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# A-Level Physics

## Bridging Project

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## Standard Form

1. Convert these numbers into normal form.

- a)  $5.239 \times 10^3$       b)  $4.543 \times 10^4$       c)  $9.382 \times 10^2$       d)  $6.665 \times 10^6$
- e)  $1.951 \times 10^2$       f)  $1.905 \times 10^5$       g)  $6.005 \times 10^3$

2. Convert these numbers into standard form.

- a) 65345                  b) 28748                  c) 548454                  d) 486856
- e) 70241                  f) 65865758                  g) 765

3. Convert these numbers into normal form.

- a)  $8.34 \times 10^{-3}$       b)  $2.541 \times 10^{-8}$       c)  $1.01 \times 10^{-5}$
- d)  $8.88 \times 10^{-1}$       e)  $9 \times 10^{-2}$       f)  $5.05 \times 10^{-9}$

4. Convert these numbers to standard form.

- a) 0.000567                  b) 0.987                  c) 0.0052
- d) 0.0000605                  e) 0.008                  f) 0.0040302

5. Calculate, giving answers in standard form,

a)                   $(3.45 \times 10^{-5} + 9.5 \times 10^{-6}) \div 0.0024$

b)                   $(2.31 \times 10^5 \times 3.98 \times 10^{-3}) + 0.0013$

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## Algebraic Manipulation

1. Simplify the following as far as possible

a)  $3ab + 2a - 3b - ab$

b)  $2x^2 + 3x - 4x + 5 + 6x^2$

c)  $2a \times 3a$

d)  $e^2 \times 4e^3$

e)  $3ab \times 2a$

f)  $\frac{2x^2}{x}$

g)  $\frac{6ab}{2ac}$

h)  $\frac{a+b}{c-b}$

2. Multiply out the following brackets, and simplify the answer as far as possible

a)  $3a(2 - b)$

b)  $x(3x - 4)$

c)  $-4y(2 + 5y)$

d)  $-3a^2(4b - a)$

e)  $(x + 2)(x - 3)$

f)  $(2x - 5)(x - 7)$

g)  $(1 - 4x)(2 + 7x)$

h)  $(x^2 + 2)(2x + 5)$

3. Rearrange each of the following to make the letter indicated the subject

a)  $s = ut + \frac{1}{2} at^2$        $u$

b)  $F = \frac{GMm}{r^2}$        $m$

c)  $F = \frac{GMm}{r^2}$        $r$

d)  $I = \frac{Q}{t}$        $t$

e)  $T = 2\pi \sqrt{\frac{L}{g}}$        $L$

f)  $y = \frac{2-x}{3+x}$        $x$

g)  $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$        $R_1$

h)  $2as = v^2 - u^2$        $v$

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4. In the following examples, the equation is given to you. Rearrange the equation for each of the other quantities. The first line shows an example of this.

Equation	First Rearrangement	Second Rearrangement
(Power of lens) $P = \frac{1}{f}$	$1 = Pf$	$f = \frac{1}{P}$
(Magnification of lens) $m = \frac{v}{u}$	$v =$	$u =$
(refractive index) $n = \frac{c}{v}$	$c =$	$v =$
(current) $I = \frac{\Delta Q}{\Delta t}$		
(electric potential) $V = \frac{\Delta E}{\Delta Q}$		
(power) $P = \frac{\Delta E}{\Delta t}$		
(power) $P = VI$		
(power) $P = I^2R$		
(power) $P = \frac{V^2}{R}$		
(stress) $\sigma = \frac{F}{A}$	$F =$	$A =$

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(strain)	$\varepsilon = \frac{x}{l}$	$x =$	$l =$
(conductance)	$G = \frac{\sigma A}{L}$		
(resistance)	$R = \frac{\rho L}{A}$		
(phase angle)	$\theta = 2\pi ft$	$f =$	$t =$
(displacement)	$y = a \sin \theta$	$a =$	$\theta =$
(Young's interference)	$x = \frac{\lambda L}{d}$		
(electron wavelength)	$\lambda = \frac{h}{mv}$		

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## Ratios

Simplify the following ratios (Example  $6:4 = 3:2$ ):

1.  $120:50$

2.  $64:24$

3.  $13:52$

4.  $100:10\ 000$

5.  $24:72$

6.  $18:90$

7.  $56:88$

8.  $36:144$

Find  $x$  by scaling the ratio.

9.  $1:2 = 4:x$

10.  $8:3 = x:9$

11.  $25:10 = x:2$

12.  $x:160 = 2:8$

13.  $49:x = 2:4$

14.  $58.5:18 = x:4$

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15. A toy is made from red bricks and yellow bricks.  
Number of red bricks: Number of yellow bricks = 5:2.  
There are 210 more red bricks than yellow bricks.

How many red bricks are in the toy?

16. There are 100 balls in a bag. The balls are red, blue, green or white. The ratio of blue to red is 5:1. There are twice as many blue as green.  $\frac{1}{4}$  of the balls are green.

How many white balls are in the bag?

17. One day, 460 people visit a zoo. 280 are adults. The ratio of women to men is 4:3. 180 are children.  $\frac{3}{5}$  of them are boys. Jane says that altogether there were more females visiting the zoo.

Show that she is correct.

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## Indices

Simplify the following expressions:

1.  $x^3 \times x^4$

2.  $y^9 \div y^4$

3.  $(z^7)^3$

4.  $\frac{x^4 \times x^2}{x^5}$

5.  $(ab)^2 \times a^3$

6.  $b^{\frac{1}{3}}$

7.  $c^{-3} \div c^4$

8.  $\frac{(x^0 \times x^3)^2}{x^4}$

Solve the following equations for  $x$

9.  $2^{x+1} = 2^4$

10.  $3^{x-2} + 1 = 28$

11.  $2^{x+6} = 128$

12.  $2(3^x)^2 = 162$

13.  $7^{x+4} = 343$

14.  $\frac{x^3 \times x^4}{x^5} = 64$



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15. Find the area of the following rectangle. Write your answer in simplified form.

$x^5$  cm



16. The moon is approximately  $4 \times 10^5$  kilometres away. If an astronaut was to travel to the moon and back 3 times, how far would he have travelled in space?

17. If that same astronaut was to travel to the moon and back  $10^3$  times, how far would he have travelled in space?

[Type here]

## Means and Anomalous Results

*For each set of values calculate the mean and then calculate the mean ignoring any anomalous results.*

<b>1</b>	<b>2</b>	<b>3</b>	<b>Mean</b>
4152	2996	4018	
935.5	925.8	926.7	
16.2	19.1	17.4	
80.1316	80.1324	80.1466	
2229	2011	1610	
127.664	127.416	127.489	
55.88	11.97	37.59	
3.767	3.763	3.751	
375.5	511.5	463.4	
1048	888	1655	
0.507	0.415	0.230	
27145	25157	26017	
1450	1014	2238	
9104.32	10529.45	9160.97	

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Mean</b>
63.10	62.97	62.53	62.99	
465.98	463.40	466.96	155.56	
3.61	7.39	3.55	3.64	
73.71	70.98	74.19	72.38	
2.058	1.566	2.078	1.787	
416	402	189	986	
700653	739762	742471	726161	
2670887	2670901	2669942	2670733	
110.4	260.1	1044.2	488.8	

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## Calculating Errors and Uncertainty

What is uncertainty of measurement?

The uncertainty of a measurement tells us something about its quality.

Uncertainty of measurement is the doubt that exists about the result of any measurement.

***The uncertainty is always written to 1 significant figure (not true for percentage uncertainty)***

The absolute uncertainty ( $\delta x$ ) in your readings is given by the larger of:

- The precision of your meter
- Half the range of a set of repeated readings.

Values should be written in the form:  $x \pm \delta x$

### Example

- A student is undertaking an Ohm's law experiment to discover the resistance of an unknown resistor, R.
- She only takes one p.d. reading of 5.00V with a voltmeter of precision  $\pm 0.01V$ . Since she only took one reading, the uncertainty in her p.d. reading ( $\delta V$ ) is  $\pm 0.01V$ . This means her p.d. reading is:  $5.00 \pm 0.01V$

- The precision of her ammeter is  $\pm 0.01A$  and she takes 3 ammeter readings, as a result of repeating her experiment. Her ammeter readings are 10.40A, 10.51A & 10.29A. Her uncertainty is half the spread of these results:

$$\delta I = \frac{\text{spread}}{2} = \frac{(10.51 - 10.29)}{2} = \pm 0.1A$$

- The student will use the larger of the two uncertainties in the current as her uncertainty.
- The average of her current is:  $\bar{I} = \frac{10.40 + 10.51 + 10.29}{3} = 10.40A$
- This means the current is:  
 $I = 10.4 \pm 0.1A$

- The student would like to now go on to calculate the value of the resistance as well as the uncertainty in her resistance calculation. She will need to first find the percentage uncertainties in the V and I measurements.

$$\% \delta V = \frac{\delta V}{V} \times 100 = \frac{0.01}{5.00} \times 100 = 0.2\%$$

$$\% \delta I = \frac{\delta I}{I} \times 100 = \frac{0.11}{10.40} \times 100 = 1.1\%$$

$$\text{Since } R = \frac{V}{I} = \frac{5.00}{10.40} = 0.481\Omega$$

$$\text{Thus the \% uncertainty in R: } \% \delta R = \% \delta V + \% \delta I = 0.2 + 1.1 = 1.3\%$$

$$\text{Thus the uncertainty in R: } \delta R = \frac{1.3}{100} \times 0.481 = 0.006\Omega$$

[Type here]

So from the experiment, the student has discovered that the resistance of the unknown resistor is

$$R = 0.481 \pm 0.006\Omega$$

*Complete the table.*

<b>Variable</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Mean Value</b>	<b>Uncertainty</b>	<b>% Uncertainty</b>
<i>L</i>	11.49	11.56	11.63	10.53			
<i>M</i>	385	322	408	328			
<i>N</i>	2736	2729	2743	2643			
<i>O</i>	5101	5108	5003	5098			
<i>P</i>	125	137	167	142			
<i>Q</i>	6124	6118	6510	6123			
<i>R</i>	3.29	3.29	3.29	3.29			
<i>S</i>	4589	4606	4644	4596			
<i>T</i>	417	488	460	456			
<i>U</i>	1.506	3.061	3.085	1.513			
<i>V</i>	274	333	338	277			
<i>W</i>	33.46	33.45	33.96	33.65			

[Type here]

You should combine uncertainties in any calculated results using the following rules:

1. If two values are added, their uncertainties are added.
2. If two values are multiplied or divided, their % uncertainties are added.
3. If a value is raised to a power, its % uncertainty is multiplied by that value.

if  $y=x+z$  then the uncertainty in  $y$ ,  $\delta y = \delta x + \delta z$

if  $y=xz \rightarrow \% \delta y = \% \delta x + \% \delta z$

if  $y=x/z \rightarrow \% \delta y = \% \delta x + \% \delta z$

if  $y=x^n \rightarrow \% \delta y = n \% \delta x$

$MO$		$MO^2N$	
$OMLM$		$N^3O$	
$\frac{L}{M}$		$\frac{NO^2}{L}$	
$NML$		$LMON$	
$P^2R$		$QPR$	
$SNO^2P$		$PMT$	
$\frac{SR}{PM}$		$\frac{R^2S}{N^2}$	
$(QR)^2S$		$TROL^2$	
$QP \frac{VR}{ST}$		$\frac{PO^2}{RUT}$	
$SWOT$		$OWLS$	
$N^4 \frac{O^4P^2}{W^2} S^2$		$\frac{TUW^2PN}{MS^2R}$	
$RUST$		$WO^2L$	

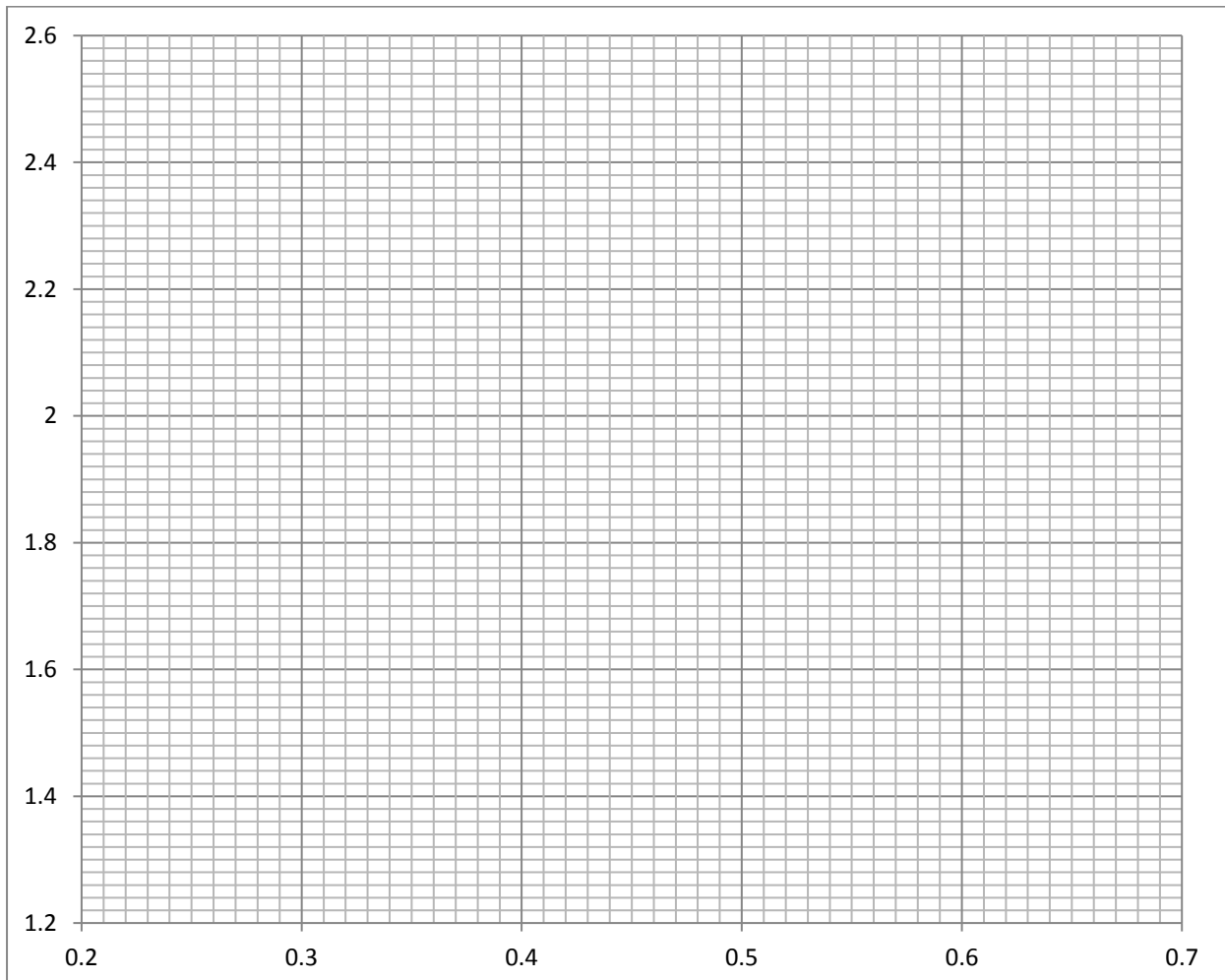
What would be the percentage error in the following quantities?

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## Points Plotting

You are going to practice plotting points on a graph. This skill carries up to 3 marks in the ISA.

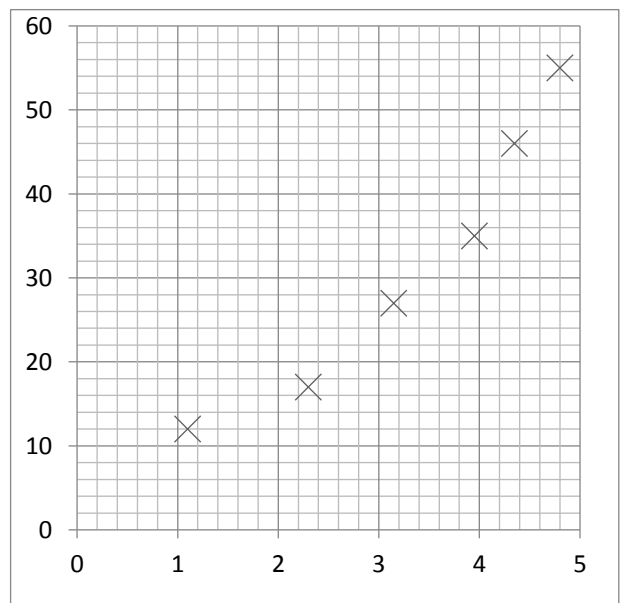
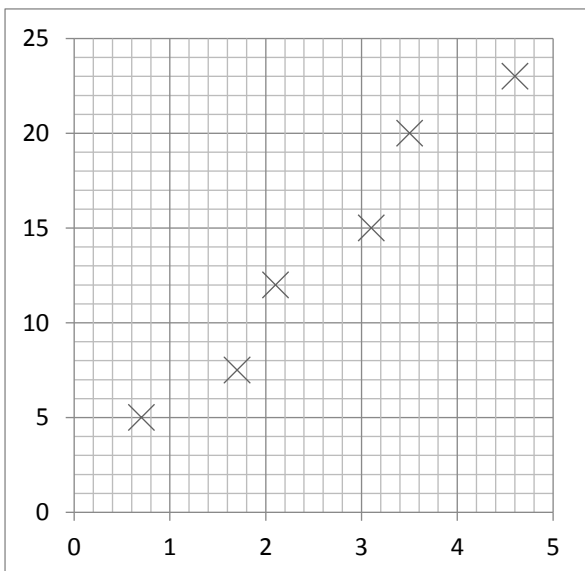
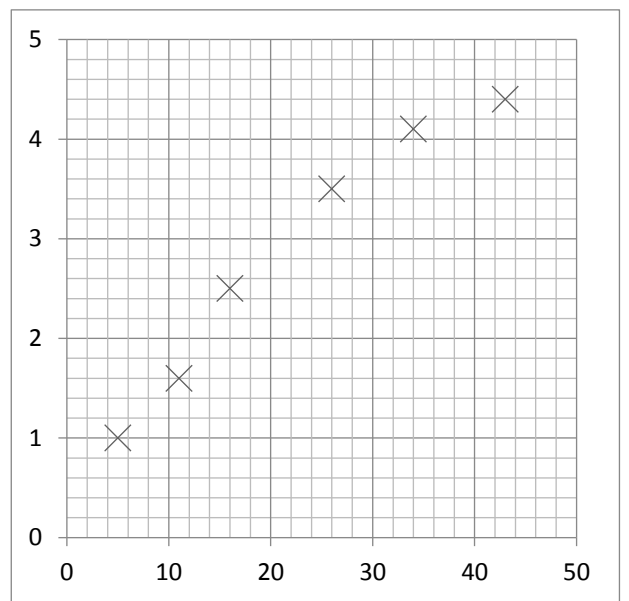
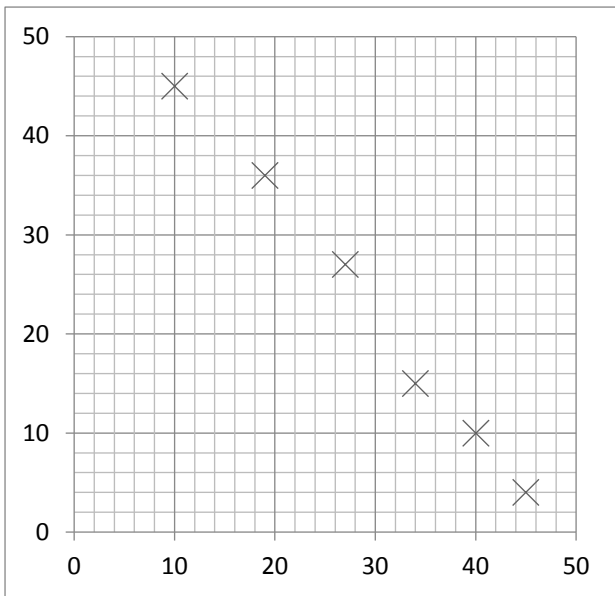
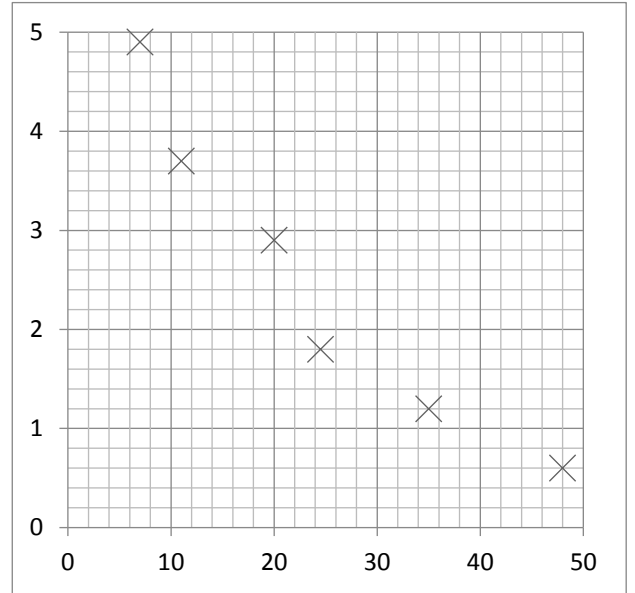
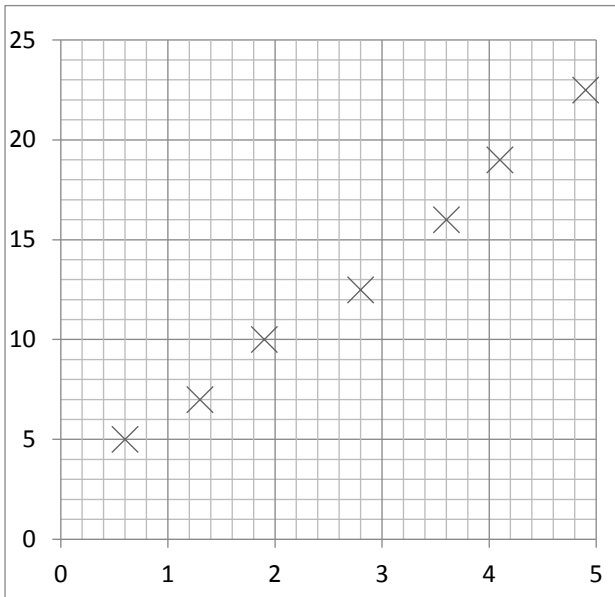
x axis	y axis	x axis	y axis	x axis	y axis
0.44	2.44	0.34	1.75	0.67	2.12
0.27	1.39	0.49	1.99	0.58	1.64
0.39	2.13	0.26	2.22	0.65	2.52
0.62	1.23	0.31	2.49	0.29	1.92
0.37	1.52	0.52	2.36	0.45	1.47
0.22	2.56	0.61	2.23	0.53	1.27
0.42	1.84	0.64	1.83	0.24	1.71
0.48	1.70	0.55	2.15	0.67	1.45



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## Lines of Best Fit

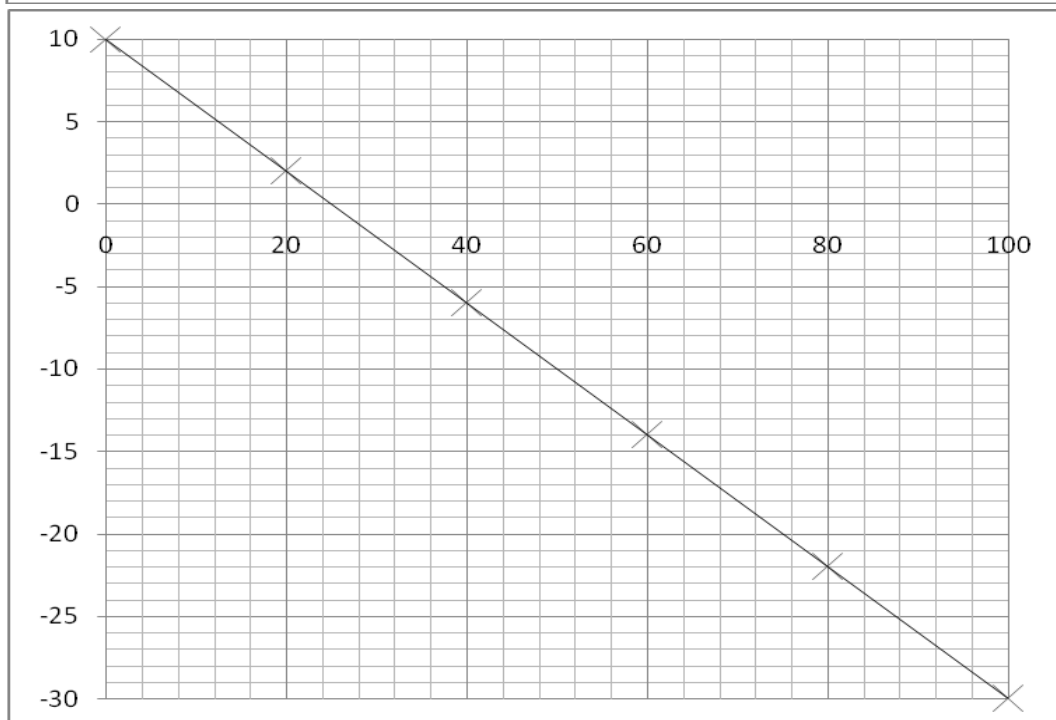
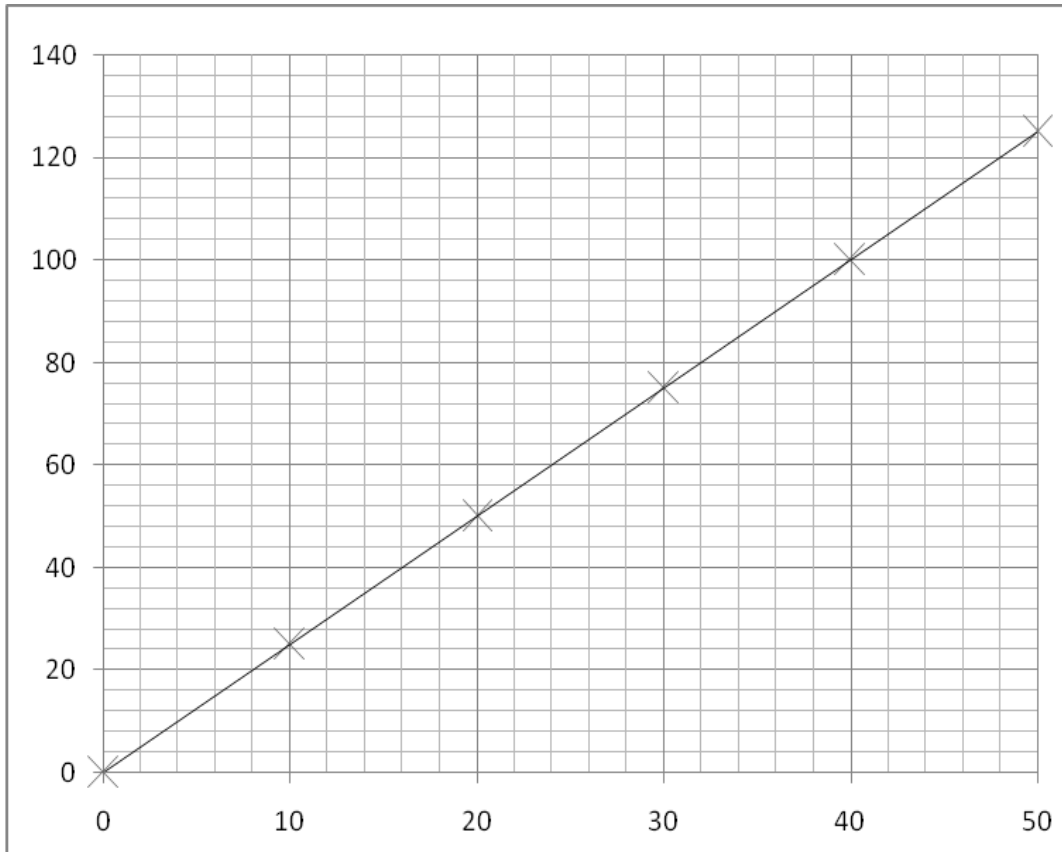
Draw a line of best fit for each graph



[Type here]

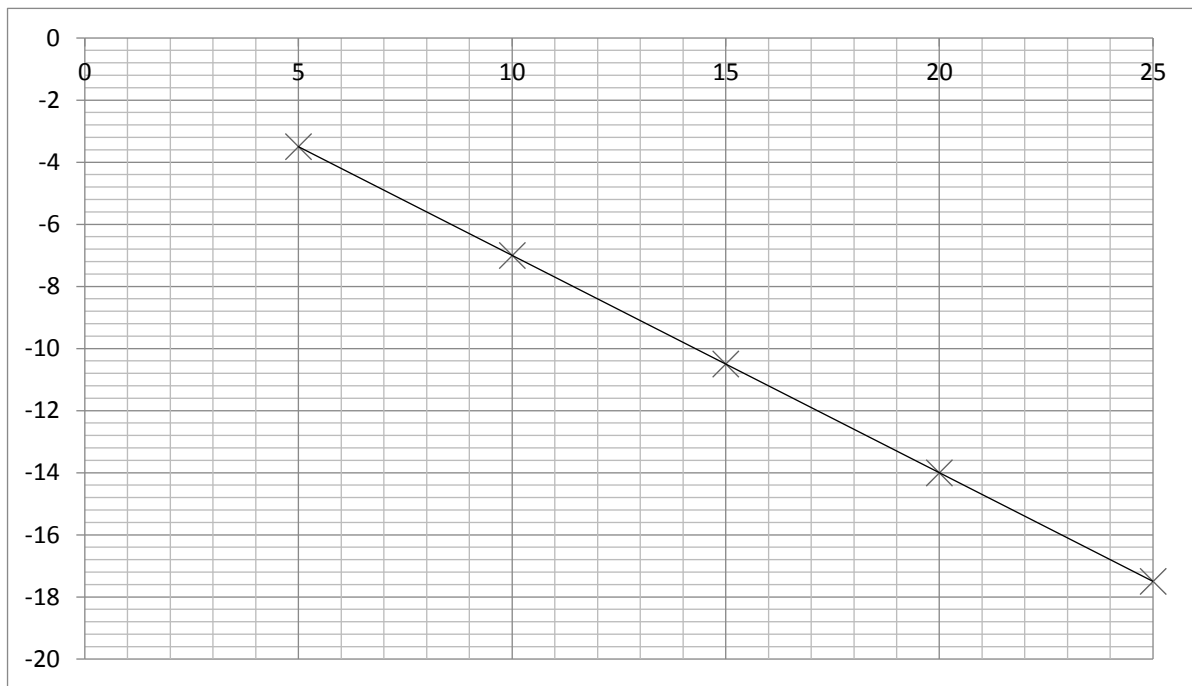
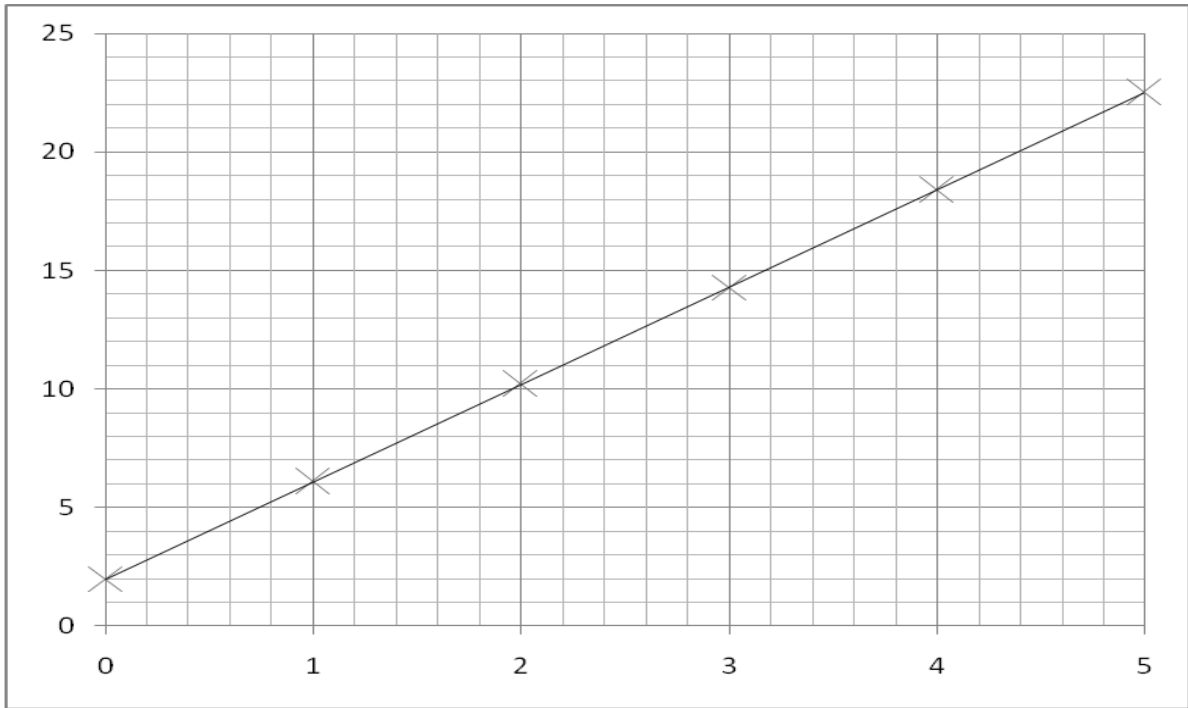
## Calculating Gradients

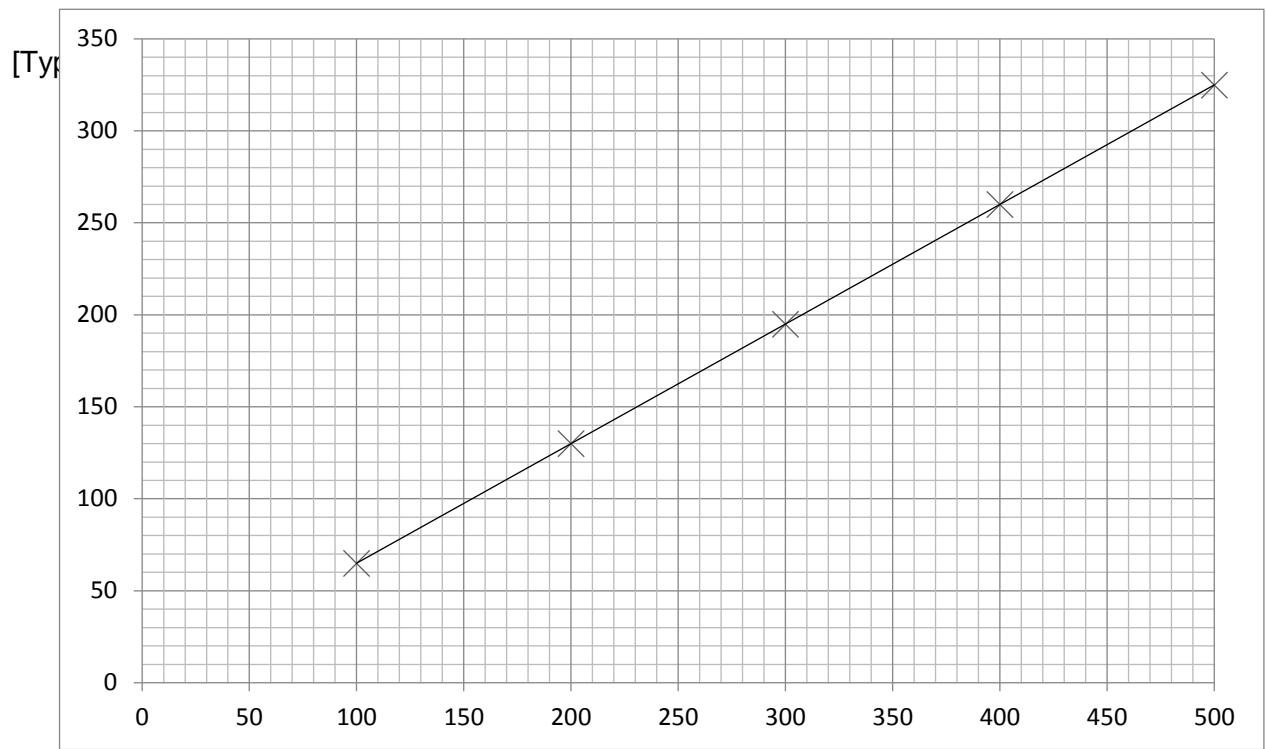
Calculate the gradients of the graphs below. Work out the equation for the line.





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## Plotting equations worksheet

On a separate sheet of paper, plot the following equations on separate axis for  $-5 < x < 5$

18.  $y = 2x + 3$

19.  $y = -x + 3$

20.  $y = 4x - 1$

21.  $y = x + 3$

22.  $y = 3x - 7$

23. The price of a phone call is made up of a connection charge of 5p, and an additional cost of 2p per minute. Letting  $P$  represent the total price and  $T$  the length of the phone call, explain the equation  $P = 2T + 5$

Plot this equation for  $0 < T < 4$

24. The mass of a beaker filled with water is made up of the mass of the glass beaker and 1 extra gram per ml of water inside the beaker.

For a beaker that has a mass of 250 g, explain the equation  $Mass = 250 + W$

Plot this relationship for  $0 < W < 250$

25. To convert between the Celsius and Fahrenheit temperature scales, there exists the formula

$$F = \frac{9}{5}C + 32$$

Plot this relationship for  $0 < C < 100$