 (4)
Q.10 (2)
Q.11 (2)
Q.12 (4)
Q.13 (1)
Q.14 (4)
Q.15 (2)
Q.16 (1)
Q.17 (3)
Q.18 (2)
Q.19 (1)
Q.20 (1)
Q.21 (2)
Q.22 (3)
Q.23 (4)
Q.24 (2)

NEET/AIPMT

Q.1 (4)
Coefficient of sliding friction has no dimension
$f = \mu_s N$

$$\Rightarrow \mu_s = \frac{f}{N}$$

Q.2 (4)

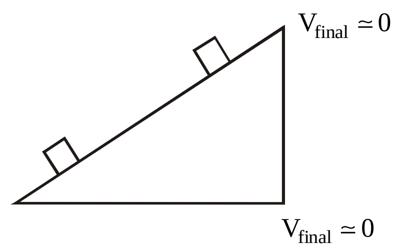


In non-inertial frame,
$N \sin\theta = ma$ ....(i)
$N \cos\theta = mg$ ....(ii)

$$\tan\theta = \frac{a}{g}$$

$a = g \tan\theta$

Q.3 (3)



$$V^{2}_{final} = u^2 - 2(g\sin\theta)x$$

$$x_1 = \frac{u^2}{2g\sin\theta_1}$$

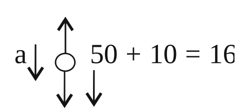
$$x_2 = \frac{u^2}{2g\sin\theta_2}$$

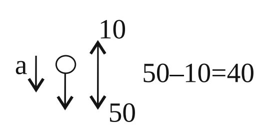
$$\frac{x_1}{x_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{\sin 30}{\sin 60} = \frac{1}{\sqrt{3}}$$

Q.4 (2)
Q.5 (1)

JEE MAIN

Q.1 (2)
m = 5 kg; retarding force = 10 N
For time of ascent (t_a); for time of decent (t_d):





$$a = \frac{60}{5} = 12\,m/s^2 \qquad a = \frac{40}{5} = 8\,m/s^2$$

$$t_a = \frac{u^2}{2a} = \frac{u^2}{12} \text{ .....(i)} \qquad h = \frac{1}{2}\alpha t_d^2$$

$$\therefore h = \frac{u^2}{2a} = \frac{u^2}{2\times 12} = \frac{u^2}{24} \qquad \frac{u^2}{24} = \frac{1}{2}\times 8\times t_d^2$$

$$\Rightarrow t_d^2 = \frac{u^2}{24\times 4} \Rightarrow td = \frac{u}{\sqrt{12\times 8}}$$

$$\frac{t_a}{t_d} = \frac{\frac{u}{12}}{\frac{u}{\sqrt{12\times8}}} = \frac{\sqrt{12\times8}}{12} = \sqrt{\frac{8}{12}} = \sqrt{\frac{2}{3}} = \sqrt{2}:\sqrt{3}$$

Q.2 **[2]**

$\vec{F} = 10\hat{i} + 5\hat{j}$

$m = 100\,g = 0.1\,kg$

$\vec{a} = \frac{\vec{F}}{m} = 100\hat{i} + 50\hat{j}$

Force is constant so acceleration is also constant

$\Delta\vec{r} = \vec{u}t + \frac{1}{2}\vec{a}t^2$ (as $\vec{u} = 0$)

$\Delta\vec{r} = \frac{1}{2}\vec{a}t^2$

$= \frac{1}{2}(100\hat{i} + 50\hat{j})2^2$

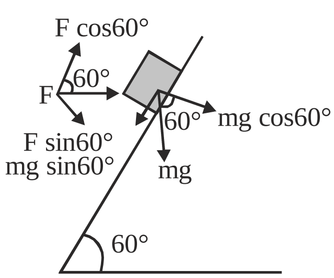
$= 200\,\hat{i} + 100\,\hat{j}$

$= a\,\hat{i} + b\,\hat{j}$

$a = 200, b = 100$

$\therefore \frac{a}{b} = 2$

Q.3 (12)



$F\cos60° = mg\sin60°$

$F\cdot\frac{1}{2} = 0.2\times10\frac{\sqrt{3}}{2}$

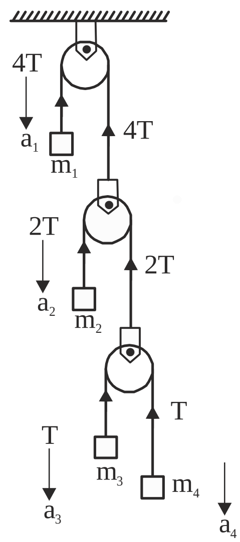
$F = 2\sqrt{3}$

$\sqrt{x} = 2\sqrt{3}$

$\boxed{x = 4\times3 = 12}$

Q.4 (2)

Q.5 (1)



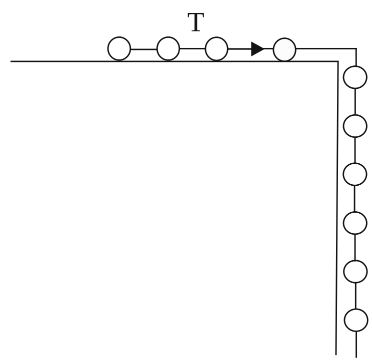
Using constraint

$\sum\vec{T}\,\vec{\alpha} = 0$

$-4Ta_1 - 2Ta_2 - Ta_3 - Ta_4 = 0$

$4a_1 + 2a_2 + a_3 + a_4 = 0$

Q.6 **[36]**



$a = \frac{6mg}{10m} = \frac{6g}{10} = \frac{3g}{5}$

$\circ\!-\!\circ\!-\!\circ \rightarrow T$

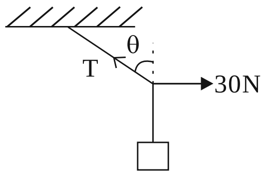
taking 8, 9, 10 together

$T = 3\,ma$

$= 3m\times\frac{3g}{5}$

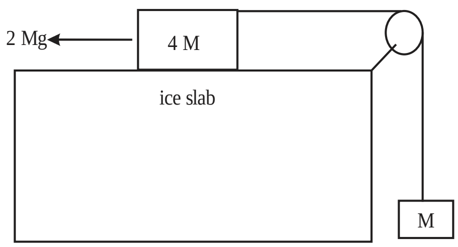
$= 36\,N$

Q.7 (3)

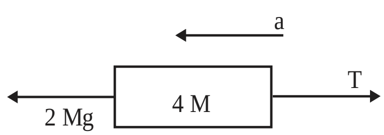


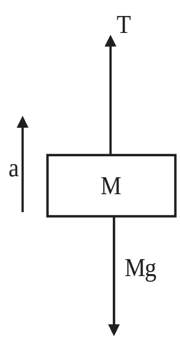
T sin θ = 30
T cos θ = 100
tan θ = 0.3

Q.8 (6)



FBD





2Mg – T = 4 Ma --------- (1)
T – Mg = Ma ------- (2)
Adding Both Eqn
2 Mg – Mg = 5 Ma a = g/5
From Eq^n (2)

$$T = Mg + \frac{Mg}{5} = \frac{6Mg}{5}$$

So X = 6

Q.9 (3)

$$a = \frac{-kx}{2} = \frac{-12x}{2} = -6x$$

$$\frac{vdv}{dx} = -6x$$

$$\int_4^v vdv = -\int_{1/2}^{3/2} 6xdx$$

$$\frac{v^3 - 4^2}{2} = -\frac{6}{2}\left[\left(\frac{3}{2}\right)^2 - \left(\frac{1}{2}\right)^2\right]$$

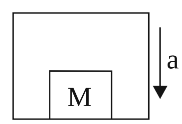
$$v^2 - 16 = -6\left(\frac{9}{4} - \frac{1}{4}\right)$$

$$v^2 = 16 - (6 \times 2) = 4$$

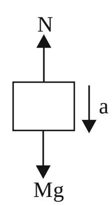
$$v = 2m/s$$

Q.10 (3)

The weight of block of Mg.



The force exerted by block on floor is equal to the normal reaction.



$$\Rightarrow N = \frac{mg}{4} \text{(given)}$$

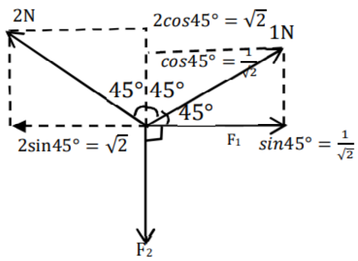
Using Newton's second law from ground frame.
Mg – N = Ma

$$\Rightarrow Mg - \frac{Mg}{4} = Ma$$

$$\Rightarrow \frac{3Mg}{4} = Ma$$

$$\Rightarrow a = \frac{3g}{4}$$

Q.11 (3)



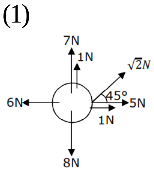
For equilibrium $\sum \vec{F} = \vec{0}$

$$F_1 + \frac{1}{\sqrt{2}} = \sqrt{2} \Rightarrow F_1 = \frac{1}{\sqrt{2}}$$

$$F_2 = \sqrt{2} + \frac{1}{\sqrt{2}} \Rightarrow F_2 = \frac{3}{\sqrt{2}}$$

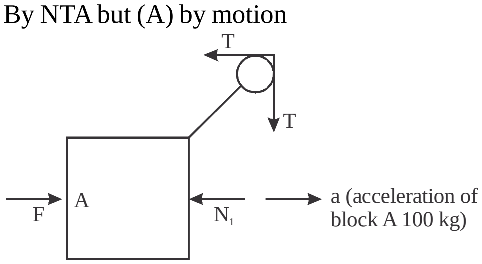
$$\frac{F_1}{F_2} = \frac{1}{3} \Rightarrow x = 3$$

Q.12 (1)



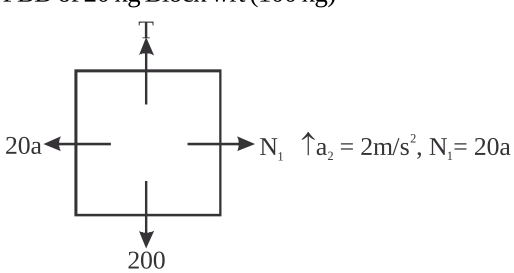
Q.13 **(1)**

By NTA but (A) by motion



$F - T - N_1 = 100\,a$ ...(1)

FBD of 20 kg Block wrt (100 kg)

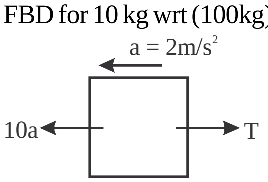


...(2)

$T–200 = 20 \times 2$

$T = 240$ N

FBD for 10 kg wrt (100kg)



$10a - 240 = 10 \times 2$

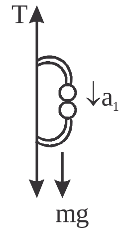
$a = 26$ m/s^2

$F - 240 - 20 \times 26 = 100 \times 26$

* $F = 3360$ N

Q.14 (3)

FBD of monkey while moving downward

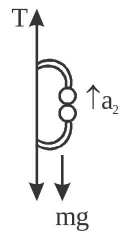


$mg - T = ma_1$

$500 - T = 50 \times 4$

$T = 300$ N

FBD of monkey while moving upward



$T - mg = ma_2$

$T - 500 = 50 \times 5$

$T = 750$ N

But breaking strength of string = 350 N.

So, string will break while monkey moving upward.

Q.15 (2)

Using Newton's law on both blocks:-

$m_1g - T = m_1a$ .....(1)

$T - m_2g = m_2a$ ....(2)

adding equation (i) and (ii), we get

$$\Rightarrow (m_1 - m_2)g = (m_1 + m_2)a$$

$$\Rightarrow a = \frac{(m_1 - m_2)}{(m_1 + m_2)}g$$

Now, for case (1): $m_1 = 2m_2$

$$\therefore a_1 = \frac{(2m_2 - m_2)}{(2m_2 + m_2)}g = \frac{1}{3}g$$

And for case (2) : $m_1 = 3m_2$

$$\therefore a_2 = \frac{(3m_2 - m_2)}{(3m_2 + m_2)}g = \frac{1}{2}g$$

Now, according to question ratio of these two acceleration is $\frac{a_1}{a_2} = \frac{g}{3} \times \frac{2}{g} = \frac{2}{3}$

Q.16 (1)

Force per unit area must remain same.

$$\Rightarrow \frac{10}{2.5\times10^{-4}} = \frac{25}{A}$$

$$\Rightarrow A = \frac{25\times2.5\times10^{-4}}{10} = 6.25\times10^{-4}$$

Q.17 (2)

$\frac{dm}{dt} = 0.5$ kg/sec Velocity = 5 m/s

Power = F.V. ... (1)

Now,

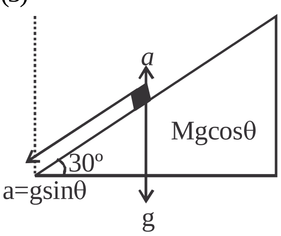
$F = \frac{dp}{dt}$ (Here V → Cont. and mass → Variable)

So, $F = V\frac{dm}{dt}$

From (1) $P = \frac{Vdm}{dt}\cdot V = V^2\frac{dm}{dt}$

$P = (5)^2 \cdot (0.5) = 25 \times 0.5 = 12.5$ Watt

Q.18 (3)



In case 30°

$$t = \sqrt{\frac{2l}{g\sin30^\circ}}$$

Solving l = 45°

In case of θ = 45°

$$t_2 = \sqrt{\frac{2l}{g\sin45^\circ}}$$

$$t_2 = \sqrt{\frac{2\times10}{10\times\frac{1}{\sqrt{2}}}}$$

$$t_2 = \sqrt{2\sqrt{2}} \Rightarrow 1.414\sqrt{1.414}$$

$\Rightarrow 1.4\times1.2$

t = 1.68 sec

Q.19 (2)

Impulse = change in momentum

$I = \Delta P$

$$F_{avg} = \frac{\Delta P}{\Delta t}$$

$\Delta t_1 = 3$ $\Delta t_2 = 5$

$\Delta P_1 = \Delta P_2$

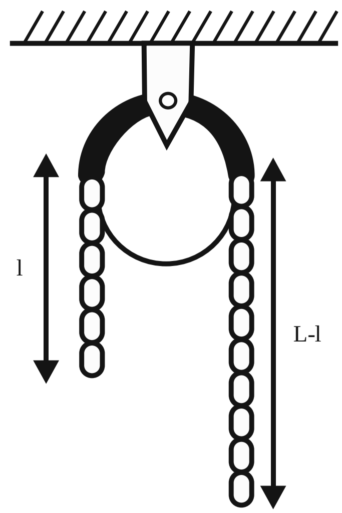
$I_1 = I_2$

F_{avg} in case (i) is more than (ii)

Q.20 (B)

$$F = \frac{dm}{dt}v = \frac{10g}{5s}(4.5\,cm/s) = (9\ gcm/s^2) = 9\ dyne$$

.**Q.21** (4)



Given if $\ell = \frac{L}{x}$, then $a = \frac{g}{2}$

Mass of l part

$$m_1 = \frac{M}{L}\cdot l$$

Mass of L– l part

$$m_2 = \frac{M}{L}(L–1)$$

Apply NLM

$$m_2g - m_1g = (m_1+m_2)\frac{g}{2}$$

$$\left[\frac{M}{L}(L-1) - \frac{M}{L}\ell\right]g = \frac{mg}{2}$$

$$\frac{L-l}{L} - \frac{1}{L} = \frac{1}{2}$$

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

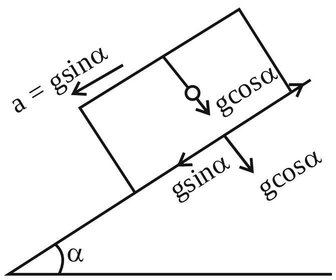
$$L - 2l = \frac{L}{2} \Rightarrow 2l = \frac{L}{2}$$

$$l = \frac{L}{4}$$

given heat $l = \frac{L}{x}$

So, $x = 4$

Q.22 (1)



$g_{cff} = g\cos\alpha$

$$T = 2\pi\sqrt{\frac{L}{g\cos\alpha}}$$

Q.23 (2)

For equilibrium $m_2 g = m_1 g \sin\theta$

$$\sin\theta = \frac{m_2}{m_1} = \frac{3}{5}$$

$$\cos\theta = \frac{4}{5}$$

Normal force on $m_1 = 5g\cos\theta$

$$= 5\times 10\times\frac{4}{5} = 40N$$

Q.24 (2)

In upward motion

$$\frac{1}{2} g\sin 45^o t^2 = 10\sqrt{2}$$

$$\frac{1}{2}\times\frac{10}{\sqrt{2}} t_1^2 = 10\sqrt{2}$$

$t_1 = 2$

In downward motion

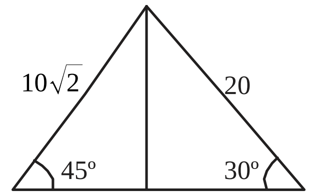
$$\frac{1}{2} g\sin 30^o t^2 = 20$$

$$\frac{1}{2}\times\frac{10}{2} t_2^2 = 20$$

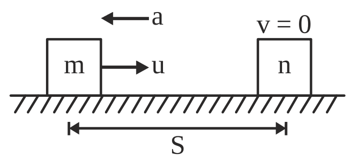
$$t_2 = 2\sqrt{2}$$

Total time $= 2\left(1+\sqrt{2}\right)$

$t = 2$



Q.25 (2)



$a = -\mu g = -0.5\times 9.8$

$u = 9.8$ m/s, $v = 0$

$v^2 = u^2 + 2as$

$$S = \frac{u^2}{2a} = \frac{9.8\times 9.8}{2\times 0.5\times 9.8}$$

$= 9.8$ m

Q.26 **(2)**

Mass per unit length $= \lambda$

$N = m_1 g = \lambda(L-x)g$

$fs_{max} = \mu_s N$

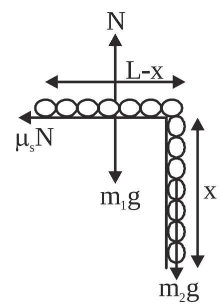
$fs_{max} = (0.5)(\lambda)(L-x)g$

And also $fs_{max} = m_2 g$

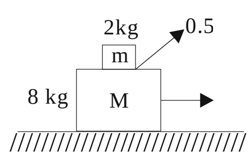
$0.5\lambda(L-x)g = \lambda xg$

$$\frac{L-x}{2} = x$$

$$L = 3x \Rightarrow x = \frac{L}{3} = \frac{6}{3} = 2m$$

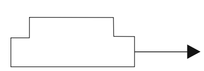


Q.27 (3)



$(a_A)_{max} = 0.5\,g = 4.9$ m/s^2

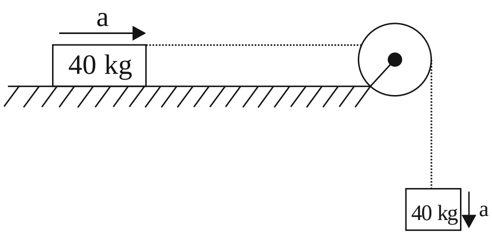
For moving together



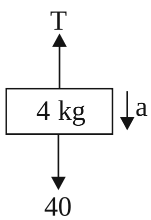
$F_{max} = m_T a_A$

$= 49$ N

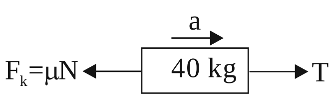
Q.28 (4)



Let the acceleration of both blocks is a.



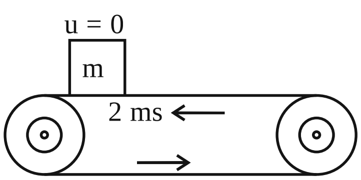
For 4 kg block applying second law :
$40 - T = 4a$



$F_k = 0.02 \times 40 \times 10 = 8N$
For 40 kg block applying Newton's Second law
$T - 8 = 40\,a$
Solving above equations

$$a = \frac{8}{11} ms^{-2}$$

Q.29 (2)



$\mu = 0.4$
Velocity of conveyor belt = 2 m/s
Initially when bag is dropped on conveyer belt is starts slipping so kinetic friction acts on its due to which it finally stop after some time.
Motion w.r.t. belt $\rightarrow$
$u_{rel} = 0 - (-2) = 2$ m/s

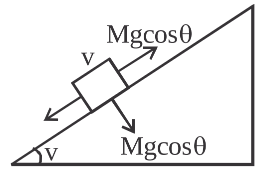
$$a_{rel} = \frac{\mu mg}{m} = \mu g = 0.4 \times 10 = 4\ m/s^2$$

$$V_{rel}^2 = u_{rel}^2 + 2a_{rel} \cdot S_{rel}$$

$0 = (2)^2 - 2(4)\,(S_{rel})$

$$S_{rel} = \frac{4}{8} = \frac{1}{2} = 0.5\,m$$

Q.30 (1)



Block sliding with constent v
So friction
$F = mg\sin\theta$ upward is a contact force and another contact force is $mg\cos\theta$, both the are $\perp$ hence Net contact force $= \sqrt{(mg\sin\theta)^2 + (mg\cos\theta)^2} = mg$

Work, Power and Energy

EXERCISE-I (MHT CET LEVEL)

Q.1 (2)

Q.2 (2)

In the string elastic gorce is conservative in nature.

$\therefore W = -\Delta U$

work done by elastic force of string,

$$W = \frac{1}{2}kx^2 - \frac{k}{2}(x+y)^2$$

$$= \frac{1}{2}kx^2 - \frac{1}{2}k\left(x^2 + y^2 + 2xy\right)$$

$$= \frac{1}{2}kx^2 - \frac{1}{2}ky^2 - \frac{1}{2}kx^2 - \frac{1}{2}k^2\left(2xy\right)$$

$$= -kxy - \frac{1}{2}ky^2$$

Therefore, the work done against elastic force

$$W_{extemal} = -W = \frac{ky}{2}\left(2x+y\right)$$

Q.3 (2)

Work done = Force × displacement

= Weight of the book × Height of the book shelf

Q.4 (4)

$$W = \vec{F}.\vec{s} = (5\hat{i} + 6\hat{j} - 4\hat{k}).(6\hat{i} + 5\hat{k}) = 30 - 20 = 10\,\text{units}$$

Q.5 (4)

$$W = \vec{F}.\vec{s} = (5\hat{i} + 6\hat{j} - 4\hat{k}).(6\hat{i} + 5\hat{k}) = 30 - 20 = 10\,\text{units}$$

Q.6 (4)

Here, $m = 3g = 3 \times 10^{-3}$ kg, $x = t^3 - 4t^2 + 3t$

$$\therefore \quad \frac{dx}{dt} = 3t^2 - 8t + 3, \quad \frac{d^2x}{dt^2} = 6t - 8$$

$$W = \int F\,dx = \int m\frac{d^2x}{dt^2}\left(\frac{dx}{dt}\right)dt$$

$$= \int_0^4 (3\times10^{-3})(6t-8)(3t^2 - 8t + 3)\,dt$$

$$= 3\times10^{-3}\int_0^4 (18t^3 - 48t^2 + 18t - 24t^2 + 64t - 24)\,dt$$

$$= 3\times10^{-3}\int_0^4 (18t^3 - 72t^2 + 82t - 24)\,dt$$

$$= 3\times10^{-3}\left[\frac{18}{4}t^4 - \frac{72}{3}t^3 + \frac{82}{2}t^2 - 24t\right]_0^4$$

$$= 3\times10^{-3}\left[\frac{18}{4}(4^4) - 24(4^3) + 41(4^2) - 24\times4\right]$$

$= 528 \times 10^{-3}$ J = 528 mJ

Q.7 (2)

$$W\int_0^{x_1} F.dx = \int_0^{x_1} Cx\,dx = C\left[\frac{x^2}{2}\right]_0^{x_1} = \frac{1}{2}Cx_1^2$$

Q.8 (4)

Q.9 (3)

According to work-energy theorem

W = Change in kinetic energy

$$FS\cos\theta = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Substituting the given values, we get

$20 \times 4 \times \cos\theta = 40 - 0$

$(\because u = 0)$

or $\cos\theta = \frac{40}{80} = \frac{1}{2}$ or $\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60^o$

Q.10 (2)

(Applied force - frictional force) × distance = Gain in kinetic energy.

$\therefore$ (20 – f) × 2 = 10 or 20 – f = 5 or f = 15 N.

Q.11 (3)

Here, $\vec{F} = 3x^2\hat{i} + 4\hat{j}$

$\vec{r} = x\hat{i} + y\hat{j} \quad \therefore d\vec{r} = dx\hat{i} + dy\hat{j}$

Work done, $W = \int \vec{F}.d\vec{r}$

$$= \int_{(2,3)}^{(3,0)} (3x^2\hat{i} + 4\hat{j}).(dx\hat{i} + dy\hat{j}) = \int_{(2,3)}^{(3,0)} 3x^2 + 4dy$$

$$= \int_{(2,3)}^{(3,0)} d(x^3 + 4y) = [x^3 + 4y]_{(2,3)}^{(3,0)}$$

$= 3^3 + 4 - (2^3 + 4 \times 3) = 27 + 0 - (8 + 12) = 27 - 20 = 7$ J

According to work energy theorem,

Change in the kinetic energy = Work done, W = + 7J.

Q.12 (3)

Q.13 (1)

Q.14 (1)

$$W = \vec{F}\cdot\vec{s} = \left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)\cdot\left(3\hat{i} + 4\hat{j} + 5\hat{k}\right)$$

$= 2 \times 3 + 3 \times 4 + 4 \times 5 = 38$J

$$P = \frac{W}{t} = \frac{38}{4} = 9.5W.$$

Q.15 (2)

P = Fv = 4500 × 2 = 9000 W = 9 kW

Q.16 (4)

$$P = \frac{\text{Workdone}}{\text{Time}} = \frac{mgh}{t} = \frac{300 \times 9.8 \times 2}{3} = 1960\,W$$

Q.17 (1)

$$p = \frac{mgh}{t} = \frac{200 \times 10 \times 200}{10} = 40kW$$

Q.18 (1)

Q.19 (2)

Q.20 (4)

W = change in PE of COM of hanging part

$$= \frac{M}{n} g \frac{L}{2n} = \frac{MgL}{2n^2}$$

Q.21 (4)

$$V = \frac{1}{2}k(x)^2 = \frac{1}{2}k(2)^2 \text{ or } k = \frac{2V}{4} = \frac{V}{2}$$

$$V = \frac{1}{2}k(10)^2 = \frac{1}{2} \times \left(\frac{V}{2}\right)(10)^2 = 25V$$

Q.22 (4)

In compression or extension of a spring work is done against restoring force.

In moving a body against gravity work is done against gravitational force of attraction.

It means in all three cases potential energy of the system increases.

But when the bubble rises in the direction of upthrust force then system works so the potential energy of the system decreases.

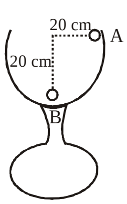
Q.23 (2)

According to the conservation of energy, kinetic energy at A + potential energy at B

$$\Rightarrow 0 + mgh = \frac{1}{2}mv^2 + 0$$

or $v^2 = 2gh = 2 \times 9.8 \times 0.20$

($\because$ h = radius = 20 cm = 0.2m)



According to work - energy theorem,

Work done on the ball = change in kinetic energy

$$= \frac{1}{2}mv^2 - (0)^2 \quad = \frac{1}{2} \times \frac{2}{1000} \times 2 \times 9.8 \times 0.2$$

$= 3.92 \times 10^{-3}$ J = 3.92 mJ

EXERCISE-II (NEET LEVEL)

Q.1 (3)

W = (force) (displacement) = (force) (zero) = 0

Q.2 (1)

$$\text{Joule} = (\text{Newton})\ (\text{Metre}) = \frac{4\,\text{Newton}}{4} \times \frac{4\,\text{Metre}}{4} = \frac{\text{Joule}}{16}$$

Hence : 1 Joule = 16 joule (Joule is new unit of energy)

Q.3 (4)

Stopping distance $S \propto u^2$. If the speed is doubled then the stopping distance will be four times.

Q.4 (3)

Q.5 (2)

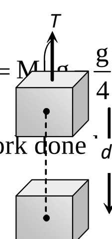
Work done = mgh = 10 × 9.8 × 1 = 98 J

Q.6 (3)

$$W = (3\hat{i} + c\hat{j} + 2\hat{k}).(-4\hat{i} + 2\hat{j} + 3\hat{k}) = 6J$$

Q.7 (3)

When the block moves vertically downward with acceleration $\frac{g}{4}$ then tension in the cord

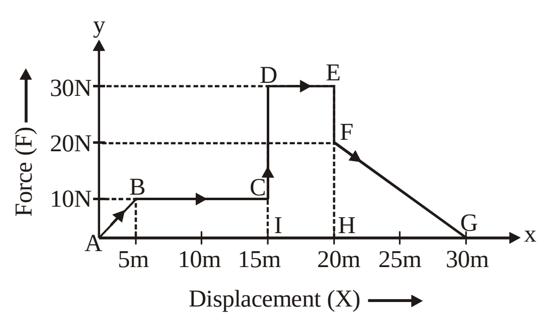


$$T = M\left(g - \frac{g}{4}\right) = \frac{3}{4}Mg$$

Work done by the cord = $\vec{F}.\vec{s}$ = Fs cos θ

$$= Td\cos(180^\circ) = -\left(\frac{3\,Mg}{4}\right) \times d = -3Mg\frac{d}{4}$$

Q.8 (2)



Work done = Area under the force-displacement graph

= Area of trapezium ABCI + Area of rectangle IDEH + Area of triangle FHG

$$= \left[\frac{1}{2}(10+15)10\right] + [5\times 30] + \left[\frac{1}{2}\times 10\times 20\right]$$

= 125 + 150 + 100 = 375 J.

Q.9 (2)

Change in gravitational potential energy
= Elastic potential energy stored in compressed spring

$$\Rightarrow mg(h+x) = \frac{1}{2}kx^2$$

Q.10 (1)

Q.11 (3)

Here, m = 1.0 kg, v_i = 2 m/s

Initial kinetic energy of the block is

$$K_i = \frac{1}{2}mv_i^2 = \frac{1}{2}(1.0\text{ kg})(2\text{ m/s})^2 = 2\text{J}$$

Work done by the retarding force is

$$W = \int_{10\text{m}}^{100\text{m}} F_r\,dx = \int_{10\text{m}}^{100\text{m}} \left(-\frac{k}{x}\right)dx = -k\ln[x]_{10\text{m}}^{100\text{m}}$$

$$= -(0.5\text{J})\ln\left[\frac{100\text{ m}}{10\text{ m}}\right] = -(0.5\text{ J})(2.302) = -1.15\text{ J}$$

According to work-energy theorem

$K_f - K_i = W$

$\therefore$ $K_f = K_i + W = 2\text{J} - 1.15\text{ J} = 0.85\text{ J}$

Q.12 (1)

If two bodies of masses m_1 and m_2 moving with the same velocities are stopped by the same force, then the ratio of their stopping distances is

$$\frac{d_{s_1}}{d_{s_2}} = \frac{m_1}{m_2}$$

Here, m_1 = 1 kg and m_2 = 2kg

$$\therefore \quad \frac{d_{s_1}}{d_{s_2}} = \frac{1\text{kg}}{2\text{kg}} = \frac{1}{2}$$

Q.13 (3)

Q.14 (3)

Here, m = 10 g = 10^{-2} kg,

R = 64 cm = 6.4×10^{-2} m, $K_f = 8\times 10^{-4}$ J

$K_i = 0$, a_t = ?

Using work energy theorem,

Work done by all the forces = Change in KE

$W_{\text{tangential force}} + W_{\text{centripetal force}} = K_f - K_i$

$\Rightarrow$ $F_t \times s + 0 = K_f - 0$

$\Rightarrow ma_t \times (2\times 2\pi R) = K_f$

$$a_t = \frac{K_f}{4\pi Rm} = \frac{8\times 10^{-4}}{4\times\frac{22}{7}\times 6.4\times 10^{-2}\times 10^{-2}}$$

$= 0.099 \approx 0.1\text{ ms}^{-2}$

Q.15 (1)

$$P = \frac{dW}{dt}$$

$$P = \vec{F}.\frac{\vec{ds}}{dt} = \vec{F}.\vec{v}$$

Q.16 (4)

$$P = \vec{F}.\vec{v} = ma\times at = ma^2t\,[\text{as } u = 0]$$

$$= m\left(\frac{v_1}{t_2}\right)^2 t = \frac{mv_1^2t}{t_1^2}$$

[As $a = v_1 / t_1$]

Q.17 (2)

$$\text{Power} = \frac{\text{Work done}}{\text{time}} = \frac{\frac{1}{2}m(v^2-u^2)}{t}$$

$$P = \frac{1}{2}\times\frac{2.05\times 10^6\times\left[(25)^2-(5^2)\right]}{5\times 60}$$

$P = 2.05\times 10^6$ W = 2.05 MW

Q.18 (2)

$$F_x = -\frac{\partial U}{\partial x} = \sin(x+y)$$

$$F_y = -\frac{\partial U}{\partial x} = \sin(x+y)$$

$$\therefore F_y = \frac{1}{\sqrt{2}}\left[\hat{i}+\hat{j}\right]$$

Q.19 (2)

In the stable equilibrium, a body has minimum potential energy.

Q.20 (4)

Condition for vertical looping $h = \frac{5}{2}r = 5\text{cm}$

$\therefore$ r = 2 cm

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3)

$25 = 5 \times 10 \times \cos\theta$ so $\theta = 60^o$

Q.2 (3)

$W = 20 \times 10 \times 20 \times 0.25 = 1000$ J

Q.3 (3)

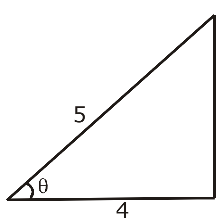
$S_1 = \frac{1}{2} g\, 1^2,\ s_2 = \frac{1}{2} g\, 2^2,\ S_3 = \frac{1}{2} g\, 3^2$

$S_2 - S_1 = \frac{1}{2} g\, 3,\ S_3 - S_2 = \frac{1}{2} g\, 5$

$W_1 = (mg)\, S_1,\ W_2 = (mg)\,(S_2 - S_1),\ W_3 = (mg)\,(S_3 - S_2)$

$W_1 : W_2 : W_3 = 1 : 3 : 5$

Q.4 (2)



$w = mgh,\ \cos\theta = 4/5$

$= 10 \times 9.8 \times 3 = 294$ joule

Q.5 (3)

$F = K_1x_1,\ x_1 = \frac{F}{K_1},\ W_1 = \frac{1}{2} K_1 x_1^2 = \frac{F^2}{2K_1}$

similarly $W_2 = \frac{F^2}{2K_2}$ since $K_1 > K_2,\ W_1 < W_2$

Q.6 (4)

$W_F = \int \left(\frac{K}{S}\right) ds = K \ln s + C$ Ans : (D)

Q.7 (3)

Let $\vec{r} = dx\,\hat{i} + dy\,\hat{j},\ F = 3x\,\hat{i} + 4\,\hat{j}$

$w = \int (3x\hat{i} + 4\hat{j}).(dx\hat{i} + dy\hat{j})$

$= \int_{2m}^{3m} 3x\,dx + \int_{2m}^{0} 4\,dy = \left[\frac{3x^2}{2}\right]_{2m}^{3m} + [4y]_{3m}^{0}$

$= \left[\frac{3\times 9}{2} - \frac{3\times 2^2}{2}\right] + [0 - 12] = -4.5$ J

Q.8 (4)

$2\,K.E_{man} = K.E._{boy}$

$2 \times \frac{1}{2} M \times v_{man}^2 = \frac{1}{2}.\frac{M}{2} v_{boy}^2$

$V_{man} = \frac{v_{boy}}{2}$

...(i)

$\Rightarrow \frac{1}{2} M(v_{man} + 1)^2 = \frac{1}{2}.\frac{M}{2} v_{boy}^2$

$\Rightarrow (v_{man} + 1)^2 = \frac{V_{boy}^2}{2} \Rightarrow v_{man} = (\sqrt{2} + 1)\,m/sec$

Q.9 (2)

$a = \frac{F}{m},\ S = \frac{1}{2}\left(\frac{F}{m}\right)t^2,\ W_F = FS = F\left(\frac{Ft^2}{2m}\right)$

Q.10 (4)

$W = \text{area} = 80 = \frac{1}{2}(0.1)\,u^2 - 0,$

so $u = 40$ m/s

Q.11 (4)

$V = O + aT,\ a = \frac{V}{T}$, velocity $= O + at = \frac{Vt}{T}$

$K.E = \frac{1}{2}(m)\left(\frac{Vt}{T}\right)^2$

Q.12 (4)

$W_G = \frac{1}{2} mV_f^2 - \frac{1}{2} mV_i^2,\ mg\,h = \frac{1}{2} mV_f^2 - \frac{1}{2} mV^2,$

So V_f is free from direction of V.

Q.13 (2)

$-F\,x = 0 - \frac{1}{2} m\,(2)^2$ and $-FS = 0 - 2\left[\frac{1}{2} m\,(2)^2\right]$

So $\frac{S}{x} = 2,\ S = 2x$

Q.14 (1)

$W_G + W_f = 0 - 0$

$10 \times 1 + W_f = 0$

$10 - \mu mg\, x = 0$

$10 = (.2)(10)\, x ,\ x = 5\text{ m}$

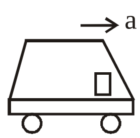
Q.15 (1)

$w = \frac{1}{2} k (x_2{}^2 - x_1{}^2)$

$= \frac{1}{2}\ 10\,(6^2 - 4^2) = 100\text{ N cm}$

= 1 joule

Q.16 (3)



$P = F.V = (R + ma)\,V$

Q.17 (3)

$P = \bar{F}.\bar{v} = 50 - 30 + 120 = 140\text{ J}$

Q.18 (2)

$P_1 = 80\text{ gh}/15 ,\ P_2 = 80\text{ gh}/20$

$\frac{P_1}{P_2} = \frac{20}{15} = \frac{4}{3}$

Q.19 (2)

Q.20 (3)

Potential energy depends upon positions of particles

Q.21 (3)

$\frac{1}{2}\ mu^2 = mgh,\ u^2 = 2gh$ ....(i)

$mg\left(\frac{3h}{4}\right) + K.E. = mgh$

$K.E. = \frac{mgh}{4}$

$\frac{K.E.}{P.E.} = \frac{mgh/4}{3mgh/4} = \frac{1}{3}$

Q.22 (4)

$\frac{1}{2}K(0.3)^2 = 10 \Rightarrow K = \frac{20}{0.09} = \frac{2000}{9}$

work done $= \frac{1}{2}.\frac{2000}{9}[(0.45)^2 - (0.3)^2] = 12.5\text{ J}$

Q.23 (3)

$100 = \frac{1}{2}\ K(2cm)^2 ,\ E = \frac{1}{2}\ K(4cm)^2$

so $\frac{E}{100} = 4$, E = 400 J

$\therefore$ E – 100 = 300 J

Q.24 (4)

$4\text{ J} = \frac{1}{2}\ k\,(2)^2$

.................(1)

$X\text{ J} = \frac{1}{2}\ k\,(10)^2$

.................(2)

from equation (1) & (2)

x = 100 J

Q.25 (3)

For m, $N\cos\theta = mg$

For M , $N\sin\theta = kx$

so $\tan\theta = \frac{Kx}{mg}$

so $\frac{1}{2}\ Kx^2 = \frac{(mg\tan\theta)^2}{2K}$

Q.26 (1)

$mg\,(h + \frac{3mg}{K}) = \frac{1}{2}\ K\left(\frac{3mg}{K}\right)^2$

Q.27 (2)

$\left.\frac{dU}{dx}\right|_{x=A} = -ve,\ \left.\frac{dU}{dx}\right|_{x=B} = +ve$

So, F_A = positive , F_B = negative

Q.28 (1)

Only in (A), U is minimum for some value of r

Q.29 (1)

$\frac{\partial U}{\partial x} = \cos(x+y)$,

$\frac{\partial U}{\partial y} = \cos(x+y)$

$\overline{F} = -\cos(x+y)\,\hat{i} - \cos(x+y)\,\hat{j}$

$= -\cos(0+\frac{\pi}{4})\,\hat{i} - \cos(0+\frac{\pi}{4})\,\hat{j} \Rightarrow |\overline{F}| = 1$

Q.30 (1)
Area under force vs displacement gives work and area above x-axis taken as positive while area below x-axis taken as negative.
$W_{net} = 10 \times 1 + 20 \times 1 - 20 \times 1 + 10 \times 1 = 20$ erg.

Q.31 (1)

$mg\frac{\ell}{2} = \frac{1}{2}mv^2$

$v = \sqrt{g\ell}$

Q.32 (2)
For light rod
$v_{top} = 0$
Using energy conservation

$\frac{1}{2}mv^2 + 0 = 0 + mg\ell$

$v = \sqrt{2g\ell}$

EXERCISE-IV

INTEGER TYPE

Q.1 [0010]
When the maximum speed is achieved, the propulsive force is equal to the resistant force. Let F be this propulsive force, then

F = aV and FV = 600 W

Eliminating F, we obtain

$V^2 = \frac{400}{a} = 100\ m^2/s^2$

and the maximum speed on level ground with no wind

v = = 10 m/s

Q.2 [0450]

$a = \frac{(m_1 - m_2)}{m_1 + m_2} g = \frac{4-1}{4+1} g = 6\ m/s^2$

$\Delta k = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - \frac{1}{2}m_1u_1^2 - \frac{1}{2}m_2u_2^2$

$= m_1gh_1 + m_2gh_2$

$= (m_1 - m_2)gh$

$h = 0 + \frac{1}{2}a(2n-1)$

$= \frac{1}{2} \times 6 \times (2 \times 3 - 1) = 15$ m

$= 3 \times 10 \times 15 = 450$ J

Q.3 [75]

$p = \frac{mgh}{t} = \frac{300 \times 10 \times 24}{t} = 960$

$t = \frac{300 \times 10 \times 24}{960} = 75$ sec.

Q.4 [0640]

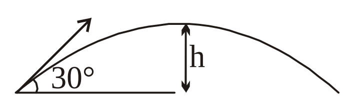
$WD_A = \frac{1}{2}m_1v_1^2 = 960$ kJ

$WD_B = \frac{1}{2}m_2v_2^2 = 1600$ kJ

$WD_B - WD_A = 640$ kJ

Q.5 [0025]
U = mgh

$= mg\frac{v_0^2 \sin^2\theta}{2g} = \frac{1}{2}mv_0^2\sin^2\theta$



$= 100 \times \frac{1}{4} = 25$ J]

Q.6 [9600]
When the spring is compressed by 1.00 m, the sledge moves further down vertically by

$1.00 \times \sin 30° = 0.50$ m.

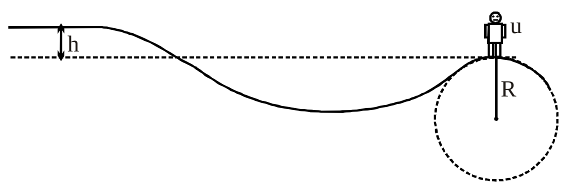
Conservation of energy (gravitational potential energy and elastic potential energy) :

$120 \times 10 \times (3.50 + 0.50) = \frac{1}{2}k \times 1.00^2$

$k = 9600\ Nm^{-1}$

Q.7 [0018]

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

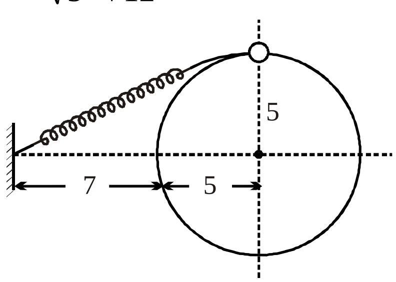


$N = 0 \Rightarrow mg = \frac{mv^2}{R} = \frac{2mgh}{R}$

$\Rightarrow h = \frac{R}{2} = 18\text{ m}$

Q.8 [1480]

$l_0 + x = \sqrt{5^2 + 12^2} = 13$



$x = 6m$

$mg \times 5 + \frac{1}{2}k(0^2 - 0^2) = \frac{1}{2}mv^2$

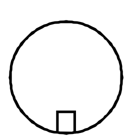
$100 + \frac{1}{2} \times 100 \times 36 = \frac{1}{2} \times 2 \times v^2$

$v^2 = 3700$

$N = \frac{mv^2}{R} = \frac{2 \times 3700}{5} = 1480\text{ N}$

Q.9 [0002]

$V_{bottom} = \sqrt{5gr}$



$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 = \frac{5}{2}mgr$

$x = \sqrt{\frac{5mgr}{k}} = \sqrt{\frac{8 \times 10 \times 0.18}{4500}} = \sqrt{\frac{18}{45000}} = \frac{1}{50}$

$= 2\text{ cm}$

Q.10 [0008]

Applying work energy theorem when block comes down by x = 10 cm

$w_{mg} + w_{sf} + w_f = 0$

$mgx\sin\theta - \frac{1}{2}kx^2 - \mu\, mg\, x\cos\theta = 0$

on solving it gives $\mu = \frac{1}{8}$ Ans.]

Q.11 (2)

Q.12 (1)

Q.13 (1)

All central forces like gravitation force, electrostatic force which follow the inverse square Law $\left(F \propto \frac{1}{r^2}\right)$ are conservative forces.

Work done by conservative forces is path independent.

Q.14 (3)

Potential energy is stored when work is done against a conservative force only.

Both potential energy and kinetic energy are relative quantities.

Q.15 (4)

Q.16 (2)

(A) $W_F = (F.\cos 37^\circ).\ 10 = 100 \times \frac{4}{5} \times 10 = 800J$

(B) $W_N = N.10\cos 90^\circ = 0$

(C) $W_f = f.10\cos 180^\circ$

$= -\mu mg.\ 10 = -0.5\,(10 \times 10 \times 10)$

$= -500\text{ J}$

(D) $W_{F_{net}} = W_F + W_f + W_N$

$= 800 + (-500) + 0$

$= 300J$

PREVIOUS YEAR'S

MHT CET

Q.1 (4)
Q.2 (1)
Q.3 (1)
Q.4 (4)
Q.5 (2)
Q.6 (2)
Q.7 (2)
Q.8 (3)
Q.9 (3)
Q.10 (1)

Given, $P = 2kW = 2\times10^3$ W
h = 20 m

$$\therefore\ P = \frac{W}{t}$$

$$P = \frac{mgh}{t}$$

$$\Rightarrow\ m = \frac{Pt}{gh} = \frac{2\times10^3\times1}{10\times20} = 10$$

Q.11 (4)

Given force,

$F = 30\text{ kg} - \text{wt} = 30\times9.8N$
$s = 20\text{ m}, \theta = 60°$

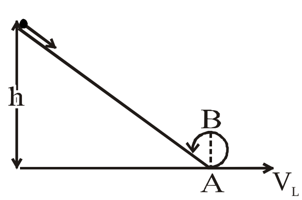
$\therefore$ Work done, $W = Fs\cos\theta$
$= 30\times9.8\times20\times\cos60°$
$= 2940$ J

Q.12 (3)

Work done by conservative force, $W_c = -\Delta U$
If W_c is positive, then ΔU negative.
So, potential energy decreases.

NEET/AIPMT

Q.1 (4)



As track is frictionless, so total mechanical energy will remain constant
$T.M.E_I = T.M.E_F$

$$0 + mgh = \frac{1}{2}mv_L^2 + 0$$

$$h = \frac{v_L^2}{2g}$$

For completing the vertical circle, $v_L \ge \sqrt{5gR}$

$$h = \frac{5gR}{2g} = \frac{5}{2}R = \frac{5}{4}D$$

Q.2 (3)

Work done by variable force $\int F.dy$

Work done =

$$\int_{y=0}^{y=1} F.dy = \int_0^1 (20+10y)dy = \left[20y + \frac{10}{2}y^2\right]_0^1 = 20 + \frac{10}{2} = 25J$$

Q.3 (3)

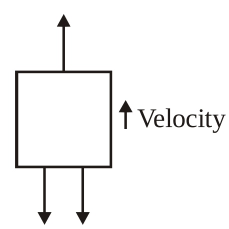
In vertical circular motion, tension in wire will be maximum at lower most point, so the wire is most likely to break at lower most point.

Q.4 (1)

Q.5 (2)

Constant velocity $\Rightarrow a = 0$

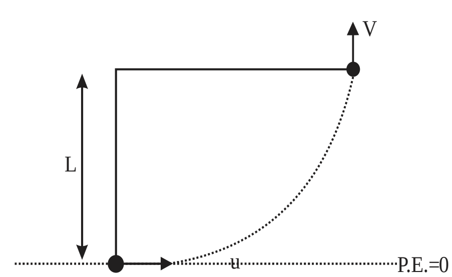
$\Rightarrow$ $T = W + f$
$= 20000 + 3000$
$= 23000$ N



$\Rightarrow$ Power = Tv
$= 23000\times15$
$= 34500$ watts

JEE MAIN

Q. 1 (2)



$v = \sqrt{u^2 - 2gL}$

$\Delta v = \sqrt{u^2 + v^2}$

$\Delta v = \sqrt{u^2 + v^2 - 2gL}$

$\Delta v = \sqrt{2u^2 - 2gL}$

$\Delta v = \sqrt{2(u^2 - 2gL)}$

$\therefore x = 2$

Q.2 (3)

Q.3 (3)

ΔKE = work

(by work energy theorem)

$= 4\int_1^2 x dx + 3\int_2^3 y^2 dy$

$= \frac{4}{2}[x^2]_1^2 + \frac{3}{3}[y^3]_2^3$

$= 2[4 - 1] + [3^3 - 2^3]$

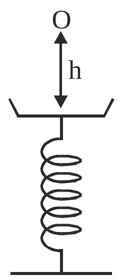
$= 6 + 27 - 8$

$= 25$ J

Q.4 (120)

By energy conservation

$\Sigma w = \Delta K$



$mg\left(h + \frac{h}{2}\right) - \frac{1}{2}Kx^2 = -(\Delta K = 0)$

$mg\left(\frac{3h}{2}\right) = \frac{1}{2}kx^2$

$\frac{3mgh}{2} = \frac{1}{2}k\frac{h^2}{4}$

$k = \frac{12mg}{h} = \frac{12 \times 100 \times 10^{-3} \times 10}{10 \times 10^{-2}} = 120$

K = 120 N/m

Q.5 (3)

$U = \frac{A}{r^{10}} - \frac{B}{r^5}$

For equilibrium $F_{net} = 0$

$F_{net} = \frac{dU}{dr} = -\frac{10A}{r^{11}} + \frac{5B}{r^6} = 0$

$\frac{5B}{r^6} = \frac{10A}{r^{11}}$

$r^5 = \frac{2A}{B}$

$r = \left(\frac{2A}{B}\right)^{\frac{1}{5}}$

Q.6 [600]

Using conservation of energy

$U_i + K_i = U_f + K_f$

$0 + \frac{1}{2}m(12)^2 = \frac{1}{2}K(0.3)^2 + \frac{1}{2}m(6)^2$

$0.5(12^2 - 6^2) = K(0.3)^2$

K = 600 N/m

Q.7 (5)

Q.8 (1)

Work done = area under F – x curve. Area below x-axis is negative & area above x-axis is positive.

So $W_3 > W_2 > W_1 > W_4$

Q.9 (2)

$= \frac{9 \times 10^4 \times g \times 40}{3600} \times 0.5 = n \times 100$

$\frac{10^4 \times 0.5}{100} = n$

$100 \times 0.5 = n$

$n = 50$

Q.10 (4)

$v = bx^{5/2}$

m = 0.5 kg = ½ kg $(b = 0.25\ m^{-3/2}\ S^{-1})$

$W = \Delta K$

$W = \frac{1}{2}m(v^2_{(x=4)} - v^2_{x=0})$ $\because v^2_{x=0} = 0$

$= \frac{1}{2}mb^2(4)^5$ $\because v^2_{x=4} = (b(4)^{5/2})^2$

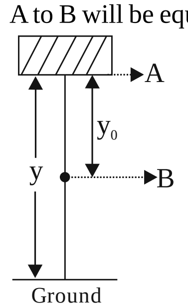
$\because v^2_{x=4} = (b^2(4)^5$

$W = \frac{1}{2}mb^2(4)^5 = \frac{1}{2} \times \frac{1}{2} \times (0.25)^2 \times 4^5 = \frac{1}{2} \times \frac{1}{2} \times \left(\frac{1}{4}\right)^2 \times 4^5$

$= (4)^2 = 16$ J

Q.11 (4)

Clearly the potential energy lost by block in going from A to B will be equal to its kinetic energy.



Kinetic energy at B = mgy_0

Q.12 (2)

Using work energy theorem

$w = \Delta K$

$$w = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$

$V = 3x^2 + 4$

At $x = 0, v_1 = 4$ m/s

At $x = 2$ m, $V_2 = 3 \times 4 + 4 \Rightarrow V_2 = 16$ m/s^2

$$w = \frac{1}{2}(0.5)(16^2 - 4^2) \quad \{m = 0.5 \text{ kg}\}$$

$w = 60$ J

Q.13 (2)

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

$P = mv$

Using these two relations, we get $P = \sqrt{2mK}$

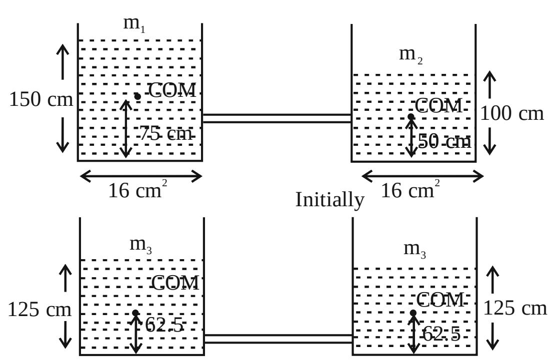
Therefore : $\frac{P_1}{P_2} = \frac{\sqrt{2m_1K_1}}{\sqrt{2m_2K_2}}$

And Both have same Kinetic energies.

$$\therefore \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{8}{2}} = \sqrt{4} = 2$$

$$\frac{P_1}{P_2} = \frac{2}{1}$$

Q.14 (2)



$m_1 = \rho(Al)$

$= 10^3 \times 16 \times 150 \times 10^{-6}$

$= 2400 \times 10^{-3}$

$\boxed{m_1 = 2.4 \text{ kg}}$

$m_2 = \rho(Al)$

$= 10^3 \times 16 \times 100 \times 10^{-6}$

$\boxed{m_2 = 1.6 \text{ kg}}$

$$m_3 = \frac{m_1 + m_2}{2} = \frac{(2.4 + 1.6)}{2} = 2 \text{ kg}$$

$\Rightarrow m_3 = 2$kg

Potential energy : $-U_i = m_1 g(h_1)_{com} + m_2 g(h_2)_{com}$

$$= \left(2.4 \times 10 \times \frac{75}{100}\right) + \left(1.6 \times 10 \times \frac{50}{100}\right)$$

$U_i = 18 + 8 = 26$ J ... (1)

$U_f = m_3 gh_{com}) \times 2 = 2 \times (2 \times 10 \times \frac{62.5}{100}) = 25$ J ... (2)

Work done by gravity $= -\Delta U$

$= -U_f + U_i = -25 + 26 = 1$ J

Q.15 (24)

Using work – energy theorem

$W_{net} = (K_f - K_i)$

$$\Rightarrow -\frac{1}{2}Kx^2 = \frac{1}{2}m\left(\frac{v}{2}\right)^2 - \frac{1}{2}mv^2 = \frac{E}{4} - E$$

$$\Rightarrow \frac{1}{2}Kx^2 = \frac{3E}{4} \Rightarrow K = \frac{3E}{2x^2}$$

$$\Rightarrow K = \frac{3E}{2 \times \left(\frac{1}{4}\right)^2} = 24E$$

$n = 24$

Q.16 (1)

$k_i = 90$ J $\quad k_f = 40$ J $\quad$ in 1 sec

$m = 200$ g $= 0.2$ kg

we know that

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

$$v_i^2 = \frac{2k_i}{m} = \frac{2 \times 90}{0.2} = 900$$

$v_i = 30$ m/s

$$V_f^2 = \frac{2K_f}{m} = \frac{2 \times 40}{0.2} = 400$$

$v_f = 20$ m/s

$v = u + at$

$20 = 30 + a \times 1 \Rightarrow a = -10$ m/s^2

So, distance covered before stop

$v^2 = u^2 + 2as$

$0 = (30)^2 + 2(-10) \times s$

$$s = \frac{900}{20} = 45 \text{ m}$$

Minimum length of pool.