

PHYSICS ASSIGNMENT

1. Work = Force $\times$ Distance

$$= \left(\frac{46}{1000} \times 9.8 \right) \times 0.95$$

$$= \cancel{0.437}$$

$$= 0.42826$$

$$\approx \underline{0.43 \text{ Nm}}$$

ANSWER

2. $W = F \times d$

$$\text{Force} = (4.7 \times 9.8) \text{ N}$$

$$\text{distance} = 3 - 2.1$$

$$= 0.9 \text{ m}$$

$$W = 4.7 \times 9.8 \times 0.9$$

$$= 41.454$$

$$\approx \underline{41.5 \text{ Nm}}$$

ANSWER

3. Work = $\frac{1}{2} M V^2$

$$W_1 = \frac{1}{2} \times 55 \times 4^2$$

$$= 440$$

$$W_2 = \frac{1}{2} \times 55 \times 8^2$$

$$= 1760$$

$$W_f = 1760 - 440$$

$$\underline{1320 \text{ J}}$$

ANSWER

$$440 \times P = 1760$$

$$\therefore P = \frac{1760}{440} = 4$$

So it is 4 times

ANSWER

4. Work = Area under the graph

$$= \frac{1}{2} (a+b) h$$

$$= \frac{1}{2} (25 +$$

$$\frac{1}{2} (80 + 30) 25$$

$$= \frac{1}{2} \times 110 \times 25$$

$$= \underline{1375 \text{ J}}$$

ANSWER

5. Person who is lifting and the force of gravity on objects.

6. (a) $K.E = \frac{1}{2} M V^2$

$$= \frac{1}{2} \times 800 \times 15^2$$

$$= 90000$$

$$= \underline{9 \times 10^4 \text{ J}}$$

ANSWER

7

$$6(b) \text{ K.E} = \frac{1}{2} MV^2$$

$$= \frac{1}{2} \times 800 \times 30^2$$

$$= 360000$$

$$= \underline{3.6 \times 10^5 \text{ J}}$$

ANSWER

$$90,000 \times P = 360000$$

$$\therefore P = \frac{360000}{90,000}$$

$$= 4$$

So, it is 4 times bigger

$$(c) \text{ K.E} = \frac{1}{2} MV^2$$

$$180,000 = \frac{1}{2} \times 800 \times V^2$$

$$\therefore V^2 = \frac{180,000}{400}$$

$$= 450$$

$$V = \sqrt{450}$$

$$= 21.2132 \text{ m/s}^2$$

$$= \underline{21.2 \text{ m/s}}$$

ANSWER

(d) Relationship between speed and Kinetic energy.

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

So, Kinetic energy varies directly with velocity of the object. That is, the higher the velocity, the higher the K.E.

7. 

$$W = u F d$$

$$= 0.4 \times 75 \times 4.2$$

$$= \underline{126 \text{ J}}$$

ANSWER

$$8. \text{ P.E} = \text{K.E}$$

$$1.6 \times 9.8 \times 15 = \frac{1}{2} \times 1.6 \times V^2$$

$$235.2 = 0.8 V^2$$

$$\therefore V^2 = \frac{235.2}{0.8} = 294$$

$$V = \sqrt{294}$$

$$= 17.14642 \dots$$

$$\approx \underline{17 \text{ m/s}^2}$$

ANSWER

9.

$$\frac{1}{2} MV^2 = mgh + \frac{1}{2} MV_f^2$$

$$\frac{1}{2} MV^2 = \frac{1}{2} \times 30^2 \times M + 9.8 \times 15 \times M$$

$$\frac{1}{2} MV^2 = 450M + 147M$$

$$\frac{1}{2} MV^2 = 597M$$

$$V^2 = 1194$$

$$V =$$

$$9. \quad \frac{1}{2} MV^2 = mgh - \frac{1}{2} MV^2$$

$$\frac{1}{2} MV^2 = \frac{1}{2}$$

$$9. \quad \frac{1}{2} MV^2 = \frac{1}{2} MV^2 - mgh$$

$$(a) \quad \frac{1}{2} MV^2 = \frac{1}{2} \times 30^2 \times M - 9.8 \times 15 \times M$$

$$\frac{1}{2} MV^2 = 450M - 147M$$

$$\frac{1}{2} MV^2 = 303M$$

$$V^2 = 606$$

$$V = \sqrt{606} = 24.617$$

$$\approx 25 \text{ m/s}$$

ANSWER

Using Kinematics

(b)

$$V^2 = U^2 + 2as$$

$$30^2 = U^2 + (2 \times 9.8 \times 15)$$

$$900 = U^2 + 294$$

$$\therefore U^2 = 606$$

$$U = \sqrt{606}$$

$$= 24.61706 \dots$$

$$\approx 25 \text{ m/s}$$

ANSWER

(c)

Initial Energy

$$= \frac{1}{2} MV^2 = \frac{1}{2} \times 2 \times 30^2$$

$$= 900 \text{ J}$$

Final Energy.

$$mgh + \frac{1}{2} MV^2$$

$$= 2 \times 9.8 \times 15 + \frac{1}{2} \times 2 \times 22.2^2$$

$$= 786.84$$

Energy Lost

$$= 900 - 786.84$$

$$= 113.16 \text{ J}$$

$$\approx 113 \text{ J}$$

ANSWER

10.

$$\begin{aligned} (a) \quad m_1 v_1 + m_2 v_2 &= (m_1 + m_2) v_f \\ (575 \times 15) + (1575 \times 5) &= (575 + 1575) v_f \\ 16500 &= 2150 v_f \\ v_f &= 7.674418... \\ &\approx \underline{\underline{7.7 \text{ m/s}}} \\ &\text{ANSWER} \end{aligned}$$

(b)

$$\begin{aligned} K_1 + K_2 &= 0.5 m_1 v_1^2 + 0.5 m_2 v_2^2 \\ &= 0.5 (m_1 + m_2) v_f^2 \\ 0.5 \times 575 \times 15^2 + 0.5 \times 1575 \times 5^2 &= 0.5 (575 + 1575) v_f^2 \\ 84375 &= 1075 v_f^2 \\ \therefore v_f^2 &= 78.488 \\ v_f &= \sqrt{78.488} \\ &= 8.859366 \\ &\approx \underline{\underline{8.9 \text{ m/s}}} \\ &\text{ANSWER} \end{aligned}$$

(c) You can't use conservation of energy, since after the collision, there is only one object. This is an elastic collision. You can use conservation of momentum since there is no external forces. Part (a) is correct.

(d) Can only use conservation of kinetic energy in cases where the collision is elastic.

11.

$$\begin{aligned} (a) \quad Mgh &= \frac{1}{2} Mv^2 \\ gh &= \frac{1}{2} v^2 \\ 9.8 \times 20 &= \frac{1}{2} v^2 \\ v^2 &= 392 \\ v &= \sqrt{392} \\ &= 19.79898 \\ &\approx \underline{\underline{20 \text{ m/s}}} \\ &\text{ANSWER} \end{aligned}$$

$$\begin{aligned} (b) \quad \frac{1}{2} Mv^2 &= Mgs \times 0.21 \\ \frac{1}{2} v^2 &= 0.21gs \\ \frac{1}{2} \times 20^2 &= 0.21 \times 9.8 \times s \\ 200 &= 2.058s \\ s &= 97.1817 \approx \underline{\underline{97.2 \text{ m}}} \\ &\text{ANSWER} \end{aligned}$$

12.

$$\cancel{M}gh = \cancel{\frac{1}{2}} \cancel{M} V^2$$

$$(a) gh = \frac{1}{2} V^2$$

$$\cancel{h_{max}} = \cancel{\frac{1}{2}}$$

$$h_{max} = \frac{V^2}{2g}$$

$$= \frac{5^2}{2 \times 9.8}$$

$$= 1.2755$$

$$\approx 1.3 \text{ m}$$

$$\underline{\underline{1.3 \text{ m}}}$$

ANSWER

(b) Answer is independent of mass.

(c) No, the answer depends only on her speed as she began to swing up.

$$13. (a) K.E = \frac{1}{2} MV^2$$

$$= 1200 \times 20^2 \times \frac{1}{2}$$

$$= 240000$$

$$= 2.4 \times 10^5 \text{ J}$$

ANSWER

13 (b)

The energy is entirely dissipated by the force of friction in the brake system.

(c)

$$\text{Work} = \Delta K.E$$

$$= K.E_f - K.E_i$$

$$= 0 - 240000$$

$$= -240000$$

$$= -2.4 \times 10^5 \text{ J}$$

ANSWER

(d)

$$F \times d = \Delta K.E$$

$$F = \frac{\Delta K.E}{d}$$

$$= \frac{-240000}{50}$$

$$= -4800 \text{ N}$$

Therefore magnitude of the force = 4800 N

ANSWER

14 (a) Explanation Page 6

If the track is assumed to be frictionless, then the energy change is from mechanical energy or in this case mechanical work done due to the pulling force to potential gravitational energy from A to B. From B to C I can assume that the potential energy will be converted to kinetic energy as it must be going down hill, but unless it goes as low as A or lower, then not all P.E. will be transformed to K.E. Again, assuming the car then goes back uphill partially from C to D, then some of the K.E. is converted back to P.E.

$$(b) Mgh = \frac{1}{2} M V^2$$

$$500 \times 9.8 \times 35 = \frac{1}{2} \times 500 \times V^2$$

$$171500 = 250 V^2$$

$$V^2 = 686$$

$$V = \sqrt{686} = 26.2 \text{ m/s}$$

ANSWER

$$(c) Mgh = \frac{1}{2} M V^2$$

$$= 500 \times 9.8 \times 20$$

$$= 98000$$

$$= 9.8 \times 10^4 \text{ J}$$

ANSWER

$$(d) Mgh = \frac{1}{2} M V^2$$

but this will be K.E. Lost

$$\Rightarrow 500 \times 9.8 \times 20$$

$$= -98000$$

$$= 9.8 \times 10^4$$

ANSWER

~~$$(e) Mgh = \frac{1}{2} M V^2$$~~

~~$$500 \times 9.8 \times 20 = \frac{1}{2} \times 500 \times V^2$$~~

~~$$98000 = 250 V^2$$~~

~~$$V^2 = 392$$~~

~~$$V = 19.7989$$~~

(e)

$$171500 = (500 \times 9.8 \times 20) + \left(\frac{1}{2} \times 500 \times V^2 \right)$$

$$171500 - 98000 = 250 V^2$$

$$73500 = 250 V^2$$

$$V^2 = 294$$

$$V = \sqrt{294}$$

$$= 17.14642$$

$$\approx 17.1 \text{ m/s}$$

ANSWER

14 (f)

$$\begin{aligned}
 M.E &= \frac{1}{2}MV^2 + Mgh \\
 &= \left(\frac{1}{2} \times 500 \times 13^2 \right) + (500 \times 9.8 \times 20) \\
 &= 42250 + 98000 \\
 &= 140250 \text{ J} \\
 &\approx \underline{1.4 \times 10^5 \text{ J}} \\
 &\text{ANSWER}
 \end{aligned}$$

(g) Mgh - Mechanical Energy above

$$\begin{aligned}
 &= (500 \times 9.8 \times 35) - 140250 \\
 &= 171500 - 140250 \\
 &= 31250 \\
 &\approx \underline{3.1 \times 10^4} \\
 &\text{ANSWER}
 \end{aligned}$$

(h) Efficiency = $\frac{M.E}{P.E} \times 100\%$

$$\begin{aligned}
 &= \frac{140250}{171500} \times 100\% \\
 &= 81.7784 \\
 &\approx \underline{82\%} \Rightarrow \text{ANSWER}
 \end{aligned}$$

15. $\frac{1}{2}MV^2 \times \frac{80}{100} = Mgh$

$$\frac{2}{5}V^2 = 9.8h$$

$$\frac{2}{5} \times 7^2 = 9.8h$$

~~$$h = \frac{9.8 \times 9.8}{5}$$~~

$$19.6 = 9.8h$$

$$\begin{aligned}
 \therefore h &= \frac{19.6}{9.8} \\
 &= \underline{2 \text{ m}}
 \end{aligned}$$

ANSWER

16. $\frac{1}{2}MV^2 = Mgh$

~~$$\therefore h = \frac{V^2}{2g}$$~~

$$= \frac{1.8^2}{2 \times 9.8}$$

$$= 0.1653 \dots$$

$$\begin{aligned}
 &\approx \underline{0.17 \text{ m}} \\
 &\text{ANSWER}
 \end{aligned}$$

$$17. Mgh = \frac{1}{2} MV^2$$

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

$$= \sqrt{2 \times 9.8 \times 5}$$

$$= 9.89949 \dots$$

$$\approx \underline{9.9 \text{ m/s}}$$

ANSWER

18(a) The two forces are the external force 40N and the other is friction force.

Force, 40N is positive while friction force is negative since it is acting on the opposite side.

$$(b) \text{ Work} = \text{Force} \times \text{Distance}$$

$$= 40 \times 10$$

$$= \underline{400 \text{ J}}$$

ANSWER

This is Kinetic Energy.

$$(c) K.E = \frac{1}{2} MV^2$$

$$400 = \frac{1}{2} \times 50 \times V^2$$

$$\therefore V^2 = \frac{400}{25} = 16$$

$$V = \sqrt{16}$$

$$= \underline{4 \text{ m/s}}$$

$$(d) \text{ Friction} = Mgu$$

$$= 50 \times 9.8 \times 0.2$$

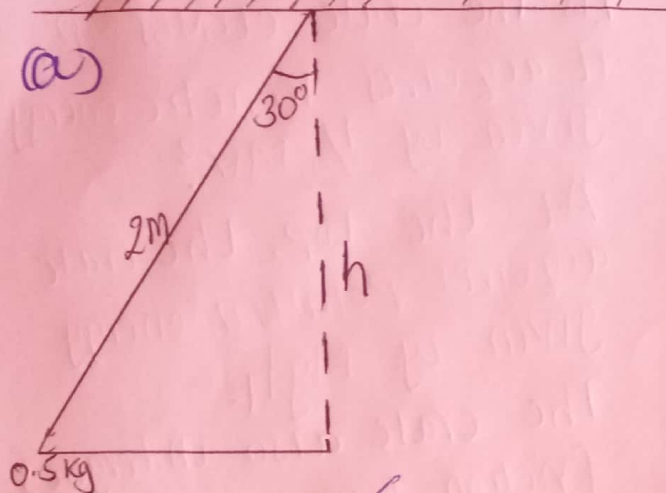
$$= 98 \text{ N}$$

Force, F , is less than friction

Through distance A and B, the crate move with reduced speed due to friction.

19.

(a)



$$\cos 30 = \frac{(2-h)}{2}$$

$$2 \cos 30 = 2-h$$

$$\cos 30 = \frac{h}{2}$$

$$\therefore h = 2 \cos 30$$

$$= 1.7320 \dots$$

$$\text{Launch height} = 2 - 1.732$$

$$= 0.267949 \dots$$

$$\approx \underline{0.27 \text{ m}}$$

ANSWER

(b) $P.E = K.E$

$$P.E = Mgh$$

$$= 0.5 \times 9.8 \times 0.27$$

$$= 1.323 \text{ J}$$

$$\therefore \cancel{1.323} = 0.5 \times$$

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

$$\therefore 1.323 = \frac{1}{2} \times 0.5 \times V^2$$

$$0.25 V^2 = 1.323$$

$$\therefore V^2 = \frac{1.323}{0.25}$$

$$= 5.292$$

$$V = \sqrt{5.292}$$

$$= 2.3 \text{ m/s}$$

ANSWER

20 (a)

$$\frac{1}{2} MV^2 = Mgh$$

$$Mgh = 60 \times 9.8 \times 10$$

$$= 5880 \text{ J}$$

$$\frac{1}{2} \times 60 \times V^2 = 5880$$

$$30V^2 = 5880$$

$$V^2 = 196$$

$$V = \sqrt{196} = 14 \text{ m/s}$$

ANSWER

$$\begin{aligned}
 (b) \quad K.E &= \frac{1}{2} MV^2 \\
 &= \frac{1}{2} \times 60 \times 12^2 \\
 &= 4320 \text{ J}
 \end{aligned}$$

Change in Energy

$$\begin{aligned}
 &= (5880 - 4320) \text{ J} \\
 &= \underline{1560 \text{ J}} \\
 &\text{ANSWER}
 \end{aligned}$$

20(a) Work

Work = Area under the graph

$$\begin{aligned}
 &= \frac{1}{2} (a+b) h \\
 &= \frac{1}{2} (65+50) 10 \\
 &= 575 \text{ Joules}
 \end{aligned}$$

In this part we are multiplying force by distance. Now, force x distance gives units of energy, joules.

20(b)

As the crate climbs up it acquires kinetic energy given by $\frac{1}{2} MV^2$.

At the top, the crate acquires potential energy given by Mgh .

The crate also undergoes friction force, which turns some energy into heat.

(c)

$$\text{Energy} = K.E = \frac{1}{2} MV^2$$

~~$$\frac{1}{2} MV^2 = 150$$~~

$$\frac{1}{2} MV^2 = Mgh$$

$$\begin{aligned}
 \text{but } Mgh &= 10 \times 9.8 \times 4 \\
 &= 392 \text{ J}
 \end{aligned}$$

Now we subtract the amount of energy converted to thermal energy.

$$392 - 150 = 242 \text{ J}$$

So the amount of K.E = 242 J

$$\therefore \frac{1}{2} MV^2 = 242 \text{ J}$$

$$\frac{1}{2} \times 10 \times V^2 = 242$$

$$V^2 = \frac{242}{5} = 48.4$$



$$\begin{aligned}
 V &= \sqrt{48.4} = 6.957 \\
 &\approx \underline{6.96 \text{ m/s}}
 \end{aligned}$$

ANSWER

$$1. \text{ Power} = \frac{\text{Work}}{\text{Time}}$$
$$= \frac{650 \times 12}{11}$$
$$709.09 \dots$$

$$\approx \underline{710 \text{ W}}$$

ANSWER

$$1 \text{ W} = 0.00134102 \text{ HP}$$
$$710 \text{ W} = ? = 710 \times 0.00134102 = 0.95 \text{ HP}$$

$$2. 4200 \text{ J} \rightarrow 70 \text{ sec}$$
$$? \leftarrow 1 \text{ sec}$$

$$= \frac{1}{70} \times 4200$$
$$= \underline{60 \text{ W}}$$

ANSWER

$$3. \text{ Mass} = 68 \text{ kg}$$
$$\text{Distance} = \left(\frac{20 \times 14}{100} \right) \text{ m} = 2.8 \text{ m}$$

$$\text{Time} = 4.8 \text{ sec}$$

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$
$$= \frac{68 \times 2.8 \times 9.8}{4.8} = \frac{3966.72}{4.8}$$

$$= 388.73$$

$$\approx \underline{390 \text{ W}}$$

ANSWER

4. Time

$$5. \text{ Work} = \text{Force} \times \text{Distance}$$

$$(a) = 70 \times 9.8 \times 290$$

$$= 1.989 \times 10^5$$

$$\approx \underline{2 \times 10^5 \text{ J}}$$

ANSWER

(b) No, it would not change
It just remain the same

(c) No, it would not change.
It just remain the same.

(d) Power will change
due to the change
in time duration.

$$6. (a) \text{ P.E} = mgh$$

$$= 70 \times 9.8 \times 400$$

$$= 274400$$

$$= \underline{2.74 \times 10^5 \text{ J}}$$

1. ~~Power = Work x Time~~
~~= 650 x 12 x 11~~

6(b) $\frac{274\ 400}{4 \times 60}$
 $= 1443$
 $\approx 1440 \text{ J/s}$
ANSWER

(c) Total P.E
 $= 570 \times 9.8 \times 400$
 $= 2,234\ 400 \text{ J}$
Rate = $\frac{\text{Work}}{\text{Time}}$
 $= \frac{2,234\ 400}{4 \times 60}$
 $= 9310 \text{ J/s}$
ANSWER

(d) Power = $\frac{\text{Work}}{\text{Time}}$
 $= \frac{2234\ 400}{4 \times 60}$
 $= 9310 \text{ W}$
ANSWER

(e) 25 % of the power
 $= 0.4 \times 9310$
 $= 3724 \text{ W}$
 $\approx 3.72 \times 10^4$
ANSWER

§
7. Work = Power x Time
 $= 3 \times 1000 \times 30 \times 60$
 $= 5,400,000$
 $= 5.4 \times 10^6 \text{ J}$
ANSWER

EFFICIENCY

1. The rest energy is usually transferred to the surroundings, making them warmer.

This energy eventually becomes so spread out that it becomes very difficult to do anything useful with it.

2. Work needed to lift the motorcycle $1.3 \text{ m} = F \times d$

$$W \Rightarrow F \times d$$

$$= 1200 \times 1.3 = 1560 \text{ J}$$

Work done through the ramp

$$W = F \times d$$

$$= 820 \times 2.4 = 1968 \text{ J}$$

$$\text{Efficiency} = \frac{1560}{1968} \times 100\%$$

$$= 79.26829\%$$

$$\approx 79\%$$

ANSWER

3. ^{heat} Ideally, the rate of transfer into the water would be,
- $$\frac{MC\Delta T}{t} = \frac{1 \times 4220 \times (88 - 18)}{3.6 \times 60}$$

$$= 1368 \text{ W}$$

But the kettle needs 1500W to achieve the same ~~tempera~~ temperature rise over the same time interval.

$$\text{Efficiency} = \frac{\text{Ideal Power}}{\text{Actual Power}} \times 100\%$$

$$= \frac{1368 \text{ W}}{1500 \text{ W}} \times 100\%$$

$$= 91.2\%$$

$$\approx 91\%$$

ANSWER

4. At time of throw;

$$E_1 = Mgh_1 + \frac{1}{2} M V_1^2$$

At time of bouncing

$$E_2 = Mgh_2 + \frac{1}{2} M V_2^2$$

$$\text{Efficiency} = \frac{E_2}{E_1} \times 100\%$$

Note that mass will cancel out.

$$V_1 = 4 \text{ m/s}$$

$$h_1 = 2.5 \text{ m}$$

$$V_2 = 0$$

$$h_2 = 2.7 \text{ m}$$

$$\text{Efficiency} = \frac{gh_2}{(gh_1 + \frac{1}{2} V_1^2)} = \frac{9.8 \times 2.7}{(9.8 \times 2.5) + \frac{1}{2} \times 4^2}$$

$$= 81.4\% \approx 81\%$$

ANSWER

5. The portion of final energy which is actually available after final conversion to the consumer for the respective use. In final conversion, electricity becomes for instance light, mechanical energy or heat.

6(a)

Energy before;

$$180000 \rightarrow 100\%$$

$$? \leftarrow 60\%$$

$$\frac{60\%}{100\%} \times 180000$$

$$= \underline{108000 \text{ btu}}$$

ANSWER

(b) In this case the furnace is 92% efficient hence to provide 108000 btu energy we have the size of furnace be n btu

Hence, 92% of $n = 108000$

$$\frac{92 \times n}{100} = 108000$$

$$n = \frac{108000 \times 100}{92}$$

$$= 117391.3 \text{ btu}$$

$$\approx \underline{117000 \text{ btu}}$$

ANSWER

7.

$$P = FV$$

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

Where $P = nW$

$$F = \mu Mg$$

then,

$$V = \frac{nW}{\mu Mg}$$

$$= \frac{0.81 \times 3.7 \times 10^3}{0.35 \times 450 \times 9.8}$$

$$= 1.94 \text{ m/s}$$

$$= \underline{1.94 \text{ m/s}}$$

ANSWER

MOMENTUM

1.

Momentum is convenient to work with because it is based on the concepts of Newton's Laws.

Momentum is more so convenient because it is a conserved quantity and it has the information of the dynamics of the system, like if we somehow know the momentum of a particle, we can evaluate physical quantities like velocity, force, energy e.t.c.

2. Elastic Collision—Both kinetic energy and momentum after collision are equal to kinetic energy and momentum before collision.

Inelastic collision—Both objects acquire same velocity after collision. Here, only momentum is conserved. Final kinetic energy is not equal to initial kinetic energy.

3.

Total momentum before collision = Total momentum after collision

$$\text{Mass 1} = M_1$$

$$\text{Velocity 1} = V_1$$

$$\text{Mass 2} = M_2$$

$$\text{Velocity 2} = V_2$$

$$\therefore \underline{M_1 V_1 + M_2 V_2 = M_1 V_1 + M_2 V_2}$$

$$4. M_1 V_1 = M_2 V_2$$

Note, here there is no negative sign.

$$5. M_1 V_1 = -M_2 V_2$$

Where $M = \text{Mass}$
 $V = \text{Velocity}$

Because the object explodes into two objects, one of the piece will move in the opposite direction as the other piece hence the negative sign.

$$6. \quad M_1 = 571 \text{ kg} \quad V_1 = 0 \text{ m/s}$$

$$M_2 = 1 \text{ kg} \quad V_2 = 0 \text{ m/s}$$

$$V_{1f} = ? \quad V_{2f} = 3.8 \times 10^5 \text{ m/s}$$

$$\Rightarrow M_1 V_1 + M_2 V_2 = M_1 V_{1f} + M_2 V_{2f}$$

$$(57 \times 0) + (1 \times 0) = (57 \times V_{1f}) + (3.8 \times 10^5 \times 1)$$

$$= -6700 \text{ m/s}$$

Now, -ve sign means it is acting on the opposite direction.

$$= \underline{6700 \text{ m/s}}$$

ANSWER

7.

$$P_i = 0$$

$$P_f = M_a V_a + M_c V_c$$

$$M_a = 145 \text{ kg}$$

$$V_a = 2.5 \text{ m/s}$$

$$M_c = 1850 \text{ kg}$$

$$V_c = ?$$

Since total momentum must be conserved, we have,

$$P_i = P_f = 0$$

$$\therefore M_a V_a + M_c V_c = 0$$

$$\therefore V_c = - \frac{M_a V_a}{M_c}$$

$$= - \frac{145 \times 2.5}{1850}$$

$$= -0.195$$

$$\approx \underline{0.20 \text{ m/s}}$$

ANSWER

The negative sign indicates that the speed is on the opposite side.

8. When the 1st astronaut throws the second one at the third one, he will be pushed back equally as far as he threw. Since he is in space and there is nothing to slow him down, he will drift away. First astronaut gone.

Once the second one arrives at the third astronaut, he will hit him and then both the second and third will go flying into space.

The second and third will probably be traveling half as fast into space as the first astronaut.

The game will not continue past the first throw, unless, while drifting in space, the third astronaut passed the second one to the first one. The second one would come to a stop, and the third astronaut would then be travelling as fast as the first, in opposite directions, into space.

$$\begin{aligned}
 9. \quad M_p V_p &= (M_p + M_s) V_{\text{final}} \\
 V_p &= \frac{(M_p + M_s)}{M_p} V_{\text{final}} \\
 &= \left(1 + \frac{M_s}{M_p}\right) V_{\text{final}} \\
 &= \left(1 + \frac{495}{5}\right) \times 2 \\
 \underline{V_p} &= \underline{200 \text{ m/s}}
 \end{aligned}$$

$$\begin{aligned}
 10. \quad p &= \text{Mass} \times \text{Velocity} \\
 m_1 v_1 &= m_2 v_2 \\
 (64 \times 3.2) &= (96 + 64) \times v_2 \\
 \therefore v_2 &= \frac{64 \times 3.2}{96 + 64} \\
 &= \frac{64 \times 3.2}{160} \\
 &= \underline{1.28 \text{ m/s}} \\
 &\quad \text{ANSWER}
 \end{aligned}$$

$$\begin{aligned}
 11. \quad \text{Mass of Titanic} &= M \\
 \text{Mass of iceberg} &= \frac{M}{2}
 \end{aligned}$$

$$V_{\text{ice}} = 0$$

$$V_{\text{tit}} = 22 \text{ knots}$$

$$V_{\text{ice}} = ?$$

$$V_{\text{tit}} = 6 \text{ knots}$$

We know,

$$M_{\text{tit}} V_{\text{tit}} + M_{\text{ice}} V_{\text{ice}} = M_{\text{t}} V_{\text{t}} + M_{\text{i}} V_{\text{i}}$$

$$M \times 22 + 0 = M \times 6 + \frac{M}{2} \times V_i$$

$$22M = 6M + \frac{M}{2} V_i$$

$$16M = \frac{M}{2} V_i$$

$$32M = M V_i$$

$$\text{So, } V_i = 32 \text{ knot} = \underline{16.4 \text{ m/s}}$$

ANSWER

12. $M = 0.35 \text{ kg}$

$V_i = +40 \text{ m/s}$

$V_f = -21 \text{ m/s}$

Impulse, $J = ?$

Impulse = Change in Momentum, P

but $P = MV$

So $J = \Delta P = P_f - P_i$

$J = MV_f - MV_i$

$= M(V_f - V_i)$

$= 0.35(-21 - 40)$

$= -21.35 \text{ Ms}$

$\approx -21.4 \text{ Ms}$

The negative sign indicates that the impulse is moving on the opposite direction, so we just ignore it and give the answer as 21.4 Ms

ANSWER

13. Change in Momentum

(a) $= MV_f - MV_i$

$= M(V_f - V_i)$

$= 0.045(38 - 0)$

$= 0.045 \times 38 = \underline{1.71 \text{ Ms}}$

ANSWER

13(b)

Acceleration = $\frac{\text{Velocity}}{\text{Time}}$

$V = 38 \text{ m/s}$

$t = 3 \times 10^{-3} = 0.003 \text{ s}$

$a = \frac{V}{t} = \frac{38}{0.003} = 12666.667$

$= 12666.667 \text{ m/s}^2$

Force = Mass x Acceleration

$= 0.045 \times 12666.667$

$= \underline{570 \text{ Newtons}}$

14. Velocity = $40 - -50 = 90 \text{ m/s}$

Time = 0.02 seconds

Acceleration = $\frac{\text{Velocity}}{\text{Time}}$

$= \frac{90}{0.02} = 4500 \text{ m/s}^2$

Force = Mass x Acceleration

$= 0.12 \times 4500$

$= \underline{540 \text{ Newtons}}$

ANSWER

15. Impulse = Area under the graph.

$$= \frac{1}{2} b h$$

$$= \frac{1}{2} \times \frac{4}{1000} \times 80$$

$$= 0.16 \text{ Ms}$$

ANSWER

16. Follow through increase the amount of time that ball is in touch with you. So, greater time, more force hence more momentum. Thus increasing the speed of puck. It dissipates the energy slowly rather than letting it go suddenly.

17 (a) Impulse

$$\text{Impulse} = \text{Force} \times \text{Time}$$

$$= 1 \times 10^6 \times 20$$

$$= 20000000$$

$$= 2 \times 10^7 \text{ Ms}$$

$$= -2 \times 10^7 \text{ Ms} \Rightarrow \text{ANSWER}$$

The negative sign means it is acting on the opposite direction.

(b)

$$\text{Impulse} = \text{Momentum}_{\text{Final}} - \text{Momentum}_{\text{Initial}}$$

$$20000000 = M_f - 13000 \times 1000 \times 11$$

$$20000000 = M_f - 143000000$$

$$M_f =$$

(b)

$$\text{Initial Momentum} = \text{Final Momentum}$$

Now, our impulse is $-2 \times 10^7 \text{ Ms}$

$$\Rightarrow -2 \times 10^7 = M_f - (13000 \times 1000 \times 11)$$

$$-2 \times 10^7 = M_f - 143000000$$

$$\therefore M_f = 143000000 - 20000000$$

$$= 123000000$$

$$= 1.23 \times 10^8 \text{ kg m/s}$$

ANSWER

(c)

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$

$$\therefore \text{Velocity} = \frac{\text{Momentum}}{\text{Mass}}$$

$$= \frac{1.23 \times 10^8}{13000 \times 1000}$$

$$= 9.4615 \text{ m/s}$$

$$\approx 9.5 \text{ m/s}$$

ANSWER

18.

$$\text{Initial Momentum} = \text{Final Momentum}$$

$$(20000 \times 5) + (40000 \times 1.8)$$

$$= (20000 \times -1.5) + (40000 V_2)$$

$$\Rightarrow 172000 = -30000 + 40000 V_2$$

$$\Rightarrow 202000 = 40000 V_2$$

$$\therefore V_2 = \frac{202000}{40000}$$

$$= 5.05 \text{ m/s}$$

$$\approx \underline{5.1 \text{ m/s}}$$

ANSWER

19.

$$M_1 V_1 + M_2 V_2 = M_T V_f$$

Conservation of momentum shows that mass $\times$ velocity is conserved, so the mass of the two cars together at 19 km/h is equal to Newton's car on its own and how fast he was going pre-impact.

$$(2100 + 2600) 19 = 2100 \times V$$

$$\therefore V = 42.5 \text{ km/h}$$

So his speed was faster than 35 km/h and is not telling the truth.

Explanation

2a (a)

This is an elastic collision. It can not be inelastic collision because, for inelastic both objects move at a common velocity and mostly, they get embedded into each other.

(b) (i) Initial and final kinetic energy.

(ii) Initial and final momentum.

(c) The velocity of the rear will reduce. This is so because for any system, the initial momentum must be equal to the final momentum.

20(a)

$$\begin{aligned} \text{Initial Momentum} &= \text{Final Momentum} \\ (1200 + 450) \times 230 &= 1200V + (450 \times 280) \end{aligned}$$

$$379500 = 1200V + 126000$$

$$\therefore 1200V = 253500$$

$$V = \underline{211.25 \text{ m/s}}$$

ANSWER

(e) Change of Momentum for front rear.

$$\begin{aligned} \text{Initial Momentum} &= 1200 \times 230 \\ &= 276000 \end{aligned}$$

$$\begin{aligned} \text{Final Momentum} &= 1200 \times 211.25 \\ &= 253500 \end{aligned}$$

$$\begin{aligned} \text{Change} &= 276000 - 253500 \\ &= \underline{22500 \text{ kg m/s}} \end{aligned}$$

ANSWER

(f)

Impulse = Change in Momentum

$$\begin{aligned} &= 276000 - 253000 \\ &= \underline{22500 \text{ kg m/s}} \end{aligned}$$

ANSWER

OR

$$253000 - 276000$$

$$\begin{aligned} &= -22500 \text{ kg m/s} \\ &\quad \downarrow \\ &= \underline{22500 \text{ kg m/s}} \end{aligned}$$

ANSWER

(g)

Impulse can take both positive and negative signs. It all depends on the direction of the force causing it.

21 (a) The units given by area under the graph is Newton-second (Ns). The unit Newton-second represent impulse.

21 (b)

$$\text{Number of full squares} = 16$$

$$\text{Number of Partial squares} = 12$$

$$\text{Area} = 16 + \frac{1}{2}(12) = 22$$

$$50 \times \frac{1}{100} \times 22$$

$$= 1.1 \text{ M/s}$$

$$\approx 1 \text{ M/s}$$

ANSWER

(c) The impulse given to the ball is given by area under the graph. According to calculation in part b, the impulse is

$$1 \text{ M/s}$$

ANSWER

(d) Impulse = Change in Momentum

$$\text{Initial Momentum} = 0.055 \times 0 = 0$$

$$\text{Final Momentum} = 0.055 \times V_f = 0.055 V_f$$

$$\therefore \Rightarrow 0.055 V_f - 0 = 1$$

$$\Rightarrow 0.055 V_f = 1$$

$$V_f = \frac{1}{0.055} = 18.1818 \dots$$

$$\approx 18.1 \text{ M/s}$$

ANSWER

~~(c)~~

22 (c)

This is an inelastic collision. A collision where the two objects combine and move with a common velocity.

$$\text{Initial Momentum} = \text{Final Momentum}$$

$$0.05 \times 125 = V_f (2.6 + 0.05)$$

$$6.25 = 2.65 V_f$$

$$\therefore V_f = \frac{6.25}{2.65}$$

$$= 2.35849$$

$$\approx 2.36 \text{ M/s}$$

ANSWER

22(b)

The energy obtained by the block is kinetic energy.

At maximum height, this kinetic energy is converted to potential energy.

(c)

$$P.E = K.E$$

$$P.E = Mgh$$

$$\therefore Mgh = \frac{1}{2} M V^2$$

$$2.65 \times 9.8 \times h = \frac{1}{2} \times 2.65 \times 2.36^2$$

$$9.8h = 2.7848$$

$$h = \frac{2.7848}{9.8}$$

$$= 0.2841 \text{ m}$$

$$\approx 0.28 \text{ m}$$

ANSWER

23.

Situation	Total K.E after	Is there change in K.E
Elastic Collision	Same	No Change
Inelastic Collision	Decrease	Yes. It decreases
Explosion	Increase	Yes, the object may speed up.

24. Now, locomotives are very heavy and so they produce very large momentum. There is simply no vehicle which can cause a sudden serious and dangerous deceleration apart, only a very heavy object like a big tree or another train.

2D Momentum

1. Initial Momentum

=

Final Momentum

$$(0.25 \times 5) + (0.25 \times 0) = (0.25 \times 1) + (0.25 \times V)$$

$$\Rightarrow 1.25 = 0.25 + 0.25V$$

$$1 = 0.25V$$

$$\therefore V = \frac{1}{0.25} = 4 \text{ m/s}$$

$$\therefore = \underline{4 \text{ m/s East}}$$

ANSWER

2. (a)

The final momentum must be equal to initial momentum.

Now, initial momentum is given by mass $\times$ Velocity.

$$\text{ie } M \times V = (20 \times 0) = 0$$

Therefore, the total momentum of the three pieces should also be

Zero.

ANSWER

(b) Explosions occur when energy is transformed from one kind eg chemical, potential energy to another eg heat energy or kinetic energy extremely quickly. So, like in inelastic collisions, total kinetic energy is not conserved in explosions. But total momentum is always conserved.

(c) If only internal forces are doing work (ie no work done by external forces), then there is no change in the total amount of mechanical energy. The total mechanical energy is said to be conserved.

(d) Net momentum must be Zero.

5 kg

$$5V_1 + 9V_2 + 6V_3 = 0$$

$$5V_1 + 9V_2 = -6V_3$$

$$-V_3 = \frac{(5 \times 7) + -9 \times 4 \cos 38 + -9 \times 4 \sin 38}{6}$$

$$= \frac{35 - 36 \sin 38 - 9 \cos 38 \times 4}{6}$$

$$= \frac{12.836 \text{ J} - 28.361 \text{ J}}{6}$$

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$$V_3 = 4.72\hat{i} - 2.13935\hat{j}$$

$$\text{Magnitude} = \underline{5.19 \text{ M/s}}$$

ANSWER

For direction we use;

$$\tan^{-1} \frac{2.13}{4.72} = 24.28^\circ$$

$$\text{Now, } 90^\circ - 24.28^\circ = 65.72^\circ$$

$$\approx 66^\circ$$

$$\Rightarrow \underline{66^\circ \text{ East of South}}$$

ANSWER

3(a)

$$M_1 V_{1i} + M_2 V_{2i} = M_1 V_{1f} + M_2 V_{2f}$$

Now, when they combine, we have;

$$M_1 V_{1i} + M_2 V_{2i} = V_f (M_1 + M_2)$$

$$\therefore V_f = \frac{(M_1 V_{1i} + M_2 V_{2i})}{M_1 + M_2}$$

$$V_f = \frac{98(-1.8\hat{i} - 1.12\hat{j}) + 87(1.04\hat{i} + 0.94\hat{j})}{98 + 87}$$

$$V_f = (-0.463\hat{i} - 0.155\hat{j}) \text{ M/s}$$

The magnitude is given by

$$\sqrt{-0.463^2 + -0.155^2}$$

$$= \sqrt{0.238394}$$

$$= 0.488 \text{ M/s}$$

Then we have

$$\underline{0.488 \text{ M/s, } 18.5^\circ \text{ South of West}}$$

ANSWER

(b)

Impulse

$$= 98(-0.463\hat{i} - 0.155\hat{j}) - (-1.8\hat{i} - 1.12\hat{j})$$

$$= (131\hat{i} + 94.9\hat{j}) \text{ kg M/s}$$

$$\text{Magnitude} = \sqrt{131^2 + 94.9^2}$$

$$= \sqrt{26167.01}$$

$$= 161.76$$

$$\approx 161.8 \text{ kg M/s}$$

$$\text{direction } \tan^{-1} \left(\frac{-94.9}{-131} \right)$$

$$= 35.92^\circ \approx 36^\circ$$

$$\text{So, } 161.8, 36^\circ \text{ North of East}$$

ANSWER