Standard Units and Prefixes

5th Sep

A QUANTITY is something that can be MEASURED.

Nearly all quantities have a UNIT.

Quantity	Unit	Symbol of the unit
Mass	kilogram	kg
Length	metres	m
Time	second	s
Force	newtons	N
Energy	joules	J

Prefix name	Prefix symbol	Meaning
tera-	T	1,000,000,000,000 of
giga-	G	1,000,000,000 of
mega	M	1,000,000 of
kilo-	k	1,000 of
deci-	d	1/10 of
centi-	c	1/100 of
milli-	m	1/1000 of
micro-	μ	1/1,000,000 of
nano-	n	1/1,000,000,000 of

Standard Form

Very large or very small numbers can be written in terms of the powers of 10.

$4000 \rightarrow 4 \times 1000 \rightarrow 4 \times 10^3$

This is where we show a number as the following:

'Any value between 1 and 10' x 'ten raised to a power'

For very small numbers we can also use standard form.

0.0092 is equivalent to $\frac{9.2}{1000}$ or $\frac{9.2}{10^3}$

This is the same as 9.2×10^{-3}.

Calculations in Science — 11th Sep

It is important to show your working out for calculation questions.

Each step is usually worth one mark.

Calculations using equations are worth a minimum of two marks. One for substitution (putting numbers into the equation) and one for evaluation (getting the correct answer).

- CONVERT any strange units first e.g. km to m, minutes to seconds
- SUBSTITUTION is next
- REARRANGE the equation to CHANGE THE SUBJECT if you need to
- EVALUATE using your calculator
- ROUND your answer if the question asks you to

Sometimes we have to change the subject of the equation

For example, making 'a' the subject of 'F = ma'

$$F = ma$$

$\div m$ (both sides) $\div m$

$$\frac{F}{m} = \frac{\cancel{m}a}{\cancel{m}}$$

the 'm' in the numerator cancels out with the m in the denominator

$$\frac{F}{m} = a.$$

An earthed conductor was brought near the charged student.
A spark jumped between the conductor and the student.

The potential difference between the conductor and the student was 2.5 kV
The energy transferred by the spark was 0.0050 J

Calculate the charge transferred by the spark.

Use the equation: E = QV
(Energy transferred = charge x potential difference)

2.5 kV = 2500 V

0.0050 = Q x 2500 ✓

✓ Q = 0.0050 / 2500

$Q = \frac{E}{V}$

Charge = 2×10^{-6} C ✓✓✓

(3)

1500 W

The useful power output from the motor is 1.5 kW

Use the equation: E = Pt
(Energy transferred = Power x time)

Calculate the time it takes for the motor to transfer 450 000 J of useful energy.

450,000 = 1500 x t ✓

450,000 / 1500 = t ✓

Time = 300 seconds ✓✓✓

(3)

The power input to the motor is 1.8 kW 1800 W

The resistance of the motor is 32 Ω

Calculate the current in the motor.

Use the equation: $P=I^2R$
(Power = (Current)^2 x Resistance)

$1800 = I^2 \times 32$ ✓

$I^2 = \frac{1800}{32} = 56.25$ ✓

Current = 7.5 A ✓✓✓

(3)

Errors

17th Sep

- Measurements are affected by RANDOM ERRORS due to results varying in unpredictable ways.
- The impact of random errors can be reduced by REPEATING MEASUREMENTS, REMOVING ANOMALOUS RESULTS, and recording a MEAN MEASUREMENT.
- SYSTEMATIC ERRORS are due to faults in the method that cause results to be incorrect in a consistent way.
- A ZERO ERROR occurs when a piece of equipment has not been set to zero before a measurement was taken.

Measurements

Height [m]	Time to fall [s]			Mean time to fall [s]	g [m/s²]
	Trial 1	Trial 2	Trial 3		

Analysis

1. Use the equation $g = \frac{2 \times height}{t^2}$ to calculate the acceleration due to gravity, g, for each value of the mean time.
2. Find the mean of your values of g.

The UNCERTAINTY in a measurement tells us the range above and below the mean within which a measurement could lie.

e.g. The gravitational field strength is 10 ± 1 N/kg tells us that the mean value was 10, but the actual value could be between 9 and 11.

$$\text{Uncertainty} = \frac{\text{range}}{2} = \frac{\text{largest value} - \text{smallest value}}{2}$$

LEARN

For example; A student wishes to know their 100 m sprint time. They run the race 4 times and record the following:

14.0	15.0	11.9	13.0	Time /s

$$\text{Mean} = \frac{14.0 + 15.0 + 11.9 + 13.0}{4} = 13.5\ \text{s}$$

$$\text{Uncertainty} = \frac{15.0 - 11.9}{2} = 1.55\ \text{s}$$

So we can say their 100 m time is: 13.5 ± 1.55 s

Graphs

19th Sep

- Draw and plot graphs with a pencil and a ruler
- **Independent variable** goes on **x-axis** (horizontal) and **dependent variable** goes on **y-axis** (vertical)
- When choosing a scale, you should check the **range** of data you need to plot.
- Choose increments that are easily divisible by 2, 4, 5 or 10.
- Make sure **each square** along that axis has the **same value** (e.g. each small square is 0.2, so each big square is worth 2).
- The x-axis and y-axis **do not** have to have the same scale.
- Each axis should have a **label** and **unit.**

When drawing a LINE OF BEST FIT we either have a RULED STRAIGHT LINE or a SMOOTH CURVE.

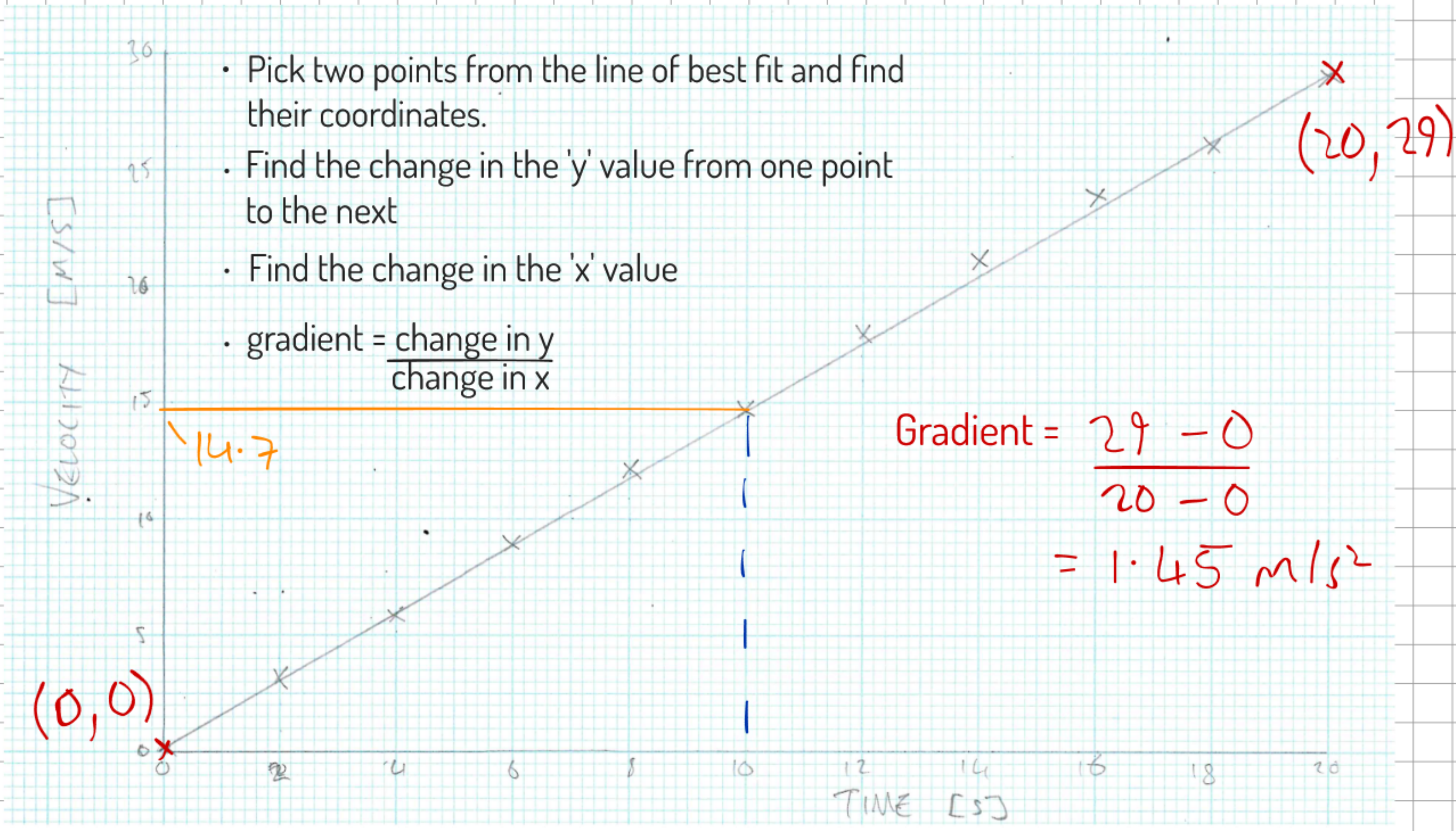
To draw: place ruler between your first and last points, and if all of the points between these two are above or below the ruler we would draw a curve.

If the points are scattered above and below the ruler we would draw a ruled straight line with an equal number of points above and below the line.

Gradients

25th Sep

- Pick two points from the line of best fit and find their coordinates.
- Find the change in the 'y' value from one point to the next
- Find the change in the 'x' value
- gradient = $\frac{\text{change in y}}{\text{change in x}}$



The AREA underneath a line of best fit can also give us useful information.

In this case the area under a velocity-time graph gives us distance.

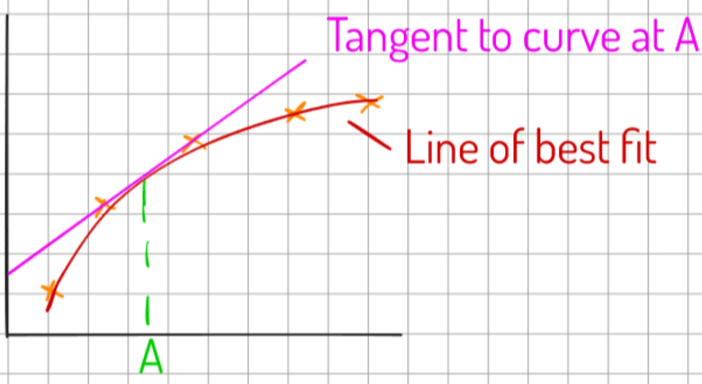
Example: Find the distance travelled in the first 10 seconds.

$$\text{Area} = \frac{\text{base} \times \text{height}}{2} = \frac{10 \times 14.7}{2} = 73.5 \text{ m}$$

When a line of best fit is CURVED we can ESTIMATE the gradient at a point on the curve.

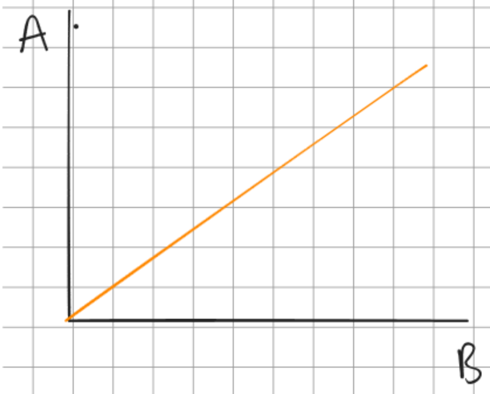
We draw a STRAIGHT RULED LINE called a TANGENT to the curve at our chosen point.

We then calculate the GRADIENT of the TANGENT.



Describing Relationships

1st Oct



If we plot a graph for two variables and the result is a STRAIGHT LINE through the ORIGIN (0, 0) then we can say that these variables are DIRECTLY PROPORTIONAL to each other.

e.g. A is directly proportional to B.

This would mean that A doubles if B doubles.

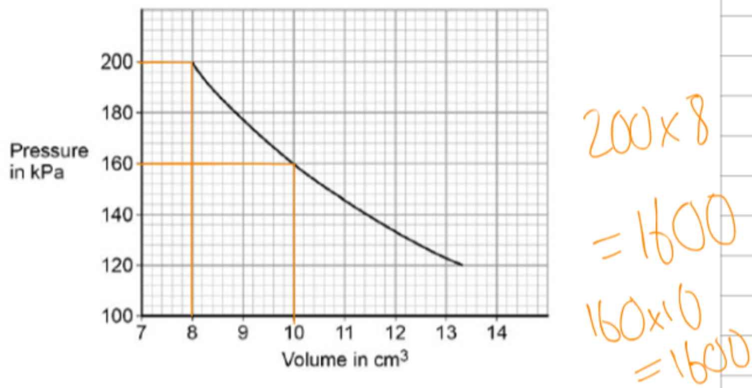
We can check for this relationship by dividing any value of A by its corresponding value of B. If we always get the same answer then A is directly proportional to B.

Here C is INVERSELY PROPORTIONAL to D.

As D doubles, C halves.

If we multiply any value of C by its corresponding value for D and get the same number each time, then C and D are inversely proportional.

For example:



(b) What conclusion can the student make from the data in the graph? Use data from the graph in your answer.

Pressure is inversely proportional to volume

(as P x V = constant)

r of 2.5 kW 2500W

ment is 17 Ω ✓

e the equation:

$^2 \times resistance$

fers 15 MJ of energy in 10 minutes. 600 s

15,000,000 J

$l = power \times time$

0 °C ✓

water as it froze was 0.70 kJ 700 J

water is 330 kJ/kg 330,000 J/kg

he equation:

ecific latent heat

ns!

0 5 . 2 At midday 35.4 GW of electricity was generated. 3.54×10^{10} W

✓ 20.8% of this was provided by gas-fired power plants.

What power was provided by gas-fired power plants?

0 6 . 3 Calculate the charge that flows through the cell in 1 minute. 60 s

Each filament lamp has a power of 3 W ✓ and a resistance of 12 Ω ✓

Use the equations: $Power = (current)^2 \times resistance$

then $Charge = current \times time$

0 4 . 3 The length of the wire in the magnetic field is 0.050 m ✓

The force on the wire is 0.072 N ✓

magnetic flux density = 360 mT 0.360 T

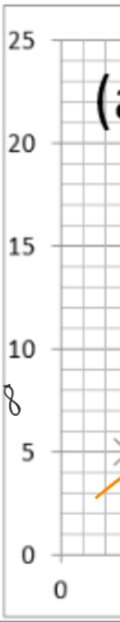
Calculate the current. Use the equation:

$Force = magnetic\ flux\ density \times current \times length$

Draw an appropriate line of b

Gradient = $\frac{22-5}{4.8-0.8}$

= 2.83



ubject shown in the middle column.

e Equation
$\frac{V}{I}$

Equation		Rearrange Equation
$v^2 = u^2 + 2as$	s	$v^2 - u^2 = 2as$ $\frac{v^2 - u^2}{2a} = s$

nge Equation
$= k$

Equation		Rearrange Equation
$p = h\rho g$	h	$\frac{p}{\rho} = hg$ $\frac{p}{\rho g} = h$

Describe the following types of error:

Random error – changes each time.
Minimised by repeating measurements, removing anomalies and calculating mean values

Systematic error –
Same every time. Can be corrected for.

Zero error -
Equipment was not set to 0 before it was used.

Calculate the mean of

Value 1	
1	
435	
3.038	
0.00040	0

In addition, st

4.6: $2500 = I^2 \times 17$

$I^2 = \frac{2500}{17}$

$I^2 = 147$

$I = 12$ A

5.2: $0.28 \times 3.54 \times 10^{10}$

$= 9.91 \times 10^{10}$ W

5.4: $15,000,000 = P \times 600$

$P = 15,000,000 / 600 = 25,000$ W

6.3: $3 = I^2 \times 12$

$I^2 = 3/12$

$I = 0.5\,A$ ↗ $Q = 0.5 \times 60$

$= 30\,C$

2.2: $700 = m \times 330{,}000$

$m = 700/330{,}000$

$= 2.12 \times 10^{-3}\,kg$

4.3: $0.072 = 0.360 \times I \times 0.05$

$I = \frac{0.072}{0.360 \times 0.05}$

$= 4\,A$.