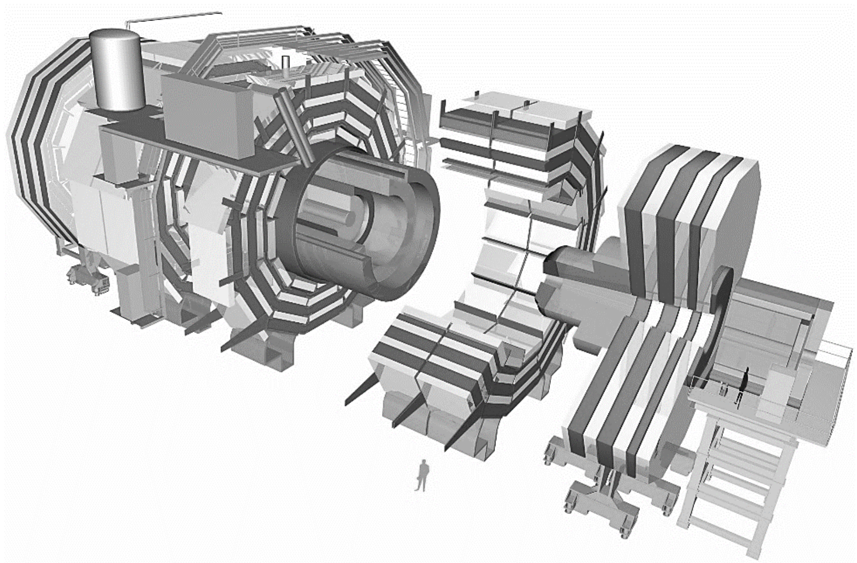
PHYSICS CORE PRACTICALS



Science (9-1)

Combined Science / Physics

Core Practicals

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Topic 1: SI units in Physics

Name	Symbol	Multiple of base unit	Example units	Number of zeros
Centi	c	10^{-2}	cm	0.01
Milli	m	10^{-3}	mm	0.001
Micro	µ	10^{-6}	µm	0.000001
Nano	n	10^{-9}	nm	0.000000001
Kilo	k	10^{3}	kg	1000
Mega	M	10^{6}	MB	1 000 000
Giga	G	10^{9}	GB	1 000 000 000

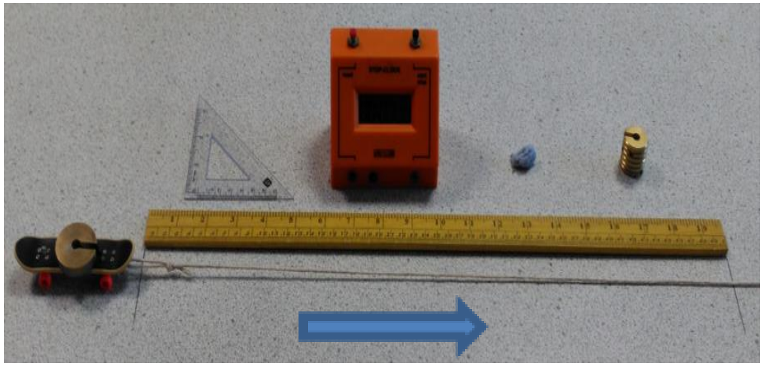
Base unit	symbol
metre	m
kilogram	kg
second	s
ampere	A
kelvin	K
mole	mol

When using **standard form** you would usually quote your value to 3 sig fig (no more) and be consistent with the number of **decimal places**

name	unit	symbol
Frequency	hertz	Hz
Force	newton	N
Energy	joule	J
Power	watt	W
Charge	coulomb	C
Pressure	pascal	Pa
Magnetic flux density	tesla	T

Topic 2: *Force investigation*

Core Practical: *Investigate the relationship between force, mass and acceleration by varying the masses added to trolleys*



Small trolleys are accelerated down a ramp by a fixed force.

The force to accelerate these masses is provided by mass (weight), attached to a string, hanging off the end of the table.

The table is angled slightly to compensate for friction

In this experiment the mass of the trolley is changes whilst the accelerating force (weight) remains constant. Acceleration is measured using two light gates, a card of known length and a datalogger.

$$a = \frac{(v - u)}{t} \qquad \text{acceleration} = \frac{\text{Final velocity} - \text{initial velocity}}{\text{time}}$$

(You might record the speed at each gate and the time between gates or just allow the computer to do this for you)

Topic 2: *Force acceleration investigation*

Mass of trolley and masses /g	**Accelerating force (m x g) /N**	**acceleration /m/s²**		**Av.**
100	0.50	1.20	1.15	1.17
90	0.50	1.41	1.43	1.42
80	0.50	1.90	1.84	1.87
70	0.50	2.25	2.31	2.28
60	0.50	3.07	3.16	3.12
50	0.50	3.99	3.64	3.99
40	0.50	5.12	5.04	5.08

- The accelerating force remains constant throughout, this is the mass hanging from the string:
- m (0.05kg) x g (10N/kg)
- The mass of the trolley (and masses) changes.
- The acceleration is found using light gates, an interrupt card and a datalogger/computer.

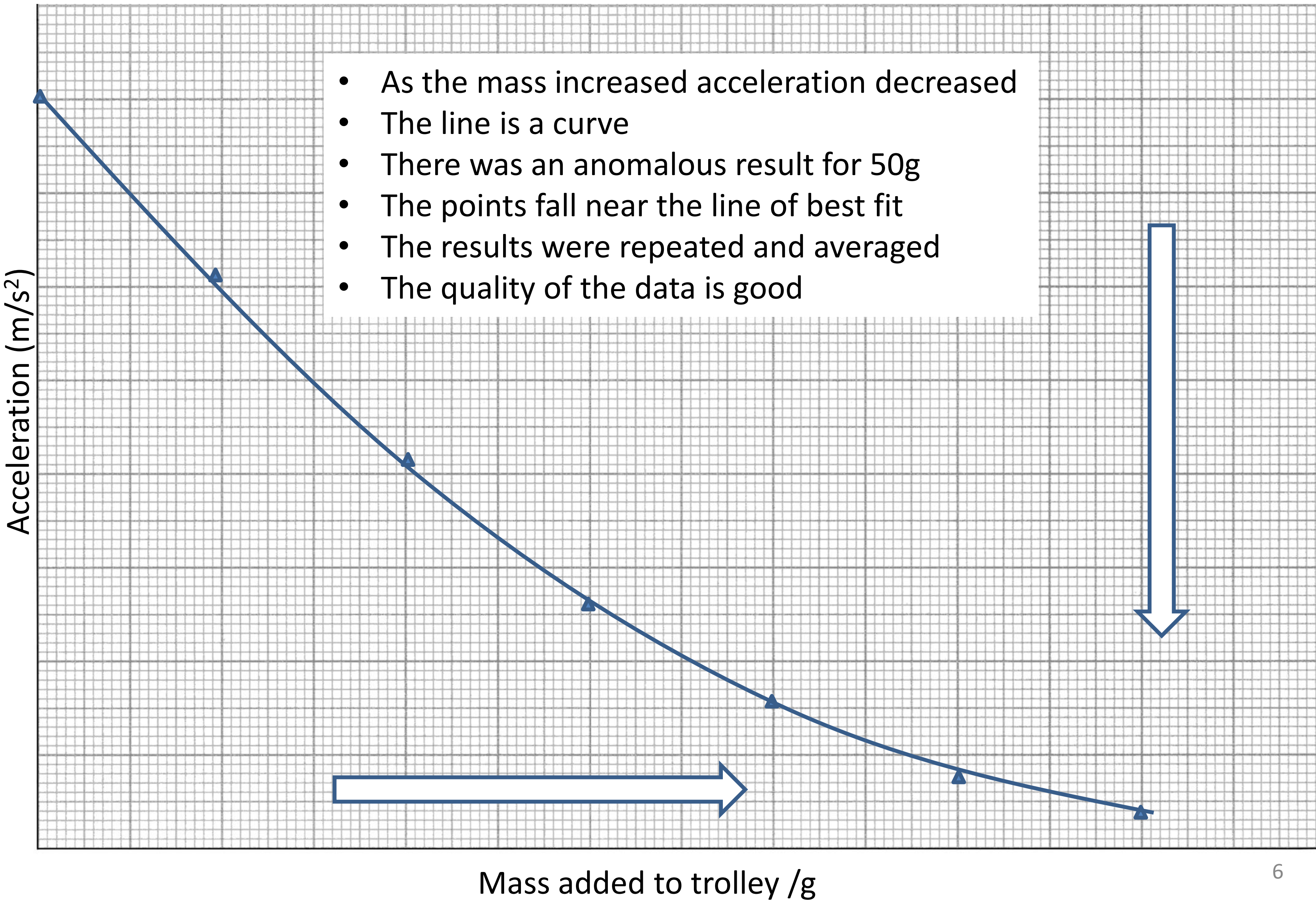
Repeats improve the quality of results and the circled anomaly is clear from the graph

To find the relationship between acceleration and mass of trolley, plot a graph. You will see that as the mass of the trolley increases the acceleration decreases.

The closer the points fall to the line of best fit, the better the quality of the data.

It's not a direct relationship because the graph isn't a straight line.

Topic 2: *Added mass vs acceleration graph*

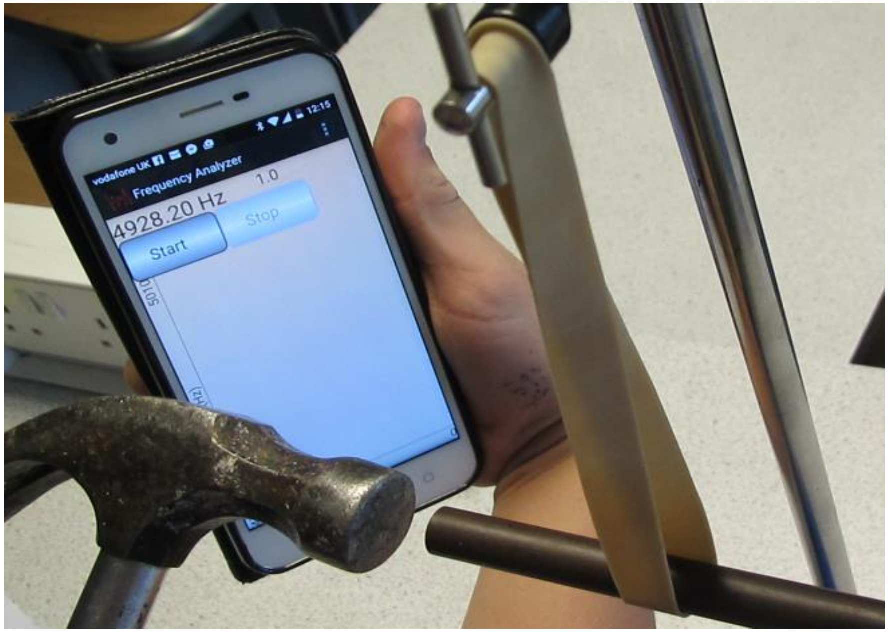


Topic 4: *Investigation: Speed of a wave*

***Core Practical:** Investigate the suitability of equipment to measure the speed, frequency and wavelength of a wave in a solid and a fluid.*

You are looking at the suitability of the apparatus used in previous investigations and it anticipates that you have used the equation $v = f \times \lambda$

It assumes that you have looked at and measured the speed of waves in a liquid using a ripple tank (ruler and stopwatch) and also looked at a method of measuring the frequency of waves in a metal rod (spectrum analyses App)

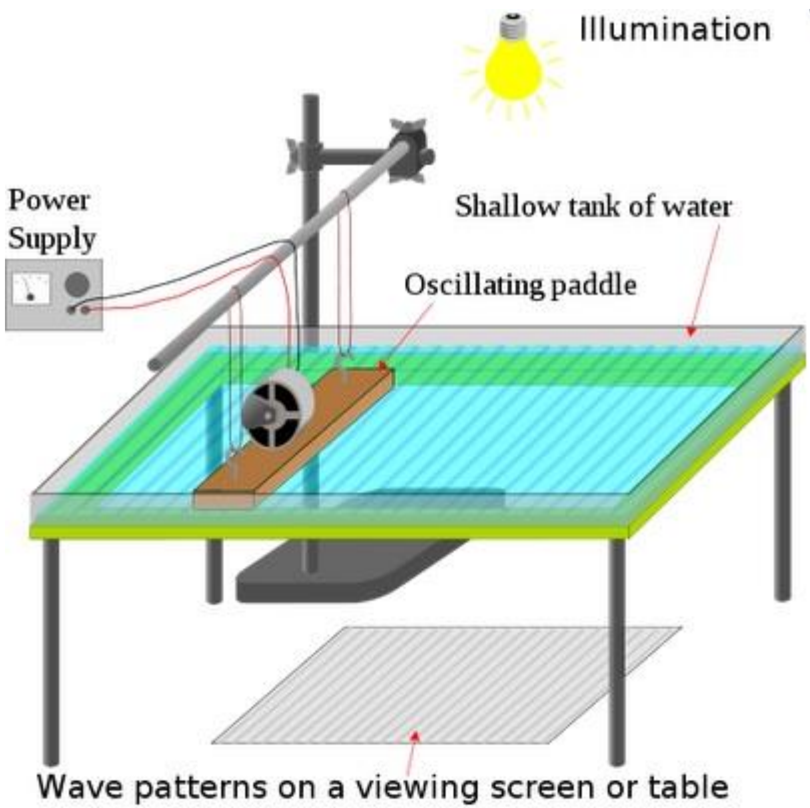


The apparatus required is not specified so you will be looking at the issues raised. The quality of the evidence, anomalies, the necessity of precise readings, the need for repeats and the effectiveness (strengths and weaknesses) of the equipment chosen.

Video and still cameras often offer very precise solutions

Topic 4: *Investigation: Speed of a wave*

Where a stopwatch and a tape measure might be used to measure the speed of a wave in a swimming pool (stopwatch to measure time and the tape measure to measure distance), speed = distance / time, this might not be so easy in a ripple tank:



The motor can be used to shake the dipper. Count the number of waves formed in, say, 10 seconds (and divide by 10). This is the frequency.

Use a ruler to measure from one wavefront to the next in metres (or measure 2 and divide by 2) this is the wavelength.

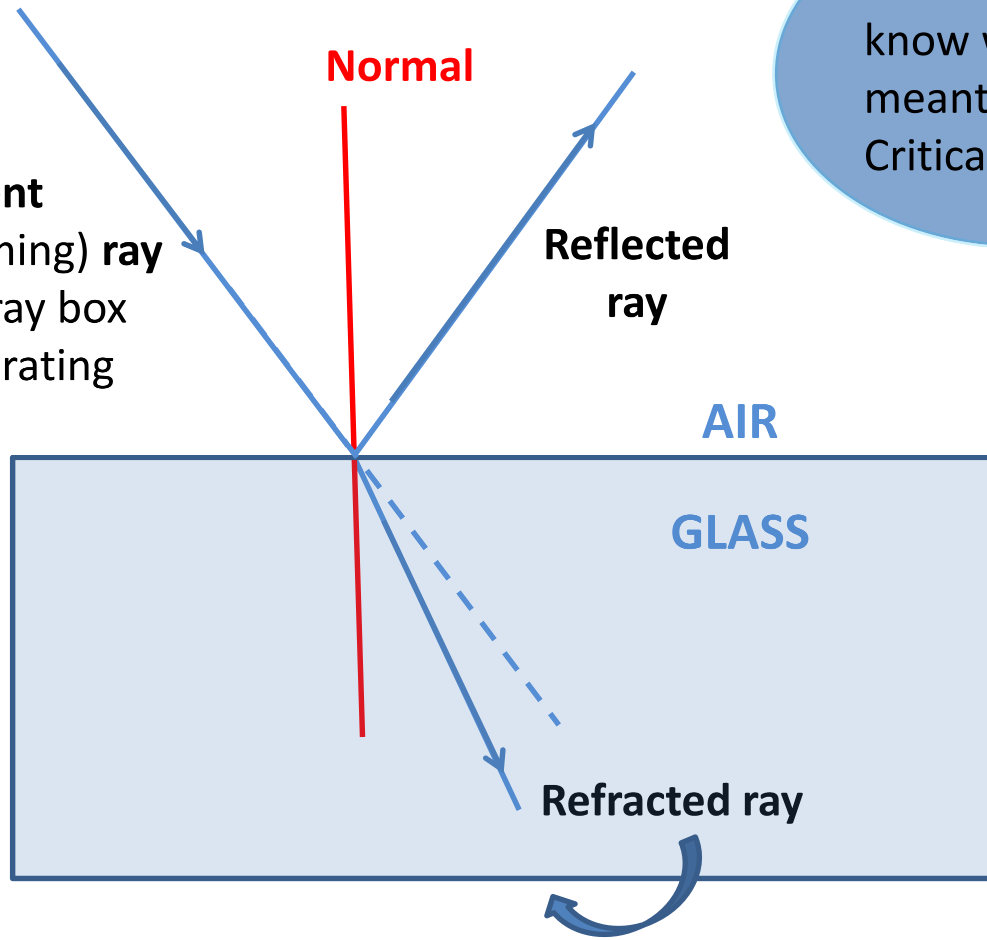
Use $v = f \times \lambda$ to calculate the speed of the wave

Again a camera helps with the quality of data

Think – why did you count ten waves and divide by ten (accuracy not precision), why might you use a camera (more precise measurements / better quality data).

Topic 5: *Refraction investigation*

Core Practical: *Investigate refraction in rectangular glass blocks in terms of the interaction of electromagnetic waves with matter.*



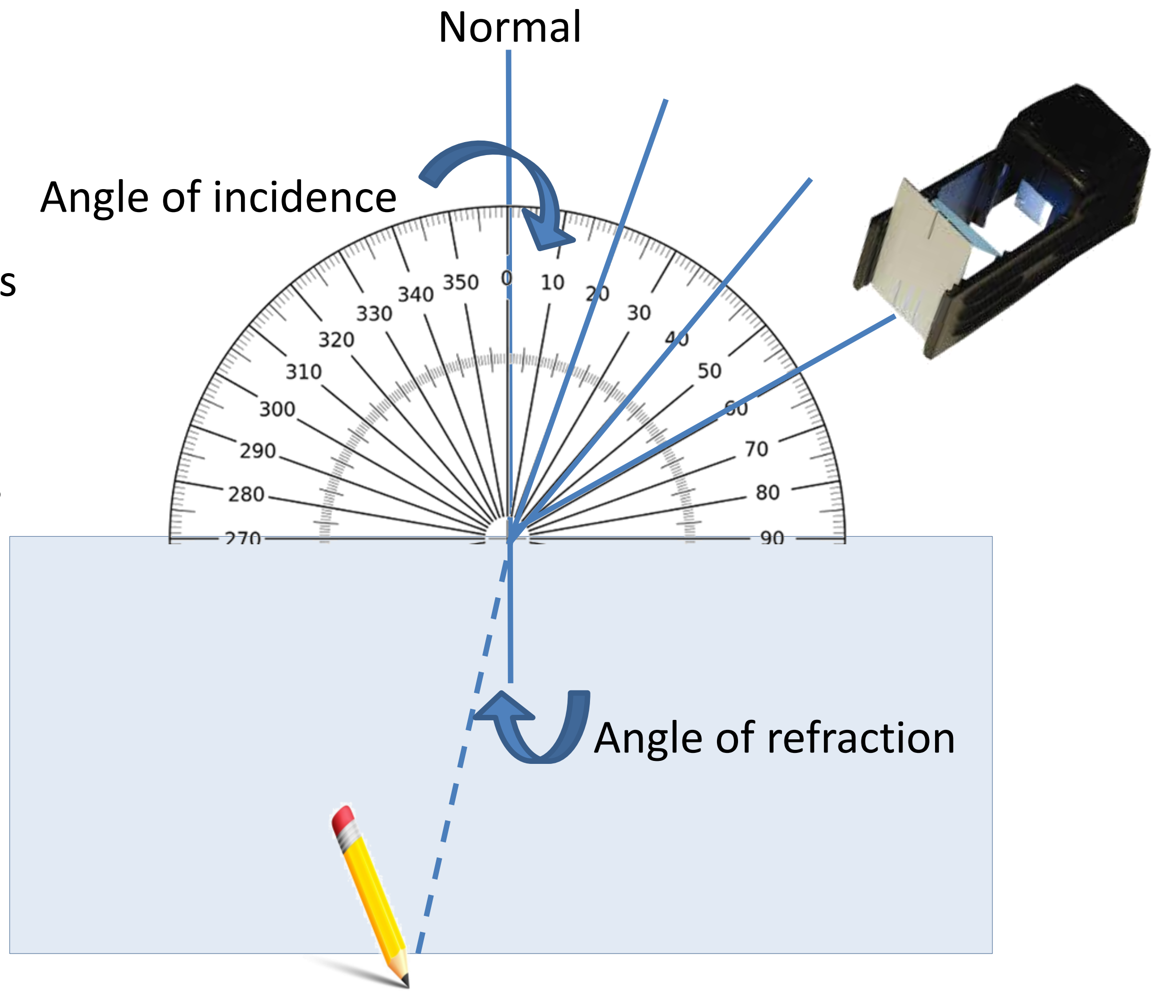
Make sure you know what is meant by the term Critical Angle

Light slows down in glass so it is refracted and bends towards the normal

At angles greater than the **critical**, light is reflected not refracted.

Topic 5: *Refraction investigation*

- Draw around the rectangular glass block
- Draw the ‘normal’
- Mark the path for light rays entering the block at the normal.
- Mark where the ray leaves the block
- Remove the block from the paper
- Use a ruler to join the incoming line to the mark
- Measure the angles of incidence and refraction



If light follows the path of the normal, it passes through the glass block undeflected.

Topic 5: *Investigation – surfaces (P)*

***Core practical:** Investigate how the nature of a surface affects the amount of thermal energy radiated and absorbed.*

Fill each container with a <u>fixed volume</u> of hot water (fair test), cover with a lid (to reduce convection) and stand on a foam pad (to reduce conduction). Record, in a table, the temperature over time.

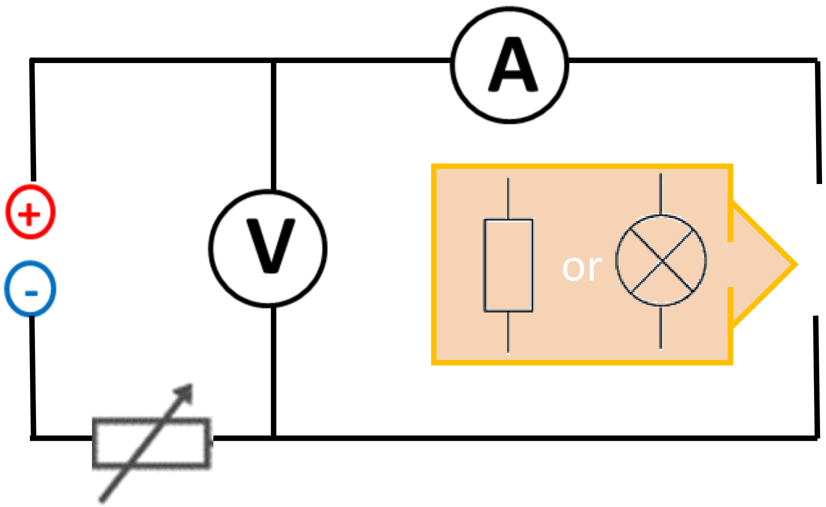
- Four different colour beakers or test tubes.
- Shiny and matt.
- Same volume of hot water.
- Thermometers.
- Stopwatch.
- Lids.

Dark, matt colours are the best radiators, these cups will cool the quickest. Shiny silver retains heat for longer.

Time /min	Silver /°C	Red /°C	Black /°C	Yellow /°C
0	88.7	88.4	87.1	88.1
20	76.8	75.3	70.2	75.2
40	71.4	69.8	64.9	69.2
60	68.6	67.0	60.3	66.8
80	66.8	65.3	56.6	65.0
100	64.2	62.0	53.0	62.0
120	62.7	59.1	49.6	58.4
140	61.2	58.3	47.0	57.8

Topic 10: *V = I x R investigation a*

***Core Practical:** Construct electric circuits to investigate the relationship between potential difference, current and resistance for a resistor and a filament lamp*



Fill the gap in the circuit with one of the above components. Vary the potential difference, record the current and plot a graph for the current vs voltage. The gradient of this graph is 1/resistance of the component. Repeat for others.

Use V = I x R and calculate and record resistance in the third column. Note that the calculations are to the same number of decimal places as the data.

Resistor

P.D. / Volts V	Current / Amps A	Resistance / Ohms Ω
3.01	0.12	25.08
4.35	0.18	24.16
5.78	0.25	23.12
7.18	0.31	23.16
8.71	0.38	22.92
11.22	0.44	25.50

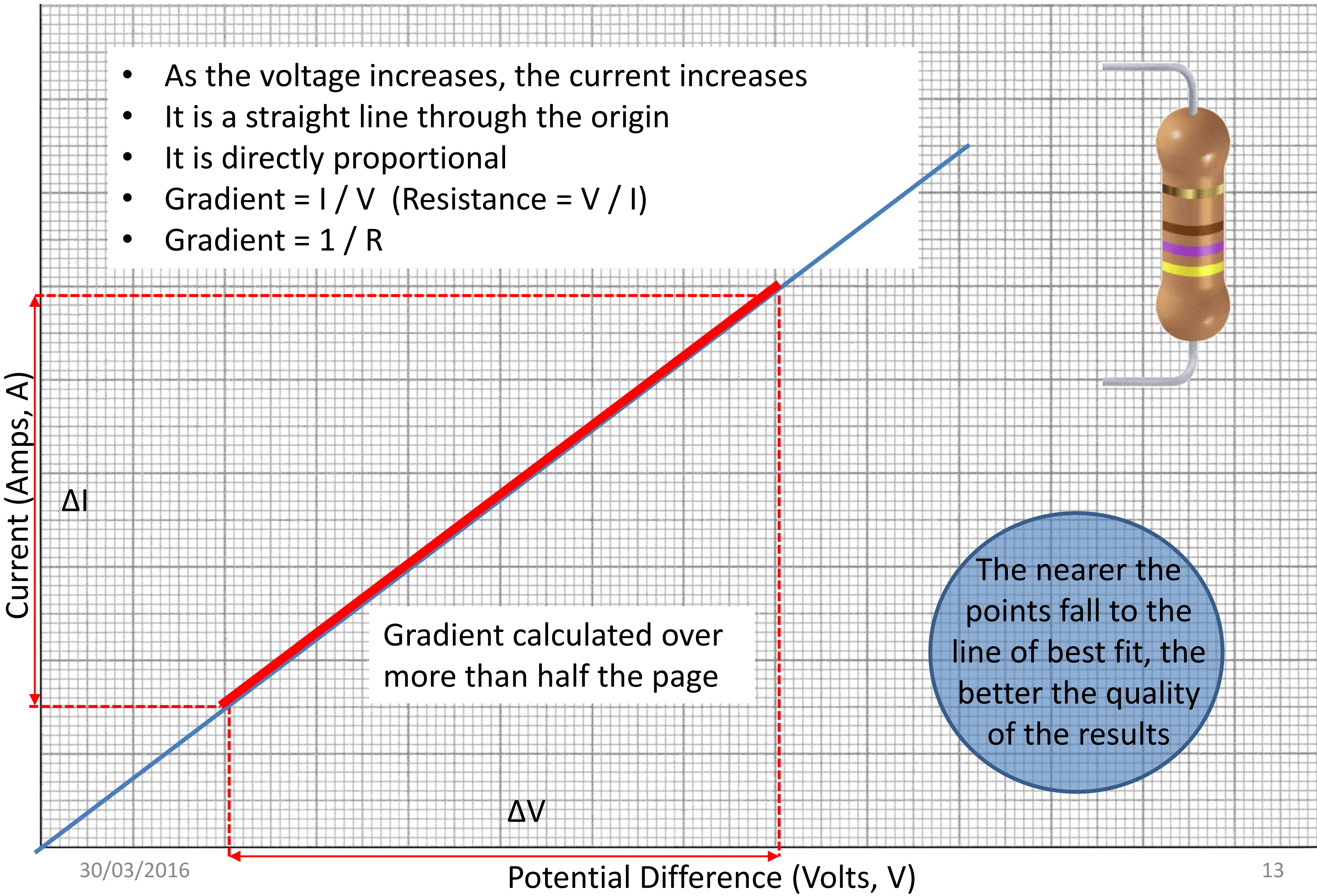
Lamp

P.D. / Volts V	Current / Amps A	Resistance / Ohms Ω
2.87	0.80	3.59
4.14	0.97	4.27
5.55	1.12	4.96
8.50	1.39	6.12
11.05	1.59	6.95
11.23	1.60	7.02

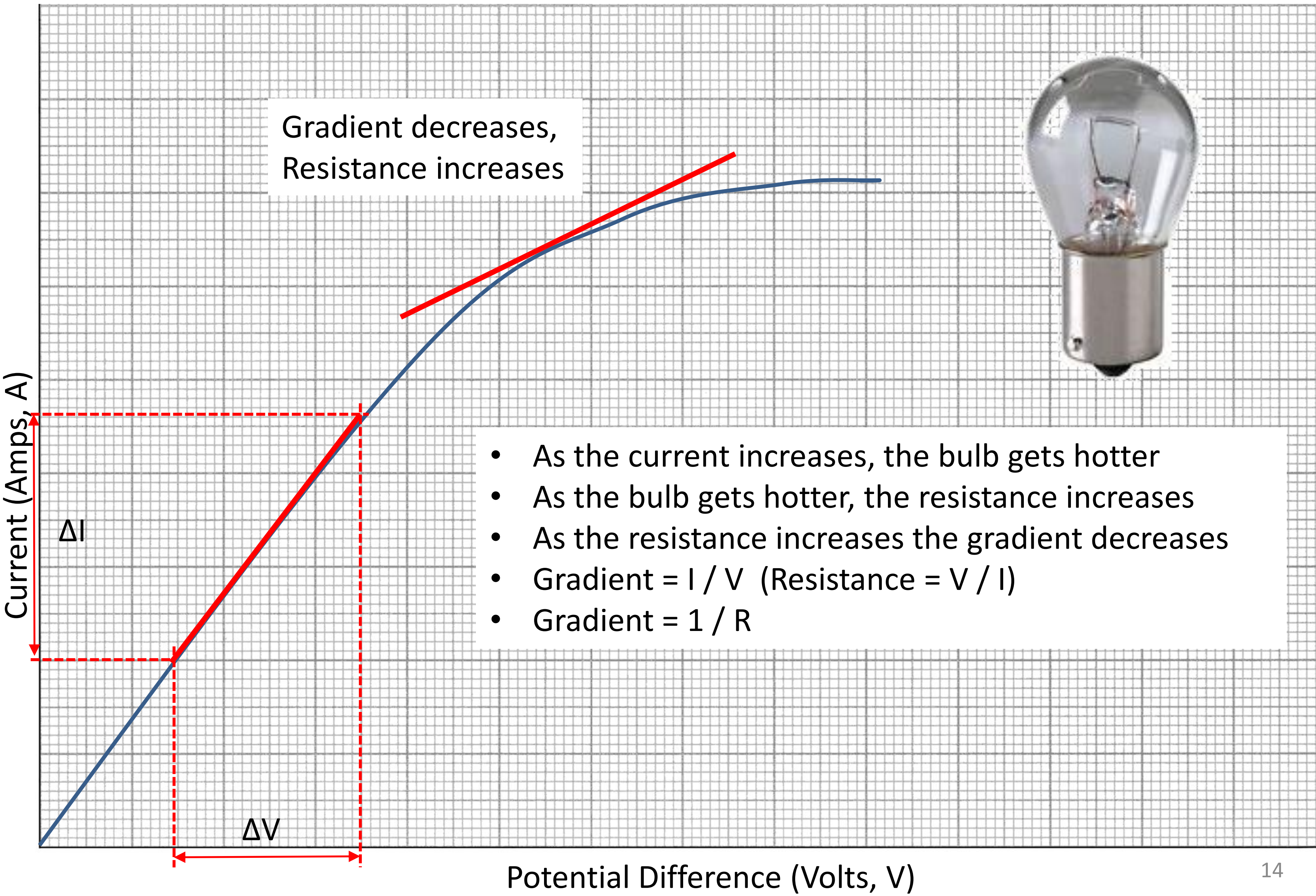
10.17a 10.21

Topic 10: *I vs V for a Resistor*

- As the voltage increases, the current increases
- It is a straight line through the origin
- It is directly proportional
- Gradient = I / V (Resistance = V / I)
- Gradient = 1 / R



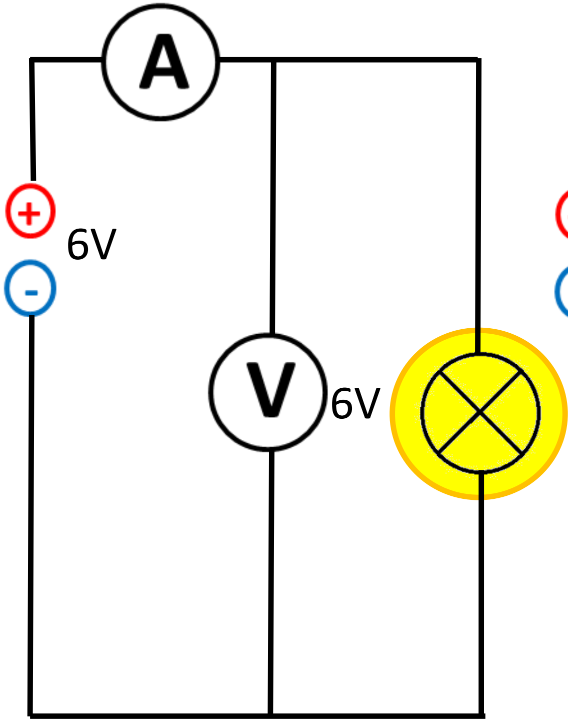
Topic 10: *I vs V for a Lamp*



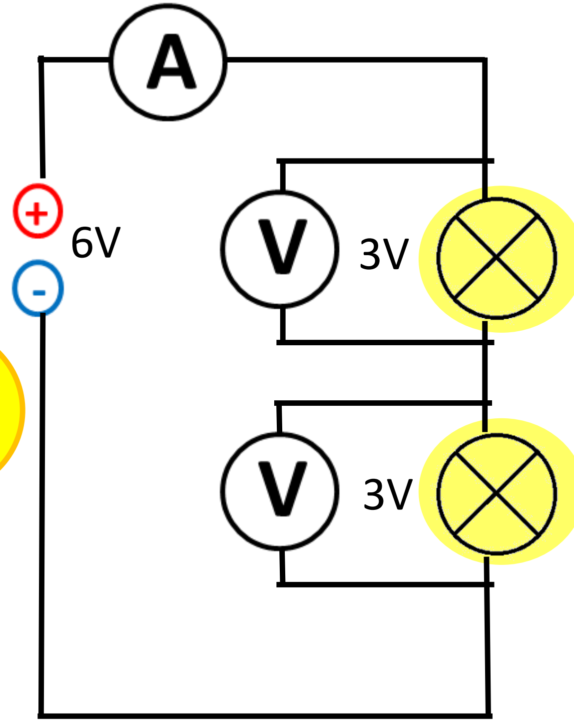
- As the current increases, the bulb gets hotter
- As the bulb gets hotter, the resistance increases
- As the resistance increases the gradient decreases
- Gradient = I / V (Resistance = V / I)
- Gradient = 1 / R

Topic 10: *V = I x R investigation b*

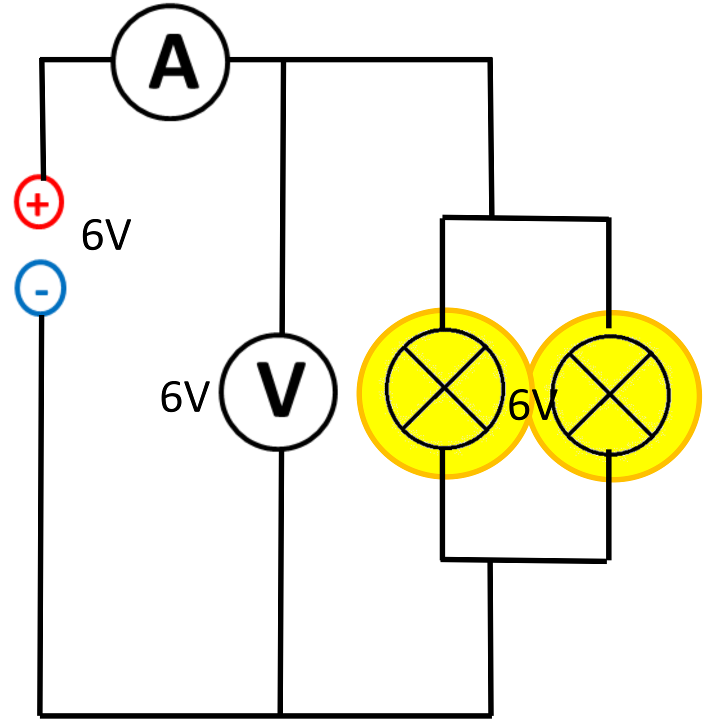
Core Practical: *Construct electric circuits to test series and parallel circuits using resistors and filament lamps. Potential Difference (Volts)*



Control circuit.
Brightness = 1



Bulbs in series. Less P.D. across each bulb.
Bulbs are dimmer < 1



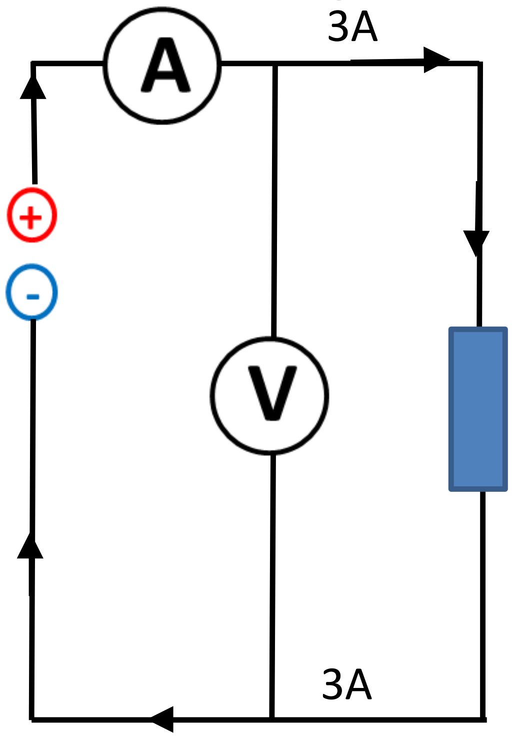
Bulbs in parallel, the same potential across each bulb.
Brightness the same = 1.

(The same would be true if the lamps were replaced with resistors though it would just be less obvious)

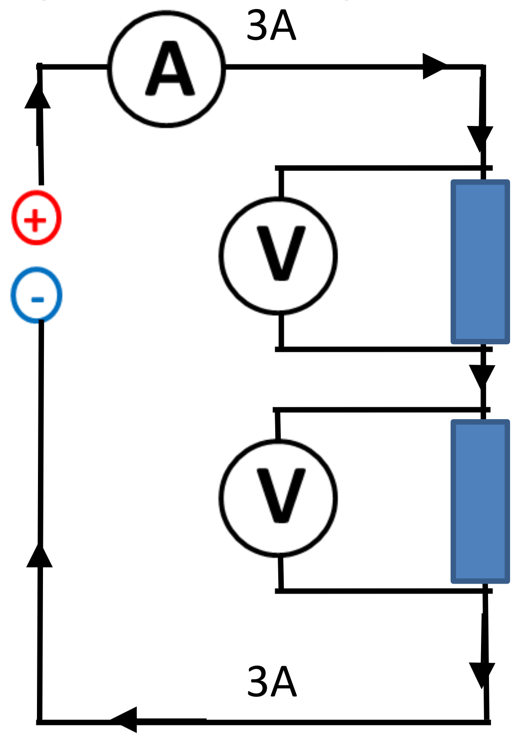
10.17b

Topic 10: *V = I x R investigation b*

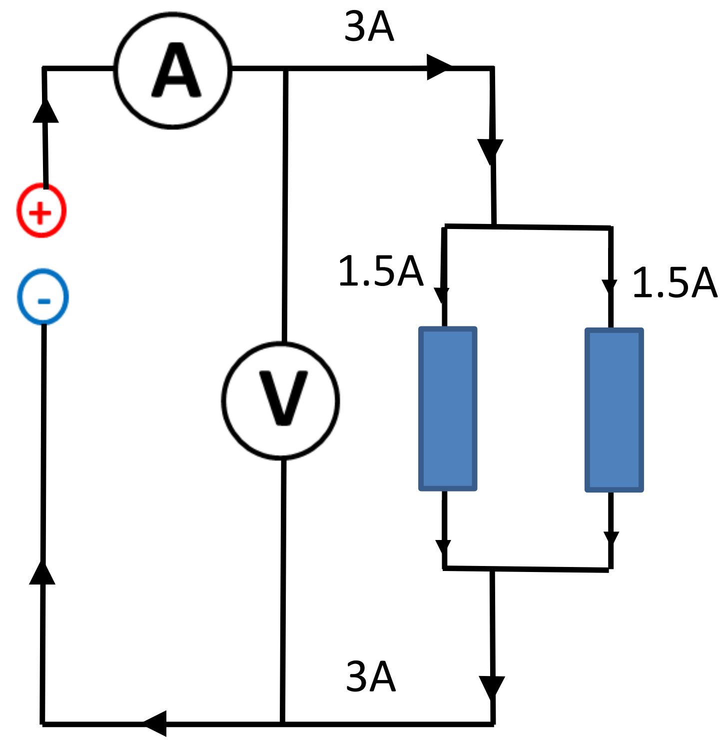
Core Practical: *Construct electric circuits to test series and parallel circuits using resistors and filament lamps. Current (Amps)*



Almost no current flows through the voltmeter



The same current flows through the two lamps



The current splits between the two parallel lamps

(The same would be true if the lamps were replaced with resistors though it would just be less obvious)

Topic 14: *Densities investigation*

Core Practical: Investigate the densities of solids and liquids

To find the density of a solid:

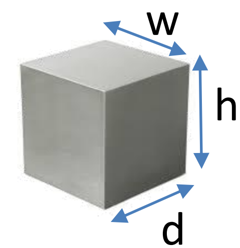
- Measure the mass using a balance
- Measure the volume using either
    - a ruler or a micrometer (more precise) for a cube
    - Or a displacement can for an irregular solid
- $density(kg/m^3) = \frac{mass(kg)}{volume(m^3)}$

To measure the density of a liquid:

- Put the measuring cylinder on the scales
- Zero the scales
- Pour in the liquid
- Use the mass on the scales and the volume on the measuring cylinder.

From	To	Calculation
cm^3	m^3	$\times 10^{-6}$
mm^3	m^3	$\times 10^{-9}$

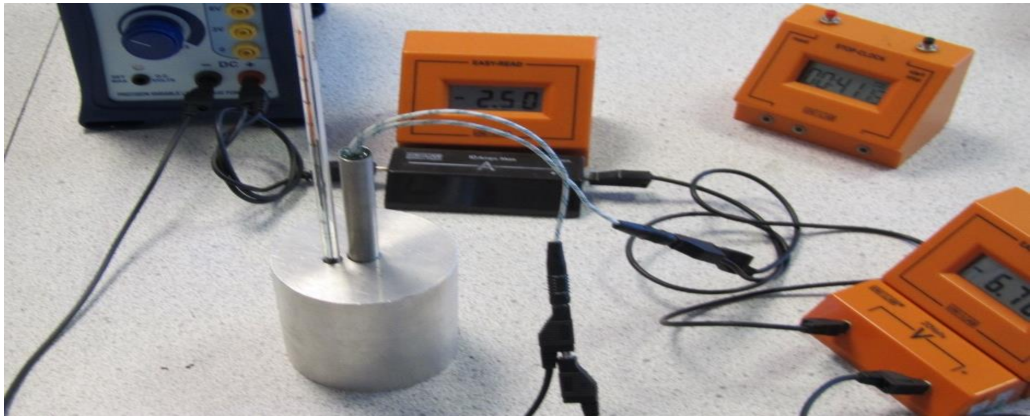
Volume = w x d x h



Topic 14: *SHC of metal investigation*

Core Practical: *Investigate the properties of water by determining the specific heat capacity of water*

Current /Amps	P.D. /V	Time /Min	Temp /°C
2.04	11.8	0	27
2.04	11.8	1	33
2.04	11.8	2	34
2.04	11.9	3	41
2.04	11.9	4	46
2.04	11.9	5	50
2.02	11.9	6	57
2.02	11.9	7	60
2.02	11.9	8	64
2.03	11.9	9	66
2.03	11.9	10	69



Knowing the electrical energy (ΔQ) going into the heater (Current x p.d. x time = 14,500J), the mass of the Cu block (1kg) and the temperature change (ΔΘ = 42°C), calculate the specific heat capacity (c) of the copper block.

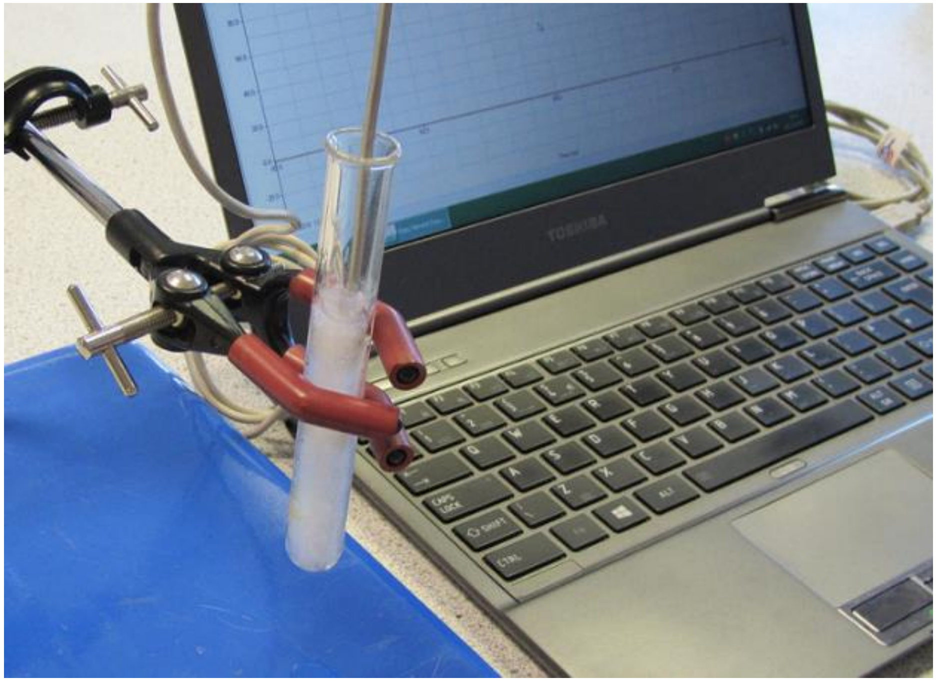
Specific heat capacity of Cu = ΔQ / (m x ΔΘ)

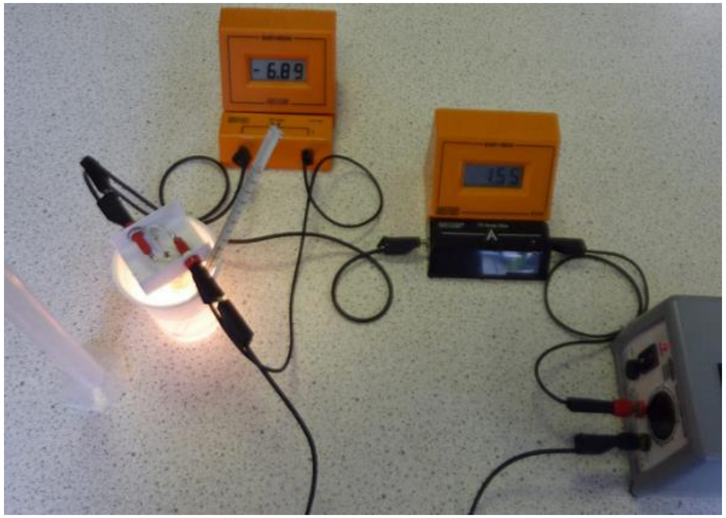
Differs from the book value as heat is lost through conduction, convection and radiation. How might you make it better ?

Topic 14: *Melting ice*

Core Practical: Obtain a temperature-time graph for melting ice.

This is a very basic experiment. The examboard suggest adding hot water and then keeping it hot with a Bunsen burner, this obviously has lots of issues, not least how do you measure the amount of heat energy in. Clearly this is designed to show the shape of the graph and possible ways of recording data.



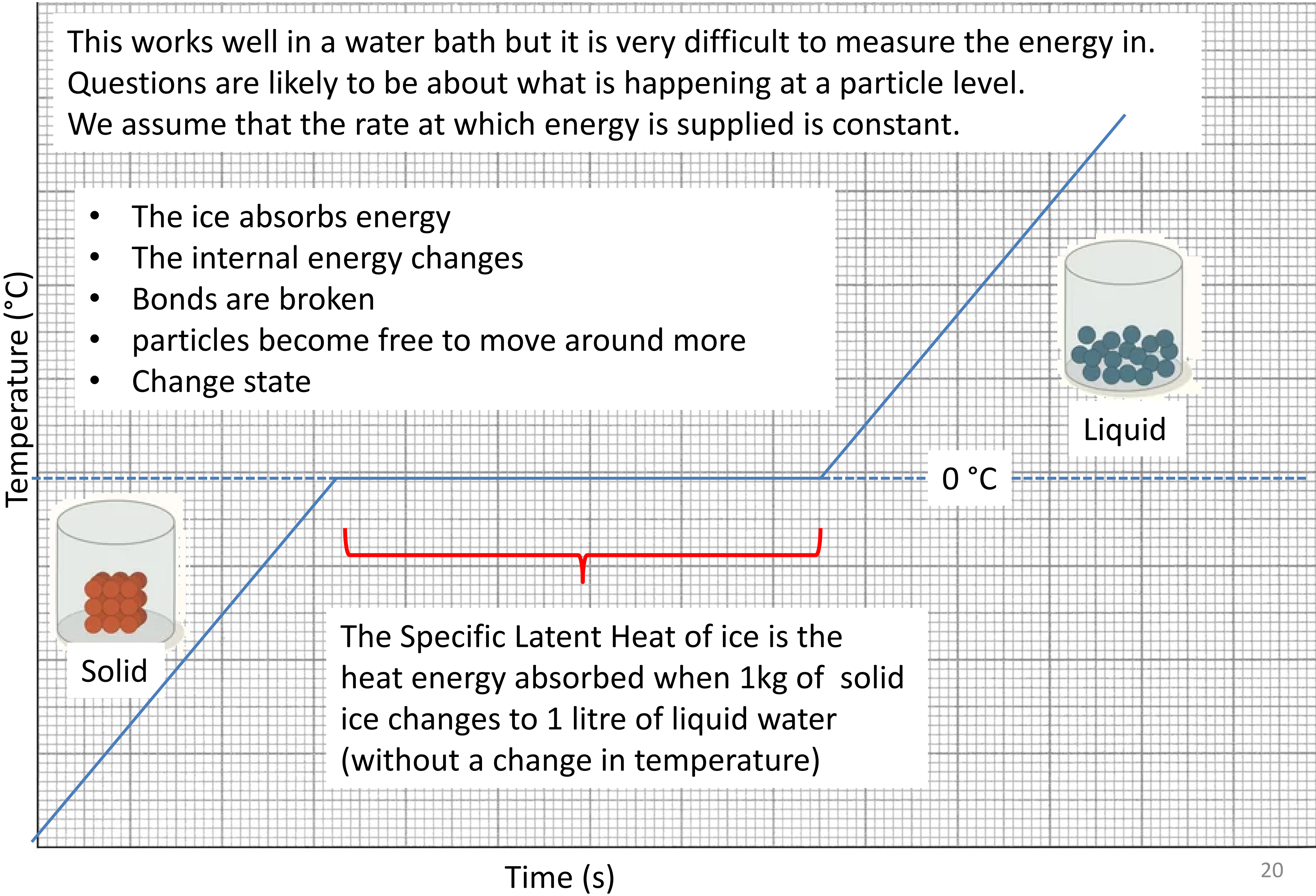


Using a lightbulb to find the specific heat capacity of water is interesting as the electrical energy in can be measured and the wasted energy (light) is obvious.

Topic 14: *Temp vs time Melting ice*

This works well in a water bath but it is very difficult to measure the energy in.
Questions are likely to be about what is happening at a particle level.
We assume that the rate at which energy is supplied is constant.

- The ice absorbs energy
- The internal energy changes
- Bonds are broken
- particles become free to move around more
- Change state

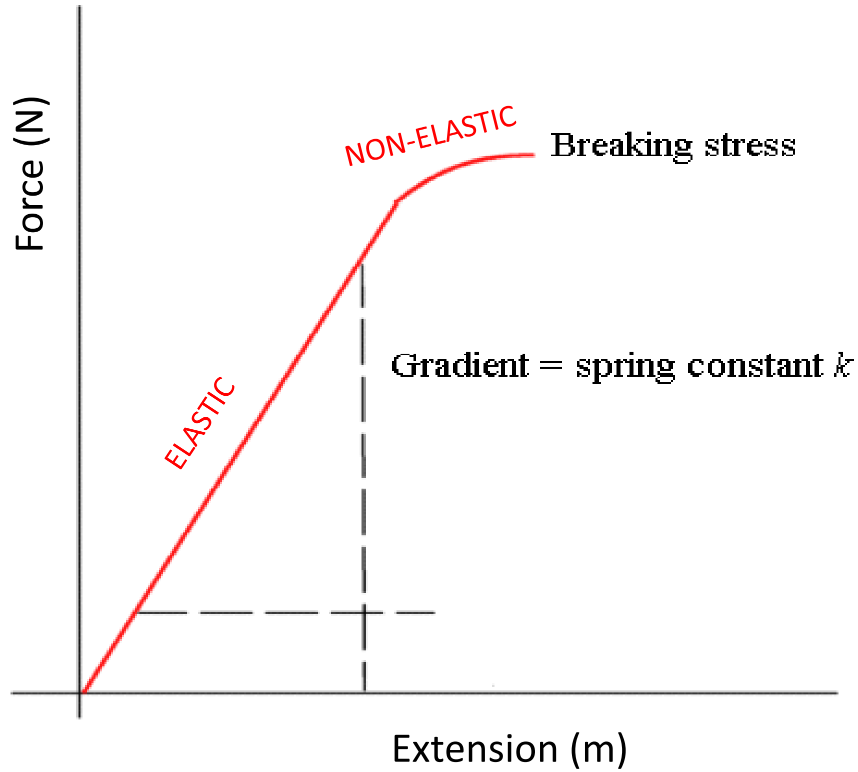


The Specific Latent Heat of ice is the heat energy absorbed when 1kg of solid ice changes to 1 litre of liquid water (without a change in temperature)

Topic 15: *Springs investigation*

Core Practical: *Investigate the extension and work done when applying forces to a spring*

Add a known mass each time to the apparatus in the picture. Force (weight) is calculated from: $W = m \times g$ (g = 10 N/kg = gravitational field strength)



Force vs extension

The loading and unloading results fall on the same line.

Area under line is energy stored in spring

To get accurate results:

- Keep the ruler vertical
- Avoid parallax
- Use a fiducial point
- Use a finely calibrated ruler or
- Use a calliper to measure extension or distance off the ground.

Topic 15: *Springs investigation*

Added mass /g	Force /N	Length /cm	Xtn /cm	Work done /J
0	0	5	0	
50	0.50	6.5	1.5	
100	1.00	8.5	3.5	
150	1.50	11.0	6.0	
200	2.00	13.5	8.5	
250	2.50	16.5	10.5	
300	3.00	17.5	12.5	
350	3.50	20.0	15.0	

Force = Weight

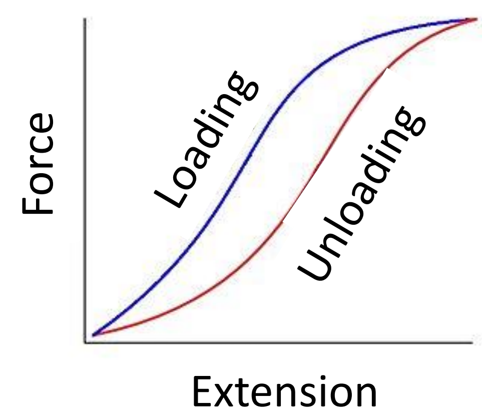
Weight = mass x g
(g = 10 N/kg)

To find the extension, subtract the initial length from the measured length

The gradient of a graph of Force vs. extension is k (the spring constant)

The energy transferred in stretching the spring is the area under the graph. $E = \frac{1}{2} k x^2$

Loading and unloading a spring produces a nice straight line but the graph is different for an elastic band which gets quite hot when you stretch it:

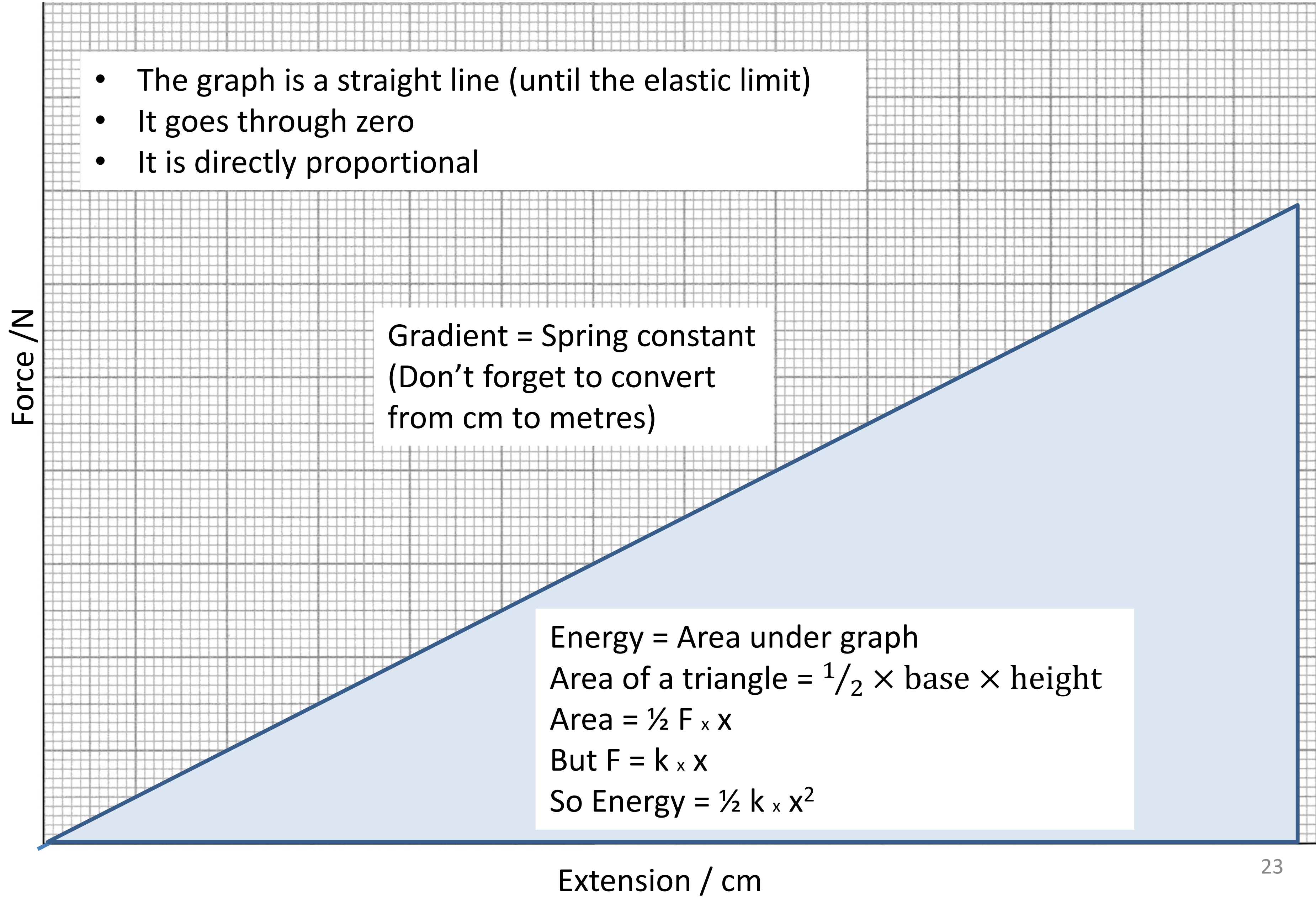


Topic 15: *Force vs extension graph*

- The graph is a straight line (until the elastic limit)
- It goes through zero
- It is directly proportional

Gradient = Spring constant
(Don't forget to convert
from cm to metres)

Energy = Area under graph
Area of a triangle = $^1/_2 \times \text{base} \times \text{height}$
Area = ½ F x x
But F = k x x
So Energy = ½ k x x^2



Health & Safety

CP1	Make sure masses cannot fall on your feet	Place a box of crumpled paper below where you are working
CP2	Don’t slip on wet floors	Mop up any spills
CP3	Ray box may get hot Glass can cut	Do not touch the ray box Beware the edges or use Perspex block
CP4	Boiling water can burn	Carry small quantities. Hold a beaker by the rim where the glass is thickest.
CP5	Risk of electric shock	Check cables and do not use mains electricity
CP6	Don’t slip on wet floors Sharp edges on micrometer	Mop up any spills Use with care
CP7a	Immersion heaters get very hot	Leave in vessel to cool down
CP7b	Ice can shatter into eye	Wear Safety glasses
CP8	Make sure masses cannot fall on your feet Springs / bands can fly into the eye	Place a box of crumpled paper below where you are working Wear safety glasses

You may not agree but theses are the expected assessments