A LEVEL PHYSICS

DAILY WORKOUT

Year 1: March - June

Lewis Matheson

BOOK 3

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ACKNOWLEDGEMENTS

This series of books has been a big undertaking!

I'm extremely grateful to the following contributors who have helped write many of the questions in this guide. Between them, they have many years of experience teaching physics.

- Dr Peter Edmunds
- Muhammad Kashif Jamal
- Dr Dan Jones
- Dave Grainger
- Matthew Lewis
- Melissa Lord

Joe Cattermole collated the first draft and wrote hundreds of additional questions before James Hills, Rufus Jones and Ally Davies assisted with formatting and proofreading the many edits that I made.

It was a real team effort, and I hope the resulting book will be useful to you as you study A Level Physics.

Lewis Matheson

HOW TO USE THIS BOOK

The idea is simple – attempt a few short questions every day to help build on your existing knowledge, and strengthen your understanding of the core content, as you continue your A Level Physics course.

Find out how to use this book by scanning the QR code, or search for ‘A Level Physics Online Books’ to watch a video explaining everything you need to know.

ALevelPhysicsOnline.com/**books**

Please be aware that every school teaches the content in a different order. If you cannot complete a question because you haven’t been taught that topic, then:

- Have a look at your textbook or watch one of my videos
- Research it on the internet or using AI
- Mark the question, and come back to it at a later date
- Ask your teachers - they are really helpful!

Daily Workout - Book 1 - March

	Question 1	Question 2	Question 3
1st	Mixed calculations		
2nd	Percentage uncertainty	Projectile motion calculation	Double slit
3rd	Practical – double slit		
4th	Practical – double slit		
5th	Angles	Definition	Electrical calculation
6th	Resistivity	Rearranging equations	Internal resistance
7th	Percentage uncertainty	Definition	Motion calculations
8th	Values and units	Resistor calculation	Moments
9th	Travelling microscope	Travelling microscope	Travelling microscope
10th	Resistor calculation	Definition	Moments
11th	Projectile motion calculation	Symbols and units	
12th	Centre of mass	Centre of mass	Moments
13th	Derivation	Forces	
14th	Practical – terminal velocity		
15th	Potential divider	Definition	Projectile motion calculation
16th	Values and units	Circuit calculation	Circuit calculation
17th	Single slit diffraction		
18th	Values and units	Definition	Diffraction grating
19th	Practical – diffraction grating		
20th	Diffraction grating	Diffraction grating	Diffraction grating
21st	Values and units	Circuit calculation	Circuit calculation
22nd	Forces	Definition	Standing waves
23rd	Practical – standing waves		
24th	Derivation	Circuit calculation	
25th	Practical – standing waves		
26th	Values and units	Circuit calculation	Circuit calculation
27th	Practical – standing waves		
28th	Values and units	Definition	IV characteristics
29th	Power	Power	Standing waves
30th	Practical – springs		
31st	Practical – standing waves		

Daily Workout - Book 1 - April

	Question 1	Question 2	Question 3
1st	Practical – standing waves		
2nd	Circuit calculation	Standing waves	Circuit calculation
3rd	Percentage uncertainty	Definition	Circuit calculation
4th	Micrometer		
5th	Internal resistance	Circuit calculation	Materials
6th	Practical – Young modulus		
7th	Practical – Young modulus		
8th	Percentage uncertainty	Definition	Resistivity
9th	Practical - resistivity		
10th	Materials	Springs	Circuit calculation
11th	Values and units	Definition	Materials
12th	Graphs	Graphs	
13th	Springs	Units	
14th	Practical – acceleration due to gravity		
15th	Practical – acceleration due to gravity		
16th	Practical – acceleration due to gravity		
17th	Materials	Definition	Materials
18th	Units	Motion	Motion
19th	Units	Motion	Materials
20th	Practical – springs		
21st	Definition	Cells in series and parallel	Circuit calculation
22nd	Practical – rubber band		
23rd	Force	Cells in series and parallel	Forces
24th	Moment	$y = mx + c$	
25th	Units	$y = mx + c$	
26th	Units	Definition	EMF and internal resistance
27th	Practical – IV characteristics		
28th	Practical – power		
29th	IV characteristics	Definition	Equilibrium
30th	Work	Energy	Equilibrium

Daily Workout - Book 1 - May

	Question 1	Question 2	Question 3
1st	Practical – IV characteristics		
2nd	Practical – IV characteristics		
3rd	Motion graph	Energy	Percentage uncertainty
4th	Motion graph	Definition	Motion calculation
5th	Motion calculation	Angles	Springs
6th	Practical – refraction		
7th	Units	Symbols and units	
8th	Intensity	Definition	Photoelectric effect
9th	Photoelectric effect	Photoelectric effect	
10th	Units	Definition	Equilibrium
11th	Practical – IV characteristics		
12th	Practical – IV characteristics		
13th	Ratios	Uncertainty	Percentage uncertainty
14th	Practical – Planck constant		
15th	Practical – Planck constant		
16th	Ratios	Internal resistance	Equilibrium
17th	Specific charge	Definition	Resistance
18th	Graphs	Graphs	
19th	Photons	Kinetic energy	Equilibrium
20th	Photons	Definition	Photons
21st	Graphs	Graphs	
22nd	TIR	Cells in series and parallel	Equilibrium
23rd	TIR	TIR	TIR
24th	Graphs		
25th	Units	Definition	Equilibrium
26th	Photons	Definition	Momentum
27th	Percentage uncertainty	Vernier scale	Motion graph
28th	Units	Double slit	Motion graph
29th	Photoelectric effect	Photoelectric effect	Photoelectric effect
30th	Vectors	Photoelectric effect	Photoelectric effect
31st	Refraction	Photoelectric effect	

Daily Workout - Book 1 - June

	Question 1	Question 2	Question 3
1st	Practical – air track		
2nd	Energy levels	Momentum	
3rd	Momentum		
4th	Energy levels	Momentum	Energy levels
5th	Standing waves	Energy levels	
6th	Diffraction grating	Energy levels	Photoelectric effect
7th	Spectrum	Definition	Energy levels
8th	$y = mx + c$	Double slit	
9th	Waves	Motion	Waves
10th	Refraction	Refraction	Refraction
11th	Graphs	Refraction	Materials
12th	Double slit	Definition	Spectrum
13th	Potential divider	Standing waves	Spectrum
14th	Potential divider	Standing waves	Standing waves
15th	Resistor combination	Standing waves	Spectrum
16th	Resistor combination	Momentum	Diffraction grating
17th	suvat calculation	Diffraction grating	Double slit
18th	Potential divider	Definition	Oscilloscope
19th	Intensity	Spectrum	Oscilloscope
20th	de Broglie	de Broglie	de Broglie
21st	Kinetic energy	Kinetic energy	suvat equations
22nd	Diffraction	Resistor combination	Kinetic energy
23rd	Momentum	Electricity calculation	Equilibrium
24th	IV characteristics	Definition	Forces on a slope
25th	Momentum		
26th	Parallax	Definition	Circuit symbols
27th	Electricity calculation	Definition	Internal resistance
28th	Momentum	Momentum	Spectrum
29th	Springs	TIR	Energy
30th	Mixed calculations		

MARCH

MARCH

Welcome to March! This book has much more of a practical focus, covering all of the essential experiments you may have carried out, as well as some alternative approaches that are worth becoming familiar with. Do not worry if you are unfamiliar with these approaches, they all use common equipment and these questions will help you prepare for any assessments you have coming up.

Developing Good Habits

Working through these questions puts you one step ahead of so many other students. By habitually completing a few questions every day you are building an excellent knowledge base and understanding as well as strengthening skills that you will draw on in lessons.

Forming good learning habits is very important; this book is part of that process. Make things regular (at the same time every day, just after something you already do regularly) and as easy as possible to reduce friction. For example, if you complete these questions every morning whilst sitting at a desk in your room, then invest in an additional calculator, pen, ruler and protractor - always have everything you need to hand so you can get started straight away.

To form a habit you should adhere to it every day. Sometimes you will not have the time to work through a full set of questions, but you might be able to spend 30 seconds reading the page and thinking through the answers. These questions can always be completed in full at a later time.

Support for All Exam Boards

This book is suitable for all exam boards and covers the core content common to all courses. You may see something that is really unfamiliar but you can always skip that question. If you happen to be taking AQA Physics then you may find that this workbook doesn't include any questions about Particle Physics - but don't worry, you can always find extra resources on my website to help you prepare for this area of the course.

Worked Examples

1. Calculate the **area**, in m^2, of a circle with a radius of:

   a. 1.25 m $A = \pi r^2 = \pi \times 1.25^2 = 4.91 \text{ m}^2$ (3 sf)

   b. 12.5 mm $A = \pi r^2 = \pi \times (12.5 \times 10^{-3})^2 = 4.91 \times 10^{-4} \text{ m}^2$ (3 sf)

   c. 125 µm $A = \pi r^2 = \pi \times (125 \times 10^{-6})^2 = 4.91 \times 10^{-8} \text{ m}^2$ (Standard form)

2. Calculate the **mass** of a robin flying at 8.9 m s^{-1} when it has a kinetic energy of 879 mJ.

   2 sf

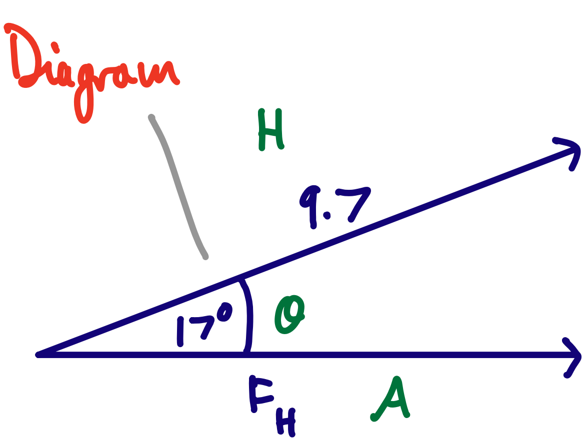
   $E_k = \frac{1}{2} m v^2$ (Equation + Rearrange)

   $m = \frac{2E_k}{v^2} = \frac{2 \times 879 \times 10^{-3}}{8.9^2}$ (Working out)

   $m = 0.02219$

   $m = 2.2 \times 10^{-2} \text{ kg}$ (2 sf) (Units)

3. Calculate the **horizontal component** of a force of 9.7 N acting at 17° above the horizontal.



$\cos\theta = \frac{A}{H}$

$A = H\cos\theta$

$F_H = 9.7 \times \cos 17$

$F_H = 9.276$

$F_H = 9.3 \text{ N}$

1st March

1. Let's start this month with some simple calculations:
   a. If a resultant force of 10 N acts on a mass of 4.0 kg, calculate the **acceleration**

   b. When a clockwise moment of 33 N m is due to a force of 5.0 N acting at a distance from the pivot, calculate the **perpendicular distance** it is acting at

   c. Calculate the **resistance** of a component that has a voltage of 3.0 V across it and a current of 0.12 A through it

   d. Calculate the **spring constant** of a steel spring that extends by 6.7 cm when a 200 g mass is hung from it

   e. Calculate the **final velocity** of an object that was initially travelling at 2.2 m s^{-1} before undergoing a uniform acceleration of 1.5 m s^{-2} for 3.2 s

   f. Calculate the **change in GPE** when a 59 g ball falls through a height of 2.5 m

   g. Calculate the **time period** of a soundwave with a frequency of 1.2 kHz

   h. Calculate the **combined resistance** of 20 Ω, 30 Ω and 40 Ω resistors connected in parallel

2nd March

1	2	3

1. Determine the **result** that should be recorded for 'g' and calculate the **percentage uncertainty** in the data:

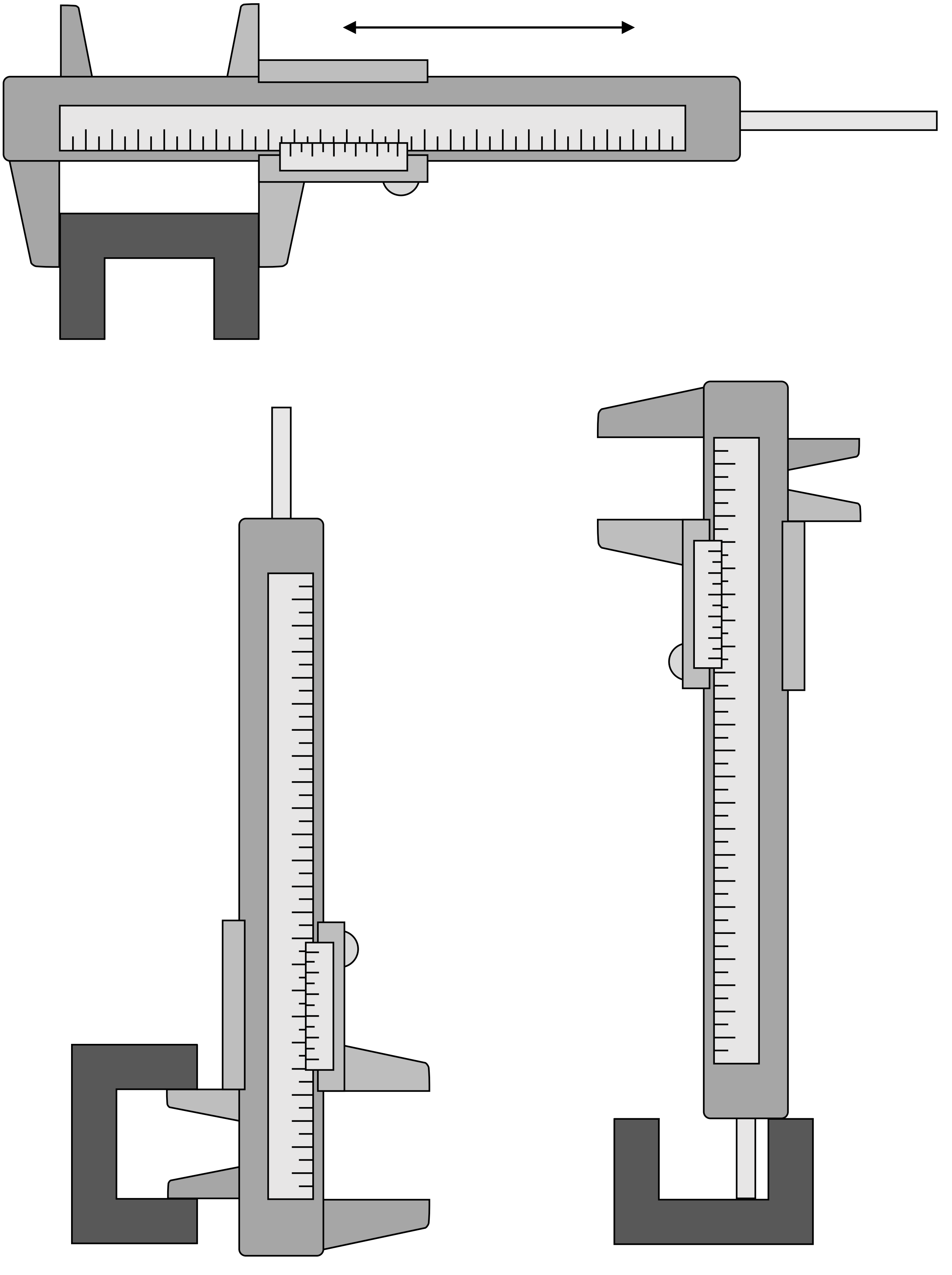
g / m s^{-2}	8.7	9.4	9.2	10.1	8.6

2. A Nerf bullet is fired horizontally at 12.0 m s^{-1} from a height of 1.6 m. Calculate how **far** it will travel horizontally before it hits the floor (assume air resistance is negligible).

3. A scientist carefully shines a purple laser, producing light of a wavelength of 400 nm, at a pair of double slits which have their centres separated by 1.00 mm. They place a piece of white paper on a screen some distance behind the slits and observe light and dark fringes. The adjacent bright fringes are 0.20 cm apart.

   Calculate the **distance** from the slits to the screen.

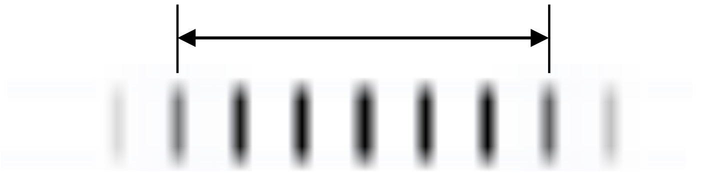
Vernier Caliper / Calliper



3rd March

1. A student is carrying out a practical using Young's slits and a laser. They are using six different distances between the double slits and the screen where the fringe pattern is observed.

   They measure the distance, as shown on the diagram, for each set of fringes observed using a vernier caliper.



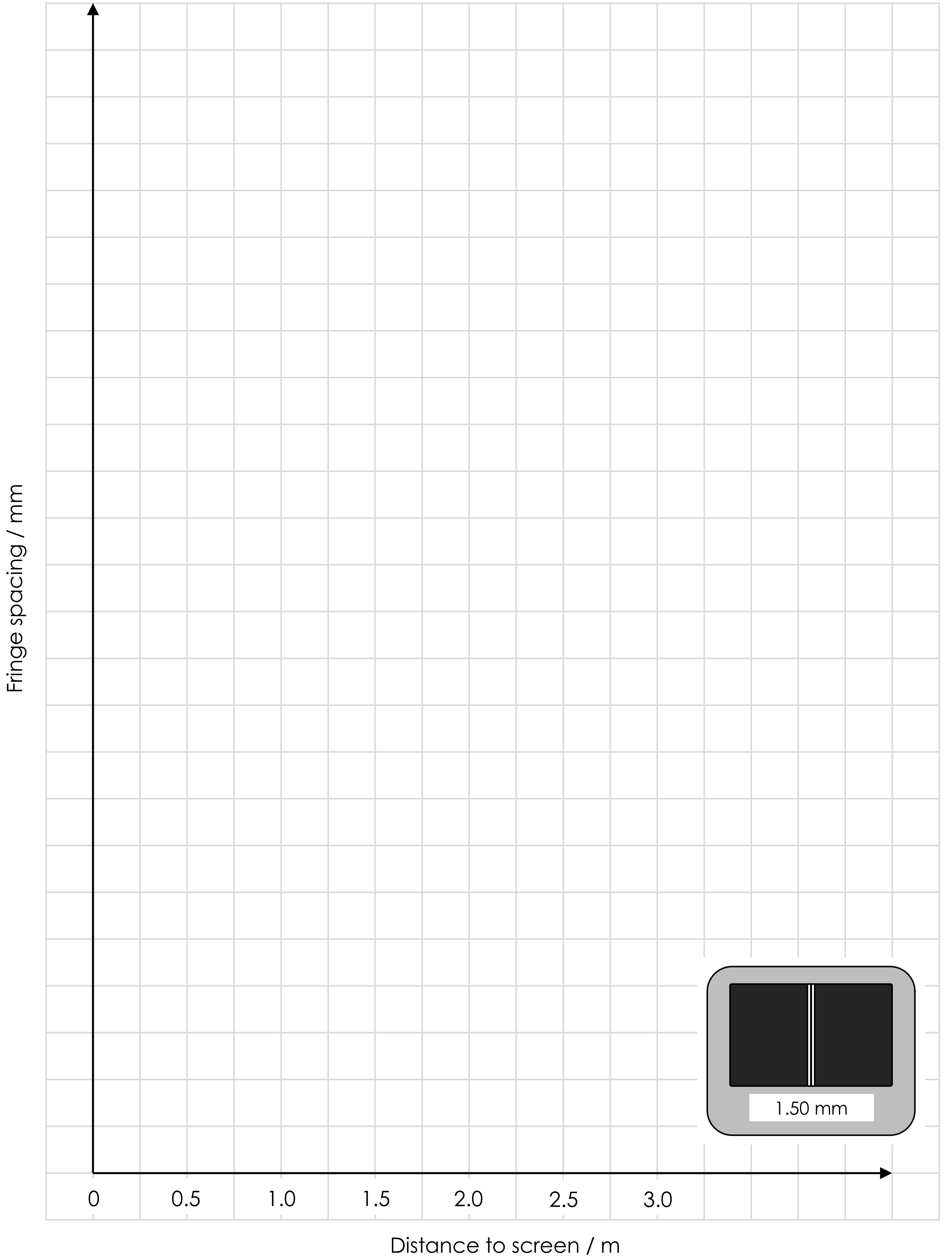
   a. Explain the **advantage** of measuring the distance shown above, rather than from one bright fringe to the next

   b. **Complete** the table and **plot** this on the graph opposite

Slit to screen distance / m	Distance measured / mm	Fringe spacing / mm
0.50	1.14	0.190
1.00	2.36	
1.50	3.72	
2.00	4.74	
2.50	6.02	
3.00	7.32	

   c. The separation of the slits used was 1.50 mm. Use this information, and the **gradient** of your graph, to calculate a value for the **wavelength** of the laser light used

3rd March

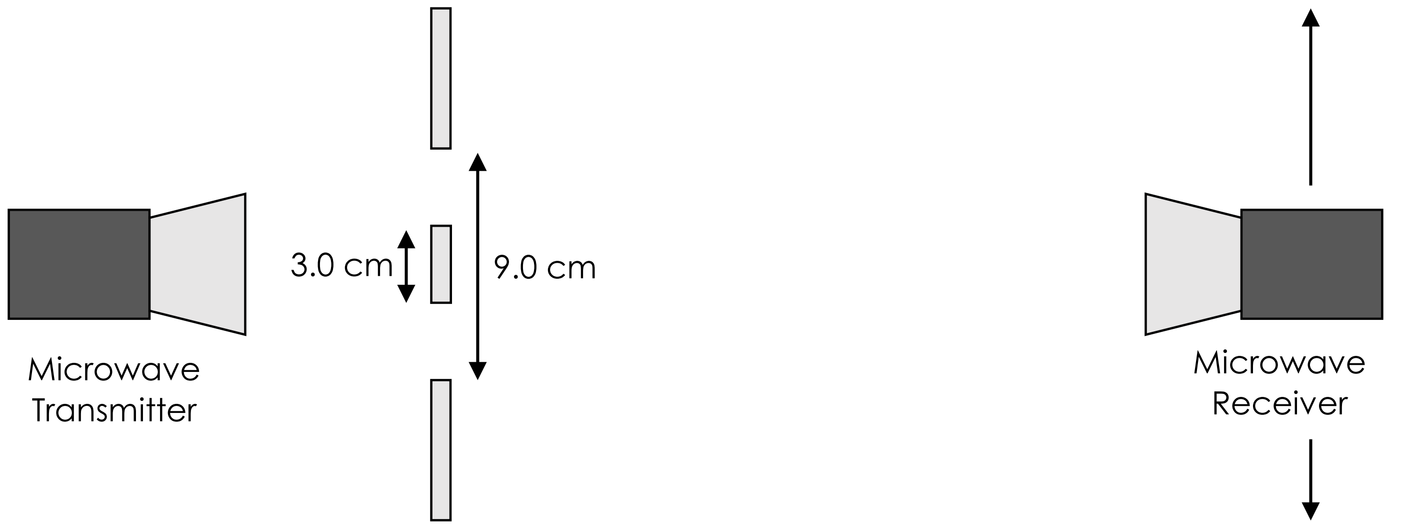


Fringe spacing / mm
0
0.5
1.0
1.5
2.0
2.5
3.0
Distance to screen / m
1.50 mm

4^{th} March – Part 1

1

1. A teacher is demonstrating interference using a microwave transmitter and receiver with metal sheets arranged to form a double slit system. The central 3.0 cm wide metal sheet is in the middle of the gap formed by the wider outer metal sheets. The microwave detector can be moved in either direction along a line drawn parallel to the slits and 1.0 m away from the slits, as shown in the plan view.



a. Determine the **distance** between the **centres** of the two slits formed in the experimental set-up above

b. The transmitter is set to 10 GHz. Calculate the **wavelength** of the microwaves

c. Coherent sources of waves are needed to form a clear interference pattern. **Define** what we mean by '**coherent**'

d. State the **path** difference and **phase** difference for the maximum constructive interference to occur:

i. Path difference

ii. Phase difference

4^{th} March – Part 2

The receiver is initially positioned to detect the central maxima opposite the transmitter and detects a maximum signal strength. If it is moved along the line away from the centre, the signal strength decreases then increases to a maximum.

e. Calculate the **distance** to this first maximum from the initial position

When the receiver is moved along the line away from the centre it detects a second and then a third position where the signal strength is a maximum.

f. Calculate the **angles** where these two maxima are detected

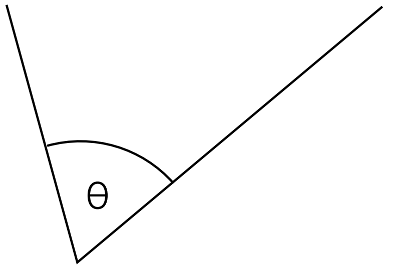
i. Second

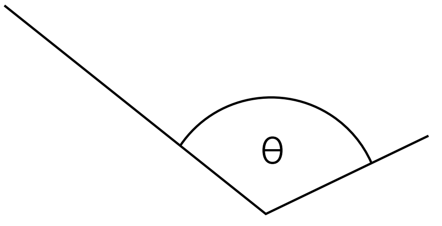
ii. Third

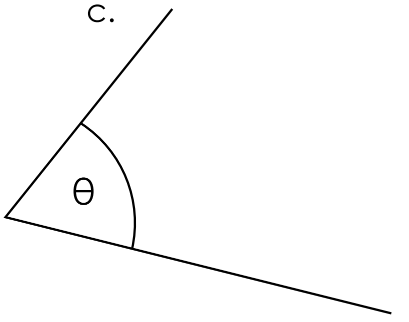
5th March

1 2 3

1. State these **angles** (using your protractor to make an accurate measurement):

   a.
   

   b.
   

   c.
   

2. Define:

   a. **Resistance**

   b. **Resistivity**

3. A current of 200 mA flows through an electrical component for a time of 1.0 hours.

   Calculate the:

   a. **Charge** that has passed through the component in this time

   b. **Number of electrons** that transfer this charge

6th March

1 2 3

1. Copper has a resistivity of 1.68×10^{-8} Ωm. Calculate the **resistance** of a copper wire of length 2.2 m and a diameter of 0.40 mm.

2. Rearrange $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ to make $\boldsymbol{R_T}$ the subject.

3. A cell of EMF 6.0 V has a sticker on it saying it is rated at 200 mAh. When the cell is placed in a circuit along with a 20 Ω resistor, the current that flows is measured as 200 mA.

   a. Calculate the **internal resistance** of the cell

   b. Calculate the **total charge** that will have flowed if the circuit is left connected until the cell is ‘empty’

7^{th} March

1 2 3

1. Three measurements of mains RMS potential difference are made: 228 V, 231 V, and 234 V.

   Calculate the **mean** RMS potential difference, its **absolute uncertainty** and the **percentage uncertainty** using these measurements.

2. Define:

   a. **Equilibrium**

   b. The **principle of moments**

3. A ball is dropped from a height of 1.5 m. Assuming air resistance is negligible:

   a. Calculate its **velocity** as it hits the ground using **conservation of energy** calculations

   b. Calculate its **velocity** as it hits the ground using '**suvat**' equations

8th March

1 2 3

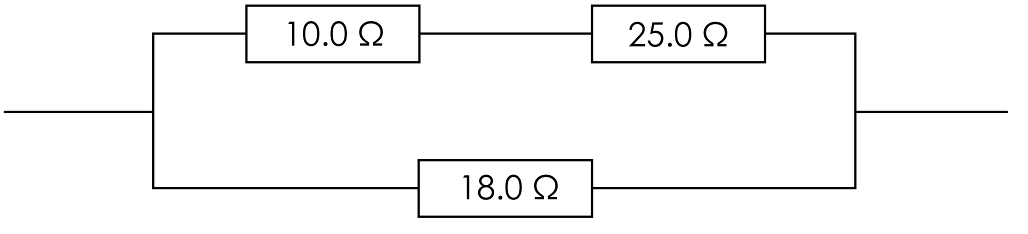
1. Write down the **value** and **units** for the following:

   a. Planck constant

   b. Charge on a proton

   c. Mass of an electron

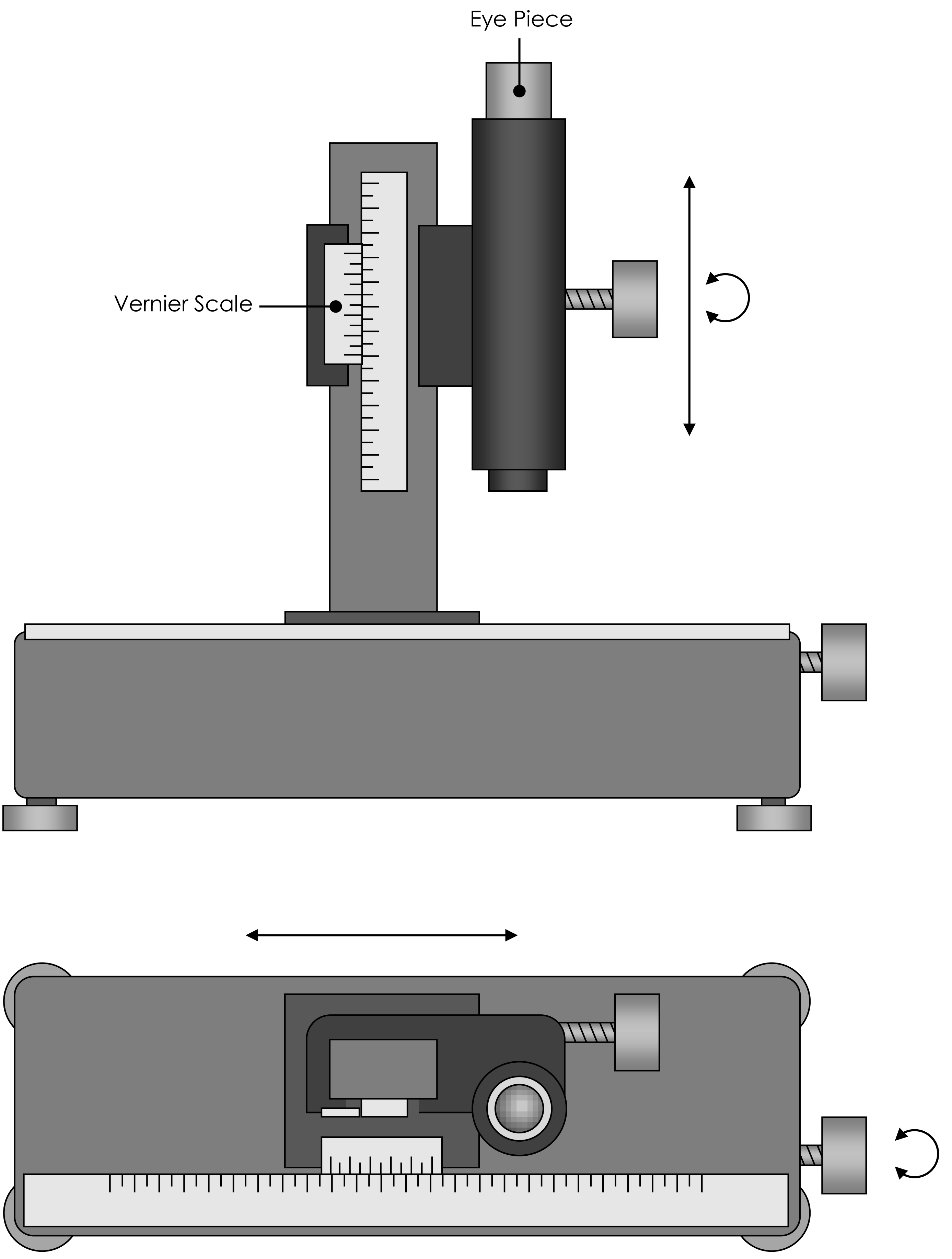
2. Calculate the **total** resistance of the following resistor combination:



3. A seesaw consists of a uniform wooden plank 3.0 m long pivoted at its centre. On one side a child of mass 40 kg sits at the end. On the other side is a 30 kg child sitting 1.0 m from the centre and an adult pushing down on the end to balance the seesaw.

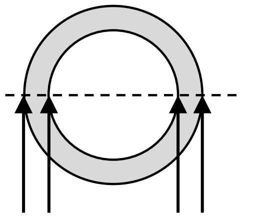
   Sketch a **diagram** and calculate the **force** applied by the adult.

Travelling Microscope



9th March

1. A travelling microscope is moved horizontally across the line on the shape to the right. The circles are concentric and the line passes through their centres. The readings (in cm) at the four boundaries moving from left to right shown by the arrows are: 2.74, 3.02, 5.64 and 5.92.

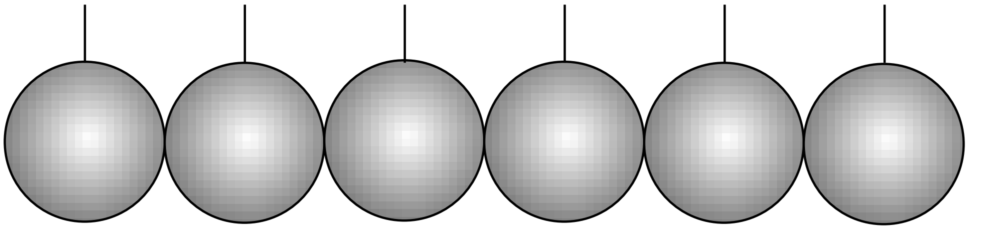
   Calculate the **area** (highlighted in grey) between the circles.

2. A travelling microscope is used with movement along the scale in a vertical direction. It is focused on one of the lines on a piece of lined paper. The reading on the scale is 5.40 cm. A 4.00 cm thick Perspex® block is placed between the paper and the microscope and the eyepiece is raised by 1.14 cm to refocus on the line.

   Using the equation: refractive index is equal to real depth divided by apparent depth, calculate the **refractive index** of the Perspex®.

3. A Newton's cradle consists of six steel spheres of density 7850 kg m^{-3}. A travelling microscope records a reading of 2.35 cm at the left-hand edge of the first ball and 16.75 cm at the right-hand edge of the sixth sphere.

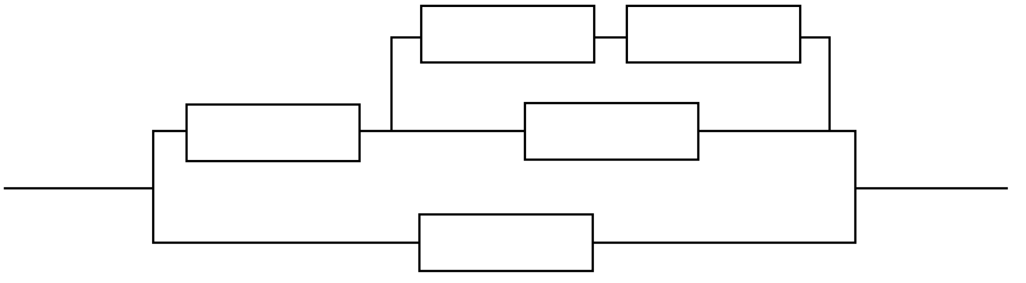
   Calculate the total **mass** of the six spheres.



10th March

1 2 3

1. Calculate the **total resistance** of the following resistors, if they all have an individual resistance of 100 Ω.



2. Define:

   a. The **centre of mass**

   b. The **centre of gravity**

3. A 4.0 m long uniform seesaw is pivoted at its centre. A parent of mass 65 kg sits at one end. They have identical twins of mass 50 kg each. One sits halfway out from the centre on the opposite side.

   Calculate **where** the other twin should sit to balance the seesaw.

11th March

1 2

1. A Nerf bullet is fired at an angle of 11° above the horizontal at 12.0 m s^{-1} from a height of 1.6 m.

   Calculate how **far** it will travel horizontally before it hits the floor (you may need to use some extra paper as you're working out your answer).

2. **Complete** the following table:

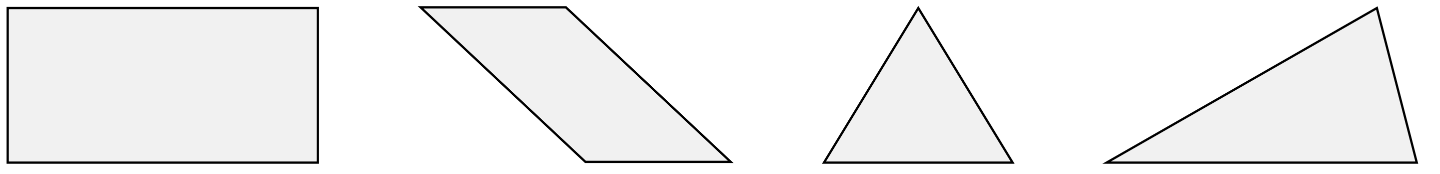
	Quantity	Symbol	Unit
a.	Strain		
b.	Wavelength		
c.	Work function		
d.	Speed of light		
e.	Efficiency		
f.	Young modulus		
g.	Internal resistance		
h.	Slit separation		
i.	Fringe spacing		
j.	Intensity		
k.	Refractive index		
l.	Elastic potential energy		
m.	Critical angle		
n.	Stress		

12th March

1 2 3

1. Draw the **position** of the centre of mass on these 2D shapes:

   a. b. c. d.



2. A student is finding the centre of mass of a non-uniform beam by suspending it from a string.

   a. State how they know if they are suspending it at the **centre of mass**

   b. List the **two forces** that are equal and opposite if the student is successful

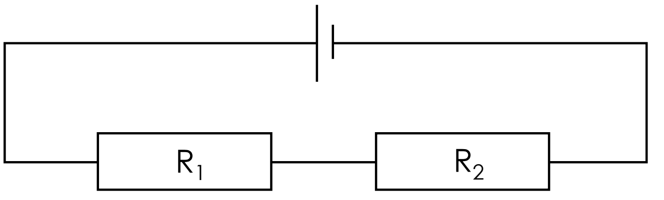
3. A student has a cricket bat of length 80 cm. The centre of mass is 30 cm from the bottom of the bat. A downwards force of 3.0 N at the top end of the handle (point T) will balance the bat if it is supported halfway along.

   Add force arrows to the diagram and calculate the **mass** of the cricket bat.

13th March

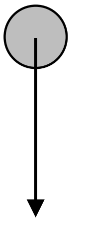
1 2

1. Using conservation of charge and energy (Kirchhoff's two laws), derive the equation for the total resistance of resistors R_1 and R_2 in series.



2. A skydiver of mass 75.0 kg is falling at their terminal velocity.

   a. Complete the diagram on the right showing the size and direction of the **forces** acting on the skydiver



   b. Describe how they could **change** their terminal velocity

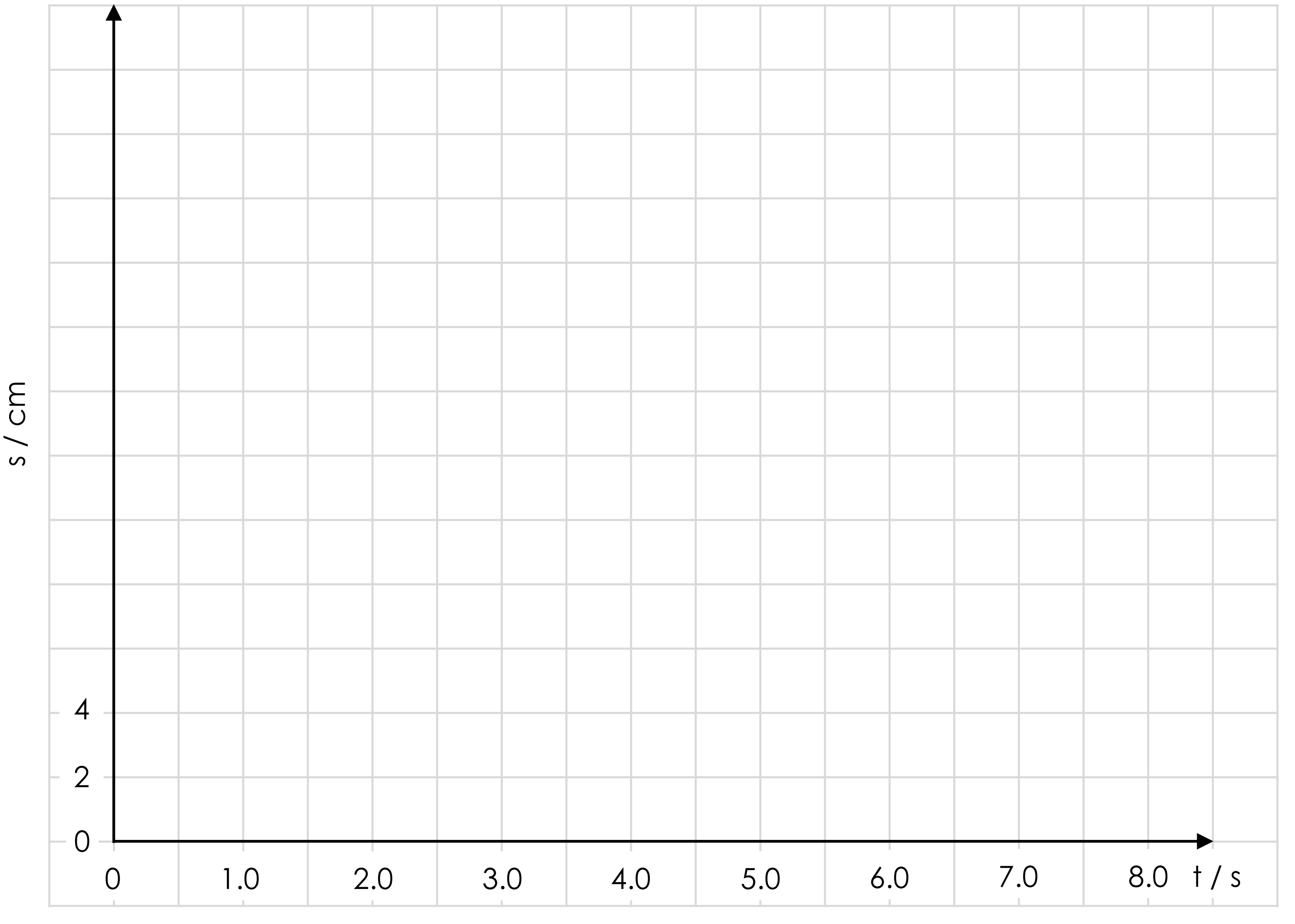
14th March

1

1. A student drops a steel ball bearing into a measuring cylinder full of oil. They measure the distance the ball has fallen at regular time intervals. Their results are in the table below.

Time / s	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
Distance / cm	0.0	0.9	2.4	4.0	6.9	10.0	14.8	19.9	24.8

a. Use this data to **plot** a graph of displacement against time on the axes below



b. Use the graph to calculate a value for the **terminal velocity** of the ball bearing

c. Calculate the value of the **velocity** of the ball bearing after 4.0 seconds

15th March

1 2 3

1. A battery with an EMF of 6.0 V and no internal resistance is connected across two resistors in series of resistance 100 Ω and 400 Ω.

   Determine the **potential difference** across the 100 Ω resistor (without a calculator).

2. Define:

   a. **EMF**

   b. **Potential difference**

3. A Nerf bullet is fired at an angle of 11° below the horizontal at 12.0 m s^{-1} from a height of 1.6 m. Calculate the **maximum velocity** it will reach.

16th March

1 2 3

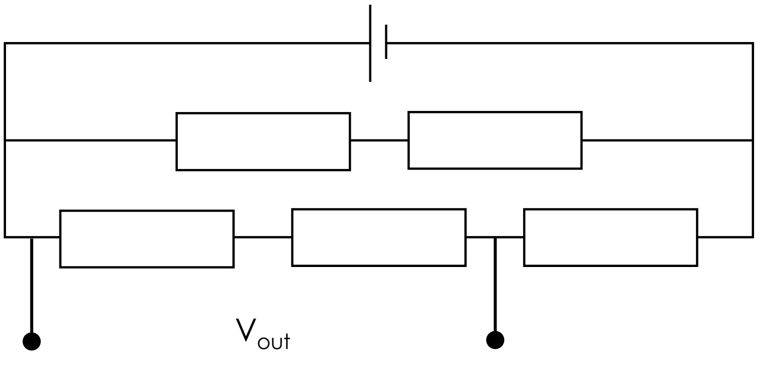
1. Write down the **value** and **units** for the following:

   a. Mass of a proton

   b. Mass of a neutron

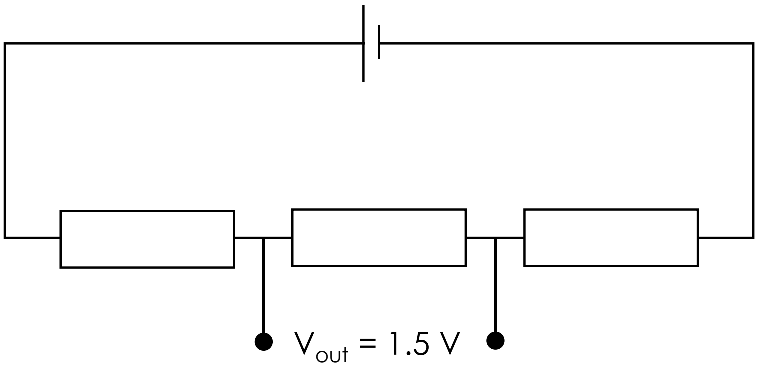
   c. Charge on a lithium nucleus

2. Calculate the **output voltage** (V_{out}) for the following circuit of five identical resistors if the cell has an EMF of 12 V.



3. Three resistors of 20, 30 and 50 ohms are connected in series in that order.

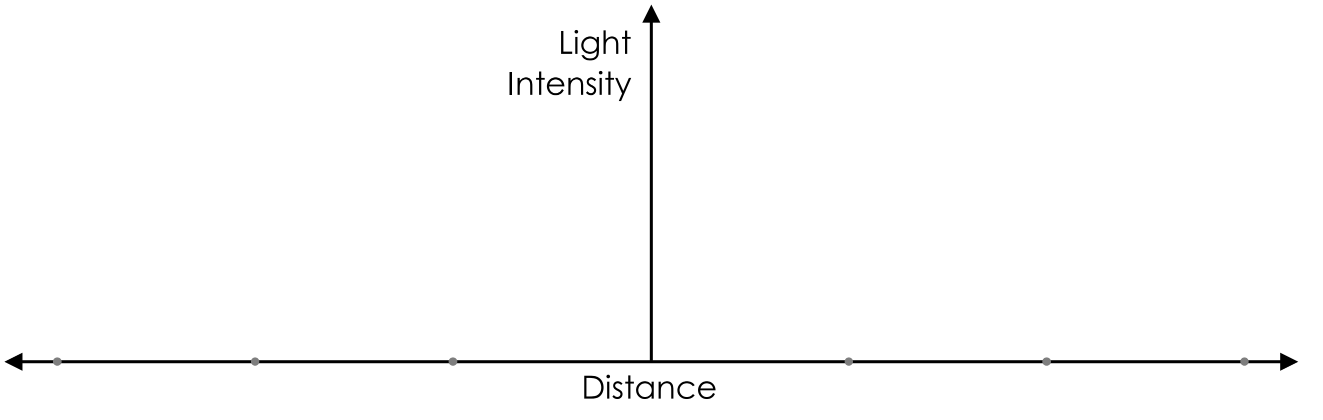
   Calculate the **EMF** of the cell assuming it has no internal resistance.



17th March

1. Light from a green laser is shone through a narrow single slit and forms a diffraction pattern on a white screen*.

   a. Sketch the **diffraction pattern** formed on the axes below



   b. How would the diffraction pattern **change** if the green laser was replaced with a **red laser** of the same intensity

For a single slit of width 'a' with a wavelength of light λ, the angle θ from the centre to the first minimum of intensity in the diffraction pattern is given by $\sin\theta = \lambda / a$.

   c. Calculate the **angle** of the first minimum for a slit of width 0.10 mm for the following wavelengths:

      i. 505 nm (green)

      ii. 660 nm (red)

*This may not be examined by all exam boards – but don't worry, you can easily do your own research on Google

18th March

1 2 3

1. Write down the **value** and **units** for the following:

    a. Charge on a uranium nucleus

    b. 1.00 electronvolts in joules

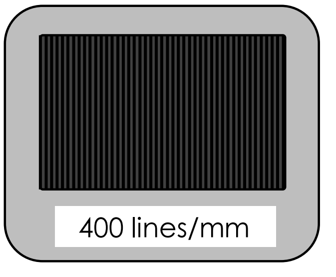
    c. Density of pure water

2. Define:

    a. **Superposition**

    b. **Coherent** wave sources

3. a. Calculate the **grating spacing** for a diffraction grating with 400 lines mm^{-1}

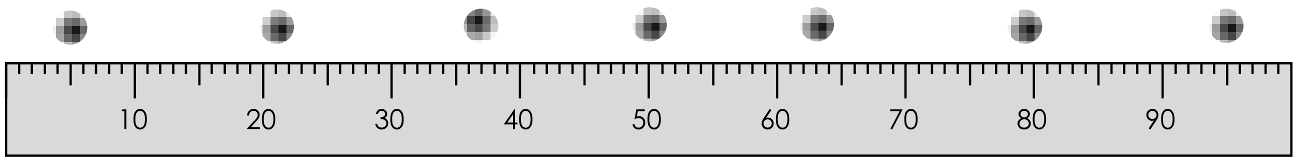


    b. If the diffraction grating spacing is 5.0×10^{-6} m, calculate how many **lines mm^{-1}** the diffraction grating has

    c. A 400 nm laser beam strikes the centre of the grating in part a. above, arriving along the normal to the grating. Calculate the **angle** between the normal and the second order maximum

19th March

1. Light from a laser is incident on a diffraction grating (with 200 lines mm^{-1}) and passes through to a white surface, which is 1.00 m behind the grating. A metre ruler is positioned directly under the diffraction pattern with the zero order maximum above the 50 cm mark.



a. Take measurements to calculate an average **distance** for the first, second and third order images from the centre of the diffraction pattern:

i. 1st

ii. 2nd

iii. 3rd

b. Using trigonometry and your measurements from part a. calculate the **angle** from the centre to the first, second and third order maxima:

i. 1st

ii. 2nd

iii. 3rd

c. Calculate the mean value for the **wavelength** of light (using the data from part b. above)

d. Calculate the **percentage uncertainty** in your value of λ

20th March

1 2 3

1. A bright white light is shone onto a diffraction grating with 400 lines mm^{-1} and then passes through to a white surface.

   a. Compare the **appearance** of the zero-order maxima compared with the other higher order maxima

   b. Suggest a **possible problem** viewing higher number maxima at larger angles from the zero-order position

2. The diffraction grating used with the white light in question 1. above is now used with monochromatic light. Calculate the **maximum** order visible and the **total number** of diffracted orders that could be observed on a screen for:

   a. **Blue** light (λ = 400 nm)

   b. **Red** light (λ = 700 nm)

3. Light from an LED contains orange light of λ = 600 nm and green light of λ = 530 nm. It is incident on a diffraction grating with 450 lines mm^{-1}.

   Calculate the **angular separation** of these lines in the 3rd order diffracted beam.

21st March

1 2 3

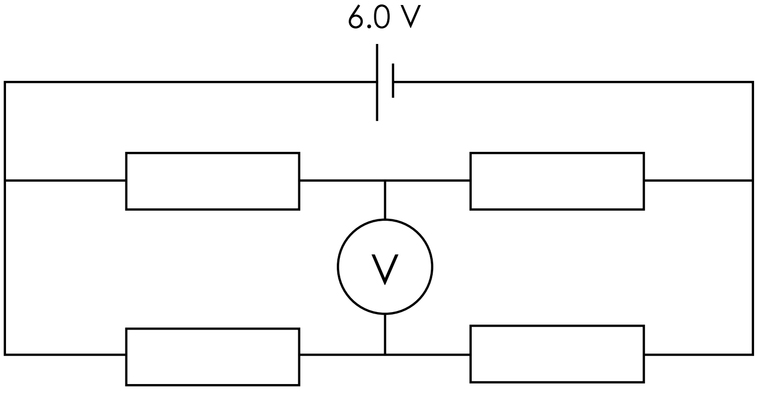
1. Write down the **value** and **units** for the following:

    a. Gravitational field strength on the Moon

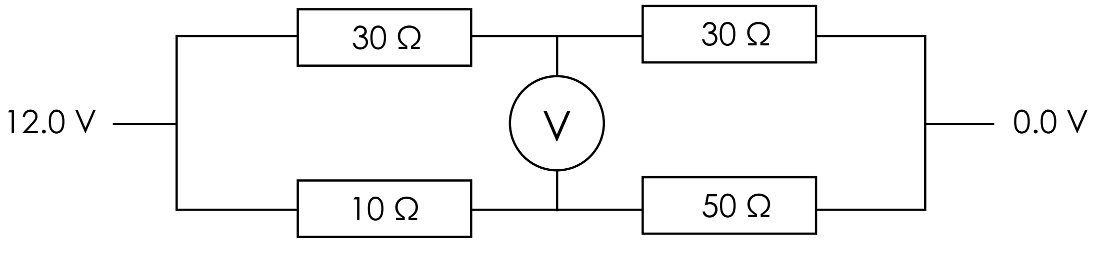
    b. Mass of the Sun

    c. Mean radius of the Earth

2. Determine the **reading** on the high-resistance **voltmeter** if all the resistors are identical.



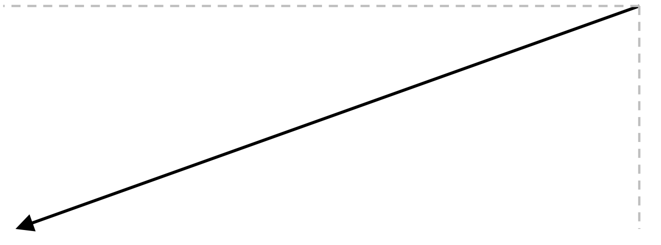
3. Calculate the **reading** on the high-resistance **voltmeter**, if the potential difference across the circuit is 12.0 V.



22nd March

1 2 3

1. Resolve this 10 N force into its **horizontal** and **vertical** components.



2. Define:
   a. A **progressive** wave

   b. A **standing** wave

3. The relationship for the fundamental frequency, f, of waves in wires or strings is:

$$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

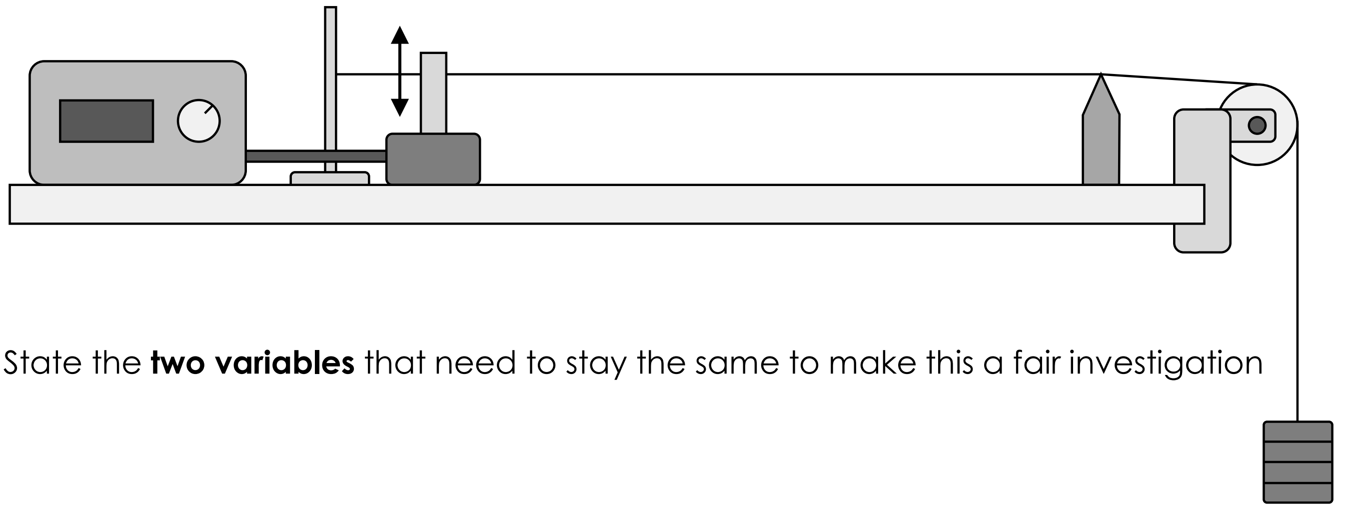
Where 'L' is the length of the string, 'T' is the tension and 'μ' is the mass per unit length of the string.

A stationary wave at the first harmonic frequency of 60 Hz is created on a string of length 50 cm and mass 5.0 g.

Calculate the **tension** in the string.

23rd March

1. A student is investigating how the resonant frequency of a vibrating string depends on the length of the string. They use a signal generator and an oscillator connected to a string. The frequency can be varied, and the length of string changed by moving the vibration generator along the bench (this is sometimes called Melde's apparatus).



a. State the **two variables** that need to stay the same to make this a fair investigation

b. Describe how the student will know when the frequency of the vibrator is equal to the **resonant frequency** of the string

The student obtains the following data.

c. Complete the **third** column

d. Describe what the data suggests about the **relationship** between frequency and length

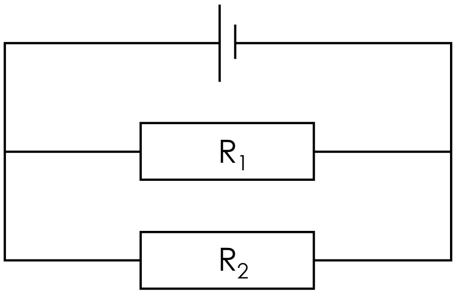
Length / m	Frequency / Hz	f x L
0.20	45	
0.40	22	
0.60	16	
0.80	11	
1.00	9.2	

e. If the tension in the string used in the experiment was 4.0 N, use a mean value for frequency x length (f x L) to calculate the **mass per unit length** of the string

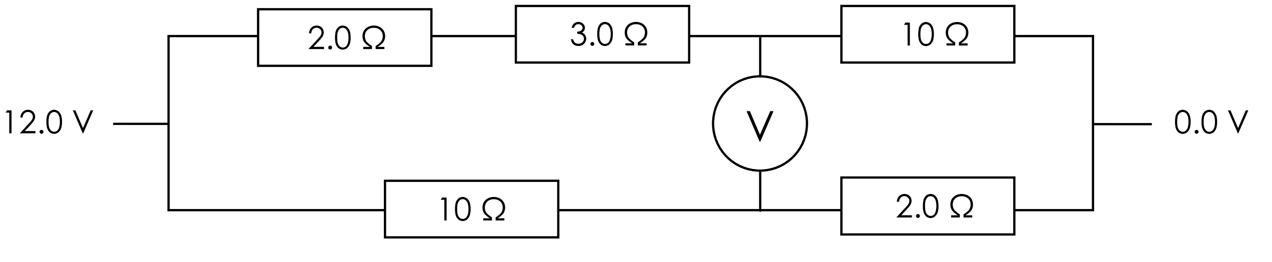
24th March

1 2

1. Using conservation of charge and energy (Kirchhoff's two laws), **derive** the equation for the total resistance of resistors R_1 and R_2 in parallel.



2. Calculate the **reading** on the high-resistance **voltmeter**.



25^{th} March

1

1. In an investigation to measure the resonant frequency of a 0.50 m length of a steel wire at different tensions, the following set of results is obtained:

Tension / N	Frequency / Hz	f^2 / Hz^2
5.0	45	2000
10	67	4500
15	80	
20	92	
30	110	
40	130	

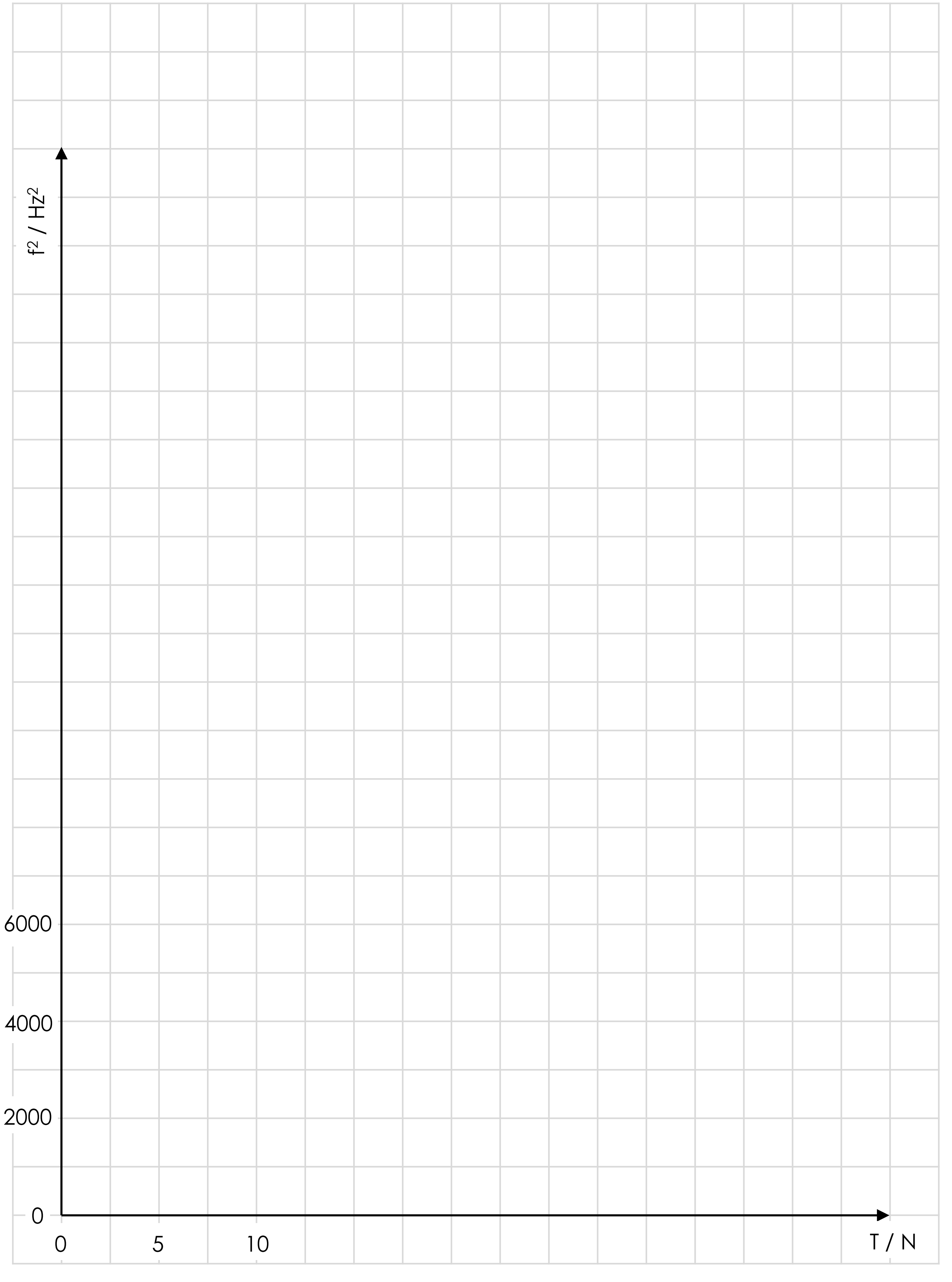
a. Complete the **third** column (giving your data to 2 s.f.)

b. Plot a **graph** of f^2 against T on the page opposite

c. Calculate the **gradient** of your line

d. Use the gradient, and the length of wire, to calculate a value for the **mass per unit length** of the steel wire

25th March



26th March

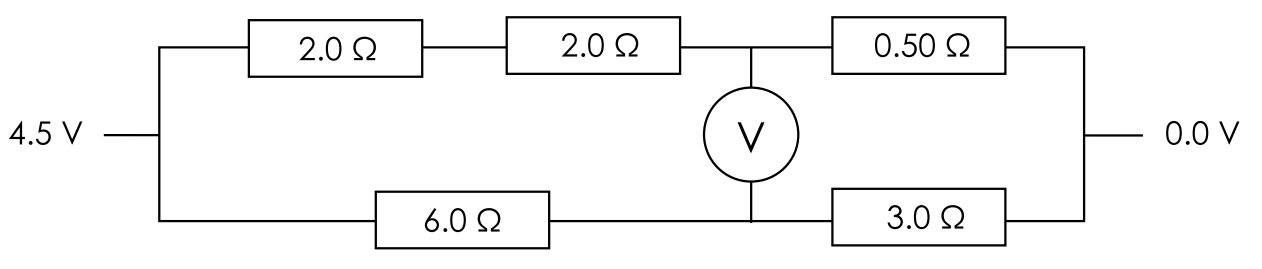
1. Write down the **value** and **units** for the following:

   a. Planck constant

   b. Mass of an electron

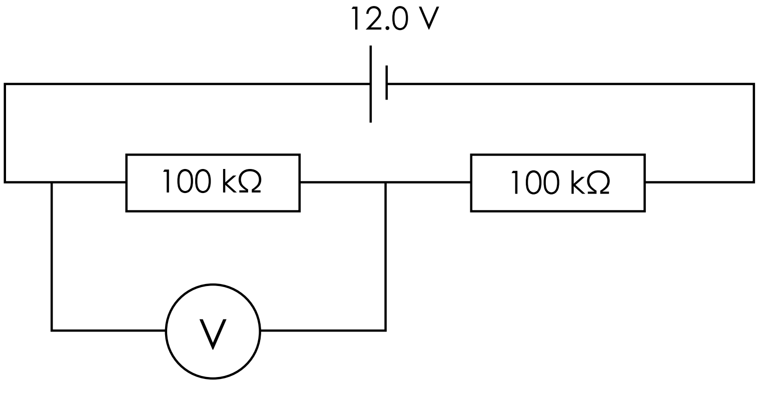
   c. Elementary charge

2. Calculate the **reading** on the high-resistance **voltmeter**.



3. A simple circuit is set up.

   a. Calculate the reading on the high resistance **voltmeter**



The high resistance voltmeter in part a. is replaced by a different voltmeter with a resistance of 400 kΩ.

   b. Calculate the reading on this new **voltmeter** in the same circuit

27th March

1. Wires are available in certain sizes labelled with their standard wire gauge (SWG) value. A student is investigating how the mass per unit length, μ, of a wire affects its fundamental frequency of vibration. They are using steel wires of density 7850 kg m^{-3} and length 0.80 m. The tension in all wires is kept constant.

   a. Taking care with the units, use the values in the table to **complete** the empty columns

SWG	Diameter / mm	Cross-sectional area / mm^2	μ / g m^{-1}	Fundamental frequency / Hz
20	0.914	0.657	5.16	19.5
22	0.711	0.397		25.2
24	0.559	0.245		31.7
26	0.457			38.9
28	0.376			46.8

The relationship for the fundamental frequency of waves in wires or strings is: $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

   b. Rearrange this equation and use it, along with the data above, to calculate the size of the **tension** force in the wire

   c. Describe the effect of **doubling** the **mass per unit length** on the fundamental frequency

28th March

1 2 3

1. Write down the **value** and **units** for the following:

    a. Mass of a proton

    b. Mass of a neutron

    c. 1.00 electronvolts in joules

2. Define:

    a. A **node**

    b. **Anode**

3. Draw a **diagram** of the circuit used to investigate the current-voltage characteristics of a filament light bulb.

29th March

1 2 3

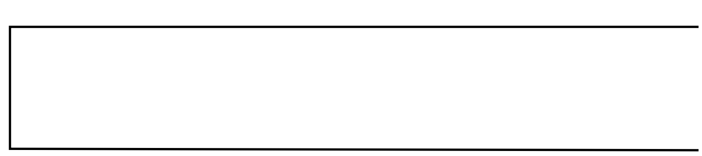
1. State the equation for calculating **power** in terms of:
    a. Energy transferred and time
    b. Work done and time
    c. Current and potential difference
    d. Potential difference and resistance
    e. Resistance and current
    f. Force and velocity

2. a. Calculate the **power** output of a filament lamp connected to 12 V and drawing 6.0 A

    b. The wire in the heating element of an electric fire has a resistance of 46 Ω. The current through the heating element is 5.0 A. Calculate the **energy transferred** every second

3. Sketch the fundamental frequency of a **standing** wave formed below:
    a. **String** fixed at both ends

    b. Tube open at **one** end



    c. Tube open at **both** ends

30th March

1. A student is investigating how the extension of a spring depends upon the load applied to it. They suspend a spring of original length 15.0 cm using a clamp and stand and arrange a ruler vertically next to the spring so that the total length of the spring can be measured.

   a. Complete the **load** and **extension** columns in the table

Mass / g	Load / N	Spring length / cm	Extension / cm
0	0.00	15.0	0.0
100	0.98	18.9	3.9
200	1.96	22.8	
300	2.94	26.8	
400		30.7	
500		34.6	

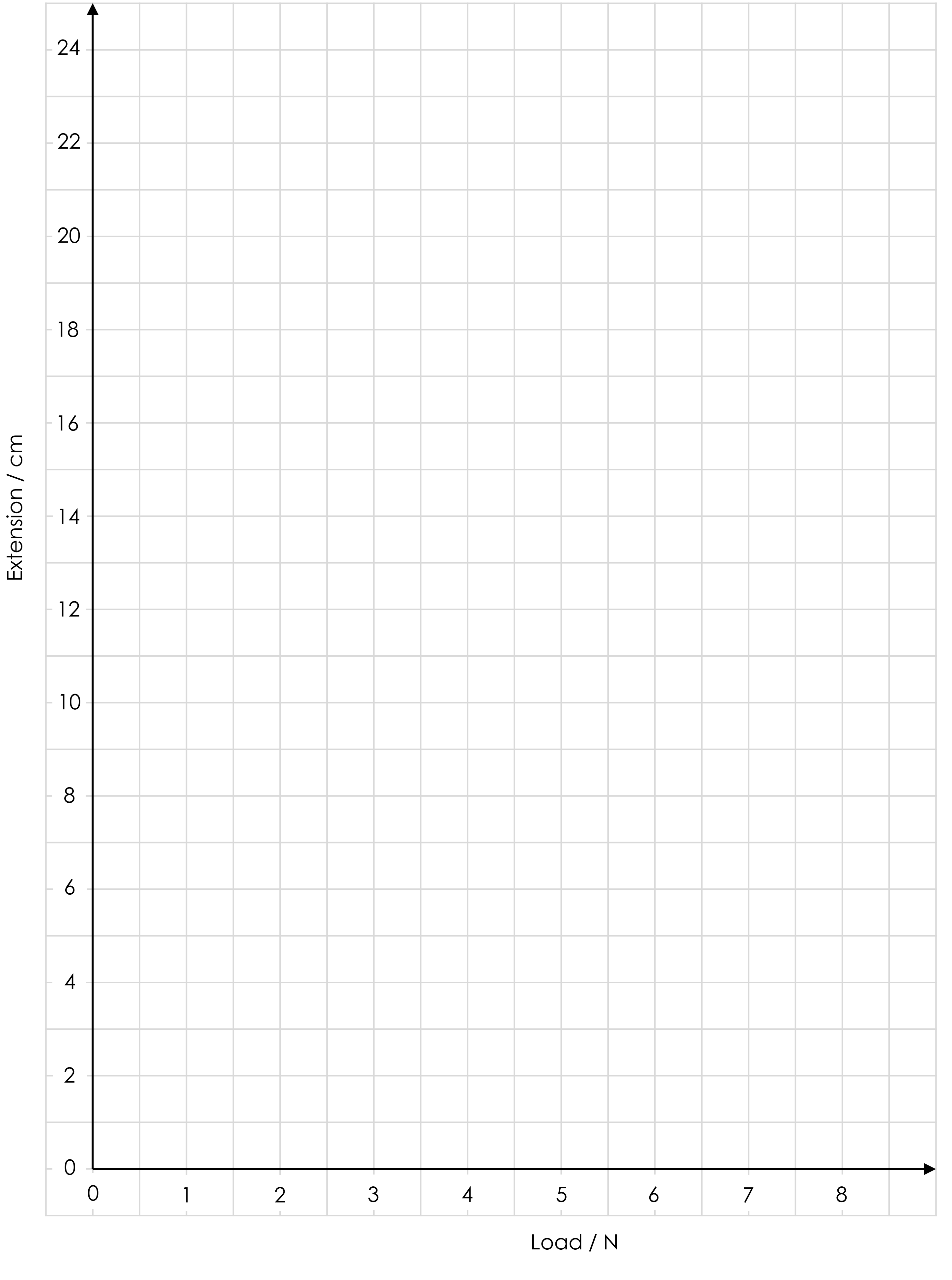
   b. Plot the data and draw in a **line of best fit**

   c. Determine the **spring constant** of the spring in N m^{-1}

   d. Calculate how much **elastic potential energy** is stored when the extension is equal to its original length

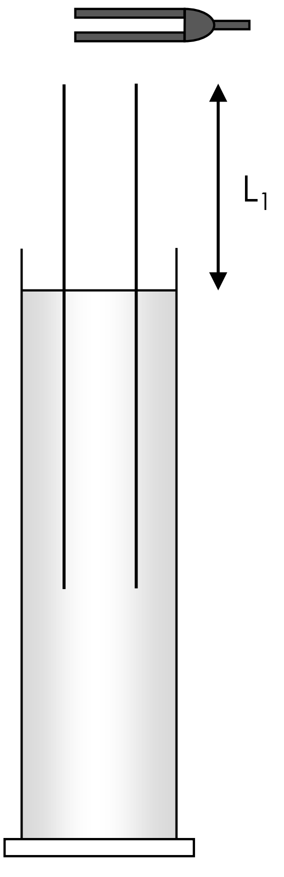
   e. The elastic limit is reached when a load of 5.0 N is applied, **sketch** how the graph may look as the spring is loaded beyond this point

30th March



31st March

1. A student holds a vertical glass tube in a measuring cylinder containing water. They hold different tuning forks above the tube and adjust the length of the air column until they hear a loud sound as the air resonates. This is when the frequency of the tuning fork is equal to the fundamental frequency (1st harmonic) of the air column.



a. Explain how the length, L_1, of the air column is **related** to the wavelength, λ, when the air resonates

If the length of the air column is increased for the same frequency tuning fork, a second resonance is heard at a longer length L_2.

b. Describe how this length is **related** to the wavelength

The first resonant length is measured for several different frequency tuning forks.

c. Calculate values for the **speed of sound** using the data in the table

Frequency / Hz	Length / m	Speed / m s^{-1}
200	0.430	
280	0.302	
360	0.241	
440	0.177	
520	0.169	
600	0.140	

d. Calculate the **mean** value and the **percentage uncertainty** for the speed of sound in air

MARCH REVIEW

Record your progress at the end of the month and have another go at any questions you may have missed.

A Level Physics Content	Red	Amber	Green
I can calculate the **percentage uncertainty** in experimental data			
I can use the equation for a **diffraction grating** to calculate an unknown quantity			
I can use the equation for a **double slit** to calculate an unknown quantity			
I can calculate the **total resistance** of a combination of resistors			
I can use **Kirchhoff's laws** to **derive** equations for resistors in series and parallel			
I can describe a number of practical methods to investigate **standing waves** in the lab			
Any other comments:			

ANSWERS

ANSWERS

Check your work with the short answers in the back of this book.

You can download written worked solutions and watch video walkthroughs on the A Level Physics Website:

ALevelPhysicsOnline.com/**books**

1st March

1. a. 2.5 m s^{-2}

   b. 6.6 m

   c. 25 Ω

   d. 29 N m^{-1}

   e. 7.0 m s^{-1}

   f. 1.4 J

   g. 8.3 x 10^{-4} s

   h. 9.2 Ω

2nd March

1. 9.2 m s^{-2} 8.2 %
2. 6.9 m
3. 5.0 m

3rd March

1. a. Reduces any random error as the average is taken, and reduces the percentage uncertainty in the measurement

   b. 0.393, 0.620, 0.790, 1.00, 1.22

   c. About 4.0 x 10^{-4}

   6.0 x 10^{-7} m

4th March

1. a. 0.060 m

   b. 0.030 m

   c. Same wavelength / frequency and a constant phase difference

   d. i. nλ

   ii. n360˚ (or nx2π radians)

   e. 0.50 m

   f. i. 45˚

   ii. 56˚

5th March

1. a. 66˚

   b. 116˚

   c. 66˚

5th March - continued

2. a. The ratio of the potential difference across a component to the current through it

   b. A measure of the resistance of a material to the flow of electrical current, equal to the resistance of a piece of material with unit cross-sectional area and unit length

3. a. 720 C

   b. 4.5 x 10^{21} electrons

6th March

1. 0.29 Ω
2. $R_T = (R_1 R_2) / (R_1 + R_2)$
3. a. 10 Ω

   b. 720 C

7th March

1. 231 V 3.0 V 1.3 %
2. a. Sum of moments (about any point) is zero and sum of the forces (in any direction) is zero

   b. For a system in equilibrium the sum of the clockwise moments is equal to the sum of the anticlockwise moments

3. a. 5.4 m s^{-1}

   b. 5.4 m s^{-1}

8th March

1. a. 6.63 x 10^{-34} J s

   b. + 1.60 x 10^{-19} C

   c. 9.11 x 10^{-31} kg

2. 11.9 Ω
3. 2.0 x 10^{2} N

9th March

1. 2.55 x 10^{-4} m^{2}
2. 1.40 (no units)
3. 0.341 kg

10th March

1. 62.5 Ω
2. a. The point on a body where the **mass** can be considered to be concentrated

   b. The point on a body where the **weight** can be considered to act

3. 1.6 m from the centre

11th March

1. 10 m
2. a. ε no units

   b. λ m

   c. φ J or eV

   d. c m s^{-1}

   e. η no units

   f. E Pa

   g. r Ω

   h. a or s m

   i. w or x m

   j. I W m^{-2}

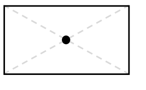
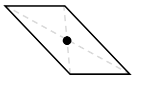
   k. n no units

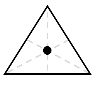
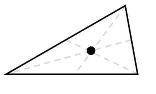
   l. E_e J

   m. C or θ_c ˚ or radians

   n. σ Pa

12th March

1. a.  b. 

   c.  d. 

2. a. It is in equilibrium

   b. Tension = weight

3. 1.2 kg

13th March

1. $R_T = R_1 + R_2$
2. a. Drag = weight = 736 N

   b. Change their shape or deploy their parachute

14^{th} March

1. a. Curve to about 5 s then a straight line

   b. 5.0×10^{-2} m s^{-1}

   c. About 2.8 to 3.2×10^{-2} m s^{-1}

15^{th} March

1. 1.2 V
2. a. Energy supplied (by the cell) per unit charge

   b. Energy transferred (by a component) per unit charge
3. 13 m s^{-1} at 27˚ to horizontal

16^{th} March

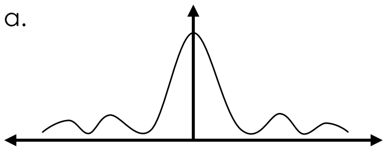
1. a. 1.673×10^{-27} kg

   b. 1.675×10^{-27} kg

   c. + 4.80×10^{-19} C
2. 8.0 V
3. 5.0 V

17^{th} March

1. a.



   Central maximum twice as wide and much more intense than other maxima, which get dimmer further from the centre

   b. As λ is longer for red light all minimum positions further out from the centre

   c. i. 0.29˚

   ii. 0.38˚

18^{th} March

1. a. + 1.47×10^{-17} C

   b. 1.60×10^{-19} J

   c. 1000 kg m^{-3}

18^{th} March - continued

2. a. When two or more waves meet at a point, the resultant displacement is equal to the sum of the displacements of the (individual) waves

   b. Waves (sources) of the same frequency that have a constant phase difference
3. a. 2.5×10^{-6} m

   b. 200 lines mm^{-1}

   c. 18.7˚

19^{th} March

1. a. i. 0.13 m

   ii. 0.29 m

   iii. 0.45 m

   b. i. 7.4˚

   ii. 16˚

   iii. 24˚

   c. 6.8×10^{-7} m

   d. 3.9 %

20^{th} March

1. a. Zero-order is white and other orders are spectra from violet to red away from the centre

   b. Higher orders may overlap each other
2. a. n = 6 13 orders

   b. n = 3 7 orders
3. 8.4˚

21^{st} March

1. a. 1.625 N kg^{-1}

   b. 1.99×10^{30} kg

   c. 6.37×10^{6} m
2. 0.0 V
3. 4.0 V

22^{nd} March

1. 9.4 N 3.4 N
2. a. A wave that transfers energy

   b. A wave on which there are points that are nodes and antinodes
3. 36 N

23^{rd} March

1. a. Tension, mass per unit length

   b. Maximum amplitude of vibration with one antinode in the middle

   c. 9.0, 8.8, 9.6, 8.8, 9.2

   d. Frequency is inversely proportional to the length

   e. 0.012 kg m^{-1}

24^{th} March

1. $1/R_T = 1/R_1 + 1/R_2$
2. 6.0 V

25^{th} March

1. a. 6400, 8500, 12 000, 17 000

   b. Graph with a straight line

   c. About 4.3×10^{2} Hz^{2} N^{-1}

   d. 2.4×10^{-3} kg m^{-1}

26^{th} March

1. a. 6.63×10^{-34} J s

   b. 9.11×10^{-31} kg

   c. 1.60×10^{-19} C
2. 1.0 V
3. a. 6.00 V

   b. 5.33 V

27^{th} March

1. a. 0.164, 0.111

   3.12, 1.92, 1.29, 0.871

27th March - continued

b. 5.0 N

c. Divide frequency by √2

28th March

1. a. 1.673×10^{-27} kg

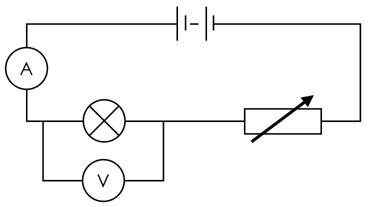
   b. 1.675×10^{-27} kg

   c. 1.60×10^{-19} J

2. a. A point on a standing wave where the wave has zero (or minimum) amplitude

   b. An anode is the positive terminal in an electrical circuit

3.



29th March

1. a. $P = E / t$

   b. $P = W / t$

   c. $P = VI$

   d. $P = V^2 / R$

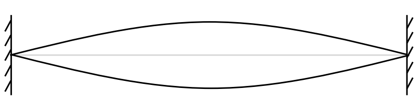
   e. $P = I^2R$

   f. $P = Fv$

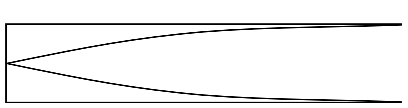
2. a. 72 W

   b. 1.2×10^3 J (per second)

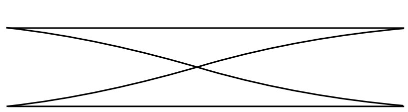
3. a.



b.



c.



30th March

1. a. 3.92, 4.91

   7.8, 11.8, 15.7, 19.6

   b. Straight line up to about 20 cm

   c. 26 N m^{-1}

   d. 0.29 J

   e. From 5.0 N a curved line upwards that gets steeper

31st March

1. a. $L_1 = \lambda / 4$

   b. $L_2 = 3\lambda / 4$

   c. 344, 338, 347, 312, 352, 336

   d. 338 m s^{-1} 5.9 %

   (or 343 m s^{-1} and 2.3 % if 312 discarded as an anomaly)

1st April

1. a. Nodes due to zero amplitude of vibration

   b. $\lambda / 2$

   c. 337, 354, 340

   d. 344 m s^{-1} 2.5 %

   e. Dry spores of club moss plants, what makes it useful is that it is extremely hydrophobic

2nd April

1. $V_a = 1.33$ V $V_b = 0.33$ V

2. 340 m s^{-1}

3.

a.	10	4.0	0.40
b.	27	8.0	0.30
c.	60	6.0	0.10
d.	20	2.0	0.10

3rd April

1. 1.6 % Measure more sheets to calculate a mean value

2. a. A wave formed by the superposition of two coherent progressive waves travelling in opposite directions

3rd April - continued

2. b. A point on a standing wave where the wave has maximum amplitude

3.

a.	1.0	2.7	2.7
b.	2.0	5.4	2.7
c.	3.0	4.0	1.3
d.	4.0	4.0	1.0
e.	5.0	1.8	0.36
f.	6.0	2.2	0.36

4th April

1. a. 1.85 mm

   b. ± 0.03 mm

   c. 1.6 %

   d. 2.69×10^{-6} m^2

   e. 3.2 %

   f. ± 8.60×10^{-8} m^2

5th April

1. 8.3 %

2. $A_a = 3.0$ A $A_b = 0.0$ A

3. 5.1×10^{-3} m

6th April

1. a. Lovely straight line graph

   b. About 0.70 N mm^{-1}

   c. 120 Gpa

7th April

1. a. 3.7×10^{-4} m ± 1×10^{-5} m

   b. 2.7 %

   c. Micrometer

   d. Repeated at different points on the wire and in different directions to confirm it is uniformly circular

   e. 1.1×10^{-7} m^2 ± 5.8×10^{-9} m^2

   f. 8.5×10^{-3} m

   g. Eye protection and a cushioned floor in case the wire snaps

8th April

1. 6.6 %

2. a. The extension of an object divided by its original length

   b. The ratio of tensile stress to tensile strain

3. 111 m

9th April

1. a. Straight line graph

   b. About 12.5 Ω m^{-1} 30 %

   c. 9.7 x 10^{-7} Ω m ± 2.9 x 10^{-7} Ω m

10th April

1. The limit of proportionality is reached first and is the point beyond which the force is no longer proportional to the extension, the elastic limit is slightly beyond this and is the point beyond which the wire will not return to its original length due to plastic deformation

2. 75 J

3.

a.	1.0	700	70
b.	6.0	420	70
c.	5.0	78	16
d.	5.0	78	16
e.	2.0	78	39

11th April

1. a. 9.11 x 10^{-31} kg

   b. - 1.60 x 10^{-19} C

   c. 6.63 x 10^{-34} J s

2. a. Materials that break or shatter under stress, with very little plastic deformation

   b. Materials that resist scratching, cutting, or abrasion

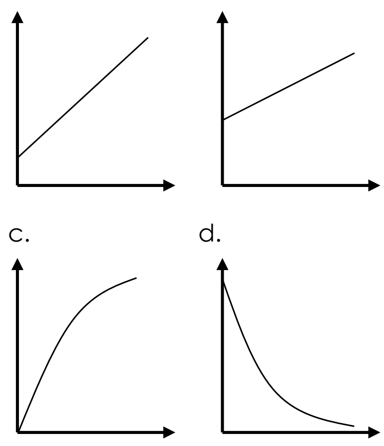
   c. Materials that have high resistance to deformation under load

3. a. 0.037 (no units)

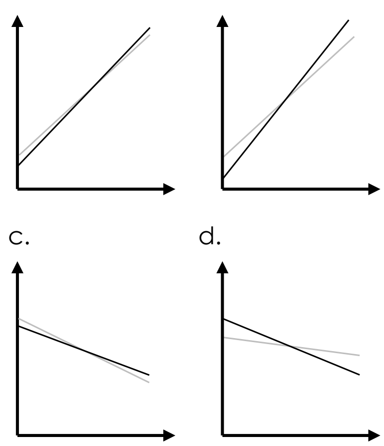
   b. 1.6 x 10^{8} Pa

12th April

1. a. b.



2. a. b.



13th April

1. a. 1.2 x 10^{2} N m^{-1}

   b. 0.21 J

2.

a.	kg	kg
b.	m	m
c.	s	s
d.	m s^{-1}	m s^{-1}
e.	m s^{-2}	m s^{-2}
f.	kg m s^{-1}	kg m s^{-1}
g.	N	kg m s^{-2}
h.	J	kg m^2 s^{-2}
i.	A	A
j.	C	A s
k.	V	kg m^2 s^{-3} A^{-1}
l.	R	kg m^2 s^{-3} A^{-2}
m.	˚C or K	K

14th April

3. a. 0.20, 0.27, 0.32

   b. Straight line graph

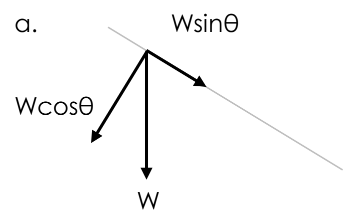
   c. About 0.20 s^2 m^{-1}

   d. 10 m s^{-2}

   e. Systematic error in the timing, perhaps due to the ball not dropping instantly due to the residual magnetic field in the electromagnet

15th April

1. a.



   b. 0.30, 0.27

   4.6, 6.7, 8.2

   c. 2.5, 4.9, 6.9, 8.5

   d. a < g sinθ (but very similar values)

   e. Friction on the slope

16th April

1. a. 0.50 m s^{-1}

   b. 1.5 m s^{-1}

   c. 9.6 m s^{-2}

   d. Allows it to fall vertically so exactly 5.0 cm of card interrupts the beam and minimises the effects of air resistance on the large surfaces on the sides of the card

17th April

1. a. 0.44 J

   b. 970 N m^{-1}

2. a. The rate of increase of velocity

   b. The force per unit mass due to gravity

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