PHYSICS NOTES

DONT WORK HARD, WORK SMART

9TH NEW

ACCORDING TO THE NEW SLO BASED SYLLABUS

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Chapter 1

1.1 (a) Seconds in a day:
1 day = 24 hours
1 hour = 60 minutes
1 minute = 60 seconds
No. of seconds in a day
=24×60×60 = 86400 s
To express using SI prefix
86400 s = 86.4 × 10^3 s = **86.4 ks**
(b) seconds in a week:
1 week = 7 days
No. of seconds in a week= 7×86400
= 604800s
To express using SI prefix
604800s=604.8×10^3s=**604.8 ks**
(c) Second in a month:
1month = 30 days
Seconds in a month= 30 × 86400
= 2592000 s
To express using SI prefix
2592000s = 2.592×10^6s= **2.592 Ms**
1.2(a) A day
86400 s = **8.64 × 10^4 s**
(b) A week:
604800 s = **6.048 × 10^5 s**
(c) A month:
2592000 s = **2.592 × 10^6 s**
1.3 (a) 4 × 10^{-4} kg + 3 × 10^{-5} kg
= 4 × 10^{-4} kg + 0.3 × 10^{-4} kg
= (4 + 0.3) × 10^{-4} kg
= 4.3 × 10^{-4} kg
In scientific notation: 4.3 × 10^{-4} kg
(b) 5.4 × 10^{-6} m – 3.2 × 10^{-5} m
To add or subtract, we need same power of exponent in all terms.
= 0.54 × 10^{-5} m – 3.2 × 10^{-5} m
= (0.54 – 3.2) × 10^{-5} m
= -2.66 × 10^{-5} m
In S.notation = –2.66×10^{-5}m
1.4 (a) (5 × 10^4 m) × (3 × 10^{-2} m):
= (5 × 3) × $10^{4+(-2)}$ m × m
= 15 × 10^2 m^2
Convert to scientific notation:
1.5 × 10^1 × 10^2 m^2 = **1.5 × 10^3 m^2**
(b) 6 × 10^8 kg / 3 × 10^4 m^3
= $(\frac{6}{3})$ × 10^8 × 10^{-4} kg m^{-3}
= 2 × 10^{8-4} kg m^{-3}
= 2 × 10^4 kg m^{-3}
In S. notation= 2.0 ×10^4kgm^{-3}

1.5 $\frac{(3\times 10^2\ kg)\times(4.0\ km)}{5\times 10^2\ s^2}$

$= \frac{(3\times 10^2\ kg)\times(4.0\times 10^3 m)}{5\times 10^2\ s^2}$

$= \frac{(3\times 4.0)\times 10^2\times 10^3 kgm}{5\times 10^2\ s^2}$

$= \frac{12.0\times 10^{2+3}\ kgm}{5\times 10^2 s^2}$

$= \frac{12.0\times 10^5\times 10^{-2} kgms^{-2}}{5}$

$= 2.4\times 10^{5-2} kgms^{-2}$

$= 2.4\times 10^3 kgms^{-2}$

In S. notation=2.4×$10^3 kgms^{-2}$
1.6(a) 0.0045 m: Number of significant digits = **2**
Reason The zeros on the left of decimal fraction do not count as significant figures.
(b) 2.047 m: Number of significant digits = **4**
Reason All non-zero digits are significant. The zero between non-zero digits is also significant.
(c) 3.40 m: Number of significant digits = **3**
Reason The ending zeros after the decimal point are significant.
(d) 3.420 × 10^4 m: No. of significant digits = **4**
Reason If number is in scientific notation, then all the digits before the exponent are significant.
1.7(a) 0.0035 m
In scientific notation: **3.5 × 10^{-3} m**
(b) 206.4 × 10^2 m:
=2.064 × 10^2 × 10^2 m
∴(decimal moved two digits to the left)
In S.notation=**2.064 × 10^4 m**
1.8 (a) 5.0 × 10^4 cm:
= 5.0 × 10^4 cm
= 5.0 × 10^4 × 10^{-2} m (1centi=10-2)
= 5.0 × 10^{4-2} m
= 5.0 × 10^2 m
= 5.0 × 100 m
= 500 m
= 0.5 × 10^3 m = **0.5 km**
(decimal point moved three digits to the left) ∴ 1k=10^3
(b) 580 × 10^2 g:
= 580 × 10^2 g
= 58000 g
= 58 × 10^3 g = **58 kg**
(c) 45 × 10^{-4} s
= 4.5 × 10^1 × 10^{-4} s
= 4.5 × 10^{1-4} s
= 4.5 × 10^{-3} s = **4.5 ms**
1.9 Given Data
v = 3.0 × 10^8 m s^{-1}
t = 1 year
t=1 year = 365 days
t=365 days × 24 × 60 × 60 seconds
t= 31,536,000 s
t= 3.1536 × 10^7 s
To find
S =?
Solve
S = v × t
S = (3.0 × 10^8)×(3.1536 × 10^7)
S = (3.0 × 3.1536) × (10^{8+7})
S = 9.4608 × 10^{15} m
S = **9.46 × 10^{15} m**
1.10 Given data
ρ = 13.6 g cm^{-3}
To find
Density (ρ) in kgm^{-3} =?
Solve
ρ = 13.6 gcm^{-3}
∴1k = 10^3
∴ 1 cm^3 = (10^{-2} m) ^{3} = 10^{-6} m^3
So,

$= \frac{13.6\times 10^3 g}{10^3\times 10^{-6}\ m^3}$ ∴ (× and ÷by 10^3)

$= \frac{13.6\times kg}{10^3\times 10^{-6}\ m^3}$

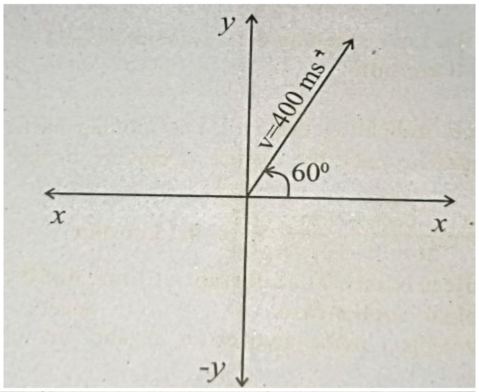
$= \frac{13.6\times kg}{10^{3-6}\ m^3}$

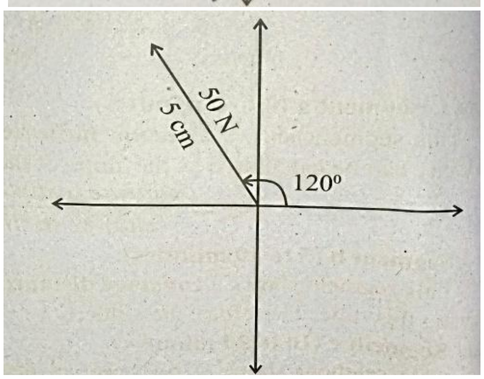
$= \frac{13.6\times kg}{10^{-3}\ m^3}$

= 13.6 × $10^3 kgm^{-3}$
∴ (decimal point moved one digit to the left)
In S.notation=1.36×10^4 kgm^{-3}

Chapter 2

2.1 (a). 100 ms^{-1} = 1cm
(b). 10 N = 1cm





2.2 Given data:

$v_{av} = 72\ kmh^{-1}$

$v_{av} = \frac{72\ X\ 1000}{3600}\ ms^{-1} = 20\ ms^{-1}$

$S = 360\ km = 360 \times 1000\ m$

$S = 360000m$

$t = ?$

Solution:

$v_{av} = \frac{S}{t}$ ---------------------(i)

$t = \frac{S}{Vav}$

$t = \frac{360000}{20} = 18000s$

$t = \frac{18000}{3600} = \mathbf{5h}$

2.3 Given data:

$Vi = 0\ ms^{-1}$

$Vf = 90\ kmh^{-1} = \frac{90 \times 1000}{3600}\ ms^{-1}$

$Vf = 25\ ms^{-1}$

$t = 50\ s$

$a_{av} = ?$

Solution:

$a_{av} = \frac{vf - vi}{t} = \frac{25-0}{50}$

$a_{av} = 0.5\ ms^{-1}$

2.4 Given data:

$V_i = 5\ m\,s^{-1}$

$a = 1.5\ ms^{-2}$

$t = 5\ s$

$v_f = ?$

Solution:

$v_f = vi + at$

$v_f = (5) + (1.5)(5)$

$v_f = (5) + (7.5)$

$v_f = 12.5\ ms^{-1}$

2.5 Given data:

$Vi = 18\ km\ h^{-1}$

$Vi = \frac{18 \times 1000}{3600} = 5\ ms^{-1}$

$a = 2\ ms^{-2}$

$S = ?$

$t = 10s$

Solution:

$S = v_i\,t + \frac{1}{2}\,a\,t^2$

$S = 5\ (10) + \frac{1}{2}\ (2)(10)^2$

$S = (50) + \frac{1}{2}\,200$

$S = 50 + 100$

S = 150 m

2.6 Given data:

$v_i = 54\ km\ h^{-1}$

$v_i = \frac{54 \times 1000}{3600} = 15\ ms^{-1}$

$S = 25\ m$

$v_f = 0\ ms^{-1}$ (body comes to rest)

$a = ?$

Solution:

$2aS = v_f^{\,2} - v_i^2$

$2(a)(25) = (0)^2 - (15)^2$

$50\ (a) = -225$

$a = \frac{-225}{50} = \mathbf{-4.5\ ms^{-2}}$

2.7 Given data:

$Vi = 0\ ms^{-1}$

$S = h = 45m$

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

$Vf = ?$

$t = ?$

Solution:

$2gS = v_f^{\,2} - v_i^2$

$2(10)(45) = v_f^{\,2} - (0)^{\,2}$

$900 = v_f^{\,2}$

Taking sq. root on both sides

$\sqrt{v_f^{\,2}} = \sqrt{900}$

$v_f = 30\ ms^{-1}$

Time to reach the ground

$v_f = vi + at$

$30 = 0 + (10)t$

$30 = (10)t$

$t = \frac{30}{10}$

$t = 3s$

2.8 Given data:

$S_1 = 10\ km = 10 \times 1000m = 10{,}000\ m$

Initial average velocity $= v_{av1} = 20\ ms^{-1}$

Final average velocity $= V_{av2} = 4\ ms^{-1}$

$S_2 = 0.8km = 0.80 \times 1000 = 800m$

Total distance(S)

$= S_1 + S_2 = 10{,}000 + 800 = 10800m$

$v_{av} = ?$

Solution:

$v_{av1} = \frac{S_1}{t_1}$

$t_1 = \frac{S_1}{v_{av_1}}$

$t_1 = \frac{10000}{20}$

$t_1 = 500s$

Similarly,

$v_{av2} = \frac{S_2}{t_2}$

$t_2 = \frac{S_2}{v_{av_2}}$

$t_2 = \frac{800}{4}$

$t_2 = 200s$

Total time $= t = t_1 + t_2$

$= 500 + 200 = 700s$

Now,

$v_{av} = \frac{Total\ distance}{Total\ time}$

$v_{av} = \frac{10000 + 800}{700}$

$v_{av} = \frac{10800}{700}$

$v_{av} = 15.4 \text{ ms}^{-1}$

2.9 Given data

$vi = 0 \text{ ms}^{-1}$

$t = 5s$

$g = 10$

$S = h = ?$

$v_f = ?$

Solution

Using 1st equation of motion

$Vf = vi + gt$

$Vf = (0) + 10(5)$

$Vf = 10(5)$

$Vf = 50 \text{ ms}^{-1}$

Using 3rd equation of motion

$2gh = vf^2 - vi^2$

$2(10)h = vf^2 - vi^2$

$20h = (50)^2 - (0)^2$

$h = \frac{2500}{20} = 15\, m$

2.10. Given data:

t = 3s

$v_f = 0$

$v_i = ?$

$h_1 = 1\text{m}$

Height from initial position =?

Total height from ground = h = $h_1 + h_2$ =?

Solution

$0 = vi + (-10)(3)$

$0 = vi - 30$

$\boldsymbol{vi} = 30 \text{ ms}^{-1}$

Using 3rd equation of motion

$2gh_2 = v_f^2 - v_i^2$

$2(-10)h_2 = 0^2 - (30)^2$

$-20h_2 = -900$

$h_2 = \frac{-900}{-20}$

$h_2 = 45\, m$

Total height from the ground

h = $h_1 + h_2$ =-1 + 45 = 46 m

h = 46 m

Chapter 3

3.1 Given data

$m = 10\, kg$

$F = 5\, N$

$vi = 0ms^{-1}$(start from rest)

$t = 5\, s$

To find

$a = ?$

$vf = ?$

Solution

$F = m\, a$

$a = \frac{F}{m} = \frac{5}{10}$

$\boldsymbol{a = 0.5\, m\, s^{-2}}$

(b) To find the velocity after 5 seconds

$vf = vi + at$

$vf = 0 + (0.5)(5)$

$\boldsymbol{vf = 2.5\, ms^{-1}}$

3.2 Given data

$m = 80\, kg$

$g_m = 1.6m\, s^{-2}$

$g_e = 10\, m\, s^{-2}$

To find

$w_m = ?$

$w_e = ?$

Solution

$w_m = m\, g_m$

$w_m = (80)(1.62)$

$\boldsymbol{w_m = 128\, N}$

Weight on earth

$w_e = m\, g_e$

$w_e = (80)(10)$

$\boldsymbol{w_e = 800\, N}$

3.3 Given data

$m = 800\, kg$

$vi = 10\, ms^{-1}$

$vf = 30\, ms^{-1}$

$t = 10\, s$

To find

F = ?

Solution

$F = m\, a - - - - - - (1)$

For acceleration a

a = $\frac{vf - vi}{t}$

$a = \frac{(30 - 10)}{10}$

$\boldsymbol{a = 2\, m\, s^{-2}}$

Put in equation (1)

$F = (800)(2)$

$\boldsymbol{F = 1600\, N}$

3.4 Given data

$m_1 = 5\, g = \frac{5}{1000}$kg = $0.005\, kg$

$v_1' = 300\, ms^{-1}$

$m_2 = 10\, kg$

Initial velocity of bullet and gun before firing $= v_1 = v_2 = 0\, ms^{-1}$

To find

$v_2' = ?$

Solution

Total momentum before = Total momentum after

$\boldsymbol{m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'}$

$(0.005)(0) + (10)(0) = (0.005)(300) + (10)v_2'$

$0 = 1.5 + (10)\, v_2'$

$(10)\, v_2' = -1.5$

$v_2' = \frac{-1.5}{10}$

$\boldsymbol{v_2' = -0.15\, ms^{-1}}$

The negative sign indicates that the recoil velocity of the gun is in the opposite direction to the velocity of the bullet.

3.5 Given data

$m_1 = 70\, kg$

$m_2 = 300\, g = \frac{300}{1000}\, kg = 0.3\, kg$

$v_2' = 3.5\, ms^{-1}$

$t = 30\, min = 30 \times 60 = 1800\, s$

$v_1 = v_2 = 0ms^{-1}$

To find

$v_1' = ?$

Distance in 30 minutes= S = ?

Solution

Total momentum before = Total momentum after

$\boldsymbol{m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'}$

$(70)(0) + (0.3)(0) = (70)v_1' + (0.3)(3.5)$

$0 + 0 = (70)\, v_1' + 1.05$

$0 = 70\, v_1' + 1.05$

$(70)v_1' = -1.05$

$v_1' = \frac{-1.05}{70}$

$\boldsymbol{v_1' = -0.015\ ms^{-1}}$

The negative sign indicates the astronaut move in the opposite direction to the wrench.

(b) Distance S

$S = v_1' \times t$

$S = -0.015 \times 1800$

$S = 0.015 \times 1800$

$\boldsymbol{S = 27\ m}$

3.6 **Given data**

$Mass\ of\ bogie\ 1 = m_1 = 6.5 \times 10^3\ kg$

$Velocity\ of\ bogie\ 1\ before\ collision =$

$v_1 = 0.8\ ms^{-1}$

$Mass\ of\ bogie\ 2 = m_2 = 9.2 \times 10^3\ kg$

$Velocity\ of\ bogie\ 2\ before\ collision$

$v_2 = 1.2\ ms^{-1}$

To find

$Common\ velocity\ after\ collision = v' = ?$

Solution

Total momentum before = Total momentum after

$\boldsymbol{m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'}$

we know, $v_1' = v_2' = v'$

$m_1v_1 + m_2v_2 = m_1v' + m_2v'$

$m_1v_1 + m_2v_2 = (m_1 + m_2)v'$

$(6.5 \times 10^3)(0.8) + (9.2 \times 10^3)(1.2) =$

$(6.5 \times 10^3 + 9.2 \times 10^3) \times v'$

$(5.2 \times 10^3) + (11.04 \times 10^3) = (15.7 \times 10^3) \times v'$

$16.24 \times 10^3 = (15.7 \times 10^3) \times v'$

$v' = \frac{(16.24 \times 10^3)}{(15.7 \times 10^3)}$

$v' = \frac{16.24}{15.7}$

$\boldsymbol{v'} \approx 1.03\ \boldsymbol{ms^{-1}}$

3.7 **Given data**

$m_c = 55\ kg$

$m_b = 5\ kg$

$M = m_c + m_b$

$M = 55 + 5 = 60\ kg$

$vi = 0\ ms^{-1}$

$F = 90N (for\ the\ first\ 8\ s)$

$Time\ for\ acceleration = t_1 = 8\ s$

$Time\ for\ constant\ speed = t_2 = 8\ s$

To find

Total distance = S =?

Solution

Phase 1:

Distance in first 8 seconds= S_1

$\boldsymbol{S_1 = vi\ t_1 + \frac{1}{2} a\ t_1^2}$ -------(1)

acceleration a during the first 8 seconds

$F = M\ a$

$a = \frac{F}{M} = \frac{90}{60}$

$\boldsymbol{a = 1.5\ m\ s^{-2}}$

Put values in (1)

$S_1 = (0)\ (8) + \frac{1}{2} (1.5)\ (8)^2$

$S_1 = 0 + \frac{1}{2}\ (1.5)\ (64)$

$S_1 = 0.75 \times 64$

$\boldsymbol{S_1 = 48\ m}$

Phase 2:

Distance for constant speed for 8 sec

$\boldsymbol{S_2 = vf \times t_2}$ --------(2)

Velocity at the end of the 8 sec

$vf = vi + a\ t_1$

$vf = 0 + (1.5)(8) = \boldsymbol{12\ ms^{-1}}$

$Putting\ in\ the\ values\ in\ eq.\ (2)$

$S_2 = 12 \times 8 = \boldsymbol{96\ m}$

$Total\ distance\ S = S_1 + S_2$

$S = 48 + 96 = \boldsymbol{144\ m}$

3.8 **Given data**

m = 0.4 kg

h_1= 1.8m

h_2 = 0.8 m

g = 10 $m\ s^{-2}$

To find

$Impulse = ?$

$Direction\ of\ impulse = ?$

Solution

$Impulse = m\ \Delta V$ -------(1)

To find impulse first we have to find change in momentum

$\Delta p = m\ \Delta V = m(v_i - vf)$

Using 3rd equation of motion

2 g S = $vf^2 - vi^2$

$vf^2 = vi^2 + 2\ g\ h_2$

$vf^2 = (0)^2 + 2\ (10)(1.8)$

$vf^2 = 0 + 36$

vf = √36 = $\pm 36\ ms^{-1}$

vf = -6 ms^{-1}

Motion after leaving the floor (upward motion):

Final velocity at highest point $vf = 0\ ms^{-1}$

$g = -10\ m\ s^{-2}$

$S = h_2 = 0.8\ m$

$Again\ using\ 3rd\ equation\ of\ motion$

$\boldsymbol{2\ g\ h_2 = vf^2 - vi^2}$

$vf^2 = vi^2 + 2\ g\ S$

$(0)^2 = vi^2 + 2\ (-10)(0.8)$

$0 = vi^2 - 16$

$vi^2 = 16$

$vi = \sqrt{16}$

$vi = +4\ ms^{-1}$

Calculate the impulse

$Impulse = m(v_i - vf)$

$Impulse = 0.4\ (4 - (-6))$

$Impulse = 0.4 \times 10$

$Impulse = 4\ Ns$

The direction of the impulse:

Impulse is upward.

3.9 **Given data**

$m_1 = 0.2\ kg$

$v_1 = 20\ ms^{-1}$

$m_2 = 0.4\ kg$

$v_2 = -5\ ms^{-1}$ (moving towards each other)

$v_1' = 6\ ms^{-1}$

To find

$v_2' = ?$

Solution

Total momentum before = Total momentum after

$\boldsymbol{m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'}$

$(0.2)(20) + (0.4)(-5) = (0.2)(6) + (0.4)v_2'$

$(4) + (-2) = (1.2) + (0.4)\ v_2'$

$2 = 1.2 + (0.4)\ v_2'$

$(0.4)\ v_2' = 2 - 1.2$

$(0.4)\ v_2' = 0.8$

$v_2' = \frac{0.8}{0.4}$

$\boldsymbol{v_2' = 2\ ms^{-1}}$

Chapter 4

4.1: Given:

F = 200 N

θ = 30°

To Find:

x-component of the force = **Fx =?**

y-component of the force = **Fy =?**

Calculations:

F_x (x-component):

$F_x = F \cos\theta$

$F_x = 200\ N \times \cos(30°)$

$F_x = 200\ N \times 0.866$

$F_x = 173.2\ N$

F_y (y-component):

$F_y = F \sin\theta$

$F_y = 200\ N \times \sin(30°)$

$F_y = 200\ N \times 0.5$

$F_y = 100\ N$

4.2: Given:

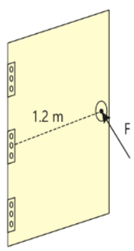
F = 300 N

Moment arm= ℓ = 1.2 m

To Find:

τ = ?

Direction of torque = ?



Calculations:

$\tau = F \times \ell$

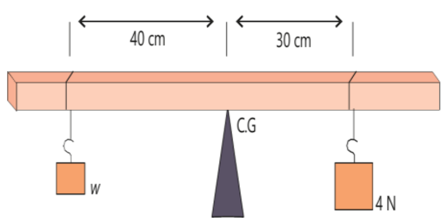
$\tau = 300 \times 1.2$

$\tau = 360\ N\ m$

Direction of torque:

As the rotation is anticlockwise, so the torque is **positive.**

4.3:



Given:

l_1 = 40 cm = 0.4 m

w_2 = 4 N

l_2= 30 cm = 0.3 m

To Find:

Unknown weight = **w**

Calculations:

Apply the Principle of Moments:

Anticlockwise moment = Clockwise moment

$w \times l_1 = w_2 \times l_2$

$w \times (0.4) = 4 \times (0.3)$

$0.4w = 1.2$

$w = \frac{1.2}{0.4}$

w = 3 N

4.4:

Given:

m_1 = 30 kg

$w_1 = m_1 g = (30) \times (10) = 300\ N$

l_1= 2 m

m_2 = 40 kg

$w_2 = m_2 g = (40) \times (10) = 400\ N$

l_2 = 1.5 m

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

To Find:

Total moment on each side=?

The see-saw is in equilibrium=?

Calculations:

Moment due to Child A = $w_1 \times l_1$

= 300 × 2

= 600 N m

Moment due to Child B = $w_2 \times l_2$

= 400 × 1.5

= 600 N m

Since,

Moment A (600 N m) = Moment B (600 Nm)

therefore see-saw is in **equilibrium**.

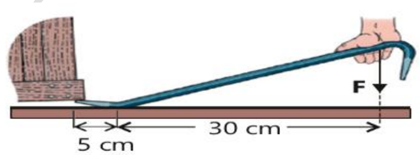
4.5: Given:

F = 250 N

l_1 = 30 cm = 0.3 m

l_2 = 5 cm = 0.05 m

To Find:



Weight the other end bears = w_2 =?

Calculations:

Clockwise moment = Anticlockwise moment

$F \times l_1 = w_2 \times l_2$

$250 \times 0.3 = w_2 \times 0.05$

$75 = 0.05 \times w_2$

$w_2 = \frac{75}{0.05}$

w_2 = 1500 N

4.6: Given:

ℓ = 30 cm = 0.3 m

τ = 150 N m

To Find:

F = ?

Calculations:

$\tau = F \times \ell$

$F = \frac{\tau}{\ell}$

$F = \frac{150}{0.3}$

F = 500 N

4.7: Given:

Weight of the ball = **w = 5 N**

Angle the rope makes with ceiling

θ_1 = 60°.

The angle rope makes with vertical

θ_2=90° - 60° = 30°.

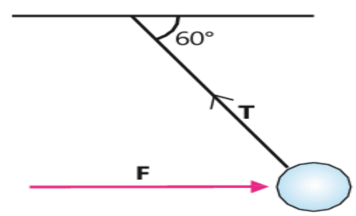
To Find:

F = ?

Tension in the rope = **T =?**

Calculations:

$T_x = T \cos\theta$



$T_y = T \sin\theta$

Apply $\sum F_y = 0$

The upward vertical component of tension must balance the downward weight of the ball.

$T_y = w$

$T \sin(60°) = 5\ N$

$T = \frac{5\ N}{\sin(60°)}$

$T = \frac{5\ N}{0.866}$

$T \approx 5.8\ N$

Apply $\sum F_x = 0$

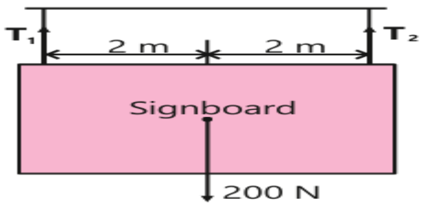
$F = T_x$

$F = T\cos\theta$

$F = (5.8) \cos(60°)$

$F = 5.8 \times 0.5 \approx$ **2.9 N**

4.8:



Given:

w = 200 N (acting vertically downwards)

To Find:

T_1 =?

T_2 =?

Calculations:

Total upward force needed = Total downward force

$T_1 + T_2 = 200$ N

$T_1 = T_2 = T$ (due to symmetry)

T + T = 200 N

2T = 200 N

T = 100 N

T_1 = 100 N and **T_2 = 100 N**.

4.9: Given:

m_1 = 30 kg

$w_1 = m_1g = (30)(10) = 300$ N

ℓ_1 = 1.6 m

m_2 = 40 kg

$w_2 = m_2g = (40)(10) = 400$ N

g = 10 ms^{-2}

To Find:

ℓ_2 =?

Calculations:

Moment due to Girl 1 = Moment due to Girl 2

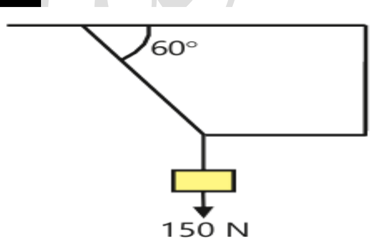
$w_1 \times \ell_1 = w_2 \times \ell_2$

$300 \times 1.6 = 400 \times \ell_2$

$480 = 400 \times \ell_2$

$\ell_2 = \frac{480}{400}$ **= 1.2 m**

4.10:



Given:

w = 150 N (acting vertically downwards)

String T_1 is horizontal.

String T_2 makes an angle of **60°** with the horizontal.

To Find:

Tension in string T_1 =**T_1=?**

Tension in string T_2= **T_2=?**

Calculations:

The block is in static equilibrium, so

Sum of forces in x-direction: **$\sum Fx = 0$**

Sum of forces in y-direction: **$\sum Fy = 0$**

Apply $\sum Fy = 0$:

The sum of upward forces must balance the downward force (weight).

$T_{2y} = w$

$T_2 \sin(60°) = 150$

$T_2 = \frac{150}{sin(60°)}$

$T_2 = \frac{150}{0.866}$ **≈ 173.2 N**

Apply $\sum Fx = 0$:

The horizontal component of T_2 must balance T_1.

$T_1 = T_{2x}$

$T_1 = T_2 \cos(60°)$

$T_1 = 173.2 \text{ N} \times \cos(60°)$

T1 = 173.2 N × 0.5

T1 ≈ 86.6 N

Chapter 5

5.1 Given Data:

F = 20 N

θ = 60°

S = 3 m

To Find:

Work done W = ?

Solution:

W = FS cosθ

W = 20 × 3 cos(60°)

W = 20 × 3 × 0.5   **∴ cos60°=0.5**

W= 30 J

5.2 Given Data:

S = 5 m

F = 8 N

W = 20 J

To Find:

θ =?

Solution:

W = FS cosθ

$\cos\theta = \frac{W}{FS}$

$\cos\theta = \frac{20}{8\times 5} = \frac{20}{40} = 0.5$

θ = $\cos^{-1}(0.5)$ = **60°**

5.3 Given Data:

Mass of water = m = 100 kg

Height = h = 80 m

Time = t = 25 s

g = 10 m s^{-2}

To Find:

Power of the engine = P = ?

Solution:

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

We know W = m g h

$P = \frac{m\,g\,h}{t}$

$P = \frac{100 \times 10 \times 80}{25}$

$P = \frac{80{,}000}{25}$ **= 3200 W**

5.4 Given Data:

Mass of body =m = 20 kg

Initial velocity = v_i = 0 m s^{-1} (at rest)

Force = F = 40 N

Time = t= 5 s

To Find:

E_k at the end of 5 seconds = E_k =?

Solution:

F = ma

$a = \frac{F}{m}$

$a = \frac{40}{20}$ = **2 m s^{-2}**

Final velocity of body after 5 seconds:

$v_f = v_i + at$

$v_f = 0 + (2 \times 5)$

$v_f = 10$ m s^{-1}

kinetic energy after 5 seconds

$E_k = \frac{1}{2} m v_f^2$

$E_k = \frac{1}{2} 20 \times (10)^2$

$E_k = \frac{1}{2} 20 \times 100$

$E_k = 10 \times 100 =$ **1000 J**

5.5 Given Data:

m = 160 g = 160 / 1000 kg = 0.16 kg

Height = h = 20 m

$g = 10 \text{ m s}^{-2}$

To Find:

Potential energy gained (E_p).

Solution:

$\mathbf{E_p = m\,g\,h}$

$E_p = 0.16 \times 10 \times 20$

$E_p = 1.6 \times 20$

$E_p =$ **32 J**

5.6 Given Data:

Mass of ball = m = 0.14 kg

Initial velocity = $v_i = 35 \text{ m s}^{-1}$

$v_f = 0 \text{ m s}^{-1}$ (at highest point)

$g = -10 \text{ m s}^{-2}$ (motion is upward)

To Find:

Maximum height reached = h ?

Solution:

$\mathbf{2gh = vf^2 - v_i^2}$

$h = \frac{vf^2 - v_i^2}{2g}$

$h = \frac{(0)^2 - (35)^2}{2(-10)}$

$h = \frac{-1225}{-20} =$ **61.25 m**

5.7 Given Data:

Height at lowest point = $h_1 = 1.2$ m

Height at highest point = $h_2 = 2.0$ m

Change in height =

$\Delta h = h_2 - h_1 = 2.0 - 1.2 = 0.8$ m

$v_f = 0 \text{ ms}^{-1}$ (at highest point)

$g = -10 \text{ m s}^{-2}$

To Find:

Maximum velocity = v_{max} = ?

Location = ?

Solution:

$\mathbf{2g\Delta h = vf^2 - v_{max}^2}$

$2(-10)(0.8) = (0)^2 - v_{max}^2$

$-v_{max}^2 = -16$

$\sqrt{v_{max}^2} = \sqrt{16}$

$\mathbf{v_{max} = 4 \text{ m s}^{-1}}$

This maximum velocity occurs at the **lowest position** of the swing.

5.8

Given Data:

F = 50 N

θ = 45°

S = 20 m

To Find:

W = ?

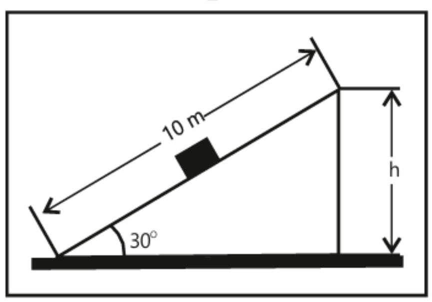
Solution:

W = FS cosθ

W = 50 × 20 cos45° ∴ cos45° ≈ 0.707

W = 1000 × (0.707) = **707 J**

5.9 Given Data:



m = 5 kg

Length of inclined plane = S = 10 m

θ = 30° (angle with horizontal)

To Find:

(i) Work done = W = ?

(ii) Work in pushing the box up the inclined plane $W_1 = E_p$ =?

Solution:

$W = F\,S$

$W = mg\sin\theta\, S$

$W = (5)(10)\sin 30 \times 10$

$W = 50 \sin 30 \times 10$

$W = (50)(0.5) \times 10$

$\mathbf{W = 250\ J}$

$\mathbf{W_1 = mgh}$

To find h

$\sin\theta = \frac{perp}{hyp}$

$\sin(30) = \frac{h}{10}$

h = 0.5 × 10 = 5 m

$W_1 = 5 \times 10 \times 5 =$ **250 J**

5.10 Given Data:

Mass of box = m = 10 kg

Length of ramp = S = 15 m

Applied force = F = 80 N

Vertical height = h = 5 m

$g = 10 \text{ m s}^{-2}$

To Find:

Efficiency of the system = E = ?

Solution:

$\% E = \frac{\text{Useful output energy}}{\text{Total input energy}} \times 100\%$ ----(1)

Calculate the total input energy:

$W_{in} = F \times S$

$W_{in} = 80 \times 15 =$ **1200 J**

Calculate the useful output energy which is total P.E

$W_{out} = mgh$

$W_{out} = 10 \times 10 \times 5 =$ **500 J**

Put in (1)

$\% E = \frac{500}{1200} \times 100\%$

% E = (0.417) × 100% ≈ **41.7%**

5.11 Given Data:

Force = F = 600 N

Distance = S = 5 m

Time = t = 15 s

To Find:

Power = P = ?

Solution:

P = W / t -------(1)

W = F × S.

W = 600 N × 5 m = **3000 J**

Put in (1)

P = 3000 J / 15 s

P = **200 W**

5.12 Given Data:

m = 40 kg

h = 10 m

t = 8 s

$g = 10\ m\ s^{-2}$

To Find:

P = ?

Solution:

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

We know: W = m g h

$P = \frac{m\ g\ h}{t}$

$P = \frac{(40)(10)(10)}{8}$

$P = \frac{4000}{8}$

P = 500 W

5.13 Given Data:

Phase 1:

Force = F_1 = F

Distance = S_1 = L

Phase 2:

Force = F_2 = 2F

Distance = S_2 = 2L (it means "further acts through 2L" as an additional displacement)

To Find:

Sketch a force-displacement graph.

W_{total} = ?

Solution:

Total work done (W_{total}) is the sum of work done in each phase.

$W_1 = F_1 \times S_1$

$W_1 = F \times L$

W_1 = **FL**

Similarly

$W_2 = F_2 \times S_2$

$W_2 = 2F \times 2L$ = **4FL**

Total work done = $W_1 + W_2$

W_{total} = FL + 4FL

W_{total} = 5FL or 5 units

Chapter 6

6.1: Given Data:

$x_1 = 20\ mm = \frac{20}{1000} = 0.02\ m$

$F_1 = 40\ N$

$x_2 = 16\ mm = \frac{16}{1000} = 0.016\ m$

To Find:

k = ?

F_2 = ?

Solution:

F = k x

$K = \frac{F_1}{x_1}$

$K = \frac{40}{0.02}$

$k = 2000\ Nm^{-1}$

$k = 2k\ Nm^{-1}$

now for second extension x_2

$F_2 = kx_2$

$F_2 = (2000)\ (0.016)$

F_2 = 32 N

6.2: Given Data:

V = 5 L

m = 4.5 kg

To Find:

Density **ρ** in SI units ($kg\ m^{-3}$) = ?

Solution:

$\rho = \frac{m}{V}$ -------------1

we know

1 litre = $0.001\ m^3$

5 litre = $5 \times 0.001\ m^3$

$V = 0.005\ m^3$

$\rho = \frac{4.5}{0.005}$

$\rho = 900\ kg\ m^{-3}$

6.3: Given Data:

Mass = m = 60 g = $\frac{60}{1000}$ = 0.060 kg

Initial volume = $V_i = 40\ cm^3$

Final volume = $V_f = 44\ cm^3$

$V = V_f - V_i = 44\ cm^3 - 40\ cm^3$ = **4 cm**

$V = 4\ cm^3 = 4 \times (10^{-2} m)^3 = 4\times10^{-6}\ m^3$

Solution:

$\rho = \frac{m}{V}$

$\rho = \frac{0.060}{4 \times 10^{-6}}$

$\rho = 15000\ kg\ m^{-3}$

$\rho = 1.5 \times 10^4\ kg\ m^{-3}$

6.4 Given Data:

$\rho = 8 \times 10^3\ kg\ m^{-3}$

$V = 60\ cm^3 = 60 \times (10^{-2}\ m)^3$

$V = 60 \times 10^{-6}\ m^3$

To Find:

Mass of the block = m =?

Solution:

$\rho = \frac{m}{V}$

$m = \rho \times V$

$m = (8 \times 10^3) \times (60 \times 10^{-6})$

$m = 480 \times 10^{-3}$ kg **= 0.48 kg**

6.5: Given Data:

length = 20 cm

breadth = 10 cm

height h = 5 cm

Mass of the brick = m = 5 kg

To Find:

Maximum pressure = P_{max} = ?

Minimum pressure = P_{min} = ?

Solution:

$P = \frac{F}{A}$

We know

F = w = mg

F =(5) × (10) = **50 N**

A_{min} = (5 cm) × (10 cm)

$A_{min} = 50\ cm^2 = 50 \times 10^{-4}\ m^2$

$P_{max} = \frac{F}{A_{min}}$

$P_{max} = \frac{50}{50 \times 10^{-4}}$

$P_{max} = 10^4 = 10{,}000$ pa

A_{max} = (10 cm) × (20 cm)

$A_{min} = 200\ cm^2 = 200 \times 10^{-4}\ m^2$

$P_{min} = \frac{F}{A_{max}}$

$P_{min} = \frac{50}{200 \times 10^{-4}}$

$P_{min} = 0.25 \times 10^4$

$P_{min} = 25 \times 10^2\ pa$

6.6: Given Data:

$\rho_{mer} = 13.6 \times 10^3\ kg\ m^{-3}$

$h_{mer} = 760\ mm = 0.760\ m.$

$\rho_{water} = 1000\ kg\ m^{-3}.$

To Find:

$h_{water} = ?$

Solution:

$P = \rho_{mer} \times g \times h_{mer}$

$P = \rho_{water} \times g \times h_{water}$

Pressure by mercury column = pressure by water column

$\rho_{mer} \times g \times h_{mer} = \rho_{water} \times g \times h_{water}$

$\rho_{mer} \times h_{mer} = \rho_{water} \times h_{water}$

$$h_{water} = \frac{\rho_{mer} \times h_{mer}}{\rho_{water}}$$

$$h_{water} = \frac{(13.6 \times 10^3) \times (0.76)}{1000}$$

$$\boldsymbol{h_{water} = 10.336\ m}$$

6.7: Given Data:

$F_1 = 500\ N$

$A_1 = 5\ cm^2 = 5 \times 10^{-4}\ m^2$

$A_2 = 20\ cm^2 = 20 \times 10^{-4}\ m^2$

To Find:

Pressure transferred to the brake oil=P =?

Force on the second piston = F_2

Solution:

Pressure transferred to oil = $P = \frac{F_1}{A_1}$

$$P = \frac{500}{5 \times 10^{-4}}$$

$P = 100 \times 10^4\ m^2$

According to **Pascal's Law**, pressure on the second piston is same as the pressure on piston one

$P = \frac{F_2}{A_2}$

$F_2 = P \times A_2$

$F_2 = (100 \times 10^4) \times (20 \times 10^{-4})$

$F_2 = 2000 \times 10^{4-4}$

$F_2 = 2000 \times 10^0$ **= 2000 N**

6.8: Given Data:

$h = 10\ m$

$\rho = 1030\ kg\ m^{-3}$

$g = 10\ m\ s^{-2}.$

To Find:

$P = ?$

Solution:

$P = \rho gh$

$P = (1030)x(10)x(10)$

$P = 103000\ pa = 1.03 \times 10^5\ pa$

6.9: Given Data:

$A_1 = 10\ cm^2 = 10 \times 10^{-4}\ m^2$

$A_2 = 100\ cm^2 = 100 \times 10^{-4} m^2$

$F_2 = 4000\ N$

To Find:

$F_1 = ?$

Solution:

$P_1 = P_2$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = \frac{F_2}{A_2} A_1$$

$$F_1 = \frac{4000}{100 \times 10^{-4}}\ 10 \times 10^{-4}$$

$$F_1 = \frac{4000}{10} = 400\ N$$

6.10: (a) Air pressure at sea level:

$h = 0.76\ m$

$\rho = 13600\ kgm^{-3}$

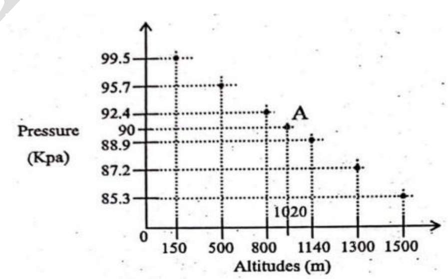
$g = 10\ ms^{-2}$

$P = \rho\ g\ h$

$P = (13600) \times (10) \times (0.76)$

$P = 1.03 \times 10^5$ pa $\approx$ 101 kPa

(b) Height at 90 kPa air pressure:



As clear from the graph:

At, P = 90 k pa

H = 1020 m or 1.02 km (at point A)

6.11: Given Data:

$P = 10\ N\ cm^{-2} = 10 \times 10^4\ Nm^{-2}$

$A = 50\ cm^2 = 50 \times 10^{-4} m^2$

To Find:

$F = ?$

Solution:

$P = \frac{F}{A}$

$F = (10 \times 10^4) \times (50 \times 10^{-4}).$

$F = 500 \times 10^0$

F = 500 N

6.12: Given Data:

$F_1 = 500\ N$

$A_1 = 5 cm^2 = 5 \times 10^{-4}\ m^2$

$A_2 = 20 cm^2 = 20 \times 10^{-4}\ m^2$

To Find:

(a) Pressure on brake oil=P=?

(b) Force on the piston = F_2 = ?

Solution:

(a)Pressure on oil = $P = \frac{F_1}{A_1}$

$$P = \frac{500}{5 \times 10^{-4}}$$

$P = 100 \times 10^4$

$P = 10^6$ pa

(b) Force on the brake piston F_2:

$P = \frac{F_2}{A_2}$

$F_2 = P \times A_2$

$F_2 = (10^6) \times (20 \times 10^{-4})$

$F_2 = 20 \times 10^{6-4}$

$F_2 = 20 \times 10^2$

F_2 = 2000 N

Chapter 7

7.1: Given Data:

$T_F = 98.6°F$

To Find:

$T_C = ?$

$T_K = ?$

Solution:

$\boldsymbol{T_C = \frac{5}{9}(T_F - 32)}$

$T_C = \frac{5}{9}\ (98.6 - 32)$

$T_C = \frac{5}{9}\ (66.6)$

$T_C = 37°C$

Convert Celsius to Kelvin:

$T_K = T_C + 273$

$T_k = 37 + 273$

T_k = 310 K

7.2:Given Data:

When Celsius (T_C) is equal to Fahrenheit (T_F).

To Find

Temperature where both scales have same value

Solution:

Let the unknown temperature be **x**

According to condition: $T_C = T_F = x$

$T_C = \frac{5}{9}(T_F - 32)$

$x = \frac{5}{9}(x - 32)$

$9x = 5(x - 32)$

$9x = 5x - 160$

$9x - 5x = -160$

$4x = -160$

$x = -160 / 4$

$x = -40°$

Result:

Celsius and Fahrenheit thermometer readings would be the same at **–40°.**

7.3:Given Data:

$T_F = 5°F$

To Find:

T_C = ?

T_k = ?

Solution:

$T_C = \frac{5}{9}(T_F - 32)$

$T_C = \frac{5}{9}(5 - 32)$

$T_C = \frac{5}{9}(-27)$

$T_C = 5 \times (-3)$ **= –15°C**

Convert Celsius to Kelvin:

$T_k = T_C + 273$

$T_k = -15 + 273$

T_k = 258 K

7.4:

$T_C = 25°C$

To Find:

T_F = ?

T_k = ?

Solution:

Convert Celsius to Fahrenheit:

$T_F = \frac{9}{5} \times T_C + 32$

$T_F = \frac{9}{5} \times 25 + 32$

$T_F = (9 \times 5) + 32$

$T_F = 45 + 32$ **= 77°F**

Convert Celsius to Kelvin:

$T_k = T_C + 273$

$T_k = 25 + 273$ **= 298 K**

7.5:Given Data:

L_{total}=192 mm

$L_{measured}$ = 67.2 mm

Celsius scale range = **100 divisions**

To Find:

Temperature on Celsius scale=**T_C**= ?

Solution:

$T_C = \frac{L_{measured}}{L_{total}} \times$ **(Upper Point - Lower Point)**

$T_C = \frac{67.2}{192} \times (100 - 0)$ °C

$T_C = 0.35 \times 100°C$

T_C = **35°C**

7.6:Given Data:

L_{total} = 20 cm

$L_{measured}$ = 4.5 cm

Celsius scale range = **100 divisions**

Fahrenheit scale fixed points:

Ice point = 32°F , Steam point = 212°F

To Find

T_F =?

Solution:

$T_C = \frac{L_{measured}}{L_{total}} \times$ **(Upper Point - Lower Point)**

$T_C = \frac{4.5}{20} \times (100 - 0)$ °C

$T_C = 0.225 \times 100°C$

T_C = 22.5°C

Convert Celsius to Fahrenheit:

$T_F = \frac{9}{5} \times T_C + 32$

$T_F = \frac{9}{5} \times 22.5 + 32$

$T_F = 9 \times 4.5 + 32$

$T_F = 40.5 + 32$

T_F = **72.5°F**

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Best of luck