Motion worksheet 5

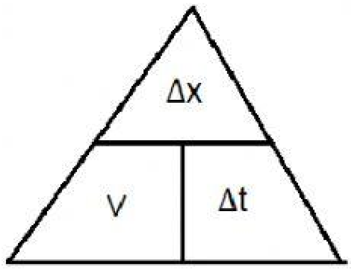
Constant velocity

Exercise 6

If an object's velocity stays the same, then it is not accelerating.

Then the following equation can be used

$\Delta x = v.\Delta t$



1. If Kelsey travels at a speed of $2 m.s^{-1}$ for 3 mins, determine the distance he covers.

2. Nathan runs at a constant velocity of $4 m.s^{-1}$ and covers a distance of 10 km. Calculate the time it took to cover the distance.

3. Nomzama is a professional race car driver. She drives around a 3km long track, 4 times in 2mins. Calculate her speed for the journey.

4. If Jordan sprints to the shop at a speed of $8 m.s^{-1}$, and covers a distance of 800 m. Calculate the time it took to cover this distance.

Acceleration

Rate of change of an object's velocity. When an object's speed increases (it travels faster and faster) then it is accelerating.

$$a = \frac{\Delta v}{\Delta t}$$

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

Vf is the final velocity of the object and vi is the initial velocity of the object

The unit for acceleration is $m.s^{-2}$

Why is this?

$$a = \frac{\Delta v}{\Delta t}$$

$$= \frac{m.s^{-1}}{s}$$

Then take the s (seconds) up to the top.

Remember your laws of exponents, and when you take the s (seconds) up it becomes: s^{-1}.

$m.s^{-1.-1}$ (multiply the -1's with each other)

Thus the unit for acceleration is $m.s^{-2}$

Acceleration is also a vector and needs direction

Consider the following table comparing 2 objects moving at a constant velocity (not accelerating) and the second object is accelerating.

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	2	2	2	2	2

+0 +0 +0 +0

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	0	2	4	6	8

+2 +2 +2 +2

When an object accelerates **uniformly** its speed increases by the same amount every single second.

What is the acceleration for the following objects. They are all travelling to the right.

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	0	3	6	9	12

a = ________ ____________ {direction}

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	0	5	10	15	20

a = ________ ____________ {direction}

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	4	4	4	4	4

a = ________

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	12	16	20	24	28

a = ________ ____________ {direction}

Δt (s)	0	1	2	3	4

v ($m.s^{-1}$)	20	15	10	5	0

a = ________ ____________ {direction}

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	30	27	24	21	18

a = ________ ____________ {direction}

*What do you notice when the car's velocity decreases - the acceleration is

Positive Negative value

The negative indicates that the object is being pulled with a force in the opposite direction

Thus the acceleration is in the opposite direction – in the above cases that would be left.

At school we only deal with constant acceleration

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	0	2	4	6	8

Thus you will never get a situation like the one below

Δt (s)	0	1	2	3	4
v ($m.s^{-1}$)	0	5	12	21	32

+5 +7 +9 +11

Equations of motion

$v_f = v_i + a.\Delta t$	$\Delta x = v_i.\Delta t + \frac{1}{2} a.\Delta t^2$
$v_f^2 = v_i^2 + 2a.\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

Write the all these equations into your physics book

What do all the symbols mean?

Notice that none of them have the little $\overrightarrow{\text{arrow}}$ above them. You no longer need to write include them here.

vf – the final velocity/speed of the object ($m.s^{-1}$)

vi – the initial velocity/speed of the object ($m.s^{-1}$)

a = acceleration ($m.s^{-2}$)

Δx – displacement (m)

Δt – time (s)

Examples:

Calculate the acceleration of the following objects:

1. A car accelerates from a speed of 2 $m.s^{-1}$ to a speed of 10$m.s^{-1}$ while travelling east, in 4 seconds.

   $v_f = v_i + a.\Delta t$

   $10 = 2 + a\ (4)$

   $10 - 2 = 4.a$

   $8 = 4.a$

   $a = 2m.s^{-2}$ east

2. A cyclist accelerates from rest to a speed of 12 $m.s^{-1}$ in 10 seconds while travelling left.

Careful of the words 'from rest'. This means the objects velocity started with zero $m.s^{-1}$

$v_f = v_i + a.\Delta t$

$12 = 0 + a(10)$

$a = 1{,}2\ m.s^{-2}$

3. A car is travelling to the right at a speed of 30$m.s^{-1}$ and sees a stop sign ahead and applies the brakes, the car **comes to rest** in 5 seconds.

$v_f = v_i + a.\Delta t$

$0 = 30 + a(5)$

$-30 = 5.a$

$a = -6m.s^{-2}$

$\therefore$ $a = 6m.s^{-2}$ left

***We are never allowed to leave answers as negative**

We need to get rid of the negative by interpreting it.

The negative means that a force is pulling the object in the opposite direction and thus the acceleration is in the opposite direction.

4. A car accelerates from a speed of 4$m.s^{-1}$ to a speed of 40$m.s^{-1}$ in 100m while travelling west.

$v_f^2 = v_i^2 + 2a\Delta x$

$40^2 = 4^2 + 2a(100)$

$(1600 - 16) / 200 = a$

$a = 7{,}92\ m.s^{-2}$ west

5. Calculate the final velocity of the following objects

5.1 a car which accelerates from a speed of 2$m.s^{-1}$ at an acceleration of 3$m.s^{-2}$ for 3 seconds, while travelling east

5.2 a car which accelerates from rest over a distance of 100 m in 4 seconds while travelling to the left

5.3 a car which decelerates at of $2 m.s^{-1}$ from a velocity of $20 m.s^{-1}$ for 5 seconds

5.4 a cyclist which slows down at $4 m.s^{-2}$ from a speed of $50 m.s^{-1}$ for 2 seconds while travelling west.

5.1 $v_f = v_i + a\,\Delta t$

$= 2 + (3x3)$

$= 11\ m.s^{-1}$ east

5.2 $\Delta x = \frac{(v_f + v_i)}{2}.\ \Delta t$

$100 = \frac{(v_f + 0)}{2}.\ 4$

*cross multiply here

$100 \times 2 = (v_f + 0).\ 4$

*use distributive law to multiply the 4 with the whole bracket

$200 = 4vf + 0$

*divide both sides by 4

$vf = 50\ m.s^{-1}$ left

5.3 $v_f = v_i + a\,\Delta t$

$= 20 + (-2x5)$

$= 10\ m.s^{-1}$

Notice that when an object is slowing down we substitute the acceleration as a negative

5.4 $v_f = v_i + a\,\Delta t$

$= 50 + (-4x2)$

$= 42\ m.s^{-1}$ west