OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



EXAM QUESTION PACK

M3 ALGEBRA

SCORE	PERCENTAGE
/232	%

STEMUP

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Gateway Physics A (9-1)

Maths 3: Algebra

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **232**.
- The total number of marks may take into account some 'either/or' question choices.

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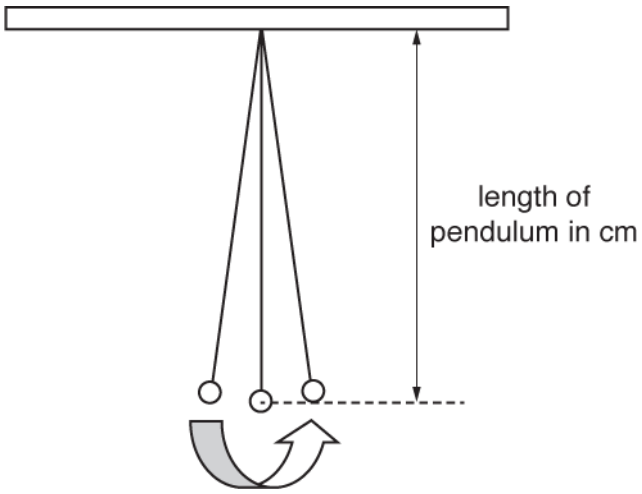
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1(a) Helen investigates children's swings.

She models the swings in the laboratory using weights attached to a string.

This type of swing is called a **pendulum**.

She sets up a pendulum and makes it swing.



Helen uses a pendulum that has a length of 60 cm.

She measures the time it takes the pendulum to complete 10 swings.

She repeats this three times, **A, B** and **C**.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
60	16.35		15.65	16.00

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The results table is incomplete.

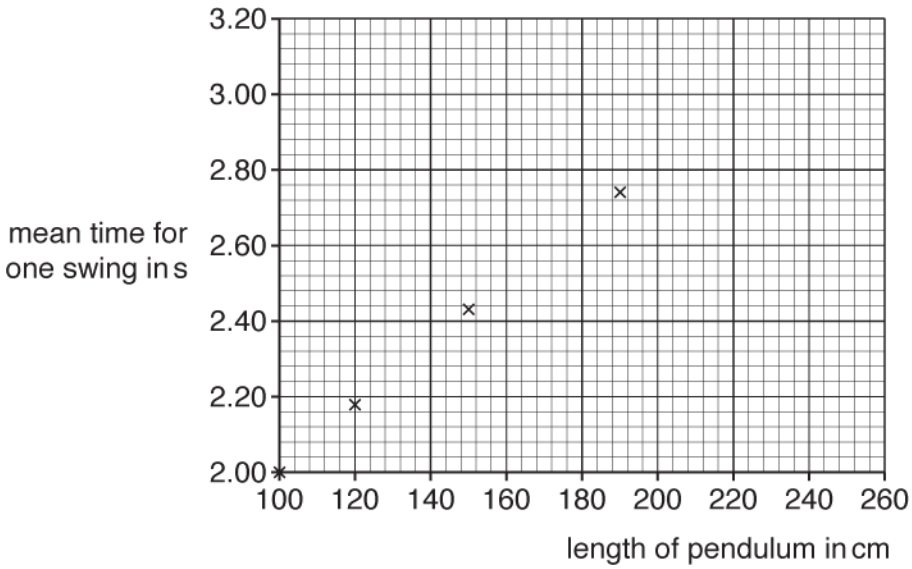
Use the data to calculate the missing value **B**.

answer _____ s **[2]**

(b) Helen wants to find out about real swings, like those used by children.

She uses longer pendulums and investigates the effect of changing the length.

Look at the graph of Helen's results.



Helen wants to make a pendulum that takes 3 s for one complete swing.

Predict the length of this pendulum.

Show your working on the graph.

answer _____ cm **[2]**

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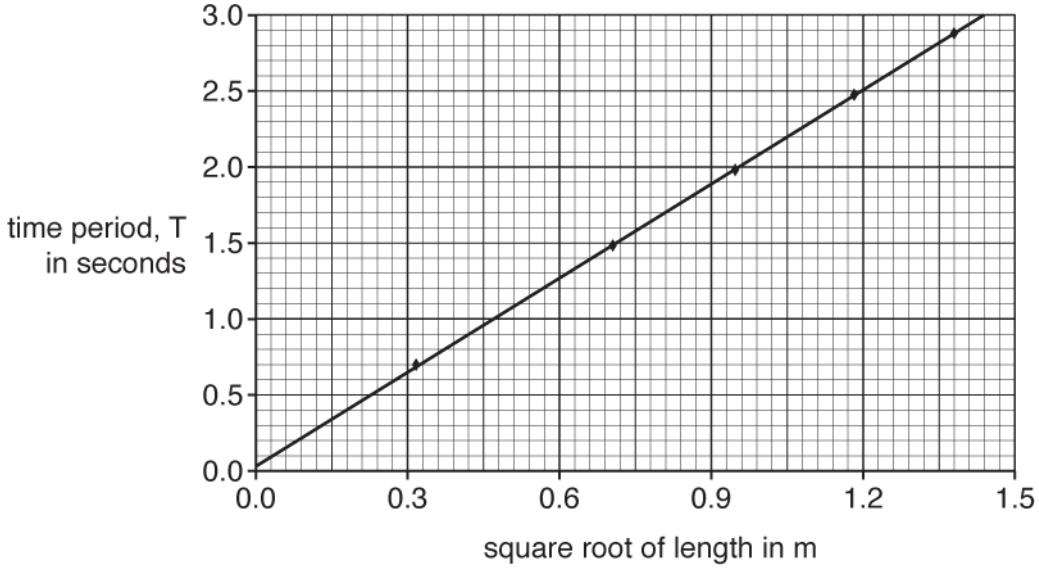
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(c) Helen collects more results using a pendulum.

She processes her results.

Look at her graph.



(i) Describe the relationship shown in the graph.

--- [1]

(ii) Helen does some research.

She finds out this information:

- the time it takes for one complete swing is called the time period, T.
- **g** = 10 m/s^2 (the acceleration due to gravity)
- **L** = the length of the pendulum
- π = 3.142

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Helen finds an equation which describes the behaviour of pendulums.

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

She wants to find the time period, T for a longer swing.

Calculate the time period for a swing that is **3 m** long.

Give your answer to one decimal place.

answer _____ s. **[3]**

(iii) Helen needs to make a swing with a time period, T, of 1 second.

Calculate the length of a pendulum with a time period of 1 second.

answer _____ m. **[2]**

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2 An object travelled 800 m in 40 seconds.

Use the equation: distance travelled (m) = speed (m/s) × time (s)

What is the speed of the object?

A 0.05 m/s

B 20 m/s

C 840 m/s

D 32 000 m/s

Your answer ☐ [1]

3 An object moved 20 cm with a force of 20 N.

Use the equation: work done = force × distance

Which is the correct calculation of work done?

A 0.4 J

B 4.0 J

C 40 J

D 400 J

Your answer ☐ [1]

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4 Which of the following has the **most** kinetic energy?

A



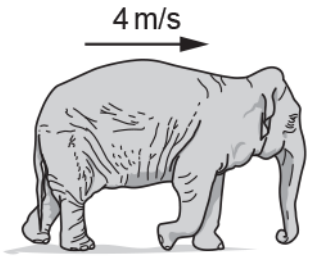
500 kg

B



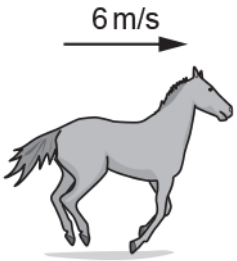
80 kg

C



3000 kg

D



750 kg

Your answer ☐ [1]

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5 A charge of 44 000 C flows through a light bulb. The potential difference is 230 V.

Calculate the energy transferred.

Use the equation: Charge = Energy ÷ Potential difference

Record your answer to **2** significant figures.

Answer = ... J **[4]**

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6 * Four students run in different races.

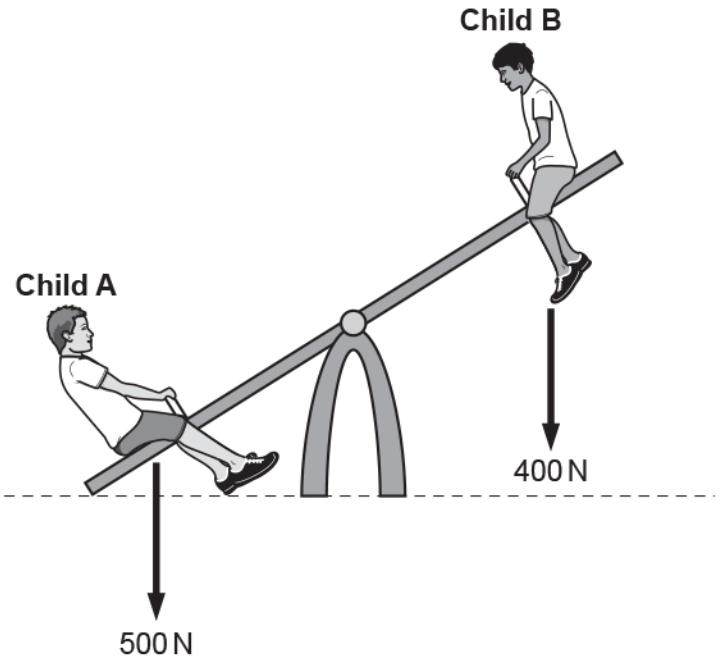
Student	Race distance (m)	Time (s)
A	50	6
B	100	15
C	100	14
D	200	31

Use the information in the table to **describe** and **compare** the motion of the four students.

Use the data in your answer.

[6]

7(a) Two children play on a seesaw.



Both children sit **2 m** from the pivot.

Calculate the clockwise and anti-clockwise moments around the pivot when the seesaw is horizontal.

Clockwise moment = ... Nm

Anti-clockwise moment = ... Nm

[3]

Calculate where **Child A** should sit to balance the seesaw.

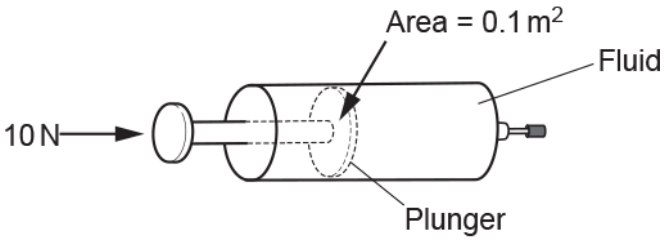
Answer = ... **[3]**

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(b) A student tries to compress the fluid in a sealed syringe with a force of 10 N.



The area of the end of the syringe is 0.1 m^2.

(i) Calculate the pressure in the fluid.

Answer = ... Pa **[3]**

(ii) Write down the direction of the force produced by the fluid on the plunger.

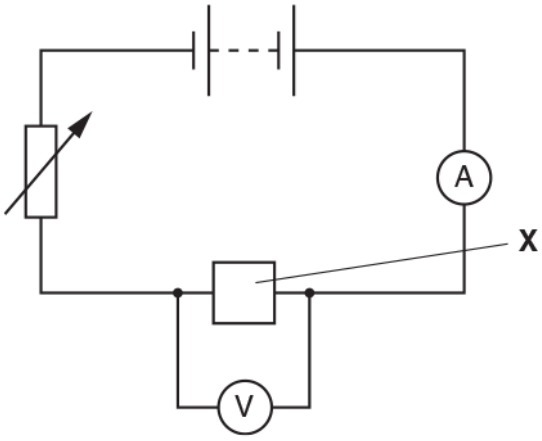
---------- **[1]**

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8 A student builds a circuit to investigate the resistance of component **X**.



Component **X** has a resistance of 16 Ω when a current of 0.25 A flows.

(i) Calculate the potential difference across component **X**.

Use the equation: Potential difference = Current × Resistance

Answer = ... V **[2]**

(ii) Calculate the power of component **X** when a current of 0.25 A flows.

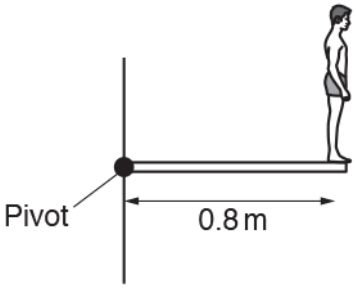
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Answer = ... W **[3]**

9 A diver stands on a diving board. He weighs 400 N.



What is the moment of the force provided by the diver around the pivot?

A 320 Nm anti-clockwise

B 320 Nm clockwise

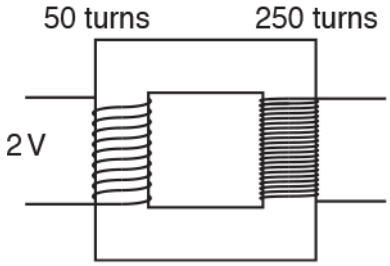
C 500 Nm anti-clockwise

D 500 Nm clockwise

Your answer ☐ **[1]**

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10 What output voltage does the transformer produce?



A 0.2 V

B 0.4 V

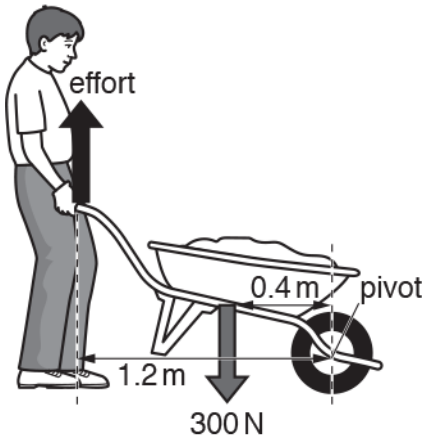
C 5 V

D 10 V

Your answer ☐ **[1]**

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11 A man lifts a load using a wheelbarrow.



What is the effort needed to lift the load using the wheelbarrow?

A 100 N

B 120 N

C 250 N

D 144 N

Your answer [1]

12 A 0.5 m length of wire is placed inside four different magnetic fields.

Magnetic Field	Force on wire (N)	Current in wire (A)
A	2.0	0.1
B	2.0	0.2
C	4.0	0.1
D	4.0	0.4

Which magnetic field has the **greatest** magnetic flux density?

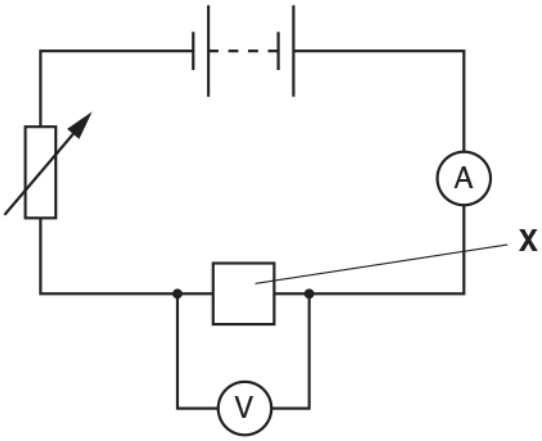
Your answer [1]

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13 A student builds a circuit to investigate the resistance of component **X**.



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(i) Calculate the potential difference across component **X**.

Use the equation: Potential difference = Current × Resistance

Answer = ... V **[2]**

(ii) Calculate the power of component **X** when a current of 0.25 A flows.

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Answer = ... W **[3]**

14

(i) Write down the conditions needed for charge to flow through a conductor.

---

[2]

(ii) Calculate the charge that flows past a point in a circuit with a 5.0 A current for five minutes.

Answer = ... C **[4]**

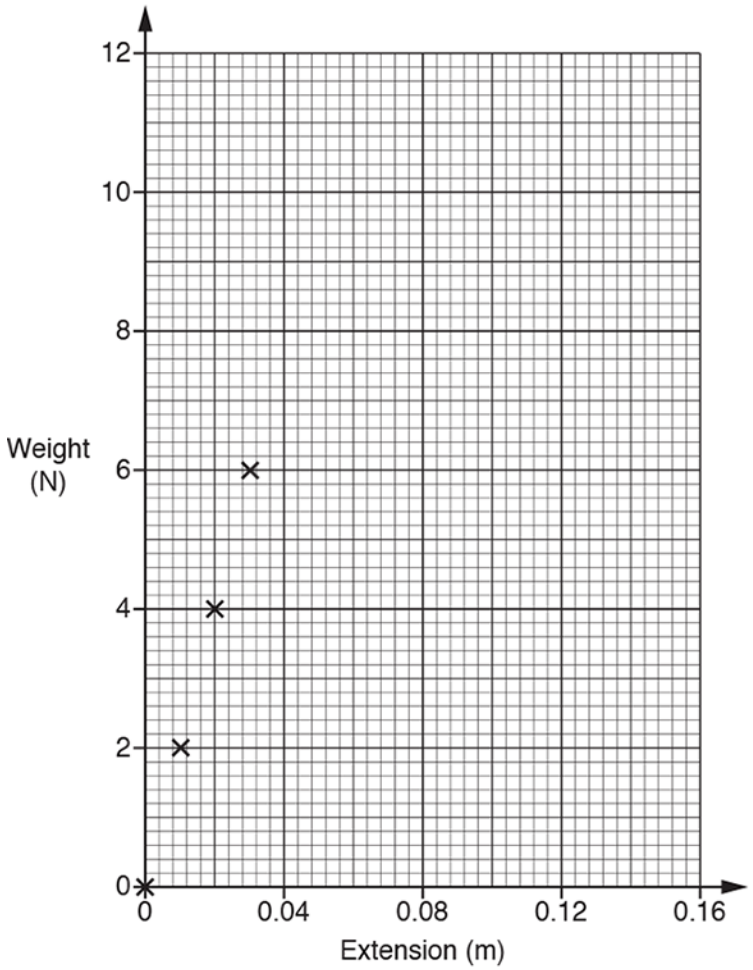
15(a) A student hangs a length of copper wire from the ceiling.

She adds weights to the bottom of the wire and measures the extension of the wire.

Look at a table of some of her results.

Weight (N)	Extension (m)
0	0
2	0.01
4	0.02
6	0.03
8	0.04
10	0.08
12	0.16

(i) Plot the values on the graph. Some have been done for you.



[2]

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(ii) Draw a line of best-fit on the graph.

[1]

(iii) Describe **and** explain the shape of the graph.

---

[3]

(b) Calculate the spring constant for the 0 – 6 N part of the graph.

Use the equation: Force = Spring constant × Extension

Answer = ... N/m **[3]**

(c) Calculate the work done in stretching the wire to 0.04 m.

Answer = ... J **[2]**

16 A student finds that 250 g of ice takes 95 kJ of energy to change state.

Calculate the specific latent heat.

Answer = ... J/kg **[3]**

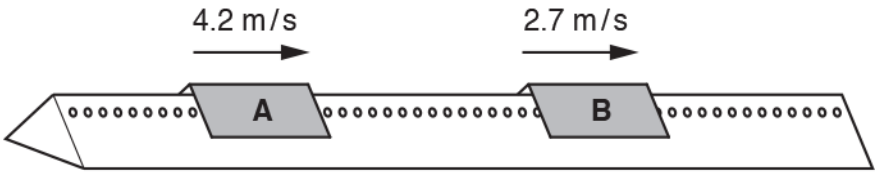
17(a) A student investigates collisions of trolleys on a horizontal airtrack.

Write down the **two** quantities involved with motion which are conserved during an elastic collision.

---

[2]

(b) Trolley **A** has a mass of 2 kg. Trolley **B** has a mass of 2.5 kg.



(i) Calculate the **momentum** of each trolley.

Trolley **A** = ... kg m/s

Trolley **B** = ... kg m/s

[3]

(ii) The two trolleys collide and stick together after the collision. Use your answers to **(i)** to calculate the **speed** of the combined trolleys after the collision.

Record your answer to **2** significant figures.

Answer = ... m/s **[3]**

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18 A student wants to find out the depth of a well.

She thinks that she can calculate this by dropping a stone into the well and timing how long it takes to hear the stone splash at the bottom.

(i) Explain how she could use this measurement to find the depth of the well.

---

19 A gas fire, used to heat a room, has an input energy transfer of 180 000 J per minute.

The fire has an efficiency of 0.8.

Use the equation: Efficiency = Useful output energy transfer / Input energy transfer

Calculate the useful output energy transfer per minute.

A 600 J

B 2400 J

C 36 000 J

D 144 000 J

Your answer ☐ [1]

20 A pump lifts 500 kg of water to a water tank at the top of a building.

The water gains 240 000 J of gravitational potential energy.

The gravitational field strength is 10 N/kg.

Use the equation: Potential energy = Mass × Height × Gravitational field strength

Calculate the height of the water tank.

A 4.8 m

B 48 m

C 240 m

D 480 m

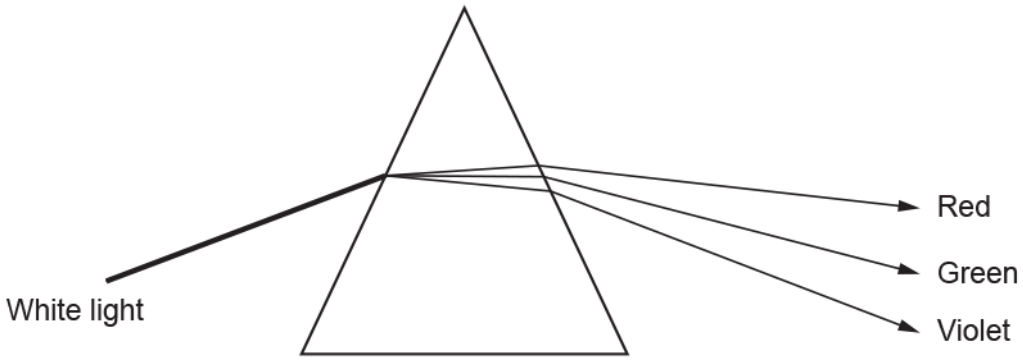
Your answer ☐ [1]

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21 Look at the diagram of white light as it passes through a prism.



A spectrum of colours is seen. It ranges from red to violet.

Why does the **violet** light refract **more** than the red light?

A Violet light changes frequency more than red light.

B Violet light has the largest change in speed.

C Violet light has the smallest change in speed.

D Violet light increases its speed in the glass prism.

Your answer ☐ **[1]**

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22 A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

(i) The domestic wind turbine has an electrical resistance of 23 Ω.

It generates a current of 11 A on a windy day.

Calculate the power output in kW of the turbine on this day.

Answer = ---------- kW **[4]**

() Suggest why the manufacturer gives a range for the power rating of the wind turbine.

---**[1]**

(i) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

---**[1]**

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23 Look at the table showing information about the electromagnetic spectrum.

Radio	Micro-wave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
3 MHz	30 GHz	3 THz		3000 THz	3 000 000 THz	300 000 000 THz
100 m	1 cm	100 μm				

The speed of all electromagnetic radiation is 3×10^8 m/s.

(i) Use data in the table to show that the speed of microwaves is 3×10^8 m/s.

[2]

(ii) Ultra-violet waves typically have a frequency of 3000 THz.

Calculate the wavelength of these ultra-violet waves in nm.

Answer = ---------- nm **[3]**

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24(a) A scientist uses different drivers to test the stopping distances of the same car.

Look at the results.

Driver	Speed (m/s)	Thinking distance (m)	Braking distance (m)
A	8	6	6
B	16	13	24
C	32	24	96
D	16	12	22
E	8	5	6
F	32	30	120

Which driver has the **quickest** reaction time?

Driver ..... has the **quickest** reaction time.

Calculate their reaction time.

Answer = ---------- s **[3]**

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(b) Driver **C** travels at 32 m/s on the road and then stops. The car has a mass of 1200 kg.

(i) Show that the **kinetic energy** stored by the car at 32 m/s is 614 000 J.

[3]

(ii) Describe what happens to the kinetic energy of the car as it brakes and stops.

---**[2]**

(iii) The braking distance of the car is 96 m.

Calculate the **braking force** on the car.

Give your answer to **4** significant figures.

Answer = ---------- N **[3]**

25 A wooden block has a mass of 2 kg and a specific heat capacity of 2000 J/kg °C.

Calculate the energy needed to raise its temperature by 6 °C.

Use the equation:

Change in thermal energy = Mass × Specific Heat Capacity × Change in Temperature

A 1 200 J

B 2 400 J

C 12 000 J

D 24 000 J

Your answer ☐ **[1]**

26 A lorry has a mass of 3500 kg. It travels at a speed of 30 m/s.

Use the equation: Kinetic Energy = 0.5 × Mass × Speed^2

Calculate the kinetic energy of this lorry.

A 10 500 J

B 52 500 J

C 1 575 000 J

D 3 150 000 J

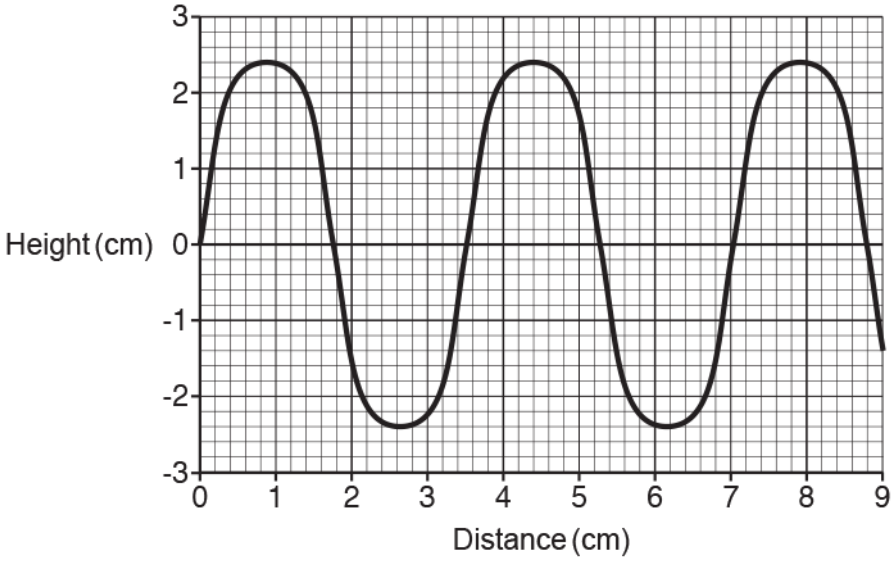
Your answer ☐ **[1]**

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27 Look at the diagram of a water wave.



(i) What is the **wavelength** of this wave?

Answer = _____ cm **[1]**

(ii) What is the **amplitude** of this wave?

Answer = _____ cm **[1]**

(iii) The wavelength of the wave is changed to 25 cm. Two waves are produced each second.

Use the equation: Wave speed = Frequency × Wavelength

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Calculate the speed of the wave.

Answer = _____ m/s **[2]**

28(a) Look at the information about different electric motors.

Electric motor	Energy input per hour (J)	Useful energy output per hour (J)	Energy 'wasted' per hour (J)
A	72 000	60 000	
B	54 000	36 000	
C	18 000		3 000
D		48 000	12 000
E	54 000	48 000	

(i) Calculate the energy input per hour in J for electric motor **D**.

Answer = _____ J **[2]**

(ii) Which electric motor has the **lowest** 'wasted' energy in one hour?

_____ **[1]**

(iii) Which electric motor has the **highest** 'wasted' energy in one hour?

_____ **[1]**

(iv) Describe how energy is 'wasted' in an electric motor.

30(a) This question is about force, mass and acceleration.

A car starts from rest and accelerates at 3 m/s^2.

Use the equation: Acceleration = Change in velocity ÷ Time taken

Calculate the **velocity** of the car after 4 s.

Answer = _____ m/s **[2]**

(b) A roller coaster car moves down a slope with an acceleration of 5 m/s^2.

The force on the roller coaster car is 4000 N.

Calculate the **mass** of the roller coaster car.

Answer = _____ kg **[2]**

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31 A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

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Calculate the **power** output in kW of the turbine on this day.

Answer = ---------- kW **[4]**

(ii) Suggest why the manufacturer gives a range for the power rating of the wind turbine.

---**[1]**

(iii) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

---**[1]**

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32 A 2.0 kg object moves at a velocity of 40 m / s.

What is the momentum of the object?

Use the equation: momentum = mass × velocity

A 20 kg m / s

B 38 kg m / s

C 42 kg m / s

D 80 kg m / s

Your answer ☐ **[1]**

33 A liquid has a volume of 0.01 m^3 and a mass of 12 kg.

What is the density of the liquid?

Use the equation: density = mass × volume

A 0.12 kg / m^3

B 12 kg / m^3

C 120 kg / m^3

D 1200 kg / m^3

Your answer ☐ **[1]**

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34 On the Moon, a 10 kg mass has a weight of 16 N.

What is the gravitational field strength on the Moon?

A 1.6 N / kg

B 6.0 N / kg

C 26 N / kg

D 160 N / kg

Your answer [ ] **[1]**

35 Which object has the **most** gravitational potential energy?

A 1 kg bag on a shelf 1 m above the ground

B 2 kg bag on a shelf 1 m above the ground

C 2 kg bag on a shelf 2 m above the ground

D 1 kg bag on a shelf 2 m above the ground

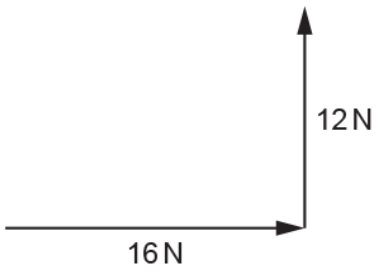
Your answer [ ] **[1]**

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36 Two forces act at right angles to each other.



What is the magnitude of the resultant force?

A 18 N

B 20 N

C 22 N

D 24 N

Your answer [1]

37 A spring stretches by 2.0 cm when a force is added.

The spring constant is 60 N / m.

Calculate the energy transferred to the spring when it is stretched.

A 0.012 J

B 0.024 J

C 120 J

D 240 J

Your answer [1]

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38(a) A TV has the label below on it.

OCR TV
Voltage: 230 V Power: 65 W Frequency: 50 Hz

Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to **2** significant figures.

Current = ... A **[4]**

(b) The TV is turned on for 30 minutes.

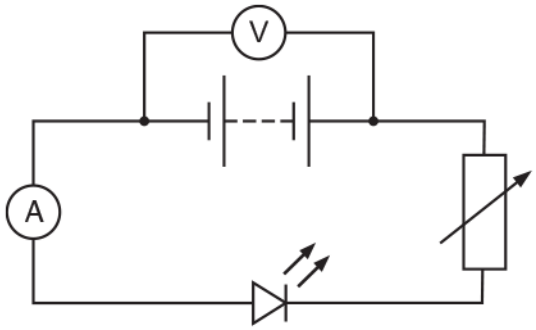
Calculate the energy transferred by the TV.

Energy used = ... J **[4]**

39(a) A student investigates the electrical characteristics of a light emitting diode (LED).

The student builds a circuit to investigate how the current through an LED and the potential difference across it vary when the LED lights up.

Look at the circuit diagram.



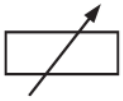
(i) The student has made **two** errors connecting the circuit.

Identify the errors.

1 _____

2 _____

[2]

(ii) What is the purpose of the component  in the circuit?

_____

[1]

(b) The student then connects the circuit correctly. He measures the current through the LED as 0.03 A when the potential difference across it is 3.0 V.

(i) Calculate the resistance of the LED.

Use the equation: potential difference = current × resistance

Resistance = ... Ω **[3]**

(ii) Calculate the charge which flows when this LED operates for 2.5 minutes.

Charge = ... C **[4]**

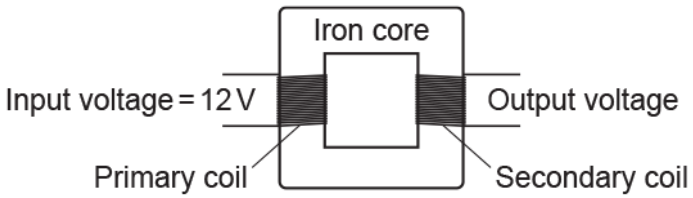
(iii) Calculate the energy transferred when this LED operates for 2.5 minutes.

Use the equation: energy transferred = charge × potential difference

Energy transferred = ... J **[2]**

40 A student investigates building model transformers in the laboratory.

Look at the diagram.



The student builds four different transformers, each with different primary and secondary coils.

Using an input voltage of 12 V the student measures the output voltage.

Look at the results.

Attempt	Number of turns in primary coil	Number of turns in secondary coil	Output voltage (V)
A	100	200	23
B	200	100	6
C	300	600	23
D	600	300	6

* Explain how a transformer works and if this data supports the expected output voltages.

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[6]

41(a) A student investigates how the angle of a ramp affects the final speed of a trolley.

He uses light gates to record the speed of the trolley at the bottom of the ramp.

The student releases the trolley from rest at the same point on the ramp each time.

Look at his results.

Angle of ramp (°)	Final speed (m / s)			
	Attempt 1	Attempt 2	Attempt 3	Mean
10	1.81	1.80	1.81	1.81
20	2.58	2.56	2.57	2.57
30	3.1	3.11	3.11	3.11
40	3.52	3.51	3.50	3.51

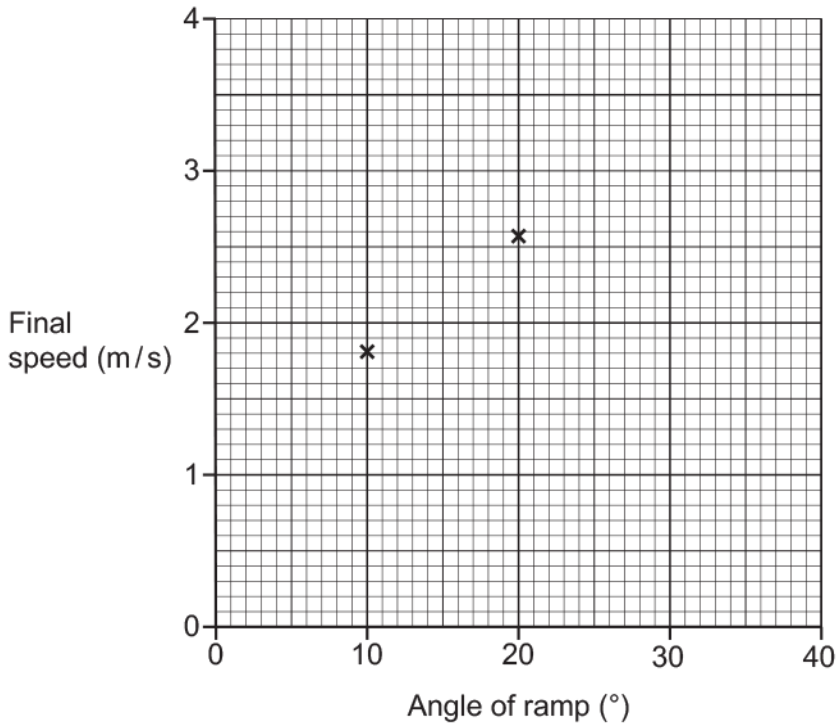
(i) Plot the results on the graph and draw a line of best fit.

Two results have been plotted for you.

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[2]

(ii) Describe the pattern shown by the results.

Use data from the table or graph in your answer.

---

[3]

(iii) Explain why the final speed changes when the angle of the ramp increases.

In your answer use ideas about energy.

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[2]

(iv) The student made a mistake when recording one of his results.

Identify the mistake **and** explain what he should have done.

[2]

(v) The student thinks this data shows that his results are **reproducible**.

He is **not** correct.

Explain why.

[2]

(b)

(i) The mean final velocity for the ramp at a 40° angle is 3.51 m / s. The distance from the top of the ramp to the light gate at the bottom is 1.0 m.

Calculate the acceleration of the trolley when the ramp is at a 40° angle.

Give your answer to decimal places.

Acceleration = ... m / s^2 **[5]**

(ii) The trolley has a mass of 2.0 kg.

Calculate the kinetic energy of the trolley at a speed of 3.0 m / s.

Kinetic energy = ... J **[3]**

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42(a) A student investigates four gases.

Look at her data.

Gas	Pressure (Pa)	Volume (m^3)
A	5	0.5
B	10	0.4
C	20	0.2
D	40	0.2

Two readings are for the same mass of the same gas at a constant temperature.

Which two readings are for the **same mass** of the **same gas** at a constant temperature?

Use calculations in your answer.

[3]

(b) Calculate the pressure at the bottom of a 0.5 m tall measuring cylinder filled with a liquid.

Density of the liquid = 1100 kg / m^3.

Pressure = ... Pa **[3]**

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43 On Mars the gravitational field strength is 4.0 N / kg.

How much would a 60 kg person weigh on Mars?

Use the equation: weight = mass × gravitational field strength

A 15 N

B 64 N

C 240 N

D 600 N

Your answer ☐ [1]

44 A car travels at 72 km / h.

How fast is this in metres per second (m / s)?

A 1.2 m/s

B 20 m/s

C 120 m/s

D 1200 m/s

Your answer ☐ [1]

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45 An object has a volume of 1.5 m^3 and a mass of 3.0 kg.

What is the density of the object?

Use the equation: density = mass ÷ volume

A 0.5 kg/m^3

B 2.0 kg/m^3

C 4.5 kg/m^3

D 6.0 kg/m^3

Your answer ☐ **[1]**

46(a) The student finds that the current is 20 mA when the potential difference is 4.0 V.

Calculate the **resistance** of the unknown resistor.

Include the **unit** for resistance in your answer.

Use the equation: resistance = potential difference ÷ current.

Resistance = ... Unit = ... **[4]**

(b) Calculate the **charge** that flows when a current of 2.5 A flows for 30 seconds.

Charge = ... C **[3]**

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47 A 2.0 N weight has a surface area of 0.005 m^2.

Calculate the **pressure** when it is placed on a surface.

Use the equation: pressure = force normal to a surface ÷ area of that surface

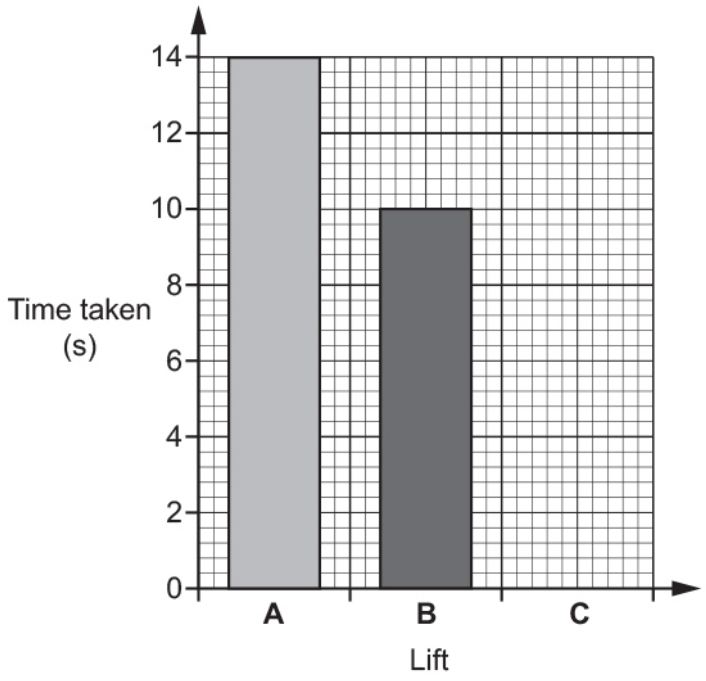
Pressure = ... Pa **[2]**

48(a) A tall building needs a lift to move people from one floor to another.

The builder has a choice of three different lifts.

Each lift takes a different amount of time to move between the two floors.

Look at a bar chart of the time taken for each lift.



(i) Lift **C** takes 12 s to move between the two floors.

Draw a bar for lift **C** on the bar chart. **[1]**

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(ii) Calculate the **mean** time of the three lift journeys.

Mean = ... s **[2]**

(iii) Explain which lift uses the most power.

---

[2]

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(b)

(i) One lift uses 50 000 J for a 12 s journey.

Calculate the power of the lift.

Give your answer to 1 decimal place.

Power = ... W **[4]**

(ii) When the lift is broken the stairs are used.

Calculate the work done when a 750 N person climbs a distance of 4 m.

Work done = ... J **[3]**

49 A student investigates the acceleration with which a trolley travels down a ramp.

The trolley starts from rest and reaches a final speed of 2 m / s.

The ramp length is 2.0 m.

Calculate the acceleration of the trolley.

Acceleration = ... m / s^2 **[4]**

50(a) A TV has the label below on it.

OCR TV
Voltage: 230 V Power: 65 W Frequency: 50 Hz

Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to **2** significant figures.

Current = ... A **[4]**

(b) The TV is turned on for 30 minutes.

Calculate the energy transferred by the TV.

Energy used = ... J **[4]**

51 A boy of mass 70 kg stands on the end of a diving board.

The boy dives vertically into the swimming pool. The water in the pool is 3.2 m below the diving board.

Calculate the velocity of the boy when he enters the water.

Use an equation from the data sheet to help you.

Gravitational field strength on Earth = 10 N / kg.

Velocity = ... m / s **[4]**

52 Water can be heated using a 12 V heater.

A transformer is used to change a 120 V supply into 12 V.
The current in the secondary coil is 9.0 A.

Calculate the current in the primary coil.

Use an equation from the data sheet.

Current = ... A **[2]**

END OF QUESTION PAPER

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