Maths skills

1. SI units

- Look up the following terms and write a few sentences about each:

Physical Quantities	
SI Units	
Base Units	
Derived Units	

- In physics all units can be derived from six base units. Research how the base units are defined.

Base Quantity	**Base Unit**	**Definition** (Note: you do not need to learn these definitions)
Length	metre (m)	
Mass	kilogram (kg)	
Time	second (s)	
Temperature	kelvin (K)	
Current	ampere (A)	

2. Derived units

In physics all non-base quantities are called **derived quantities** and are defined by equations.
E.g. (a) Define speed. (b) Define charge.

(a) speed = distance / time **(b) charge = current × time.**

The units of these new quantities are **derived units** and are established from these same equations. So,

(b) The unit of speed = unit of distance / unit of time = m / s = $\underline{m \cdot s^{-1}}$ (‘metres per second’)*

(c) The unit of charge = the unit of current × the unit of time = $\underline{A \cdot s}$ (‘amp second’)

*NOTE: At A level we write divided units, such as ‘metres per second’ as ms^{-1} **not** m/s.

In the SI system, many of these derived units get their own name. For example, the SI unit of charge is the coulomb (C). So we can say that one coulomb is equal to one amp second.

or **C = A s**

Any SI unit can be expressed in terms of base units. To find the base units work though the defining equations one by one, unit you end up with the base units. For example, what are the base units of a Joule? This requires two steps:

- Energy (Work) = Force × distance moved, So one joule = one newton metre (**J = N·m**)
- Force is defined from F = m a, so one newton = one kilogram metre per second squared (or **$N = kg \cdot m \cdot s^{-2}$**)
- Therefore, a joule = **N m** = **$(kg \cdot m \cdot s^{-2})$ m** = **$\underline{kg \cdot m^2 \cdot s^{-2}}$**

Complete the table below.
Try working these out rather than looking them up. You can use the earlier answers to help with the harder ones.

Derived quantity	**Defining equation**	**Standard SI unit (if applicable)**	**Equivalent base units**
speed	S = d / t	n/a	$m \cdot s^{-1}$
momentum	p = m v	n/a	$kg \cdot m \cdot s^{-1}$
acceleration	a = (v - u) / t	n/a	
Force	F = m a	newton (N)	
Power	power = work/time P = W/t		
frequency	frequency = 1/time period f = 1 / T		s^{-1}
Charge	charge = current × time Q = I t	coulomb (C)	A·s
potential difference	voltage = work/charge V = W/Q		
resistance	R = V / I		

3. Prefixes

In Physics we have to deal with quantities from the very large to the very small. A prefix is something that goes in front of a unit and acts as a multiplier. This questions will give you practice at converting figures between prefixes.

Symbol	Name	What it means		How to convert	
P	peta	10^{15}	1000000000000000		↓ x1000
T	tera	10^{12}	1000000000000	↑ ÷ 1000	↓ x1000
G	giga	10^{9}	1000000000	↑ ÷ 1000	↓ x1000
M	mega	10^{6}	1000000	↑ ÷ 1000	↓ x1000
k	kilo	10^{3}	1000	↑ ÷ 1000	↓ x1000
			1	↑ ÷ 1000	↓ x1000
m	milli	10^{-3}	0.001	↑ ÷ 1000	↓ x1000
µ	micro	10^{-6}	0.000001	↑ ÷ 1000	↓ x1000
n	nano	10^{-9}	0.000000001	↑ ÷ 1000	↓ x1000
p	pico	10^{-12}	0.000000000001	↑ ÷ 1000	↓ x1000
f	femto	10^{-15}	0.000000000000001	↑ ÷ 1000	

Convert the figures into the prefixes required (give answers in standard form).

s	ms	µs	ns	ps
134.6				
96.21				
0.773				

m	km	mm	Mm	Gm
12873				
0.295				
57.23				

4. Significant figures

Recap ideas about significant figures here: https://www.bellevuecollege.edu/physics/resources/measure-sigfigsintro/a-uncert-sigfigs/

For each value state how many significant figures it is stated to.

Value	Sig Figs	Value	Sig Figs	Value	Sig Figs	Value	Sig Figs
2		1066		1800.45		0.07	
2.0		82.42		2.483×10^4		69324.8	
2.00		750000		2.483		0.0063	
0.136		310		5906.4291		9.81×10^4	
0.34		3.10×10^2		200000		6717	

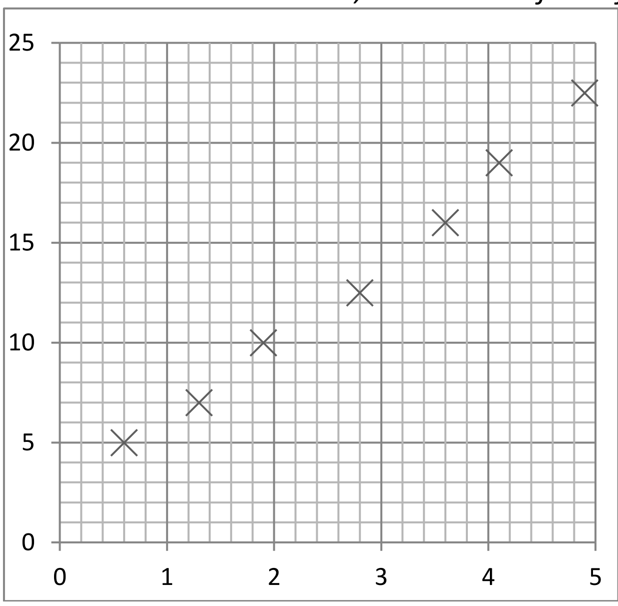
Add the values below then write the answer to the appropriate number of significant figures

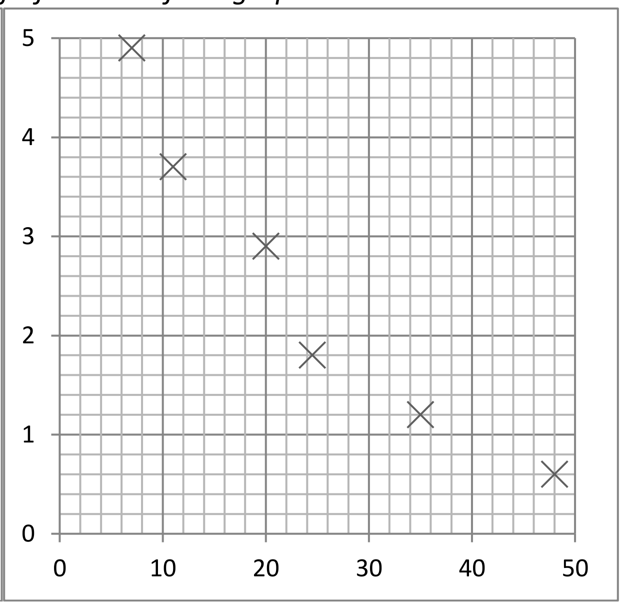
Value 1	Value 2	Value 3	Total Value	Total to correct sig figs
51.4	1.67	3.23		
7146	−32.54	12.8		
20.8	18.72	0.851		
1.4693	10.18	−1.062		

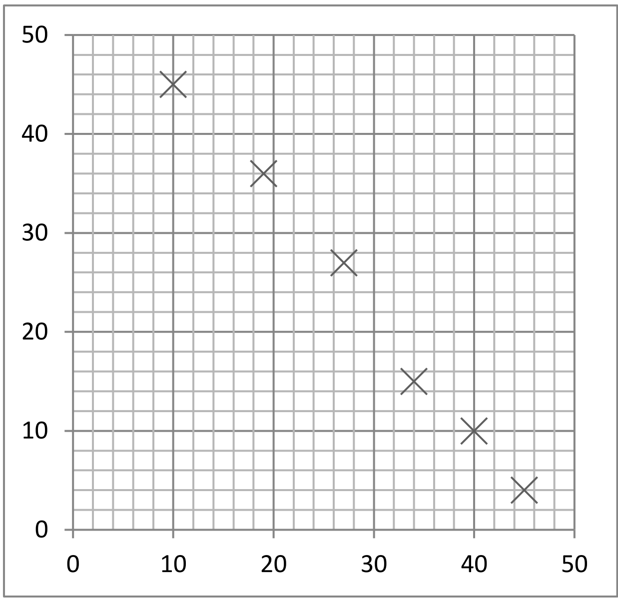
5. Lines of best fit

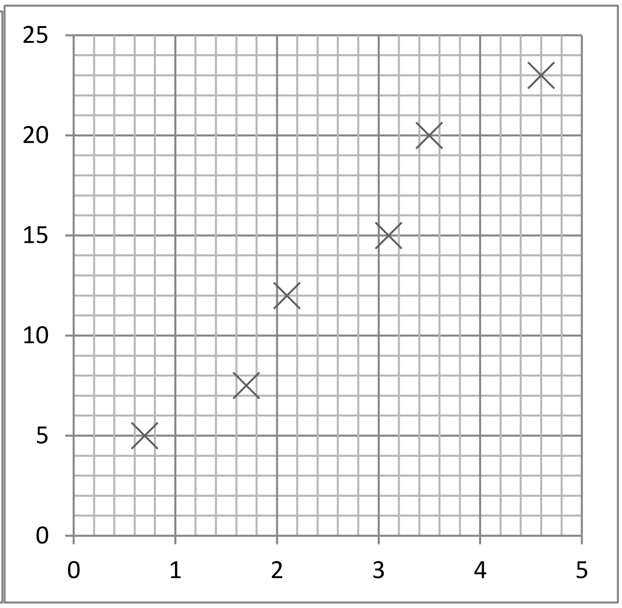
Read the guidance on lines of best fit here: https://www.matrix.edu.au/the-beginners-guide-to-physics-practical-skills/physics-practical-skills-part-4-how-to-draw-a-line-of-best-fit/

Then, draw a line of best fit for each of the graphs.



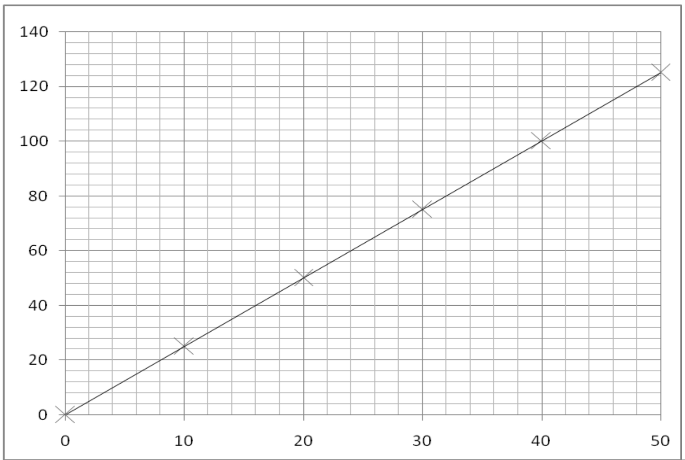


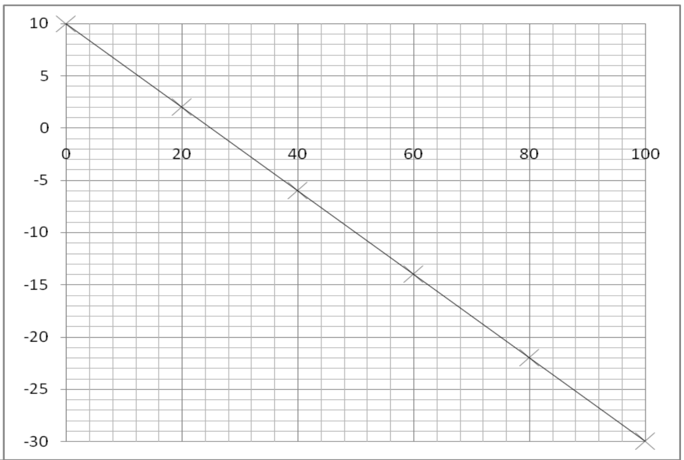


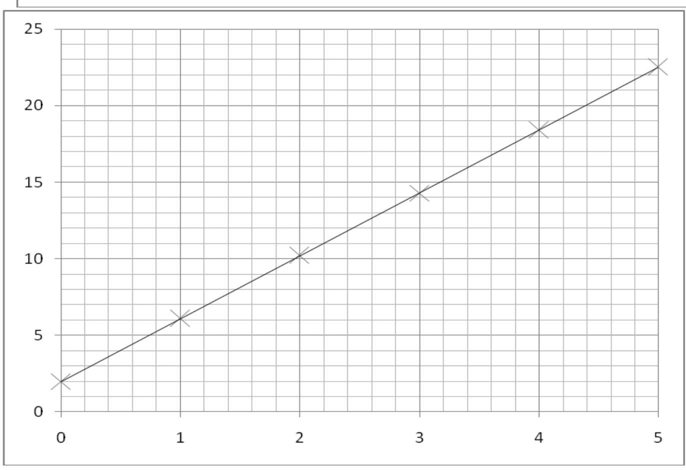


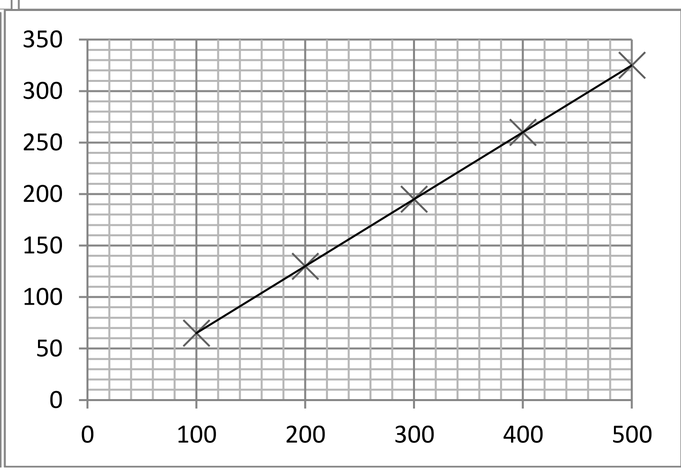
6. Gradients

Calculate the gradients of the graphs below = difference in y/difference in x (think about y=mx+c from maths).









7. Rearranging equations

Rearrange these equations to express them in the terms that follow:

1. $v = x / t$ **a.** $x = ?$ **b.** $t = ?$

2. $F = m\,a$ **a.** $m = ?$ **b.** $a = ?$

3. $a = (v - u) / t$ **a.** $t = ?$ **b.** $v = ?$ **c.** $u = ?$

4. $v^2 = u^2 + 2as$ **a.** $v = ?$ **b.** $a = ?$ **c.** $u = ?$

5. $s = ut + \frac{1}{2} a\, t^2$ **a.** $u = ?$ **b.** $a = ?$ **c.** $t = ?$

6. $\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2}$ **a.** $R_{tot} = ?$ **a.** $R_1 = ?$