National 5 Physics.

Dynamics and Space Self Checks.

Solutions

Speed, Distance and Time.

1. (a) $v = \frac{d}{t} = \frac{100}{20} = \underline{\underline{5\,ms^{-1}}}$

(b) $v = \frac{d}{t} = \frac{20}{4} = \underline{\underline{5\,ms^{-1}}}$

(c) $d = vt = 25 \times 0.5 = \underline{\underline{12.5\,m}}$

(d) $d = vt = 16 \times 55 = \underline{\underline{880\,m}}$

(e) $t = \frac{d}{v} = \frac{60}{1200} = \underline{\underline{0.05\,s}}$

(f) $t = \frac{d}{v} = \frac{15000}{75} = \underline{\underline{200\,s}}$

2. $v = \frac{d}{t}$

$v = ?$
$d = 200\,m$
$t = 25\,s$

$v = \frac{200}{25}$

$v = \underline{\underline{8\,ms^{-1}}}$

3. $V = \frac{d}{t}$

$V = ?$
$d = 1500\,m$
$t = 4\,min\ 20\,s$
$= (4 \times 60) + 20$
$= 260\,s$

$V = \frac{1500}{260}$

$V = \underline{\underline{5.8\ ms^{-1}}}$

4. $V = \frac{d}{t}$

$V = ?$
$d = 2\,km$
$= 2 \times 10^3\,m$
$t = 3\,mins$
$= 3 \times 60$
$= 180\,s$

$V = \frac{2 \times 10^3}{180}$

$V = \underline{\underline{11.1\ ms^{-1}}}$

5. $d = vt$

$d = ?$
$v = 680\,ms^{-1}$
$t = 25\,s$

$d = 680 \times 25$

$d = \underline{17,000\,m}$
$(= \underline{\underline{17\ km}})$

6. $d = vt$

$d = ?$
$v = 2\,ms^{-1}$
$t = 20\,mins$
$= 20 \times 60$
$= 1200\,s$

$d = 2 \times 1200$

$d = \underline{2400\ m}$

7. $d = vt$

$d = ?$
$V = 400\ ms^{-1}$
$t = 5\ mins$
$= 5 \times 60$
$= 300\ s$

$d = 400 \times 300$

$d = \underline{120 \times 10^3}\ m$

$(= 1 \cdot 2 \times 10^5\ m)$

$(= 120\ km)$

8. $V = \frac{d}{t}$

$V = \frac{200\ km}{1\ hour}$

$V = \frac{200 \times 10^3\ m}{(60 \times 60)\ s}$

$V = \frac{200 \times 10^3}{3600}$

$V = 56\ ms^{-1}$

$\therefore$ the train travels 56m in 1 second.

9. $t = \frac{d}{V}$

$t = ?$
$d = 40\ km$
$= 40 \times 10^3\ m$
$V = 5\ ms^{-1}$

$t = \frac{40 \times 10^3}{5}$

$t = \underline{\underline{8000\ s}}$

10. $t = \frac{d}{v}$

$t = ?$
$d = 50\ Km$
$= 50 \times 10^3\ m$
$v = 90\ ms^{-1}$

$t = \frac{50 \times 10^3}{90}$

$t = \underline{555\ s}$

11. (a) $V = \frac{d}{t}$

$V = ?$
$d = 10\ Km$
$t = 1\ hr\ 3mins$
$= 1 + \left(\frac{3}{60}\right) hr$
$= 1{\cdot}05\ hr$

$V = \frac{10}{1{\cdot}05}$

$V = \underline{9{\cdot}5\ Km\ h^{-1}}$

(b) $v = \frac{d}{t}$

$V = ?$
$d = 10\ Km$
$= 10 \times 10^3\ m$
$t = 1\ hr\ 3mins$
$= 63mins$
$= (60 \times 63)\ s$
$= 3780\ s$

$v = \frac{10 \times 10^3}{3780}$

$v = \underline{2{\cdot}6\ ms^{-1}}$

12. $t = \frac{d}{v}$

$t = ?$
$v = 1{\cdot}6\ ms^{-1}$
$d = 33\ Km$
$= 33 \times 10^3\ m$

$t = \frac{33 \times 10^3}{1{\cdot}6}$

$t = \underline{20625\ s}$

13. $V = \frac{d}{t}$

$d = 150$ km
$= 150 \times 10^3$ m
$t = 4$ hours
$= (4 \times 60 \times 60)$ s
$= 14400$ s
$V = ?$

$V = \frac{150 \times 10^3}{14400}$

$V = \underline{\underline{10.4\ ms^{-1}}}$

14. $d = vt$

$d = ?$
$V = 20\ kmh^{-1}$
$t = 3$ hr 30 min
$= 3.5$ hrs

$d = 20 \times 3.5$

$d = \underline{\underline{70\ Km}}$

15. $V = \frac{d}{t}$

$V = ?$
$d = 1$ Km
$= 1 \times 10^3$ m
$t = 3.5$ s

$V = \frac{1 \times 10^3}{3.5}$

$V = \underline{\underline{286\ ms^{-1}}}$

16. (a) $V = \frac{270\ Km}{1\ hour}$

$V = \frac{270 \times 10^3\ m}{(60 \times 60)\ s}$

$V = \frac{270 \times 10^3}{3600} = \underline{\underline{75\ ms^{-1}}}$

(b) $v = \frac{d}{t}$

$v = ?$
$d = 425$
$t = 2 \text{ hours}$

$v = \frac{425}{2}$

$v = \underline{\underline{213 \text{ Km h}^{-1}}}$

17. (a) $v = \frac{d}{t}$

$v = ?$
$d = 250 \text{ Km}$
$= 250 \times 10^3 \text{ m}$
$t = 2 \text{ hours } 59 \text{ mins}$
$= (2 \times 60) + 59 \text{ mins}$
$= 179 \text{ mins}$
$= (179 \times 60) \text{s}$
$= 10740 \text{ s}$

$v = \frac{250 \times 10^3}{10740}$

$v = \underline{\underline{23 \cdot 3 \text{ ms}^{-1}}}$

(b) Glasgow → Perth:

Perth → Dundee :

Dundee → Aberdeen :

18. (a) $v = \frac{d}{t}$

$v = ?$
$d = 36m$
$t = 12s$

$v = \frac{36}{12}$

$v = \underline{\underline{3 ms^{-1}}}$

(b) $t = \frac{d}{v}$

$t = ?$
$d = 36m$
$v = 2 \times 340$
$= 680 ms^{-1}$

$t = \frac{36}{680}$

$t = \underline{\underline{0.053 s}}$

Instantaneous Speed

1. (a) $v = \frac{d}{t} = \frac{0.2}{0.10} = \underline{\underline{2 ms^{-1}}}$

(b) $v = \frac{d}{t} = \frac{0.1}{0.10} = \underline{\underline{1 ms^{-1}}}$

(c) $v = \frac{d}{t} = \frac{0.08}{0.04} = \underline{\underline{2 ms^{-1}}}$

(d) $v = \frac{d}{t} = \frac{0.14}{0.2} = \underline{\underline{0.7 ms^{-1}}}$

(e) $v = \frac{d}{t} = \frac{0.15}{0.3} = \underline{\underline{0.5 ms^{-1}}}$

(f) $V = \frac{d}{t} = \frac{0.3}{0.4} = \underline{\underline{0.75\ ms^{-1}}}$

2. $V = \frac{d}{t}$

$V = ?$
$d = 3.5m$
$t = 2.4s$

$V = \frac{3.5}{2.4}$

$V = \underline{\underline{1.46\ ms^{-1}}}$

3. A : $V = \frac{d}{t} = \frac{0.2}{0.025} = 8\ ms^{-1}$

B : $V = \frac{d}{t} = \frac{0.2}{0.026} = 7.7\ ms^{-1}$

C : $V = \frac{d}{t} = \frac{0.2}{0.030} = 6.7\ ms^{-1}$

D : $V = \frac{d}{t} = \frac{0.2}{0.029} = 6.9\ ms^{-1}$

E : $V = \frac{d}{t} = \frac{0.2}{0.025} = 8\ ms^{-1}$

F : $V = \frac{d}{t} = \frac{0.2}{0.024} = 8.3\ ms^{-1}$

(a) Fastest at F (b) Slowest at C

4. (a) $V = \dfrac{\text{length of card}}{\text{time to pass gate}}$

$V = \dfrac{0 \cdot 1}{0 \cdot 20}$

$V = \underline{\underline{0 \cdot 5 \text{ ms}^{-1}}}$

(b) $V = \dfrac{\text{length of card}}{\text{time to pass gate}}$

$V = \dfrac{0 \cdot 1}{0 \cdot 16}$

$V = \underline{\underline{0 \cdot 63 \text{ ms}^{-1}}}$

(c) $V = \dfrac{\text{length of ramp}}{\text{time between gates}}$

$V = \dfrac{0 \cdot 8}{1 \cdot 42}$

$V = \underline{\underline{0 \cdot 56 \text{ ms}^{-1}}}$

Distance and Displacement.

1. (a) distance $= 50 + 100$
$= \underline{150\text{ m}}$

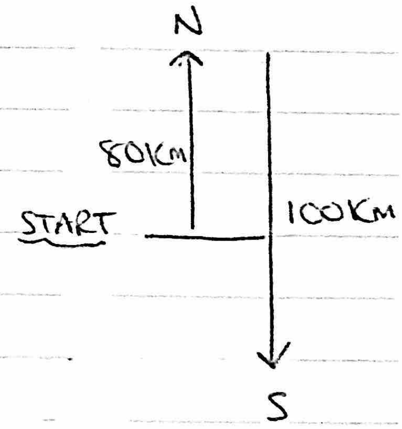
(b) displacement $= \underline{150\text{ m East}}$

2. (a) distance $= 100 + 50$
$= \underline{150\text{ m}}$

(b) displacement $= \underline{50\text{ m East}}$

3. (a) distance $= 80 + 100$
$= \underline{180\text{ Km}}$

(b) displacement $= \underline{20\text{ Km south}}$

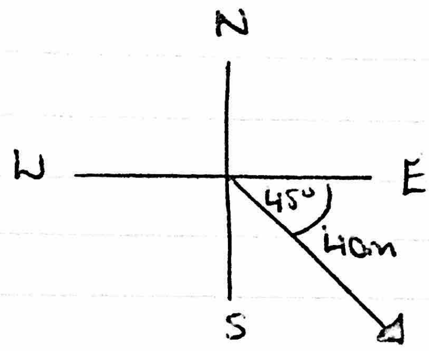


4. (a) distance $= 60 + 20$
$= \underline{80\text{ Km}}$

(b) displacement $= \underline{40\text{m South}}$

Vectors and Scalars.

1. (a) Compass point = 45° South of East

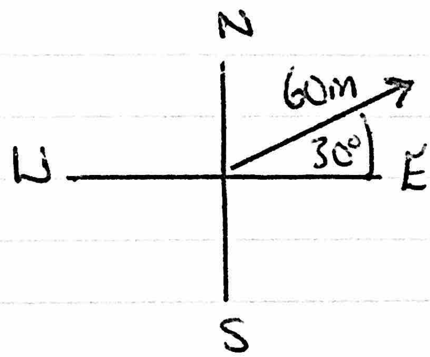


40m at 45° S of E

Bearing = 90 + 45
= 135°

40 m at 135°

(b)

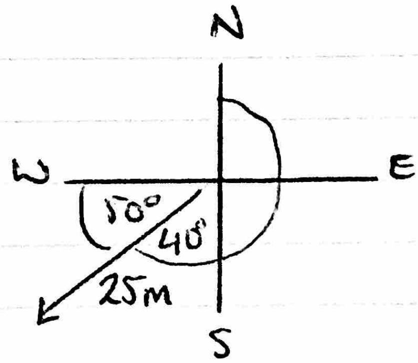


Compass point = 30° N of E
60 m at 30° N of E

Bearing = 90 − 30
= 060°

60m at 060°

(c) Compass point = 50° S of W

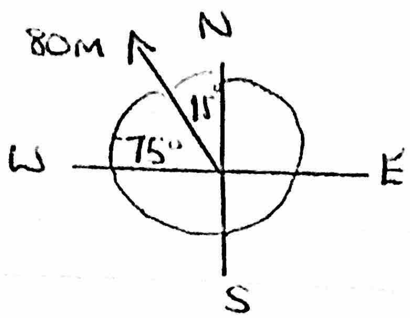


25m at 50° S of W

Bearing = 180 + 40
= 220°

25m at 220°

(d) Compass point = 75° N of W
80m at 75° N of W



Bearing = 360 - 5
= 3 5°

80m at 345°

2. A scalar has only magnitude.
A vector has both magnitude and direction.

3. (a) Displacement = straight line from X to Y

= 2 Km

(b) Distance =
= 3·6 Km

(c) (i) $V = \frac{\text{distance}}{\text{time}}$

$V = \frac{d}{t}$

$V = ?$
$d = 3{\cdot}6 \text{ Km}$
$= 3{\cdot}6 \times 10^3 \text{ m}$
$t = 40 \text{ mins}$
$= (40 \times 60) \text{s}$
$= 2400 \text{s}$

$V = \frac{3{\cdot}6 \times 10^3}{2400}$

$V = 1{\cdot}5 \text{ ms}^{-1}$

ii) $V = \frac{\text{displacement}}{\text{time}}$

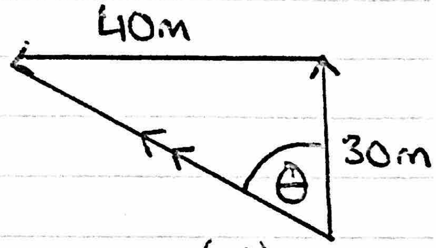
$V = ?$
$S = 2\,km$
$= 2 \times 10^3\,m$
$t = 2400\,s$

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

$$V = \frac{2 \times 10^3}{2400}$$

$$V = 0.83\,ms^{-1}\ \text{West}$$

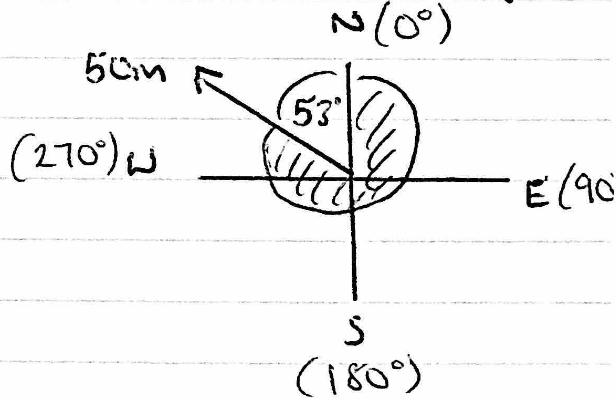
4. (a) distance $= 30 + 40 = \underline{70m}$



(b) $X^2 = 40^2 + 30^2$

$$X = \sqrt{40^2 + 30^2}$$

$$X = \underline{50\,m}$$



(c) $\tan\theta = \frac{O}{A}$

$$\tan\theta = \frac{40}{30}$$

$$\theta = \tan^{-1}\left(\frac{40}{30}\right)$$

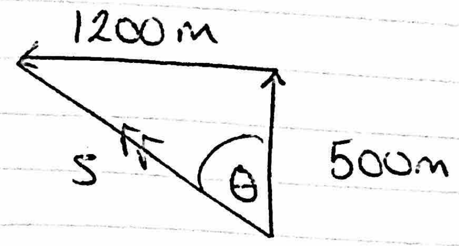
$$\theta = \underline{53°}$$

Compass point $=$ $\underline{\underline{53° \text{ W of N}}}$

Bearing $= 360 - 53 = \underline{307°}$

(d) Bearing $= 360 - 53$
$= \underline{307°}$

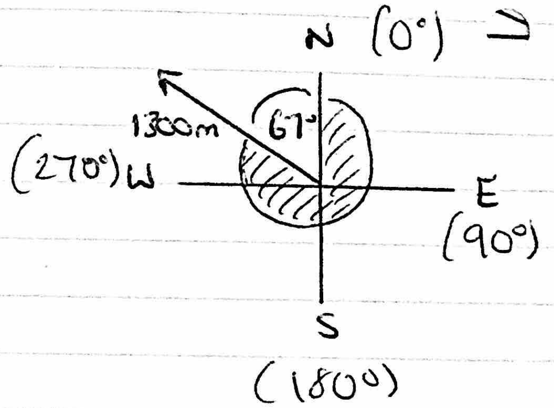
5. (a) distance $= 1200 + 500$
$= \underline{1700m}$



(b) $S^2 = 1200^2 + 500^2$

$S = \sqrt{1200^2 + 500^2}$

$S = \underline{1300m}$



$\tan\theta = \frac{O}{A}$

$\tan\theta = \frac{1200}{500}$

$\theta = \tan^{-1}\left(\frac{1200}{500}\right)$

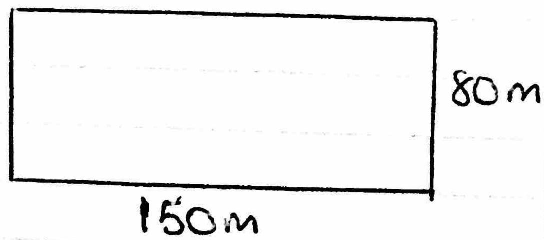
$\theta = \underline{67°}$

Compass point = $\underline{67° \text{ W of N}}$

Bearing $= 360 - 67$
$= \underline{293°}$

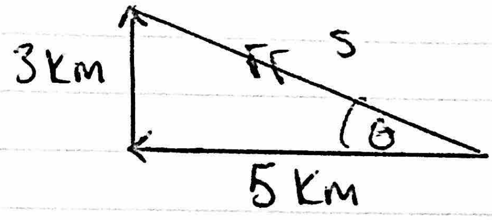
1300m at 67° W of N
or 1300m at 293°

6. (a) distance $= 150 + 80 + 150 + 80$
$= \underline{460m}$



(b) $\underline{0m}$

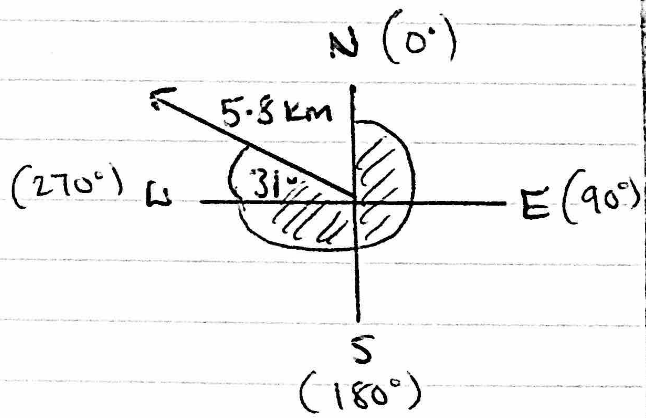
7. (a) distance $= 5 + 3$
$= \underline{8 \text{ Km}}$



(b) $s^2 = 3^2 + 5^2$

$S = \sqrt{3^2 + 5^2}$

$S = \underline{5{\cdot}8 \text{ Km}}$



$\tan\theta = \frac{O}{A}$

$\tan\theta = \frac{3}{5}$

$\theta = \tan^{-1}\left(\frac{3}{5}\right)$

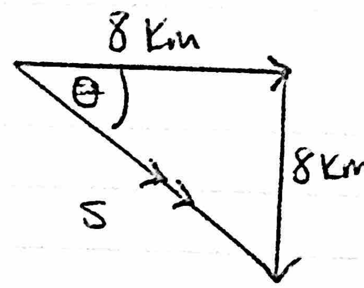
$\theta = \underline{31°}$

Compass point $= 31°$ N of W
Bearing $= 270 + 31$
$= 301°$

5·8 Km at 31° N of W
or/ 5·8 Km at 301°

8. (a) distance $= 8 + 8$

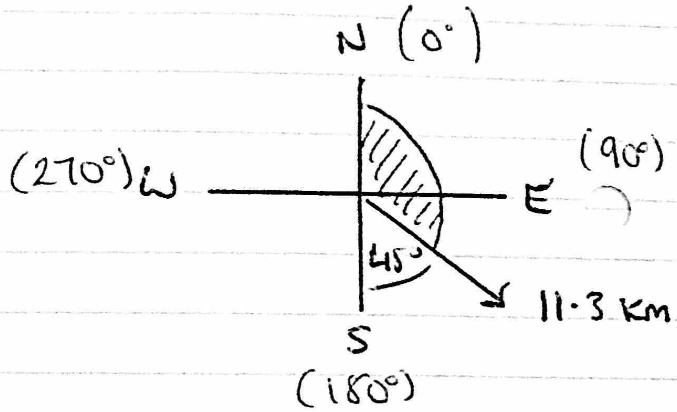
$= \underline{16 \text{ Km}}$



(b) $S^2 = 8^2 + 8^2$

$S = \sqrt{8^2 + 8^2}$

$S = \underline{11.3 \text{ Km}}$



$\tan \theta = \frac{O}{A}$

$\tan \theta = \frac{8}{8}$

$\theta = \tan^{-1}\left(\frac{8}{8}\right)$

$\theta = \underline{45°}$

Compass point $= 45°$ S of E

Bearing $= 180 - 45$

$= \underline{135°}$

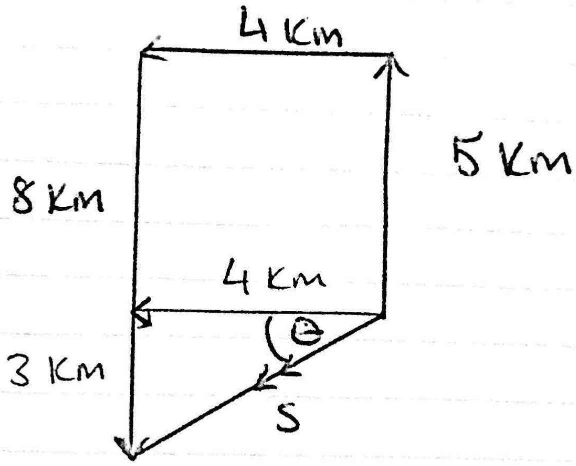
11.3 Km at 45° S of E

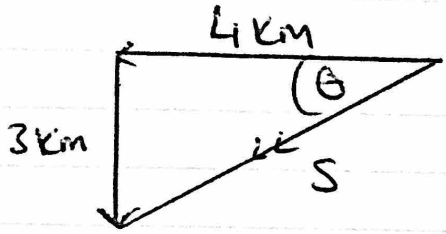
or 11.3 Km at 135°

9. (a) distance $= 5 + 4 + 8$

$= \underline{17 \text{ km}}$

(b)

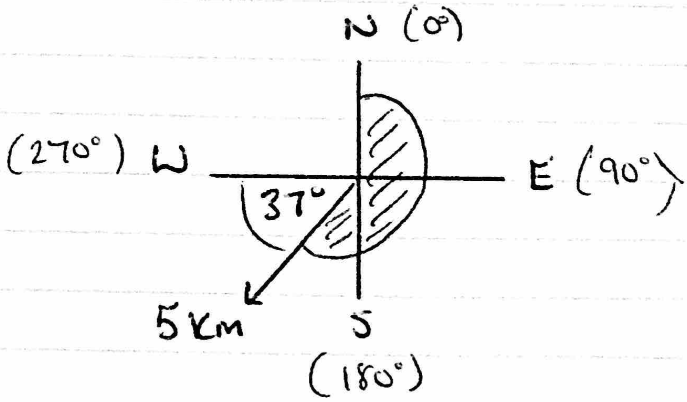




$S^2 = 3^2 + 4^2$

$S = \sqrt{3^2 + 4^2}$

$S = \underline{5 \text{ km}}$



$\tan\theta = \frac{O}{A}$

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

$\theta = \tan^{-1}\left(\frac{3}{4}\right)$

$\theta = \underline{37°}$

Compass point $= 37°$ S of W

Bearing $= 270 - 37 = 233°$

5 km at 37° S of W

or 5 km at 233°

Speed and Velocity.

1. (a) distance = 400 m

(b) displacement = 0 m

(c) $V = \frac{d}{t}$

$V = \frac{400}{48}$

$V = \underline{8 \cdot 3 \ ms^{-1}}$

(d) $V = \frac{S}{t}$

$V = \frac{0}{48}$

$V = \underline{0 \ ms^{-1}}$

2. (a) $V = \frac{d}{t}$

$V = \frac{5 \times 10^3}{4200}$

$V = \underline{1 \cdot 2 \ ms^{-1}}$

$V = ?$
$d = 5 \ Km$
$= 5 \times 10^3 \ m$
$t = 70 \ mins$
$= (70 \times 60)$
$= 4200 \ s$

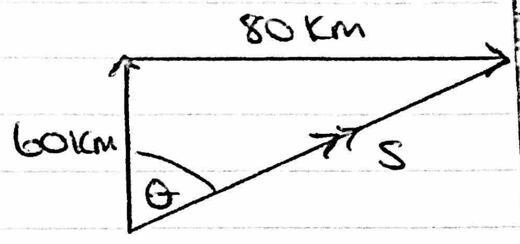
(b) $v = \frac{s}{t}$

$v = ?$
$s = 3\ km$
$= 3 \times 10^3\ m$
$t = 4200\ s$

$v = \frac{3 \times 10^3}{4200}$

$v = \underline{0.7\ ms^{-1} \text{ at } 085°}$

3. (a) $d = 60 + 80$
$= \underline{140\ km}$

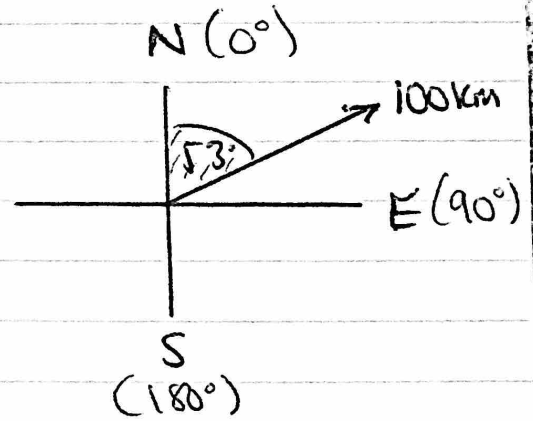


(b) $s^2 = 60^2 + 80^2$

$s = \sqrt{60^2 + 80^2}$

$s = \underline{100\ km}$

$\tan\theta = \frac{O}{A}$



$\tan\theta = \frac{80}{60}$

$\theta = \tan^{-1}\left(\frac{80}{60}\right)$

$\theta = \underline{53°}$

Compass point = 53° E of N
Bearing = 053°

100 km at 53° E of N or 100 km at 053°

(c) $V = \frac{d}{t}$

$V = ?$
$d = 140\ km$
$t = 2\ hours$

$V = \frac{140}{2}$

$V = \underline{\underline{70\ kmh^{-1}}}$

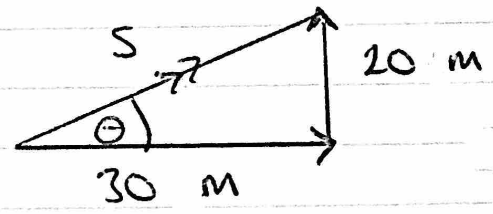
(d) $V = \frac{S}{t}$

$V = ?$
$S = 100\ km$
$t = 2\ hours$

$V = \frac{100}{2}$

$V = \underline{\underline{50\ kmh^{-1} \text{ at } 053^\circ}}$

4. (a) $d = 30 + 20$
$= \underline{\underline{50\ m}}$

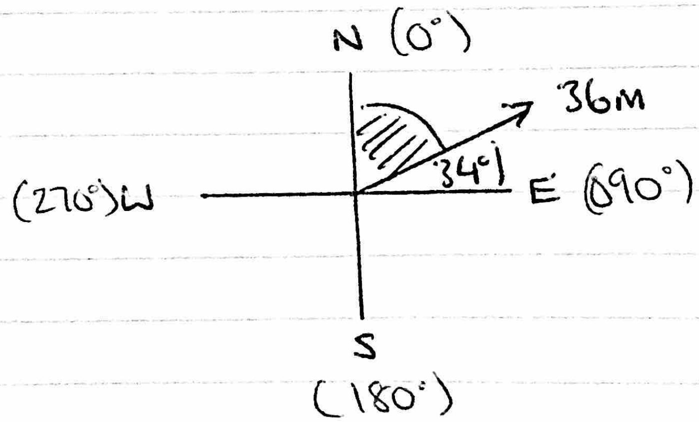


(b) $S^2 = 30^2 + 20^2$

$S = \sqrt{30^2 + 20^2}$

$S = \underline{\underline{36m}}$

$\tan\theta = \frac{20}{30}$



$\theta = \tan^{-1}(20/30)$

$\theta = \underline{\underline{34^\circ}}$

Compass points = 34° N of E

Bearing = 90 − 34 = 056°

36m at 34° N of E

or 36m at 056°

(c) $V = \frac{d}{t}$

$V = ?$
$d = 50m$
$t = 1\ min$
$= 60s$

$V = \frac{50}{60}$

$V = \underline{0{\cdot}83\ ms^{-1}}$

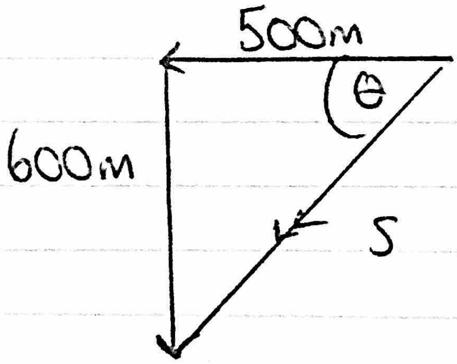
(d) $V = \frac{s}{t}$

$V = ?$
$s = 36m$
$t = 60s$

$V = \frac{36}{60}$

$V = \underline{0{\cdot}6\ ms^{-1}\ \text{at}\ 056°}$

5. (a) $d = 600 + 500$
$= \underline{1100m}$



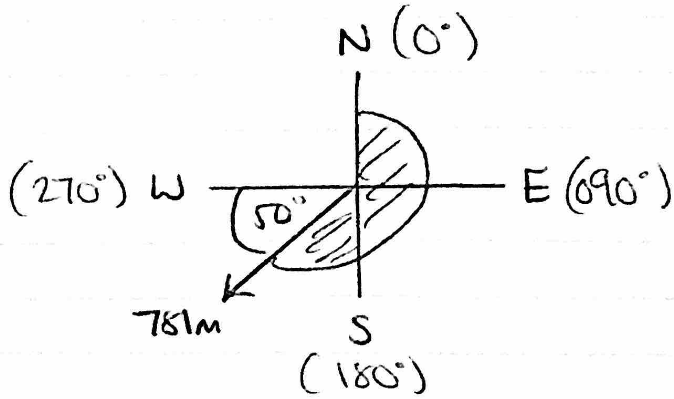
(b) $s^2 = 600^2 + 500^2$

$s = \sqrt{600^2 + 500^2}$

$s = \underline{781m}$

(b) continued.

$$\tan \theta = \frac{O}{A}$$



$$\tan \theta = \frac{600}{500}$$

$$\theta = \tan^{-1}\left(\frac{600}{500}\right)$$

$$\underline{\underline{\theta = 50°}}$$

Compass point = 50° S of W

Bearing $= 270 - 50$
$= 220°$

781 m at 50° S of W
or 781 m at 220°

(c) $V = \frac{d}{t}$

$V = ?$
$d = 1100\text{m}$
$t = 110\text{s}$

$$V = \frac{1100}{110}$$

$$V = \underline{\underline{10 \text{ ms}^{-1}}}$$

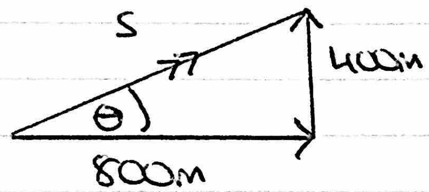
(d) $v = \frac{s}{t}$

$v = ?$
$s = 781\,m$
$t = 110\,s$

$v = \frac{781}{110}$

$v = 7.1\ ms^{-1}$ at $220°$

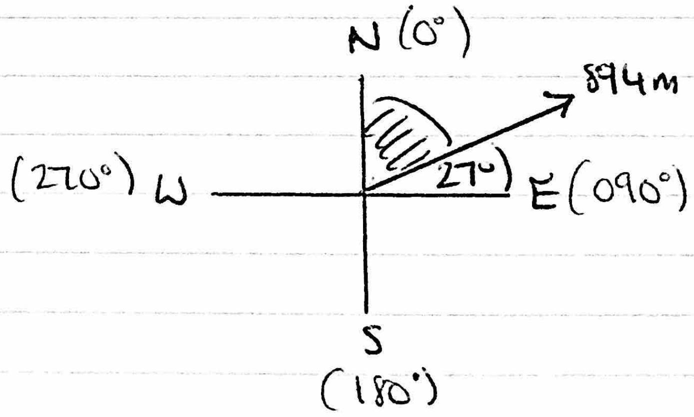
6. (a) $d = 800 + 400$
$= 1200\,m$



(b) $s^2 = 800^2 + 400^2$

$s = \sqrt{800^2 + 400^2}$

$s = 894\,m$



$\tan\theta = \frac{O}{A}$

$\tan\theta = \frac{400}{800}$

$\theta = \tan^{-1}\left(\frac{400}{800}\right)$

$\theta = 27°$

Compass points $= 27°$ N of E
Bearing $= 90 - 27$
$= 063°$

894 m at 27° N of E or 894m at 063°

(c) $t = \frac{\text{distance}}{\text{speed}}$

$V = 12\ ms^{-1}$
$d = 1200\ m$
$t = ?$

$t = \frac{1200}{12}$

$t = \underline{100\ s}$

(d) $v = \frac{s}{t}$

$V = ?$
$s = 894m$
$t = 100s$

$V = \frac{894}{100}$

$V = \underline{8.94\ ms^{-1} \text{ at } 063°}$

Combining Velocities.

1. (a) $x^2 = 3^2 + 4^2$

$x = \sqrt{3^2 + 4^2}$

$x = \underline{5\ ms^{-1}}$

$\tan\theta = \frac{O}{A}$

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

$\theta = \tan^{-1}\left(\frac{4}{3}\right) =$

$\theta = \underline{53°}$

Compass points $= 53°$ E of N
Bearing $= 053°$

Resultant velocity is $5\ ms^{-1}$ at $53°$ E of N
or $5\ ms^{-1}$ at $053°$

(b) $x^2 = 4^2 + 6^2$

$x = \sqrt{4^2 + 6^2}$

$x = \underline{7.2\ ms^{-1}}$

$\tan\theta = \frac{O}{A}$

$\tan\theta = \frac{6}{4}$

$\theta = \tan^{-1}\left(\frac{6}{4}\right)$

$\theta = \underline{56°}$

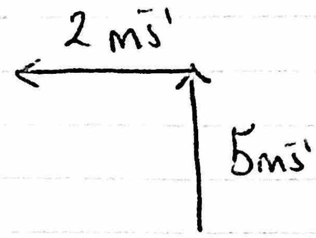
Compass points $= 56°$ S of W
Bearing $= 270 - 56$
$= 214°$

Resultant velocity $7.2\ ms^{-1}$ at $56°$ S of W
or $7.2\ ms^{-1}$ at $214°$

(c) $x^2 = 5^2 + 2^2$

$x = \sqrt{5^2 + 2^2}$

$x = \underline{5.4 \text{ ms}^{-1}}$



$\tan\theta = \dfrac{O}{A}$

$\tan\theta = \dfrac{2}{5}$

$\theta = \tan^{-1}\left(\dfrac{2}{5}\right)$

$\theta = \underline{22°}$

Compass points $= 22°$ W of N
Bearing $= 360 - 22$
$= 338°$

Resultant velocity is 5.4 ms^{-1} at $22°$ W of N
or 5.4 ms^{-1} at $338°$

2. $x^2 = 8^2 + 4^2$

$x = \sqrt{8^2 + 4^2}$

$x = \underline{8.9 \text{ ms}^{-1}}$

$$\tan\theta = \frac{O}{A}$$

$$\tan\theta = \frac{4}{8}$$

$$\theta = \tan^{-1}\left(\frac{4}{8}\right)$$

$$\theta = 27^\circ$$

Compass points $= 27^\circ$ S of W

Bearing $= 270 - 27$

$= 243^\circ$

Resultant velocity is $8.9\,ms^{-1}$ at 27° S of W

or $8.9\,ms^{-1}$ at 243°

3. $$x^2 = 3^2 + 6^2$$

$$x = \sqrt{3^2 + 6^2}$$

$$x = 6.7\,ms^{-1}$$

$$\tan\theta = \frac{O}{A}$$

$$\tan\theta = \frac{6}{3}$$

$$\theta = \tan^{-1}\left(\frac{6}{3}\right)$$

$$\theta = 63^\circ$$

Compass points $= 63°$ E of N
Bearing $= 063°$

Resultant velocity is $6 \cdot 7 ms^{-1}$ at $63°$ E of N
or $6 \cdot 7 ms^{-1}$ at $063°$

4. $X^2 = 100^2 + 40^2$

$X = \sqrt{100^2 + 40^2}$

$X = \underline{\underline{108 ms^{-1}}}$

$\tan \theta = \frac{O}{A}$

$\tan \theta = \frac{40}{100}$

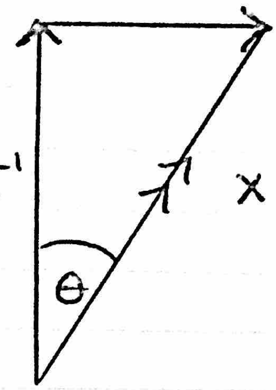
$\theta = \tan^{-1}\left(\frac{40}{100}\right)$

$\theta = \underline{\underline{22°}}$

Compass points $= 22°$ S of W
Bearing $= 270 - 22$
$= 248°$

Resultant velocity is $108 ms^{-1}$ at $22°$ S of W
or $108 ms^{-1}$ at $248°$

5. (a)



$$X^2 = 800^2 + 80^2$$

$$X = \sqrt{800^2 + 80^2}$$

$$X = \underline{\underline{804 \text{ Km h}^{-1}}}$$

$$\tan\theta = \frac{O}{A}$$

$$\tan\theta = \frac{80}{800}$$

$$\theta = \tan^{-1}\left(\frac{80}{800}\right)$$

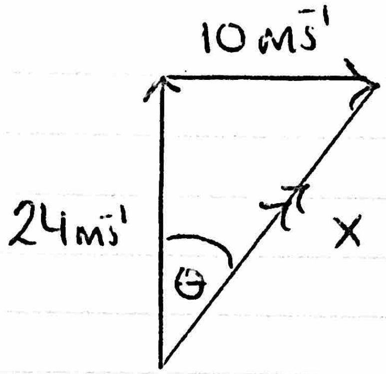
$$\theta = 6^\circ$$

Compass points = 6° E of N
Bearing = 006°

Resultant velocity = 804 Kmh^{-1} at 6° E of N
or 804 Kmh^{-1} at 006°

(b) 804 Kmh^{-1} at 6° W of N

6. $X^2 = 10^2 + 24^2$



$X = \sqrt{10^2 + 24^2}$

$X = \underline{\underline{26\ ms^{-1}}}$

$\tan\theta = \frac{O}{A}$

$\tan\theta = \frac{10}{24}$

$\theta = \tan^{-1}\left(\frac{10}{24}\right)$

$\theta = \underline{\underline{23^\circ}}$

Compass points = 23° E of N
Bearing = 023°

Resultant velocity is $26\ ms^{-1}$ at 23° E of N
<u>or</u> $26\ ms^{-1}$ at 023°

Acceleration

05 January 2021 10:45

1

$$a = \frac{v-u}{t}$$

$$a = \frac{15-0}{30}$$

$$a = \frac{15}{30}$$

$$\underline{\underline{a = 0.5\ m/s^2}}$$

$a =$

$v = 15\ m/s$

$u = 0\ m/s$ "STARTING FROM REST"

$t = 30s$

2

$$a = \frac{v-u}{t}$$

$$a = \frac{14-0}{16}$$

$$a = \frac{14}{16}$$

$$\underline{\underline{a = 0.875\ m/s^2}}$$

$a =$

$v = 14\ m/s$ AT THE "FINISHING LINE"

$u = 0\ m/s$

$t = 16s$

3

$$a = \frac{v-u}{t}$$

$$a = \frac{30-0}{3}$$

$$a = \frac{30}{3}$$

$$\underline{\underline{a = 10\ m/s^2}}$$

$a =$

$v = 30\ m/s$

$u = 0\ m/s$

$t = 3\ s$

4

$$a = \frac{v-u}{t}$$

$$a = \frac{15-5}{40}$$

$$a = \frac{10}{40}$$

$$\underline{\underline{a = 0.25\ m/s^2}}$$

$a =$

$v = 15\ m/s$

$u = 5\ m/s$

$t = 40\ s$

5

$$a = \frac{v-u}{t}$$

$$a = \frac{25-15}{8}$$

$$a = \frac{10}{8}$$

$$\underline{a = 1 \cdot 25 \ m/s^2}$$

$a =$

$v = 25 \ m/s$

$u = 15 \ m/s$

$t = 8 \ s$

6

$$a = \frac{v-u}{t}$$

$$a = \frac{0-16}{32}$$

$$a = \frac{-16}{32}$$

$$\underline{a = -0 \cdot 5 \ m/s^2}$$

$a =$

$v = 0 \ m/s$ "COME TO REST"

$u = 16 \ m/s$

$t = 32 \ s$

(Deceleration is a negative acceleration – when an object slows down)

7

$$a = \frac{v-u}{t}$$

$$a = \frac{0-8}{20}$$

$$a = \frac{-8}{20}$$

$$\underline{a = 0 \cdot 4 \ m/s^2}$$

$a =$

$v = 0 \ m/s$ "COME TO REST"

$u = 8 \ m/s$

$t = 20 \ s$

8

$$a = \frac{v-u}{t}$$

$$3 = \frac{v-0}{1 \cdot 2}$$

$$3 = \frac{v}{1 \cdot 2}$$

$$3 \times 1 \cdot 2 = v$$

$a = 3 \ m/s^2$

$v =$

$u = 0 \ m/s$ "FROM REST"

$t = 1 \cdot 2 \ s$

$\underline{\underline{v = 3.6 \text{ m/s}}}$

9 (a)

$$a = \frac{v-u}{t}$$

CHANGE IN VELOCITY $= (v-u)$

$$a = \frac{(v-u)}{t}$$

$$2 = \frac{(v-u)}{4}$$

$$2 \times 4 = (v-u)$$

$$\underline{\underline{(v-u) = 8 \text{ m/s}}}$$

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

$v =$

$u = 20 \text{ m/s}$

$t = 4 \text{ s}$

(b) FINAL VELOCITY, V :

$$(v-u) = 8$$

$$v - 20 = 8$$

$$v = 8 + 20$$

$$\underline{\underline{v = 28 \text{ m/s}}}$$

10

$$a = \frac{v-u}{t}$$

$$0.1 = \frac{v - 0.2}{30}$$

$$0.1 \times 30 = v - 0.2$$

$$3 = v - 0.2$$

$$3 + 0.2 = v$$

$$\underline{\underline{v = 3.2 \text{ m/s}}}$$

$a = 0.1 \text{ m/s}^2$

$v =$

$u = 0.2 \text{ m/s}$

$t = 30\text{s}$ "HALF A MINUTE"

11

$$a = \frac{v-u}{t}$$

$$0{\cdot}08 = \frac{5-u}{60}$$

$$0{\cdot}08 \times 60 = 5-u$$

$$4{\cdot}8 = 5-u$$

$$4{\cdot}8+u = 5$$

$$u = 5-4{\cdot}8$$

$$\underline{\underline{u = 0{\cdot}2\ m/s}}$$

$a = 0{\cdot}08\ m/s^2$

$v = 5\ m/s$

$u =$

$t = 1$ minute $= 60s$

12

$$a = \frac{v-u}{t}$$

$$3 = \frac{20-8}{t}$$

$$3 = \frac{12}{t}$$

$$3 \times t = 12$$

$$t = \frac{12}{3}$$

$$\underline{\underline{t = 4s}}$$

$a = 3\ m/s^2$

$v = 20\ m/s$

$u = 8\ m/s$

$t =$

13

$$a = \frac{v-u}{t}$$

$$1{\cdot}2 = \frac{16{\cdot}4-5}{t}$$

$$1{\cdot}2 = \frac{11{\cdot}4}{t}$$

$$1{\cdot}2 \times t = 11{\cdot}4$$

$$t = \frac{11{\cdot}4}{1{\cdot}2}$$

$a = 1{\cdot}2\ m/s^2$

$v = 16{\cdot}4\ m/s$

$u = 5\ m/s$

$t =$

$\underline{\underline{t = 9.5\ s}}$

14 $a = \frac{v-u}{t}$

$-0.4 = \frac{0-12}{t}$

$-0.4 = \frac{-12}{t}$

$-0.4 \times t = -12$

$t = \frac{-12}{-0.4}$

$\underline{\underline{t = 30s}}$

$a = -0.4\ m/s^2$ (NEGATIVE SINCE DECELERATION)

$v = 0\ m/s$ "TO STOP"

$u = 12\ m/s$

$t =$

15 BALL A:

$a = \frac{v-u}{t}$

$9.8 = \frac{v-0}{0.4}$

$9.8 = \frac{v}{0.4}$

$9.8 \times 0.4 = v$

$\underline{\underline{v = 3.9\ m/s}}$

$a = 9.8\ m/s^2$

$v =$

$u = 0\ m/s$ "FROM REST"

$t = 0.4\ s$

BALL B:

$a = \frac{v-u}{t}$

$9.8 = \frac{v-0}{0.5}$

$9.8 = \frac{v}{0.5}$

$9.8 \times 0.5 = v$

$\underline{\underline{v = 4.9\ m/s}}$

$a = 9.8\ m/s^2$

$v =$

$u = 0\ m/s$ "FROM REST"

$t = 0.4 + 0.1 = 0.5\ s$

16

(a) At maximum height, $\underline{\underline{v = 0 \text{ m/s}}}$.

(b) ON EARTH:

$$a = \frac{v-u}{t}$$

$$-10 = \frac{0-6.4}{t}$$

$$-10 = \frac{-6.4}{t}$$

$$-10 \times t = -6.4$$

$$t = \frac{-6.4}{-10}$$

$$\underline{\underline{t = 0.64 \text{ s}}}$$

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

$v = 0 \text{ m/s}$

$u = 6.4 \text{ m/s}$

$t =$

ON MOON:

$$a = \frac{v-u}{t}$$

$$-1.6 = \frac{0-6.4}{t}$$

$$-1.6 = \frac{-6.4}{t}$$

$$-1.6 \times t = -6.4$$

$$t = \frac{-6.4}{-1.6}$$

$$\underline{\underline{t = 4 \text{ s}}}$$

$a = -1.6 \text{ m/s}^2$

$v = 0 \text{ m/s}$

$u = 6.4 \text{ m/s}$

$t =$

17

$$a = \frac{v-u}{t}$$

$$0.3 = \frac{18-u}{15}$$

$$0.3 \times 15 = 18-u$$

$$4.5 = 18-u$$

$a = 0.3 \text{ m/s}^2$

$v = 18 \text{ m/s}$

$u =$

$t = 15 \text{ s}$

$4.5 = 18 - u$

$4.5 + u = 18$

$u = 18 - 4.5$

$\underline{\underline{u = 13.5 \text{ m/s}}}$

$t = 15s$

18 $a = \frac{v-u}{t}$

$-0.8 = \frac{12-u}{4}$

$-0.8 \times 4 = 12 - u$

$-3.2 = 12 - u$

$-3.2 + u = 12$

$u = 12 + 3.2$

$\underline{\underline{u = 15.2 \text{ m/s}}}$

$a = -0.8 \text{ m/s}^2$

$v = 12 \text{ m/s}$

$u =$

$t = 4s$

Velocity-time Graphs

05 January 2021 14:30

1

(a) Between A and B : constant velocity
Between B and C : constant deceleration

(b) Between A and B : constant acceleration
Between B and C : constant velocity
Between C and D : constant acceleration

(c) Between A and B : constant deceleration
Between B and C : constant velocity (of 0 m/s)
Between C and D : constant acceleration
Between D and E : constant deceleration

2

(a)

$a = \frac{v-u}{t}$

$a = \frac{15-0}{50}$

$a = \frac{15}{50}$

$\underline{\underline{a = 0 \cdot 3 \text{ m/s}^2}}$

a =

v = 15 m/s

u = 0 m/s

t = 50s

(b)

$a = \frac{v-u}{t}$

$a = \frac{40-0}{4}$

$a = \frac{40}{4}$

$\underline{\underline{a = 10 \text{ m/s}^2}}$

a =

v = 40 m/s

u = 0 m/s

t = 4s

(c)

$$a = \frac{v-u}{t}$$
$$a = \frac{10-4}{25}$$
$$a = \frac{6}{25}$$
$$\underline{\underline{a = 0.24\ m/s^2}}$$

$a =$

$v = 10\ m/s$

$u = 4\ m/s$

$t = 25\ s$

(d)

$$a = \frac{v-u}{t}$$
$$a = \frac{20-5}{30}$$
$$a = \frac{15}{30}$$
$$\underline{\underline{a = 0.5\ m/s^2}}$$

$a =$

$v = 20\ m/s$

$u = 5\ m/s$

$t = 30s$ (BETWEEN 10s AND 40s)

(e)

$$a = \frac{v-u}{t}$$
$$a = \frac{30-10}{4}$$
$$a = \frac{20}{4}$$
$$\underline{\underline{a = 5\ m/s^2}}$$

$a =$

$v = 30\ m/s$

$u = 10\ m/s$

$t = 4s$ (BETWEEN 8s AND 12s)

(f)

$$a = \frac{v-u}{t}$$
$$a = \frac{6-2}{20}$$
$$a = \frac{4}{20}$$
$$\underline{\underline{a = 0.2\ m/s^2}}$$

$a =$

$v = 6\ m/s$

$u = 2\ m/s$

$t = 20s$ ($10s \rightarrow 30s$)

3

(a) 0s → 10s :

$a = \frac{v-u}{t}$

$a = \frac{25-0}{10}$

$a = \frac{25}{10}$

$\underline{\underline{a = 2.5\ m/s^2}}$

$a =$

$v = 25\ m/s$ (AT $t = 10s$)

$u = 0\ m/s$ (AT $t = 0s$)

$t = 10s$ (0s → 10s)

(b) 10s → 20s:

$a = \frac{v-u}{t}$

$a = \frac{35-25}{10}$

$a = \frac{10}{10}$

$\underline{\underline{a = 1\ m/s^2}}$

$a =$

$v = 35\ m/s$ (AT $t = 20s$)

$u = 25\ m/s$ (AT $t = 10s$)

$t = 10s$ (10s → 20s)

4

(a) A → B:

$a = \frac{v-u}{t}$

$a = \frac{25-0}{45}$

$a = \frac{25}{45}$

$a = 0.\dot{5}$

$\underline{\underline{a = 0.56\ m/s}}$

THE DOT ABOVE THE 5 MEANS RECURRING,
SO $0.\dot{5} = 0.555555...$
NEED TO ROUND THIS TO THE APPROPRIATE NUMBER OF SIGNIFICANT FIGURES.

$a =$

$v = 25\ m/s$

$u = 0\ m/s$

$t = 45s$

(b) B → C:

THE LINE IS HORIZONTAL BETWEEN B AND C, THEREFORE THE MOTION

THE LINE IS HORIZONTAL BETWEEN B AND C, THEREFORE THE MOTION CAN BE DESCRIBED AS CONSTANT VELOCITY. SINCE THERE IS NO CHANGE IN VELOCITY OVER TIME, ACCELERATION IS ZERO.

BUT PAY ATTENTION TO COMMAND WORDS – "USE THE V-T GRAPH TO CALCULATE THE ACCELERATION":

$a = \frac{v-u}{t}$

$a = \frac{25-25}{45}$

$a = \frac{0}{45}$

$\underline{a = 0 \ m/s^2}$

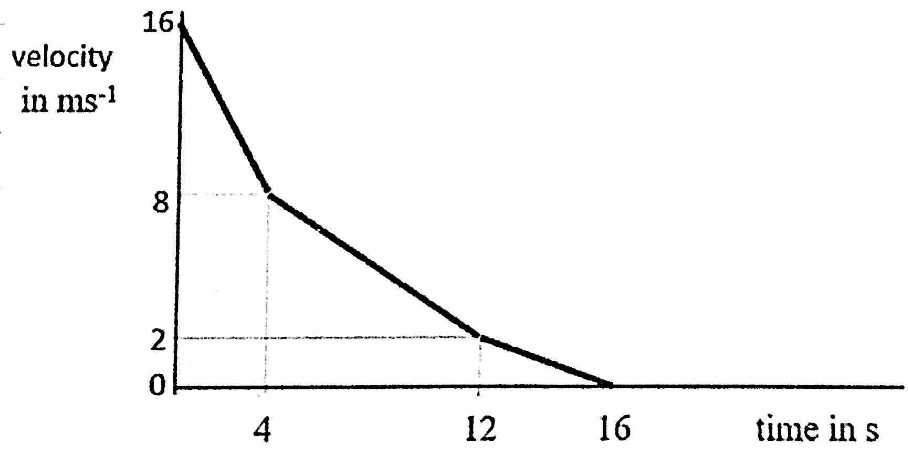
$a =$

$v = 25 \ m/s$ (at C)

$u = 25 \ m/s$ (at B)

$t = 45s$

5



$0s \rightarrow 4s$: 4^{th} GEAR
$4s \rightarrow 12s$: 3^{rd} GEAR
$12s \rightarrow 16s$: 2^{nd} YEAR

$0s \rightarrow 4s$: 4^{th} GEAR

$a = \frac{v-u}{t}$

$a = \frac{16-8}{4}$

$a = \frac{8}{4}$

$\underline{a = 2 \ m/s^2}$

$a =$

$v = 16 \ m/s$

$u = 8 \ m/s$

$t = 4s$

$4s \rightarrow 12s$: 3^{rd} GEAR

$$a = \frac{v-u}{t}$$

$$a = \frac{8-2}{8}$$

$$a = \frac{6}{8}$$

$$\underline{\underline{a = 0.75 m/s^2}}$$

$a =$

$v = 8 m/s$

$u = 2 m/s$

$t = 8s$

$12s \rightarrow 16s$: 2^{nd} GEAR

$$a = \frac{v-u}{t}$$

$$a = \frac{2-0}{4}$$

$$a = \frac{2}{4}$$

$$\underline{\underline{a = 0.5 m/s^2}}$$

$a =$

$v = 2 m/s$

$u = 0 m/s$

$t = 4s$

6

(a) GREATEST ACCELERATION OCCURS WHEN V-T GRAPH SHOWS STEEPEST SLOPE. THEREFORE GREATEST ACCELERATION BETWEEN 50S AND 70S.

(b) STATIONARY WHEN VELOCITY = 0 m/s. THEREFORE LORRY IS STATIONARY AT $t = 0s$, $t = 50s$, AND $t = 100s$.

(c)

$$a = \frac{v-u}{t}$$

$$a = \frac{0-25}{30}$$

$$a = \frac{-25}{30}$$

$$a = -0.8\dot{3}$$

$$\underline{\underline{a = -0.83 \text{ m/s}^2}}$$

$a =$

$v = 0$ m/s (at $t = 100$s)

$u = 25$ m/s (at $t = 70$s)

$t = 30$s (70s $\rightarrow$ 100s)

7

(a)

$$a = \frac{v-u}{t}$$

$$2 = \frac{v-0}{8}$$

$$2 = \frac{v}{8}$$

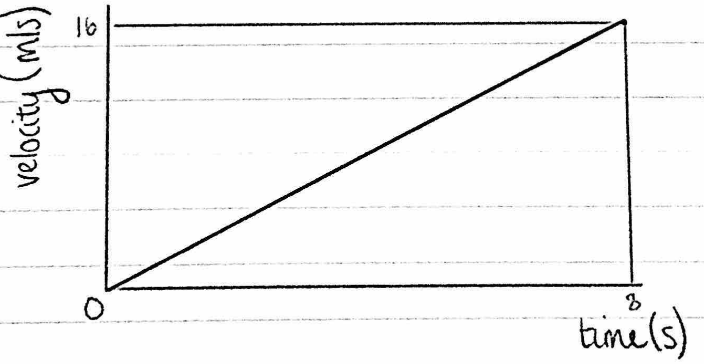
$$v = 2 \times 8 = \underline{\underline{16 \text{ m/s}}}$$

$a = 2$ m/s²

$v =$

$u = 0$ m/s "FROM REST"

$t = 8$s



(b)

$$a = \frac{v-u}{t}$$

$$5 = \frac{v-0}{10}$$

$$5 = \frac{v}{10}$$

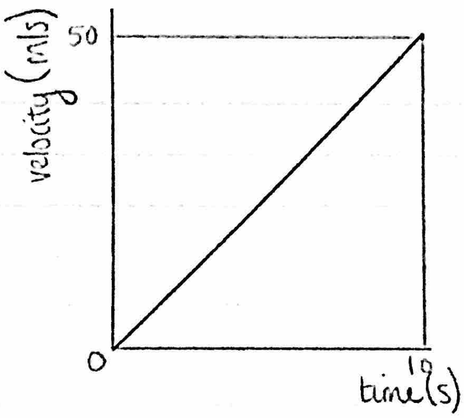
$$v = 5 \times 10 = \underline{\underline{50 \text{ m/s}}}$$

$a = 5$ m/s²

$v =$

$u = 0$ m/s "FROM REST"

$t = 10$s



(c) $a = \frac{v-u}{t}$

$2.5 = \frac{v-0}{7}$

$2.5 = \frac{v}{7}$

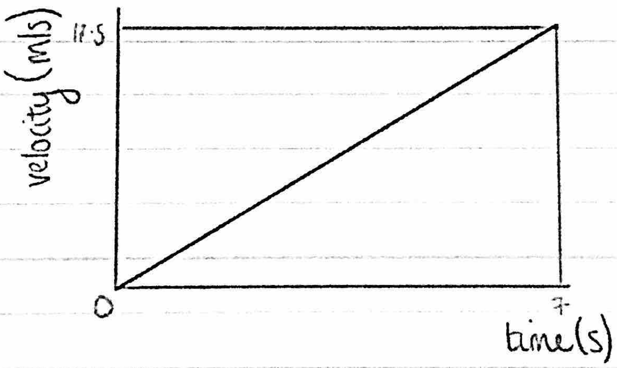
$v = 2.5 \times 7 = \underline{\underline{17.5\ m/s}}$

$a = 2.5\ m/s^2$

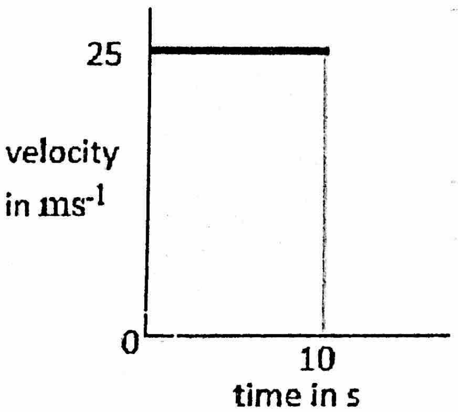
$v =$

$u = 0\ m/s$ "FROM REST"

$t = 7\ s$



8 DISPLACEMENT = AREA UNDER VELOCITY-TIME GRAPH

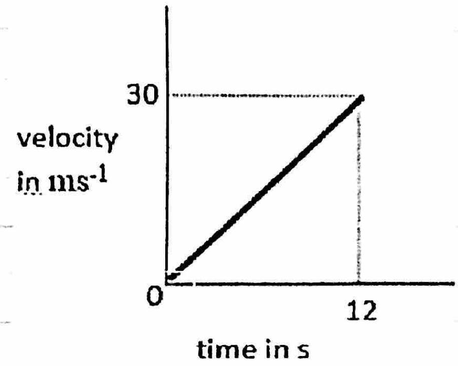


DISPLACEMENT = AREA UNDER GRAPH

$S = \square = \text{base} \times \text{height}$

$S = 10 \times 25 = \underline{\underline{250m}}$

(b)



DISPLACEMENT = AREA UNDER GRAPH

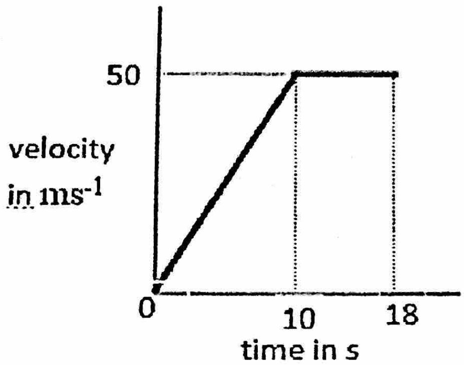
$S = \triangle$

$S = \frac{1}{2} \times \text{base} \times \text{height}$

$S = \frac{1}{2} \times 12 \times 30$

$S = 180m$

(c)



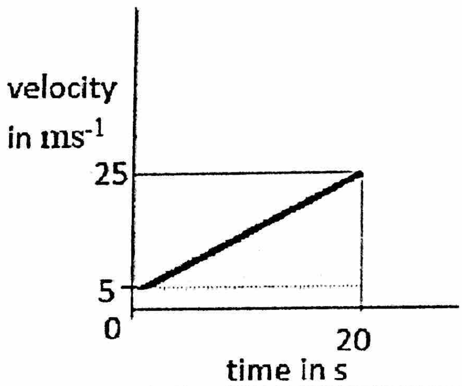
DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square$

$S = \left(\frac{1}{2} \times 10 \times 50\right) + \left(8 \times 50\right)$

$S = 650m$

(d)



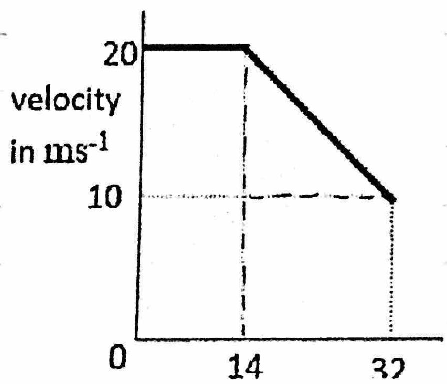
DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square$

$S = \left(\frac{1}{2} \times 20 \times 20\right) + \left(20 \times 5\right)$

$S = 300m$

(e)

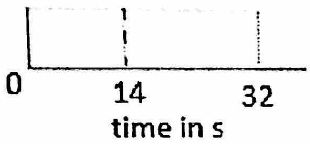


DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square + \square$

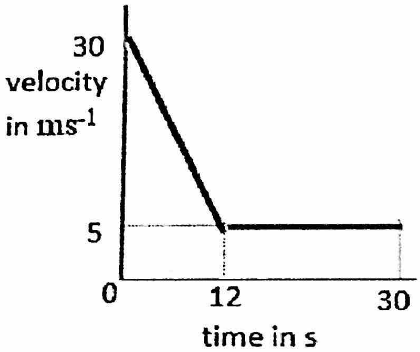
$S = \left(\frac{1}{2} \times 18 \times 10\right) + \left(18 \times 10\right) + \left(14 \times 20\right)$

$S = 550m$



$S = 550m$

(f)



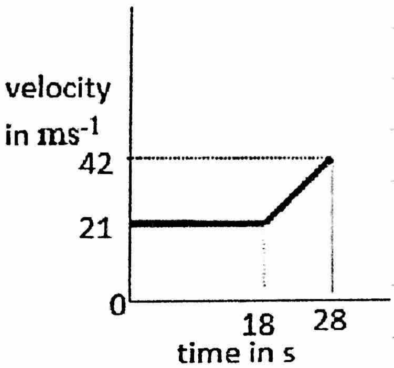
DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square$

$S = \left(\frac{1}{2} \times 12 \times 25\right) + (30 \times 5)$

$S = 300m$

(g)



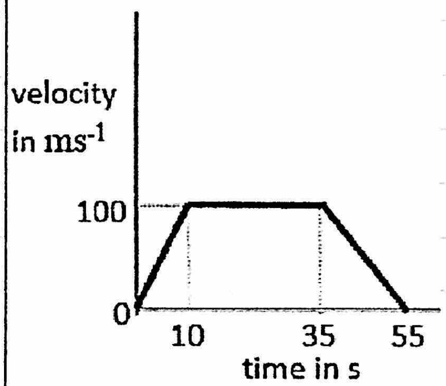
DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square$

$S = \left(\frac{1}{2} \times 10 \times 21\right) + (28 \times 21)$

$S = 693m$

(h)



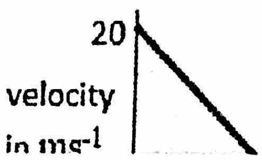
DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square + \triangle$

$S = \left(\frac{1}{2} \times 10 \times 100\right) + (25 \times 100) + \left(\frac{1}{2} \times 20 \times 100\right)$

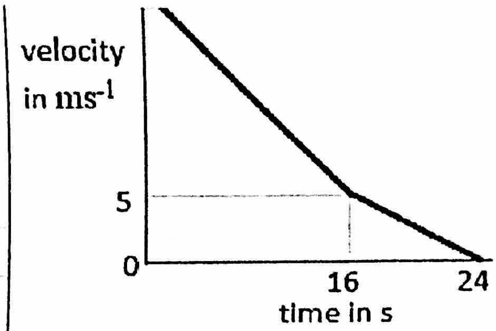
$S = 4000m$

(i)



DISPLACEMENT = AREA UNDER GRAPH

$S = \triangle + \square + \triangle$



$S = \quad + \quad + $

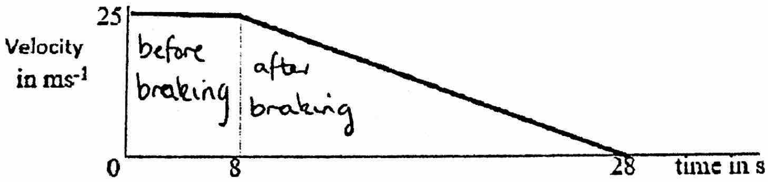
$S = \left(\frac{1}{2}\times 16\times 15\right) + \left(16\times 5\right) + \left(\frac{1}{2}\times 8\times 5\right)$

$\underline{\underline{S = 220m}}$

9

(a) At $\underline{t = 8s}$

8 SECONDS AFTER THEY SEE THE ACCIDENT



DISPLACEMENT = AREA UNDER v-t GRAPH

(b) $S = \boxed{}$

$S = 8\times 25$

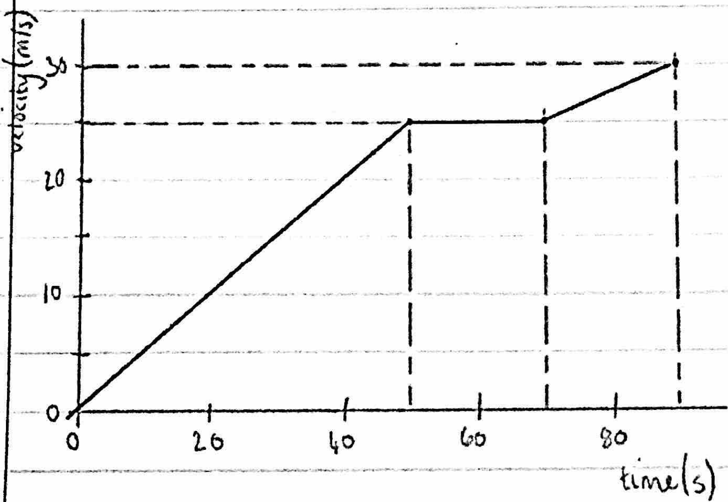
$\underline{\underline{S = 200m}}$

(c) $S = $

$S = \frac{1}{2}\times 20\times 25$

$S = 250m$

10



(a)

$$a = \frac{v-u}{t}$$

$$a = \frac{25-0}{50}$$

$$a = \frac{25}{50}$$

$$\underline{\underline{a = 0.5\,m/s^2}}$$

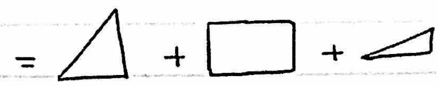
a =

v = 25 m/s

u = 0 m/s

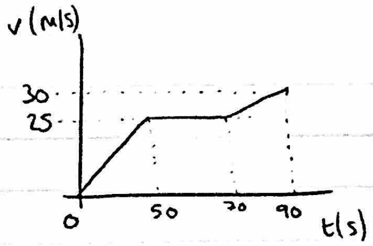
t = 50 s

(b) DISPLACEMENT = AREA UNDER GRAPH

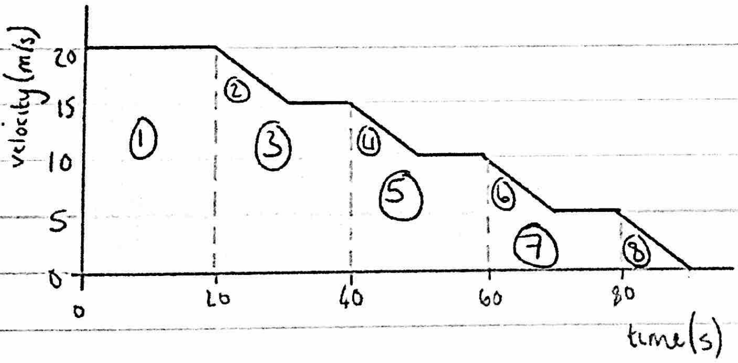
S = 

$$S = \left(\tfrac{1}{2}\times 50\times 25\right) + \left(40\times 25\right) + \left(\tfrac{1}{2}\times 20\times 5\right)$$

$$\underline{\underline{S = 1175\,m}}$$



11



(a)

$$a = \frac{v-u}{t}$$

$$a = \frac{5-10}{10}$$

$$a = \frac{-5}{10}$$

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

a =

v = 5 m/s

u = 10 m/s

t = 10s (60s → 70s)

(b) DISPLACEMENT = AREA UNDER GRAPH

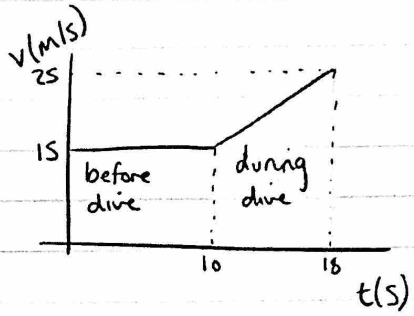
$$S = \boxed{1} + \triangle_2 + \boxed{3} + \triangle_4 + \boxed{5} + \triangle_6 + \boxed{7} + \triangle_8$$

$$S = (20 \times 20) + (\tfrac{1}{2} \times 10 \times 5) + (20 \times 15) + (\tfrac{1}{2} \times 10 \times 5)$$
$$+ (20 \times 10) + (\tfrac{1}{2} \times 10 \times 5) + (20 \times 5) + (\tfrac{1}{2} \times 10 \times 5)$$

$$\underline{\underline{S = 1100\,m}}$$

12

(a) Dive started at $\underline{\underline{t = 10\,s}}$



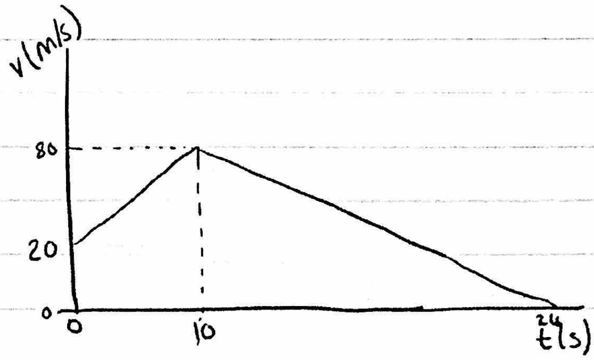
(b) Displacement = Area under graph

$$S = \square + \triangle$$

$$S = (8 \times 15) + (\tfrac{1}{2} \times 8 \times 10)$$

$$\underline{\underline{S = 160\,m}}$$

13



(a) Rocket is accelerating (positive) between 0 s and 10 s

Distance = Area under graph

$$d = \triangle + \square$$

$$d = (\tfrac{1}{2} \times 10 \times 60) + (10 \times 20)$$

$$\underline{\underline{d = 500\,m}}$$

(b) Deceleration begins at $t = 10\,s$.

Distance = Area under graph

$d = \triangle$

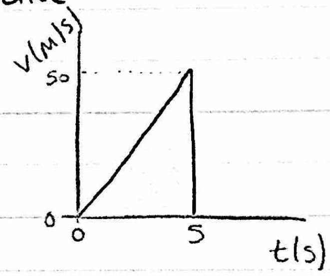
$d = \frac{1}{2} \times 14 \times 80$

$\underline{\underline{d = 560m}}$

ROCKET TRAVELS 560m AFTER DECELERATION BEGINS, THEREFORE DOES NOT REACH THE MOONS SURFACE. $d < 580m$

14
(a) BALL STRIKES GROUND AT $\underline{\underline{t = 5s}}$

(b) HEIGHT = VERTICAL DISTANCE TRAVELLED BY BALL



DISTANCE = AREA UNDER GRAPH

$d = \frac{1}{2} \times 5 \times 50$

$\underline{\underline{d = 125\,m}}$

15 INITIAL ACCELERATION BETWEEN 0s AND 4s.

$a = \frac{v-u}{t}$

$a = \frac{8-0}{4}$

$a = \frac{8}{4}$

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

$a =$

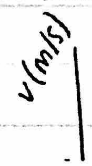
$v = 8\,m/s$ (at $t = 4s$)

$u = 0\,m/s$ (at $t = 0s$)

$t = 4s$

(b) TOTAL DISTANCE TRAVELLED = TOTAL AREA UNDER GRAPH

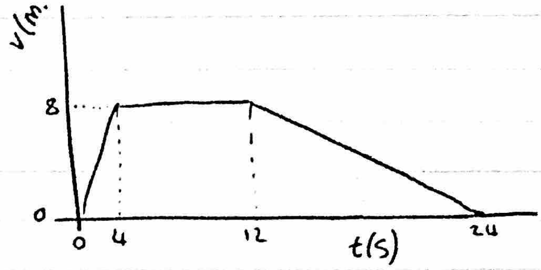
$d = \triangle + \square + \triangle$



$d = \triangle + \square + \triangleright$

$d = \left(\frac{1}{2}\times 4\times 8\right) + \left(8\times 8\right) + \left(\frac{1}{2}\times 12\times 8\right)$

$\underline{d = 128m}$



(c) AVERAGE SPEED $= \dfrac{\text{DISTANCE TRAVELLED}}{\text{TIME}}$

$d = vt$

$128 = v \times 24$

$\frac{128}{24} = v$

$v = 5.\dot{3}$

$\underline{\underline{v = 5.3\ m/s}}$

$d = 128m$

$v =$

$t = 24s$

16

(a) CONSTANT ACCELERATION : BETWEEN 0s AND 30s (POSITIVE)
BETWEEN 90s AND 105s (NEGATIVE)

(b) (i) $0s \rightarrow 30s$:

$a = \frac{v-u}{t}$

$a = \frac{30-0}{30}$

$a = \frac{30}{30}$

$\underline{\underline{a = 1\ m/s^2}}$

$a =$

$v = 30\ m/s$ (at $t = 30s$)

$u = 0\ m/s$ (at $t = 0s$)

$t = 30s$

(ii) $90s \rightarrow 105s$:

$a =$

$v-u$

(ii) 90s → 105s:

$$a = \frac{v-u}{t}$$

$$a = \frac{0-30}{15}$$

$$a = \frac{-30}{15}$$

$$\underline{\underline{a = -2\ m/s^2}}$$

$a =$

$v = 0\ m/s$ (at $t = 105s$)

$u = 30\ m/s$ (at $t = 90s$)

$t = 15s$

(c) BREAKING OCCURS BETWEEN 90s AND 105s.

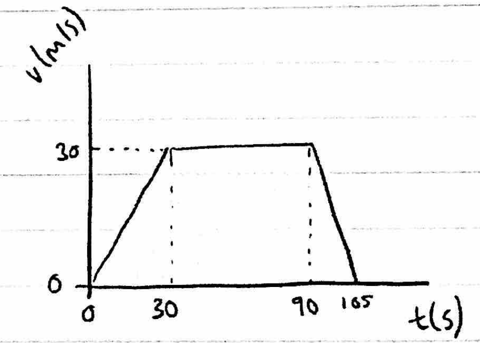
BREAKING DISTANCE = AREA UNDER GRAPH (90s → 105s)

$$d = \triangle$$

$$d = \frac{1}{2} \times 15 \times 30$$

$$\underline{\underline{d = 225m}}$$

(d)



TOTAL DISTANCE TRAVELLED = TOTAL AREA UNDER GRAPH

$$d = \triangle + \square + \triangle$$

$$d = \left(\frac{1}{2} \times 30 \times 30\right) + (60 \times 30) + \left(\frac{1}{2} \times 15 \times 30\right)$$

$$d = 2475m$$

$$\underline{\underline{d = 2500m}}$$

(e) AVERAGE VELOCITY $= \dfrac{\text{DISPLACEMENT}}{\text{TIME}}$

$d = vt$

$2500 = v \times 105$

$\frac{2500}{105} = v$

$v = 23.\dot{8}$

$\underline{\underline{v = 24\ m/s}}$

$d = 2500m$

$v =$

$t = 105s$

17

(a) MAXIMUM POSITIVE ACCELERATION WHEN SLOPE IS STEEPEST + VELOCITY INCREASES WITH TIME

THEREFORE MAXIMUM POSITIVE ACCELERATION BETWEEN 0s AND 20s:

$a = \frac{v-u}{t}$

$a = \frac{6-0}{20}$

$a = \frac{6}{20}$

$\underline{\underline{a = 0.3\ m/s^2}}$

$a =$

$v = 6\ m/s$ (at $t = 20s$)

$u = 0\ m/s$ (at $t = 0s$)

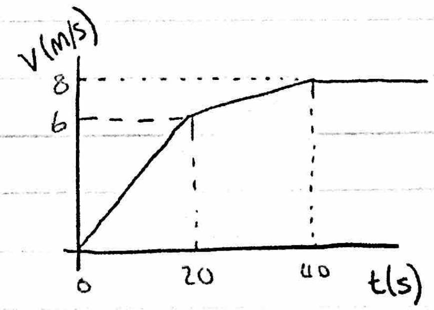
$t = 20s$

(b) (i) DISTANCE TRAVELLED WHILE ACCELERATING (POSITIVE) = AREA UNDER GRAPH (0s → 40s)

$d = \triangle + \square + \triangle$

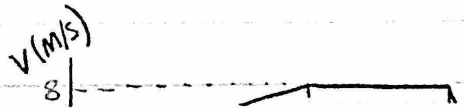
$d = \left(\frac{1}{2} \times 20 \times 6\right) + (20 \times 6) + \left(\frac{1}{2} \times 20 \times 2\right)$

$\underline{\underline{d = 200m}}$



(ii) DISTANCE TRAVELLED AT MAXIMUM VELOCITY = AREA UNDER GRAPH (40s → 60s)

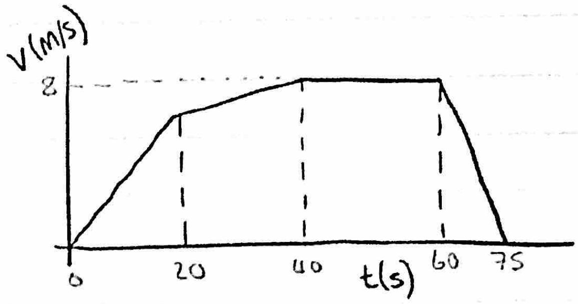
$d = \square$



$d = \square$

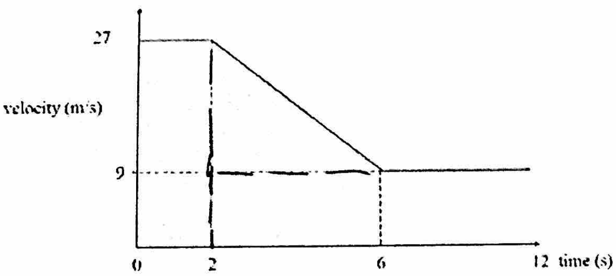
$d = 20 \times 8$

$d = 160m$



THEREFORE CYCLIST TRAVELS FURTHER WHILE ACCELERATING

18 HOW FAR HAS THE TRAIN TRAVELLED WHEN IT REACHES V = 9 m/s?



DISTANCE = AREA UNDER GRAPH

$d = \square + \square + \triangle$

$d = (2 \times 27) + (4 \times 9) + (\frac{1}{2} \times 4 \times 18)$

$d = 126m$

SINCE $d < 200m$, TRAIN IS CORRECT SPEED WHEN IT REACHES THE BRIDGE.

Weight, Mass, and Gravity

07 November 2020 13:13

1

	Weight (N)	*Mass* (kg)	*Gravitational field strength* (N/kg)
(a)	3000	300	10·0
(b)	2.2	0·6	3·7
(c)	2.34	0·2	11·7
(d)	230	23	10·0
(e)	1 680	144	11·7
(f)	69	6·0	11.5

Using $W = mg$

(a) $W = 300 \times 10.0$
$= 3000$ N

2) (a)

$W = mg$

$W = 50 \times 9.8$

$\underline{\underline{W = 490 N}}$

$W =$

$m = 50 kg$

$g = 9.8 N/kg$

(b)

$W = mg$

$W = 20 \times 9.8$

$\underline{\underline{W = 196 N}}$

$W =$

$m = 20 kg$

$g = 9.8 N/kg$

(c)

$W = mg$

$W = 9 \times 9.8$

$W = 88N$

$W =$

$m = 9kg$

$g = 9.8 N/kg$

(d)

$W = mg$

$W = 0.5 \times 9.8$

$W = 4.9 N$

$W =$

$m = 0.5kg$

$g = 9.8 N/kg$

3
(a)

$W = mg$

$750 = m \times 10$

$m = 75 kg$

$W = 750N$

$m =$

$g = 10 N/kg$

(b)

$W = mg$

$4.5 = m \times 10$

$m = 0.45 kg$

$W = 4.5N$

$m =$

$g = 10 N/kg$

(c) $W = mg$

$350 = m \times 10$

$\underline{\underline{m = 35\,kg}}$

$W = 350\,N$

$m =$

$g = 10\,N/kg$

(d) $W = mg$

$40 = m \times 10$

$\underline{\underline{m = 4\,kg}}$

$W = 40\,N$

$m =$

$g = 10\,N/kg$

4 (a) $W = mg$

$W = 0.5 \times 9.8$

$\underline{\underline{W = 4.9\,N}}$

$W =$

$m = 0.5\,kg$

$g_{Earth} = 9.8\,N/kg$

(b) $W = mg$

$W = 0.5 \times 1.6$

$\underline{\underline{W = 0.8\,N}}$

$W =$

$m = 0.5\,kg$

$g_{moon} = 1.6\,N/kg$

(c) $W = mg$

$W = 0.5 \times 0$

$W =$

$m = 0.5\,kg$

$W = 0.5 \times 0$

$\underline{\underline{W = 0\ N}}$

$m = 0.5\,kg$

$g_{Space} = 0\ N/kg$

5 (a) $W = m\,g$

$800 = m \times 9.8$

$\underline{\underline{m = 82\,kg}}$

$W_{Earth} = 800N$

$m =$

$g_{Earth} = 9.8\ N/kg$

(b) $m_{moon} = 82kg$ and (c) $m_{space} = 82kg$

Mass is the quantity of matter in an object, so does not change

6 (a) Nicola was correct.

(b) Gravitational field strength is the force that gravity exerts on each kilogram of mass

$$W = mg \Rightarrow g = \frac{W}{m}$$

7 (a) Weight (is a force, caused by gravity).

(b) $W = m\,g$

$W = 9000N$

(b) $W = mg$

$9000 = m \times 9.8$

$\underline{\underline{m = 920\,kg}}$

$W = 9000\,N$

$m =$

$g = 9.8\,N/kg$

8 (a) $W = mg$

$W = 2\times10^6 \times 9.0$

$\underline{\underline{W = 18\times10^6\,N}}$

$W =$

$m = 2\times10^6\,kg$

$g_{Saturn} = 9.0\,N/kg$

(b) $W = mg$

$W = 2\times10^6 \times 9.8$

$\underline{\underline{W = 19.6\times10^6\,N}}$

$W =$

$m = 2\times10^6\,kg$

$g_{Earth} = 9.8\,N/kg$

9 (a) $W = mg$

$784 = m \times 9.8$

$\underline{\underline{m = 80\,kg}}$

$W_{Earth} = 784\,N$

$m =$

$g_{Earth} = 9.8\,N/kg$

(b) $W = mg$

$W_{Planet} = 304\,N$

(b)

$W = mg$

$304 = 80 \times g_{planet}$

$g_{planet} = 3.8\ N/kg$

$W_{planet} = 304\ N$

$m = 80\ kg$

$g_{planet} =$

The planet could be Mars or Mercury.

($g_{mars} = 3.7\ N/kg$ and $g_{mercury} = 3.7\ N/kg$)

10

$W = mg$

$528 = m \times 8.9$

$m = 59.3\ kg$

$W_{Venus} = 528\ N$

$m =$

$g_{Venus} = 8.9\ N/kg$

$W = mg$

$W_{Earth} = 59.3 \times 9.8$

$W_{Earth} = 581\ N$

$W_{Earth} =$

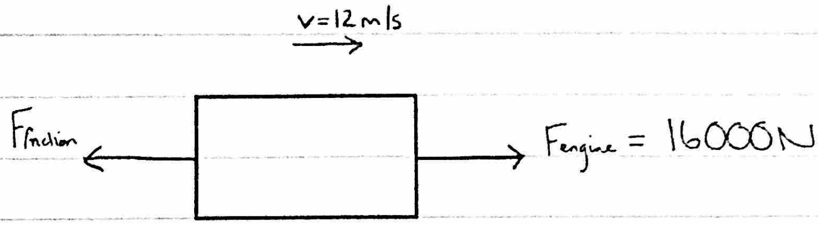
$m = 59.3\ kg$

$g_{Earth} = 9.8\ N/kg$

Newton's First Law

15 November 2020 15:14

1

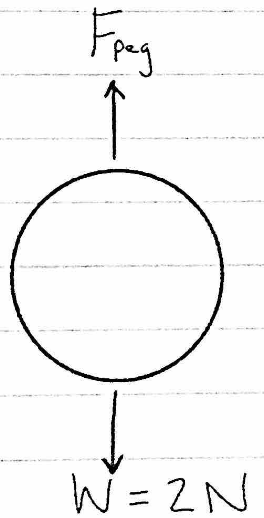


"constant speed" means that forces are balanced

friction opposes motion

Therefore $F_{friction} = F_{engine} = 16000N$

2



Clock is stationary $\Rightarrow$ forces are balanced

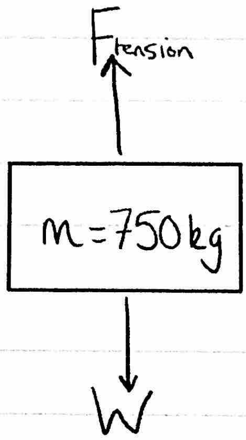
$F_{peg} = W = 2N$

3

"constant speed" $\Rightarrow$ forces are balanced

$F_{pedal} = F_{friction} = 550\,N$

4



"steady height" $\Rightarrow$ not moving

$\Rightarrow$ forces are balanced

(a) $W = mg$

$W = 750 \times 9.8$

$\underline{\underline{W = 7350\,N}}$

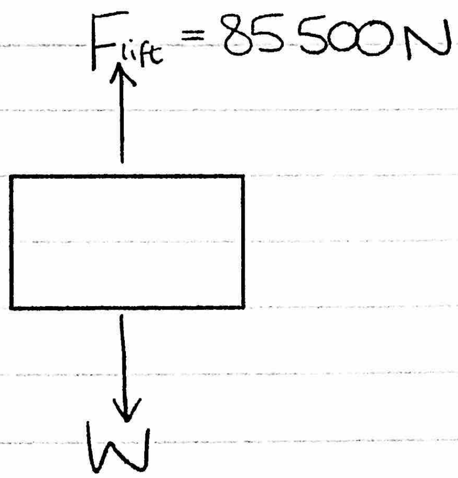
$W =$

$m = 750\,kg$

$g = 9.8\,N/kg$

(b) $F_{tension} = W = 7350\,N$

5



(a) "constant height" $\Rightarrow$ forces are balanced

$$W = F_{lift} = 85\,500N$$

(b)

$$W = mg$$

$$85\,500 = m \times 9.8$$

$$\underline{\underline{m = 8720\,kg}}$$

$W = 85\,500N$

$m =$

$g = 9.8\,N/kg$

6

(a)

$$M_{total} = M_{lift} + M_{load}$$

$$M_{total} = 800 + 153$$

$$\underline{\underline{M_{total} = 953\,kg}}$$

$M_{total} =$

$M_{lift} = 800kg$

$M_{load} = 153\,kg$

(b)

$$W = mg$$

$$W = 953 \times 9.8$$

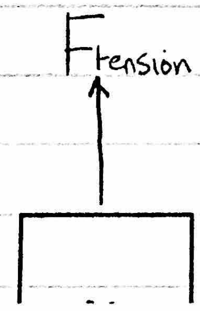
$$\underline{\underline{W = 9340\,N}}$$

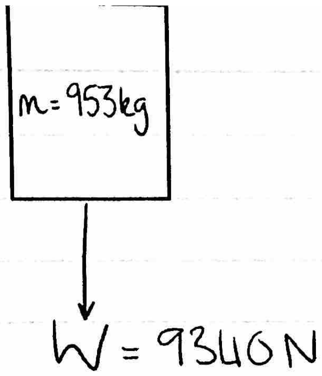
$W =$

$M_{total} = 953kg$

$g = 9.8\,N/kg$

(c)





"constant speed" ⇒ forces are balanced

$F_{tension} = W = 9340N$

(d) velocity $= 0$ when stopped ⇒ forces are balanced

$F_{tension} = W = 9340N$

(e) $F_{t.(max)} = 16\,400N$

$\Rightarrow W_{max} = F_{t.(max)} = 16400N$

$W = mg$

$16400 = m_{max} \times 9.8$

$\underline{\underline{m_{max} = 1670}}$ kg

$W_{max} = 16400N$

$m_{max} =$

$g = 9.8 N/kg$

7

(a) Terminal velocity

(b) $W = mg$ | $W =$

$W = 70 \times 9.8$ | $m = 70\ kg$

$\underline{\underline{W = 686N}}$ | $g = 9.8\ N/kg$

(c) terminal velocity / constant velocity

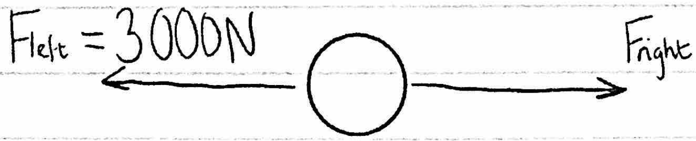
$\Rightarrow$ forces are balanced

$F_{(air\ resistance)} = W = 686N$

8 According to Newton's First Law, an object in motion will stay in motion until acted on by an unbalanced force.

Before braking, the car and the passenger are both moving forwards. When the car applies the brakes its speed will decrease but since there is no unbalanced force acting on the passenger, they will continue to move forwards.

9



(a) "remain stationary" $\Rightarrow$ forces are balanced

$F_{right} = F_{left} = 3000N$

(b) number of people $= \dfrac{\text{total force applied}}{\text{average force per person}}$

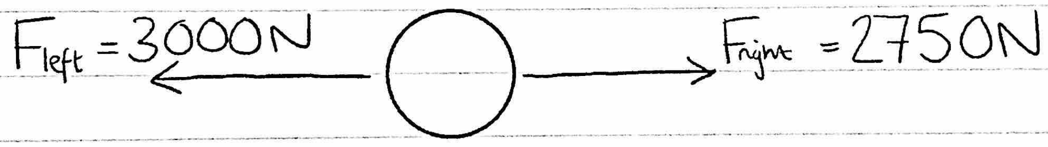
$$= \frac{3000}{250}$$

$= 12$ people

(c) new force applied $= 11$ people $\times$ averge F pp

$$F = 11 \times 250$$

$$F = 2750\text{N}$$

(d) 

Since $F_{left} > F_{right}$ forces are not balanced and the red team will be polled to the left.

10 (a) constant speed between 7s → 9s

and 13.5s → 17.5s

(b) 9 seconds

(c) At $t = 15s$, speed is constant

If speed is constant, forces are balanced

$$W = F_{(friction)}$$

(d) At $t = 16s$ $W = F_{(friction)}$

$W =$

$F_{friction} = 745N$

$$W = 745N$$

$$W = mg$$

$$745 = m \times 9.8$$

$$\underline{\underline{m = 76 kg}}$$

$W = 745 N$

$m =$

$g = 9.8 N/kg$

(e) At $t = 8s$, speed is constant

$\Rightarrow$ forces are balanced

$$F_{friction} = W = 745N$$

Freefall and Terminal Velocity

06 January 2021 15:36

1

(a) Weight.

(b) At the moment she jumps her vertical velocity is 0, therefore there will be no air resistance forces acting on her.

(c) As she falls her speed will start to increase.

(d) As her speed increases the air resistance acting on her increases.

(e) At terminal velocity, the forces acting on her are balanced.

(f) When she opens her parachute, air resistance is increased (larger surface area).

(g) She slows down because the forces are now unbalanced (air resistance > weight).

(h) She will reach a new, lower terminal velocity when the forces are balanced again. Air resistance will decrease with velocity until it is equal and opposite to the weight of the skydiver.

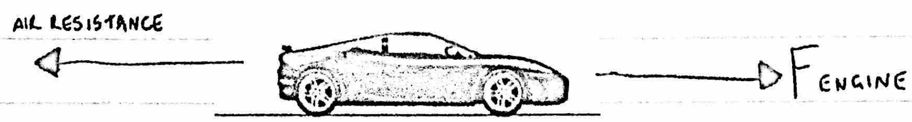
2

(a) When forces are balanced the velocity will be constant: between B and C, and between D and E.

(b) When the parachute is opened the velocity will decrease - C.

3

(a)



(b) The car is moving at a constant velocity, therefore the forces are balanced (they are the same size and act in opposite directions).

and act in opposite directions).

(c) Pressing the accelerator will increase the engine force:

- If the car is accelerating then there must be an unbalanced force acting on it.
- The engine force is increased, which increases the speed of the car.
- If the speed increases, the air resistance increases.

(d) The car will reach a new terminal velocity:

- Unbalanced force increases speed,
- Air resistance increases with speed,
- Car will remain at constant speed (terminal velocity) once air resistance and engine force are balanced.

Newton's Second Law

15 November 2020 16:48

1

$F_{un} = m\ a$

$F_{un} = 5 \times 3$

$\underline{\underline{F_{un} = 15N}}$

$F_{un} =$

$m = 5kg$

$a = 3\ m/s^2$

2

$F_{un} = m\ a$

$F_{un} = 0{\cdot}25 \times 2$

$\underline{\underline{F_{un} = 0.5\ N}}$

$F_{un} =$

$m = 250g$
$= 0{\cdot}25\ kg$

$a = 2\ m/s^2$

3

$F_{un} = m\ a$

$F_{un} = 10\,000 \times 1{\cdot}5$

$\underline{\underline{F_{un} = 15\,000N}}$

$F_{un} =$

$m = 10\,000\ kg$

$a = 1.5\ m/s^2$

4

$F_{un} = m\ a$

$12 = m \times 2$

$\underline{\underline{m = 6\ kg}}$

$F_{un} = 12N$

$m =$

$a = 2\ m/s^2$

5

$F_{un} = m\,a$

$65 = m \times 1.5$

$\underline{\underline{m = 43\,kg}}$

$F_{un} = 65\,N$

$m =$

$a = 1.5\,m/s^2$

6

$F_{un} = m\,a$

$500 = m \times 0.25$

$\underline{\underline{m = 2000\,kg}}$

$F_{un} = 500\,N$

$m =$

$a = 0.25\,m/s^2$

7

$F_{un} = m\,a$

$1.5 = 0.1 \times a$

$\underline{\underline{a = 15\,m/s^2}}$

$F_{un} = 1.5\,N$

$m = 100\,g$

$= 0.1\,kg$

$a =$

8

$F_{un} = m\,a$

$3.2 \times 10^6 = 1 \times 10^7 \times a$

$\underline{\underline{a = 0.32\,m/s^2}}$

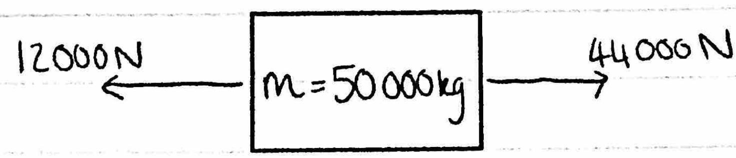
$F_{un} = 3.2 \times 10^6\,N$

$m = 1 \times 10^7\,kg$

$a =$

9

(a)



$F_{un} = 44\,000 - 12\,000 = 32\,000\text{ N}$ to the right

(b) $F_{un} = m\,a$

$32000 = 50000 \times a$

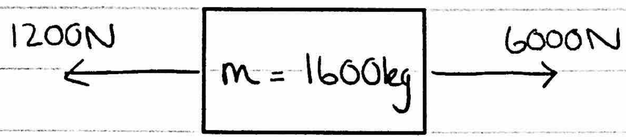
$\underline{\underline{a = 0.64 \text{ m/s}^2}}$

$F_{un} = 32\,000\text{ N}$

$m = 50\,000 \text{ kg}$

$a =$

10



$F_{un} = 6000 - 1200 = 4800\text{ N}$

$F_{un} = m\,a$

$4800 = 1600 \times a$

$\underline{\underline{a = 3 \text{ m/s}^2}}$

$F_{un} = 4800\text{ N}$

$m = 1600 \text{ kg}$

$a =$

11

(a) $F_{un} = 150\text{ N} - 45\text{ N} = \underline{105\text{ N}}$

(b) $F_{un} = m\,a$

$105 = m \times 1.5$

$\underline{\underline{m = 70 \text{ kg}}}$

$F_{un} = 105\text{ N}$

$m =$

$a = 1.5 \text{ m/s}^2$

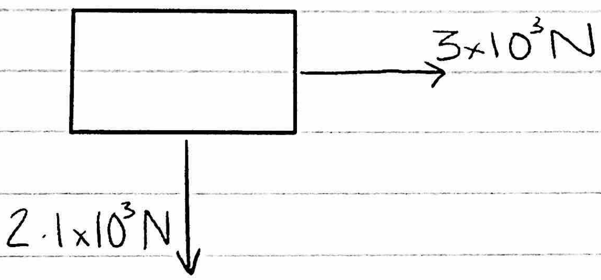
12

(a) $F_{un} = 3600N - 1600N = \underline{\underline{2000N}}$

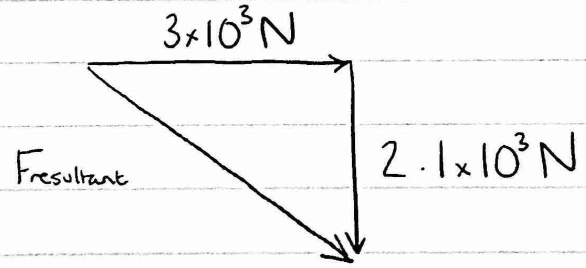
(b)

$F_{un} = m\,a$	$F_{un} = 2000N$
$2000 = 4500 \times a$	$m = 4500kg$
$\underline{\underline{a = 0.4\ m/s^2}}$	$a =$

13



Adding vectors :



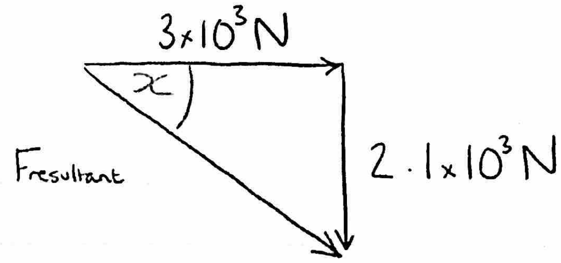
Applying pythagoras: $c^2 = a^2 + b^2$

$$F_{resultant}^{\ 2} = (3\times10^3)^2 + (2.1\times10^3)^2$$

$$F_{resultant} = \sqrt{(3\times10^3)^2 + (2.1\times10^3)^2}$$

$$\underline{\underline{F_{resultant} = 3.7\times10^3\ N}}$$

Force is a vector – magnitude AND direction



$$\tan(x) = \frac{opp}{adj}$$

$$\tan(x) = \frac{2.1 \times 10^3}{3 \times 10^3}$$

$$x = \tan^{-1}\left(\frac{2.1 \times 10^3}{3 \times 10^3}\right)$$

$$\underline{\underline{x = 35^\circ}}$$

(b)

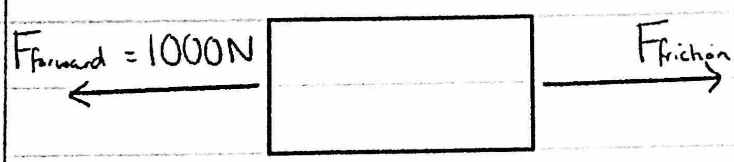
$F_{un} = m\,a$	$F_{un} = 3.7 \times 10^3$ N
$3.7 \times 10^3 = 15000 \times a$	$m = 15\,000$ kg
$\underline{\underline{a = 0.25\ m/s^2}}$	$a =$

14

(a)

$F_{un} = m\,a$	$F_{un} =$
$F_{un} = 70 \times 2.96$	$m = 70$ kg
$\underline{\underline{F_{un} = 207\ N}}$	$a = 2.96\ m/s^2$

(b)



$F_{un} = F_{forward} - F_{friction}$

Rearrange:

$F_{friction} = F_{forward} - F_{un}$

$F_{friction} = 1000N - 207N = \underline{\underline{793N}}$

15

(a)

$a = \frac{v-u}{t}$	$a =$
$a = \frac{18-6}{12}$	$v = 18\ m/s$
$\underline{\underline{a = 1.5\ m/s^2}}$	$u = 0\ m/s$
	$t = 12s$

$F_{un} = m\ a$	$F_{un} =$
$F_{un} = 800 \times 1.5$	$m = 800\ kg$
$\underline{\underline{F_{un} = 1200N}}$	$a = 1.5\ m/s^2$

(b)

$a = \frac{v-u}{t}$	$a =$
$a = \frac{0-18}{5}$	$v = 0\ m/s$
$\underline{\underline{a = -3.6\ m/s^2}}$	$u = 18\ m/s$
	$t = 5s$

$F_{un} = m\,a$

$F_{un} = 800 \times (-3.6)$

$\underline{\underline{F_{un} = -2900\,N}}$

$F_{un} =$

$m = 800\,kg$

$a = -3.6\,m/s^2$

(force is negative – braking opposes motion)

16
(a)

$F_{un} = m\,a$

$F_{un} = 1200 \times 3$

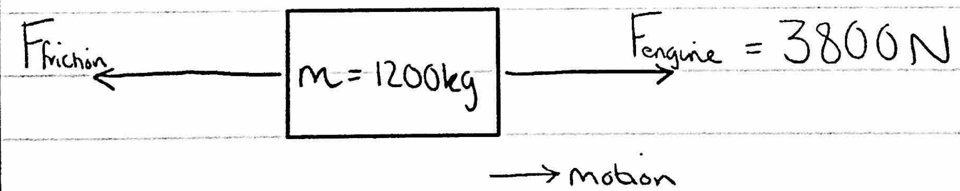
$\underline{\underline{F_{un} = 3600\,N}}$

$F_{un} =$

$m = 1200\,kg$

$a = 3\,m/s^2$

(b)



$F_{un} = F_{engine} - F_{friction}$

$3600 = 3800 - F_{friction}$

$\underline{\underline{F_{friction} = 200\,N}}$

17
(a)

$F_{un} = m\,a$

$F_{un} = 40\,N$

(a) $F_{un} = m\,a$

$40 = 375 \times a$

$\underline{\underline{a = 0 \cdot 11 \text{ m/s}^2}}$

$F_{un} = 40\text{N}$

$m = 15 \times 25\text{kg}$
$= 375\text{ kg}$

$a =$

(b) $F_{un} = ma$

$40 = 250 \times a$

$\frac{40}{250} = a$

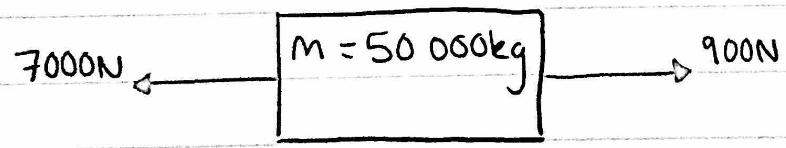
$\underline{\underline{a = 0.16 \text{ m/s}^2}}$

$F_{un} = 40\text{N}$

$m = 10$ REMAINING TROLLEYS $\times$ 25kg
$= 250\text{kg}$

$a =$

18



(a) $F_{un} = 7000\text{N} - 900\text{N} = \underline{\underline{6100\text{N}}}$

(b) $F_{un} = m\,a$

$6100 = 50\,000 \times a$

$\frac{6100}{50\,000} = a$

$\underline{\underline{a = 0.12 \text{ m/s}^2}}$

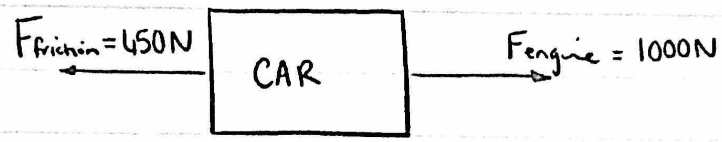
$F_{un} = 6100\text{N}$

$m = 50\,000\text{kg}$

$a =$

19

(a)



$F_{un} = F_{engine} - F_{friction} = 1000N - 450N = 550N$

$F_{un} = m\ a$	$F_{un} = 550N$
$550 = m \times 0.6$	$m =$
$\frac{550}{0.6} = m$	$a = 0.6 m/s^2$

$m = 916.\dot{6}$

$\underline{\underline{m = 920 kg}}$

20

$a = \frac{v-u}{t}$	$a =$
$a = \frac{60-0}{16}$	$v = 60 m/s$
$a = \frac{60}{16}$	$u = 0 m/s$ "FROM REST"
$a = 3.75 m/s^2$	$t = 16s$

$F_{un} = F_{engine} - F_{friction}$ BUT SINCE FRICTION IS IGNORED $F_{un} = F_{engine}$

$F_{un} = m\ a$

$1200 = m \times 3.75$

$\frac{1200}{3.75} = m$

$\underline{\underline{m = 320kg}}$

$F_{un} = F_{engine} = 1200N$

$m =$

$a = 3.75\ m/s^2$

Newton's Second Law - The Space Rocket

06 January 2021 10:13

1

$F_{un} = m\ a$

$600\,000 = 8\times10^5 \times a$

$\frac{600\,000}{8\times10^5} = a$

$\underline{\underline{a = 0{\cdot}75\ m/s^2}}$

$F_{un} = 600\,000\,N$

$m = 8\times10^5\ kg$

$a =$

2

$F_{un} = m\ a$

$F_{un} = 3\times10^6 \times 1{\cdot}4$

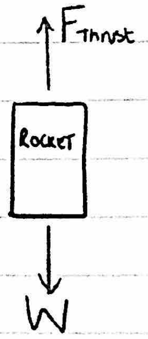
$\underline{\underline{F_{un} = 4{\cdot}2\times10^6\,N}}$

$F_{un} =$

$m = 3\times10^6\ kg$

$a = 1{\cdot}4\ m/s^2$

3 USING NEWTON'S 2^{nd} LAW:



WHEN THE ENGINE FORCE (F_{Thrust}) ACTING ON A ROCKET GREATER THAN THE WEIGHT (W) OF THE ROCKET, THERE WILL BE AN UNBALANCED FORCE ACTING ON THE ROCKET.

THIS UNBALANCED FORCE, ACTING UPWARDS, WILL CAUSE THE ROCKET TO ACCELERATE UPWARDS.

(b) SEE FREEBODY DIAGRAM ABOVE

(c) FIRST CALCULATE THE UNBALANCED FORCE

$F_{un} = F_{Thrust} - W$

where $W = mg$

$F_{un} =$

$F_{un} = F_{thrust} - W$

where $W = mg$

$F_{un} = F_{thrust} - mg$

$F_{un} = 800000 - (75\,000 \times 9.8)$

$F_{un} = 65\,000\text{ N}$

$F_{un} =$

$F_{thrust} = 800\,000\text{ N}$

$m = 75\,000\text{ kg}$

$g_{Earth} = 9.8\text{ N/kg}$

THEN CALCULATE THE ACCELERATION

$F_{un} = m \quad a$

$65000 = 75000 \times a$

$\frac{65000}{75000} = a$

$a = 0.8\dot{6} = 0.86666...$

$\underline{\underline{a = 0.87\text{ m/s}^2}}$

$F_{un} = 65\,000\text{ N}$

$m = 75\,000\text{ kg}$

$a =$

4 FIRST CALCULATE THE UNBALANCED FORCE

$F_{un} = m \quad a$

$F_{un} = 18\,000 \times 9$

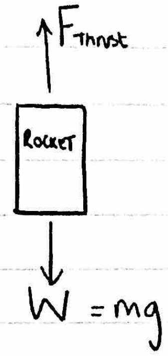
$F_{un} = 162\,000\text{ N}$

$F_{un} =$

$m = 18\,000\text{ kg}$

$a = 9\text{ m/s}^2$

THEN FIND THE ENGINE THRUST FORCE



$F_{un} = F_{thrust} - W$

where $W = mg$

$F_{un} = F_{thrust} - mg$

$162000 = F_{thrust} - (18000 \times 9.8)$

$162\,000 + (18000 \times 9.8) = F_{thrust}$

$F_{thrust} = 338400$

$\underline{F_{thrust} = 340\,000\ N}$

$F_{un} = 162\,000\ N$

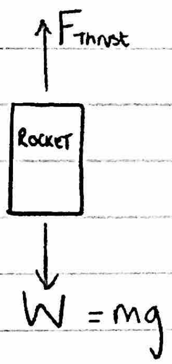
$F_{thrust} =$

$m = 18000\ kg$

$g_{Earth} = 9.8\ N/kg$

5

(a)



(b) FIRST CALCULATE THE UNBALANCED FORCE

$F_{un} = F_{thrust} - W$

where $W = mg$

$F_{un} = F_{thrust} - mg$

$F_{un} = 620000 - (50\,000 \times 9.8)$

$F_{un} = 130\,000\ N$

$F_{un} =$

$F_{thrust} = 620\,000\ N$

$m = 50\,000\ kg$

$g_{Earth} = 9.8\ N/kg$

THEN CALCULATE THE ACCELERATION

$F_{un} = m\ a$

$F_{un} = 130\,000\ N$

THEN CALCULATE THE ACCELERATION

$F_{un} = m \quad a$

$F_{un} = 130\,000$ N

$m = 50\,000$ kg

$a =$

$130\,000 = 50\,000 \times a$

$\frac{130\,000}{50\,000} = a$

$\underline{a = 2.6 \text{ m/s}^2}$

6 Due to the large amount of fuel in the rocket's tanks at lift-off its mass is large. The rocket engine provides the thrust to overcome the weight. As the rocket rises, its mass decreases and the acceleration increases. Far out in space the engine is switched off and the rocket continues on its way at constant speed.

7 USING:

$W = mg$ $\quad F_{un} = F_{thrust} - W$ $\quad a = \frac{F_{un}}{m}$

	Mass (kg)	*Weight* (N)	*Thrust* (N)	*Unbalanced force* (N)	*Acceleration* (ms^{-2})
(a)	3	29.4	60	30.6	10.2
(b)	200	1 960	21 000	19040	54.7
(c)	1 500	14700	20 000	5300	3.53
(d)	50 000	490 000	550 000	60 000	1.2
(e)	70 000	686 000	840 000	154 000	2.2
(f)	76 000	744800	896 800	152 000	2

8 (a) ACCELERATION IS GIVEN BY $a = \frac{F_{un}}{m}$ (FROM $F_{un} = ma$)

THEREFORE THE VALUE OF a WILL CHANGE IF F_{un} OR m CHANGE.

- AS THE ROCKET BURNS FUEL, IT'S MASS DECREASES $\rightarrow$ a increases
- SINCE $F_{un} = F_{thrust} - W$, INCREASING F_{thrust} WILL INCREASE F_{un}. THIS COULD BE ACHIEVED BY FASTER BURNING OF FUEL $\rightarrow$ a increases
- SINCE $F_{un} = F_{thrust} - W$, AND $W = mg$, THE ROCKETS WEIGHT

F_{un}. This could be achieved by faster burning of fuel $\longrightarrow a$ increases

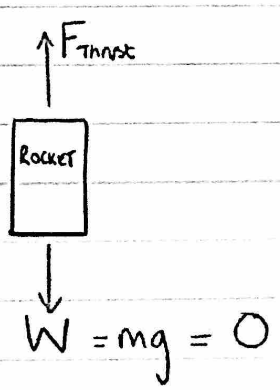
- Since $F_{un} = F_{thrust} - W$, and $W = mg$, the rockets weight will decrease as g decreases (moving away from planet's surface. Thus F_{un} will increase. $\longrightarrow a$ increases

(b)

Newton's 1st Law states: "An object will remain at rest or move at a constant velocity in a straight line unless acted on by an unbalanced force."

If g is negligible (so small that we can ignore it) then the rocket is weightless. If no unbalanced forces act on it it will continue at a constant velocity of 12 000 m/s (engines off)

Newton's Second Law states 'When an object is acted on by a constant **unbalanced force** the body moves with constant acceleration in the direction of the unbalanced force.' ($F_{un} = ma$)



An unbalanced force (F_{thrust}) is required for the rocket to change its velocity (speed or direction)

Newton's Third Law

"For every action, there is an equal and opposite reaction".

When the rocket burns fuel it pushes it "downwards", and the fuel pushes the rocket "upwards".

9 In space we can ignore gravitationa effects so:

$F_{un} = F_{thrust}$

$F_{un} = m \quad a$

$100\,000 = 7500 \times a$

$\frac{100\,000}{7500} = a$

$a = 13.\dot{3}$

$\underline{a = 13 \text{ m/s}^2}$

$F_{un} = 100\,000 \text{ N}$

$m = 7500 \text{ kg}$

$a =$

10 $W = m \quad g$

$3000 = m \times 9.8$

$\frac{3000\,000}{9.8} = m$

$\underline{\underline{m = 306\,000 \text{ kg}}}$

$W = 3000 \text{ kN} = 3\,000\,000 \text{ N}$

$m =$

$g_{Earth} = 9.8$

(b) $F_{un} = F_{thrust} - W$

$F_{un} = 7500 - 3000$

$\underline{\underline{F_{un} = 4500 \text{ kN}}}$

F_{un}

$F_{thrust} = 7500 \text{ kN}$

$W = 3000 \text{ kN}$

(c) $F_{un} = m \quad a$

$4\,500\,000 = 306\,000 \times a$

$\frac{4\,500\,000}{306\,000} = a$

$\underline{\underline{a = 14.8 \text{ m/s}^2}}$

$F_{un} = 4500 \text{ kN} = 4\,500\,000 \text{ N}$

$m = 306\,000 \text{ kg}$

$a =$

11

(a)

$$W = m g$$

$$1.8\times10^7 = m \times 9.8$$

$$\frac{1.8\times10^7}{9.8} = m$$

$$\underline{\underline{m = 1.8\times10^6\ kg}}$$

$W = 1.8\times10^7\ N$

$m =$

$g_{earth} = 9.8\ N/kg$

(b) IN SPACE WE CAN IGNORE GRAVITATIONA EFFECTS SO:

$$F_{un} = F_{thrust} = 2.7\times10^6\ N$$

$$F_{un} = m a$$

$$2.7\times10^6 = 1.8\times10^6 \times a$$

$$\frac{2.7\times10^6}{1.8\times10^6} = a$$

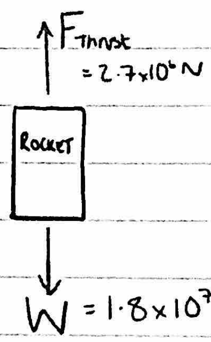
$$\underline{\underline{a = 1.5\ m/s^2}}$$

$F_{un} = 2.7\times10^6\ N$

$m = 1.8\times10^6\ kg$

$a =$

(c)



$$F_{un} = F_{thrust} - W$$

IF $W > F_{thrust}$ THEN IT COULD NOT BE LAUNCHED.

(d) FIRST CALCULATE THE UNBALANCED FORCE

$$F_{un} = F_{thrust} - W$$

$$F_{un} = 2.7\times10^7 - 1.8\times10^7$$

$F_{un} =$

$F_{thrust} = 2.7\times10^7\ N$

$F_{un} = 2.7\times10^7 - 1.8\times10^7$

$F_{un} = 0.9\times10^7\ N$

$F_{thrust} = 2.7\times10^7\ N$

$W = 1.8\times10^7\ N$

THEN CALCULATE THE ACCELERATION

$F_{un} = m\ a$

$0.9\times10^7 = 1.8\times10^6 \times a$

$\frac{0.9\times10^7}{1.8\times10^6} = a$

$\underline{a = 5\ m/s^2}$

$F_{un} = 0.9\times10^7\ N$

$m = 1.8\times10^6\ kg$

$a =$

(e) AS ABOVE (d) BUT USING $W = mg_{venus}$ WHERE $g_{venus} = 8.9\ N/kg$.

So $W = mg_{venus} = 1.8\times10^6 \times 8.9 = 1.6\times10^7 N$

FIRST CALCULATE THE UNBALANCED FORCE

$F_{un} = F_{thrust} - W$

$F_{un} = 2.7\times10^7 - 1.6\times10^7$

$F_{un} = 1.1\times10^7\ N$

$F_{un} =$

$F_{thrust} = 2.7\times10^7\ N$

$W = 1.6\times10^7\ N$

THEN CALCULATE THE ACCELERATION

$F_{un} = m\ a$

$1.1\times10^7 = 1.8\times10^6 \times a$

$\frac{1.1\times10^7}{1.8\times10^6} = a$

$\underline{a = 6.1\ m/s^2}$

$F_{un} = 1.1\times10^7\ N$

$m = 1.8\times10^6\ kg$

$a =$

$$\underline{\underline{a = 6.1\ m/s^2}}$$

(f) WHEN $a = 5\ m/s^2$, $F_{un} = 0.9 \times 10^7 N$. m IS UNCHANGED.

$$F_{un} = F_{thrust} - W$$

FIND SHUTTLE'S WEIGHT ON JUPITER:

$$W = mg$$

$$W = 1.8 \times 10^6 \times 23$$

$$W = 4.14 \times 10^7 N$$

$W =$

$m = 1.8 \times 10^6\ kg$

$g_{Jupiter} = 23\ N/kg$

FIND F_{thrust}:

$$F_{un} = F_{thrust} - W$$

$$0.9 \times 10^7 = F_{thrust} - 4.14 \times 10^7$$

$$0.9 \times 10^7 + 4.14 \times 10^7 = F_{thrust}$$

$$\underline{F_{thrust} = 5.04 \times 10^7 N}$$

Newton's Third Law

06 January 2021 16:02

1 **Newton's Third Law**

"For every action, there is an equal and opposite reaction".

2

(a) Action: golf club exerts a forward force on the ball.
Reaction: ball exerts a backwards force on the golf club.

(b) Action: cue exerts a force on the ball.
Reaction: ball exerts a force on the cue.

(c) Action: thumb exerts a force on the table.
Reaction: table exerts a force on the thumb.

3 When the bullet is fired from the gun, the gun exerts a force on the bullet in the forward direction. The bullet also exerts a force on the gun, pushing it backwards into the sniper's shoulder.

4 The astronaut exerts a force on the spanner when he throws it away from the spacecraft. The spanner exerts a force on the astronaut, pushing him back towards the spacecraft.

Projectile Motion

06 January 2021 16:02

1

(a) $d_H = v_H t$ $(d = vt)$

HORIZONTAL	VERTICAL
$d_H =$	$a = 9.8 m/s$
$v_H = 20 m/s$	$v_v =$
$t = 2s$	$u_v = 0 m/s$
	$t = 2s$

$d_H = 20 \times 2$

$\underline{\underline{d_H = 40m}}$

(b) $a = \frac{v-u}{t}$

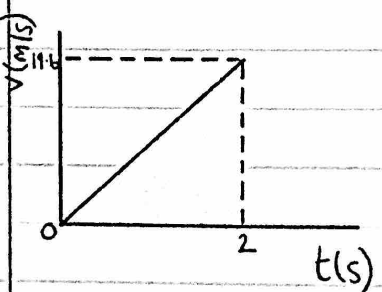
$9.8 = \frac{v_v - 0}{2}$

$9.8 = \frac{v_v}{2}$

$9.8 \times 2 = v_v$

$\underline{\underline{v_v = 19.6 m/s}}$

(c) VERTICAL DISPLACEMENT (HEIGHT) = AREA UNDER V-t GRAPH.



$h = d_v = \left(\frac{1}{2} \times 2 \times 19.6\right)$

$\underline{\underline{h = 19.6m}}$

2

(a) THE STONE FOLLOW A CURVED PATH BECAUSE:

- IT HAS A CONSTANT HORIZONTAL VELOCITY
- IT HAS A CONSTANT VERTICAL ACCELERATION

(b)

HORIZONTAL	VERTICAL
$d_H = 24\,m$	$a = 9.8\,m/s^2$
$V_H =$	$V_v =$
$t = 3s$	$u_v = 0\,m/s$
	$t = 3s$

$$d_H = V_H t$$

$$24 = V_H \times 3$$

$$\frac{24}{3} = V_H$$

$$\underline{\underline{V_H = 8\,m/s}}$$

(c)

$$a = \frac{V_v - u_v}{t}$$

$$9.8 = \frac{V_v - 0}{3}$$

$$9.8 = \frac{V_v}{3}$$

$$9.8 \times 3 = V_v$$

$$\underline{\underline{V_v = 29.4\,m/s}}$$

3

(a)

HORIZONTAL	VERTICAL
$d_H =$	$a = 9.8\,m/s^2$
$V_H = 6\,m/s$	$V_v =$
$t = 2s$	$u_v = 0\,m/s$
	$t = 2s$

$$d_H = V_H t$$

$$d_H = 6 \times 2$$

$$\underline{\underline{d_H = 12\,m}}$$

(b)

$$a = \frac{v - u}{t}$$

$$9.8 = \frac{V_v - 0}{2}$$

$$9.8 = \frac{V_v}{2}$$

$$V_v = 9.8 \times 2$$

$$\underline{\underline{V_v = 19.6 \text{ m/s}}}$$

4

(a)

HORIZONTAL	VERTICAL
$d_H = 100 \text{m/s}$	$a = 9.8 \text{ m/s}^2$
$V_H =$	$V_v =$
$t = 12\text{s}$	$u_v = 0 \text{ m/s}$
	$t = 12\text{s}$

$$d_H = V_H t$$

$$100 = V_H \times 12$$

$$\frac{100}{12} = V_H$$

$$\underline{\underline{V_H = 8.3 \text{ m/s}}}$$

(b)

$$a = \frac{V - u}{t}$$

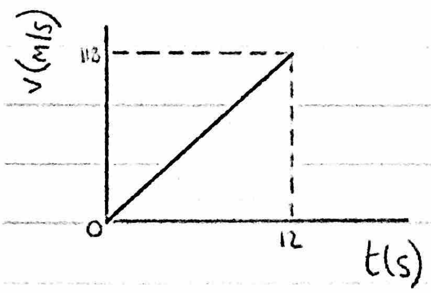
$$9.8 = \frac{V_v - 0}{12}$$

$$9.8 = \frac{V_v}{12}$$

$$9.8 \times 12 = V_v$$

$$\underline{\underline{V_v = 118 \text{ m/s}}}$$

(c) VERTICAL DISPLACEMENT (HEIGHT) = AREA UNDER V-t GRAPH.



$$h = d_v = \left(\frac{1}{2} \times 12 \times 118\right)$$

$$\underline{\underline{h = 708\text{m}}}$$

5

(a)

$$d_H = V_H t$$

$$d_H = 30 \times 10$$

$$\underline{\underline{d_H = 300\,m}}$$

HORIZONTAL	VERTICAL
$d_H =$	$a = 9.8\,m/s^2$
$V_H = 30\,m/s$	$V_v =$
$t = 10s$	$u_v = 0\,m/s$
	$t = 10s$

(b)

$$a = \frac{V-u}{t}$$

$$9.8 = \frac{V_v - 0}{10}$$

$$9.8 = \frac{V_v}{10}$$

$$9.8 \times 10 = V_v$$

$$\underline{\underline{V_v = 98\,m/s}}$$

6

(a)

$$d_H = V_H t$$

$$50 = 100 \times t$$

$$\frac{50}{100} = t$$

$$\underline{\underline{t = 0.5s}}$$

HORIZONTAL	VERTICAL
$d_H = 50m$	$a = 9.8\,m/s^2$
$V_H = 100\,m/s$	$V_v =$
$t =$	$u_v = 0\,m/s$
	$t =$

(b)

$$a = \frac{V-u}{t}$$

$$9.8 = \frac{V_v - 0}{0.5}$$

$$9.8 = \frac{V_v}{0.5}$$

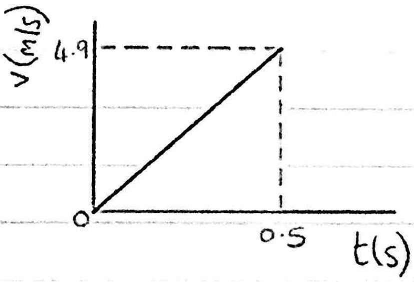
$$9.8 \times 0.5 = V_v$$

$$\underline{\underline{V_v = 4.9\,m/s}}$$

(c) LAUNCHED AT THE SAME HEIGHT AS THE TARGET CENTRE

$\Rightarrow$ NEED TO FIND VERTICAL DISPLACEMENT

VERTICAL DISPLACEMENT (HEIGHT) = AREA UNDER V-t GRAPH.



$$h = d_v = \left(\tfrac{1}{2} \times 0.5 \times 4.9\right)$$

$$\underline{\underline{h = 1.2m}}$$

7

(a) $V_v = 0\ m/s$ AT MAXIMUM HEIGHT

(b) $d = v\ t$

$400 = V_H \times 4$

$\frac{400}{4} = V_H$

$$\underline{\underline{V_H = 100\,m/s}}$$

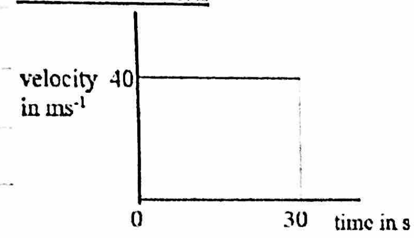
$d_H = 400m$

$V_H =$

$t = 4s$

8 DISTANCE = AREA UNDER GRAPH

Horizontal motion

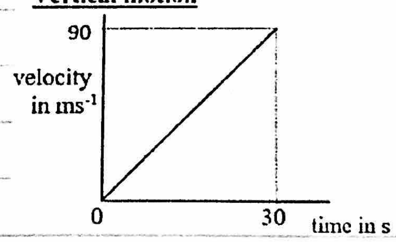


$d_H = \square$

$d_H = 30 \times 40$

$\underline{\underline{d_H = 1200\,m}}$

Vertical motion



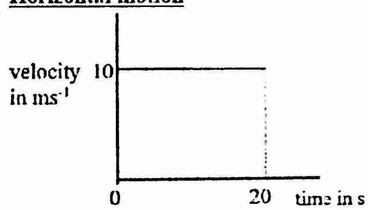
$d_V = \triangle$

$d_V = \frac{1}{2} \times 30 \times 90$

$\underline{\underline{d_V = 1350\,m}}$

9 (a) DISTANCE = AREA UNDER GRAPH

Horizontal motion



$d_H = \square$

$d_H = 20 \times 10$

$\underline{\underline{d_H = 200\,m}}$

(b)

$a = \frac{v-u}{t}$

$a = \frac{15-0}{20}$

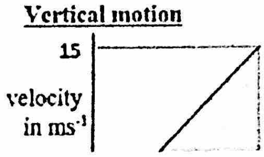
$a = \frac{15}{20}$

$\underline{\underline{a = 0.75\,m/s^2}}$

$a =$

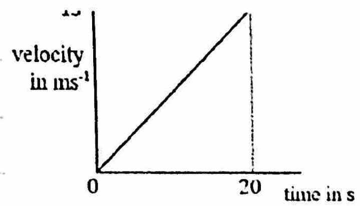
$\left.\begin{array}{l} v = 15\,m/s \\ u = 0\,m/s \\ t = 20s \end{array}\right\}$ FROM GRAPH

Vertical motion



$d_V = \triangle$

$d_V = \frac{1}{2} \times 20 \times 15$

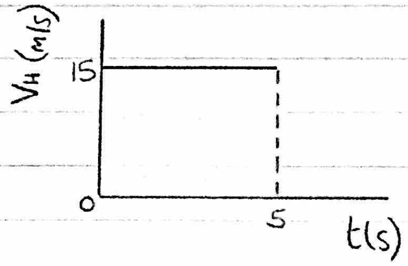


$d_v = \frac{1}{2} \times 20 \times 15$

$\underline{\underline{d_v = 150m}}$

10

(a)



(b) NEED TO FIRST CALCULATE V_v

$a = \frac{V-u}{t}$

$9.8 = \frac{V_v - 0}{5}$

$9.8 = \frac{V_v}{5}$

$9.8 \times 5 = V_v$

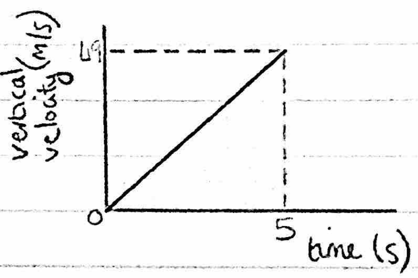
$a = 9.8 m/s^2$

$V_v =$

$u_v = 0 m/s$

$t = 5s$

$\underline{\underline{V_v = 49 m/s}}$



(c) $d_H = \square$

$d_v = \triangle$

$d_H = 5 \times 15$

$d_v = \frac{1}{2} \times 5 \times 49$

$d_H = 5 \times 15$ $\qquad\qquad$ $d_V = \frac{1}{2} \times 5 \times 49$

$\underline{\underline{d_H = 75\,m}}$ $\qquad\qquad$ $\underline{\underline{d_V = 123\,m}}$

11

(a) $d_H =$

$d_H = 2.4 \times 35$

$\underline{\underline{d_H = 84\,m}}$

HORIZONTAL	VERTICAL
$d_H =$	$a = 9.8\,m/s^2$
$V_H = 35\,m/s$	$V_V =$
$t = 2.4s$	$u_V = 0\,m/s$
	$t = 2.4s$

(b) $a = \frac{v-u}{t}$

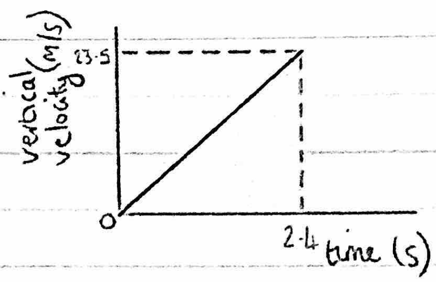
$9.8 = \frac{V_V - 0}{2.4}$

$9.8 = \frac{V_V}{2.4}$

$9.8 \times 2.4 = V_V$

$\underline{\underline{V_V = 23.5\,m/s}}$

(c)



VERTICAL DISTANCE (HEIGHT) = AREA UNDER V-t GRAPH

$d_V = \triangle$

$d_V = \frac{1}{2} \times 2.4 \times 23.5$

$\underline{\underline{d_V = 28.2\,m}}$

12

(a)

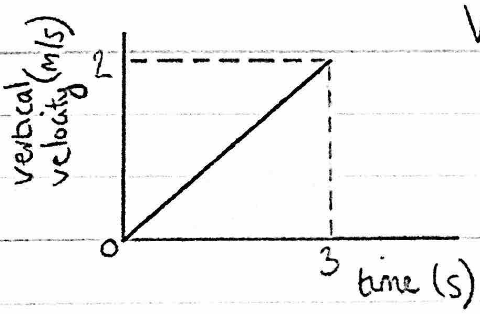
$d = v t$

$d_H = 12 \times 3$

$\underline{\underline{d_H = 36m}}$

HORIZONTAL	VERTICAL
$d_H =$	$a = 9.8 m/s^2$
$V_H = 12 m/s$	$V_v =$
$t = 3s$	$u_v = 0 m/s$
	$t = 3s$

(b)



VERTICAL DISTANCE (HEIGHT) = AREA UNDER V-t GRAPH

$d_v = \Delta$

$d_v = \frac{1}{2} \times 3 \times 2$

$\underline{\underline{d_v = 3m}}$

Satellites

06 January 2021 16:02

1

(a) $v = f\lambda$

$3\times10^8 = 6\times10^9 \times \lambda$

$\frac{3\times10^8}{6\times10^9} = \lambda$

$\underline{\underline{\lambda = 0.05m}}$

$v = 3\times10^8\ m/s$

$f = 6\ GHz = 6\times10^9\ Hz$

$\lambda =$

(b) $d = v\ t$

$20\times10^6 = 3\times10^8 \times t$

$\frac{20\times10^6}{3\times10^8} = t$

$\underline{\underline{t = 0.07s}}$

$d = 20\ 000km$
$= 20\ 000\ 000m$
$= 20\times10^6\ m$

$v = 3\times10^8\ m/s$

$t =$

2

(a) A GEOSTATIONARY SATELLITE IS A SATELLITE THAT REMAINS ABOVE THE SAME POINT OF THE EARTH'S SURFACE.

(b)

$v = f\lambda$

$3\times10^8 = f \times 0.02$

$\frac{3\times10^8}{0.02} = f$

$\underline{\underline{f = 1.5\times10^{10}\text{ Hz}}}$

$v = 3\times10^8$ m/s

$f =$

$\lambda = 2\text{ cm} = 0.02\text{ m}$

(c)

$d = v\ t$

$36\times10^6 = 3\times10^8 \times t$

$\frac{36\times10^6}{3\times10^8} = t$

$\underline{\underline{t = 0.12\text{ s}}}$

$d = 36\,000$ km
$= 36\,000\,000$ m
$= 36\times10^6$ m

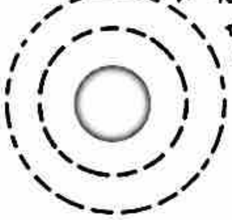
$v = 3\times10^8$ m/s

$t =$

3

(a) PERIOD = TIME TAKEN TO COMPLETE ONE COMPLETE ORBIT

(b) AS HEIGHT OF SATELLITE (ALTITUDE) INCREASES, PERIOD INCREASES.



HAS FURTHER DISTANCE TO TRAVEL, THEREFORE TAKES LONGER TO COMPLETE ONE ORBIT

4 EARLY BIRD TOOK LONGER TO COMPLETE ON ORBIT

HIGHER ALTITUDE = LONGER PERIOD

5
- ACCELERATION = CHANGE IN VELOCITY OVER TIME

$$a = \frac{(v-u)}{t}$$

- VELOCITY IS A VECTOR QUAN-TY - HAS MAGNITUDE AND DIRECTION
- SATELLITE TRAVELS AT A CONSTANT SPEED, BUT DIRECTION OF TRAVEL CHANGES CONSTANTLY.
- THEREFORE SATELLITES ARE ACCELERATING.

Distances in Space.

1. A light year is the distance travelled by light in one year.

2. a) 1 light year = speed of light × 1 year in seconds

$$= 3 \times 10^8 \times \underset{\text{days}}{\underset{\downarrow}{365}} \times \underset{\text{hours}}{\underset{\downarrow}{24}} \times \underset{\text{mins}}{\underset{\downarrow}{60}} \times \underset{\text{secs}}{\underset{\downarrow}{60}}$$

4.2 light years $= 4.2 \times 3 \times 10^8 \times 365 \times 24 \times 60 \times 60$

$$= \underline{\underline{3.97 \times 10^{16}\ m}}$$

b) 26000 light years $= 26000 \times 3 \times 10^8 \times 365 \times 24 \times 60 \times 6$

$$= \underline{\underline{2.46 \times 10^{20}\ m}}$$

3. a) Earth to Sun $= \dfrac{1.5 \times 10^{17}}{(3 \times 10^8 \times 365 \times 24 \times 60 \times 60)}$

$$= \underline{\underline{15.9 \text{ light years}}}$$

b) Earth to Andromeda $= \dfrac{1.9 \times 10^{19}}{(3 \times 10^8 \times 365 \times 24 \times 60 \times 60)}$

$$= \underline{\underline{2008 \text{ light years}}}$$

4. a) Distance to Sirius = 9 light years

$= 9 \times 3\times10^8 \times 365 \times 24 \times 60 \times 60$

$= \underline{\underline{8.5 \times 10^{16}\,m}}$

b) $t = \frac{d}{v}$

$t = ?$

$d = 8.5 \times 10^{16}\,m$

$t = \frac{8.5 \times 10^{16}}{1200}$

$v = 1200\,ms^{-1}$

$t = \underline{\underline{7.08 \times 10^{13}\,s}}$ $(2.25 \times 10^6$ years$)$

5. a) $t = \frac{d}{v}$

$t = ?$

$d = 1.9 \times 10^{19}\,m$

$t = \frac{1.9 \times 10^{19}}{3 \times 10^8}$

$v = 3\times10^8\,ms^{-1}$

$t = \underline{\underline{6.3 \times 10^{10}\,s}}$ (1998 years)

b) $t = \frac{d}{v}$

$t = ?$

$d = 1.9 \times 10^{19}\,m$

$t = \frac{1.9 \times 10^{19}}{1200}$

$v = 1200\,ms^{-1}$

$t = \underline{1.58 \times 10^{16}\,s}$ $(5.01 \times 10^8$ years$)$

6. 300 years

7. $t = \frac{d}{v}$

$t = ?$

$d = 5.763 \times 10^{12} m$

$v = 3 \times 10^{8} ms^{-1}$

$t = \frac{5.763 \times 10^{12}}{3 \times 10^{8}}$

$t = \underline{\underline{19210\ s}}$ (320 minutes)

Space Exploration.

1. Scratch - resistant lenses
(originally designed for astronaut helmets)

Firefighting and flame - retardant materials
(originally designed for use in space suits)

Solar cells (designed to power space missions)

Water filtration systems

Memory foam (originally designed for astronauts during take-off to help their bodies endure high forces)

Invisible braces (originally designed to protect radar equipment without blocking the signal)

2. A one-way trip to Mars would take between 7 and 9 months - that's a long flight for us humans! Crew health would be a major concern - keeping human beings fit in a small capsule, the effects of 'weightlessness' on the body, providing sufficient food and water for this length of time. Muscle mass and bone density would also decrease over this time unless sufficient exercise equipment was provided.

Ensuring that humans would have all of the supplies they needed for this journey is a significant challenge in itself. Carrying the required supplies such as food, water, exercise equipment and all of the other materials needed once reaching Mars adds significant mass to the rocket leaving Earth and also incurs high additional costs to an already expensive journey.

Upon reaching the surface of Mars humans would face more challenges, such as producing a sustainable food source and outfitting humans with clothing that will allow them to live in temperatures of −62°C!

3. Carrying out research in low gravity is useful as gravity can be a disrupting factor for scientists.

A low gravity environment allows physical processes and the behaviours of certain substances and organisms to be studied without the influence of Earth's gravity that we are used to observing under.

Understanding the Universe.

1. Telescopes on Earth can also detect radio signals.

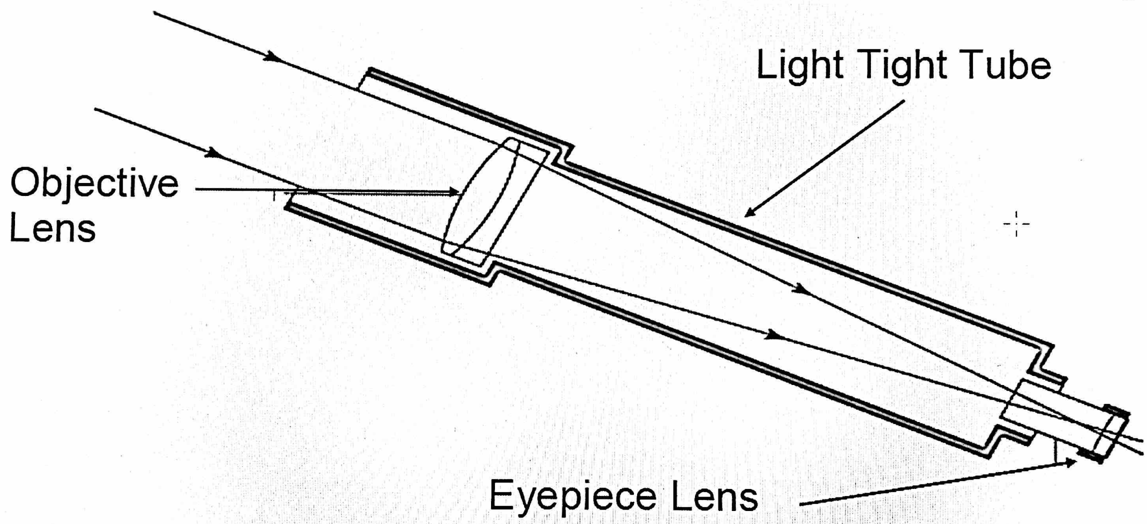
2. a) Terrestrial telescopes are unable to detect some types of radiation from space as Earth's atmosphere blocks / filters these radiations therefore preventing them from reaching telescopes on Earth's surface.

   b) The Hubble Space Telescope.

3. Reflecting and Refracting telescopes.

Refracting Telescope

Light passes through the wide objective lens. The eyepiece lens magnifies and



5. The objective lens is used to alter the brightness of the image seen in a refracting telescope.

6. Compared to reflecting telescopes, the objective lens of a refracting telescope has a much smaller collecting area and so is able to collect less light, making distant objects difficult to observe.

7. The Hubble Space Telescope is able to provide such clear images as it operates outside of Earth's atmosphere.

As a result, space-based telescopes like the Hubble are able to detect frequencies and wavelengths across the entire electromagnetic spectrum, unlike ground-based telescopes on Earth.

8. Three pieces of evidence for the Big Bang Theory are:

1. Cosmic Microwave Background Radiation.

Also known as the 'afterglow of the Big Bang', the Cosmic Microwave Background Radiation is uniformly distributed across the Universe. It is consistent with the theory that radiation emitted after the Big Bang spread out evenly in all directions across the Universe.

8. (continued)

② The Expanding Universe.

In 1929, Edwin Hubble discovered that everything in the Universe was moving away from everything else, i.e. the Universe was expanding.

This was confirmed by Hubble's observations of galactic redshift, also known as Doppler Redshift. Redshift shows that galaxies are moving away from us, causing their light to appear 'redder' than it should.

③ Abundance of Light Elements.

The Big Bang theory states that matter started in a very simple form and that the simplest elements (Hydrogen and Helium) would have formed first with all other elements forming later in stars.

As such there should be more hydrogen and helium in the Universe than any other elements. Current analysis of the abundance of these elements in existence in the Universe are in line with the predictions of the Big Bang.

9. Earth is suitable for sustaining life because

① Liquid water exists on Earth.

Water is essential to life on Earth. We need it to allow key chemical reactions to take place in animal and plant cells.

② Earth lies a comfortable distance from the Sun in a region called the habitable zone.

Earth is located at a distance where the temperature is 'just right' to support life on the planet.

③ Earth has a protective atmosphere.

The gases in the atmosphere absorb heat to keep the planet's average temperature 'just right' and also protect us on the surface from exposure to radiation.

10. An exoplanet is a planet that exists outside of our Solar System.

11. Exoplanets are often obscured from view by the light being emitted by their parent star.

As exoplanets are so far away, any light given off by the planet itself is 'drowned out' by the extreme brightness of the star it is orbiting.

12. Exoplanets can be detected by looking at the effects they have on the stars they orbit.

One example is looking for stars that appear to 'wobble'. A star that is orbited by planets does not orbit perfectly around its center and so looks like it's wobbling when viewed from far away.

Another method used for detecting exoplanets is the Transit Method. When a planet passes in front of its parent star, it blocks some of the star's light and the star appears less bright. By observing how the brightness of a star changes we can detect exoplanets and determine their size.

13. a) 2 A.U.

b) If the star is twice as bright as our Sun it is likely that the star has twice the effective temperature of the Sun.

Therefore it is reasonable to conclude that the habitable zone of this star would lie at twice the distance of the Sun's habitable zone.

14. It is important for humans to have a better understanding of the Universe for many reasons.

Firstly, it is vital to humans to have a thorough understanding of our home planet, Earth, in order for us to understand what the future of planet Earth will look like. As a result it is important for us to also develop an understanding of potential habitable planets that could support life for the human race in the future when planet Earth will no longer be a suitable home.

Developing a knowledge and understanding of the Universe has also allowed us to develop numerous pieces of technology that we now use in every day life such as scratch-resistant lenses, fire retardant materials, invisible braces and prosthetic limbs.

Using the Spectrum.

1. Gamma rays
X - rays
Ultraviolet
Visible light
Infrared
Microwaves
Radio and TV waves

shortest wavelength

Increasing wavelength

longest wavelength

2. All members of the electromagnetic spectrum travel at the speed of light, $3 \times 10^8\ ms^{-1}$.

3. Radio waves can be used to study the structure of objects in the Universe such as planets, stars and galaxies

4. a) X - Red
Y - Green
Z - Violet

b) Different wavelengths of light refract at different angles when passed through a prism

Red light (which has the longest wavelength in the visible spectrum) refracts the least while violet light (which has the shortest wavelength in the visible spectrum) refracts the most.

5.

Colour	Wavelength (m)
Red	7×10^{-7}
Yellow	5.9×10^{-7}
Green	5.5×10^{-7}
Blue	4.5×10^{-7}

6. A - Line spectrum

B - Continuous spectrum

7. Each element produces a unique line spectrum.

A hot gas, like those in the atmosphere of a star, emits certain wavelengths (colours) of light. This produces a set of bright lines corresponding to particular wavelengths on a dark background and is called a line emission spectrum.

By analysing the line emission spectrum of a given star and comparing it to the known line emission spectra of individual elements, we can identify which elements are present in the star.

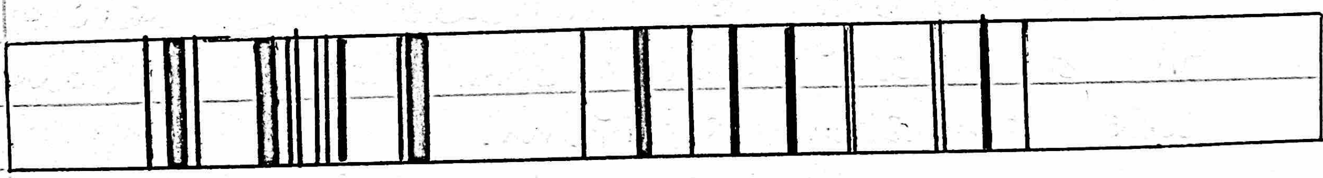
8. Astrophysicist Pierre Jules César Janssen first observed Helium in the Solar spectrum in August 1868.

Observing the spectrum produced by the Sun using a spectroscope, Janssen noticed a bright yellow line whose wavelength did not match with the spectrum of any known element at the time.

Janssen had discovered a new element, Helium, which had not been seen before on Earth.

9. Mercury, Cadmium

10. Line spectra for Titan:



11. Helium, Hydrogen