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GCSE (9–1) Physics A (Gateway Science)

J249/02 Paper 2, P5 – P8 and P9 (Foundation Tier)

Friday 15 June 2018 – Morning

Time allowed: 1 hour 45 minutes

7024631506

You must have:
- a ruler (cm/mm)
- the Data Sheet (for GCSE Physics A (inserted))

You may use:
- a scientific or graphical calculator
- an HB pencil

J249/02

First name	
Last name	
Centre number	Candidate number

INSTRUCTIONS
- The data sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **24** pages.

SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

1 Some electromagnetic waves are used to scan a person in hospital.

Which statement is true about a scan that uses **electromagnetic** waves?

A Micro-waves are used to scan skin.

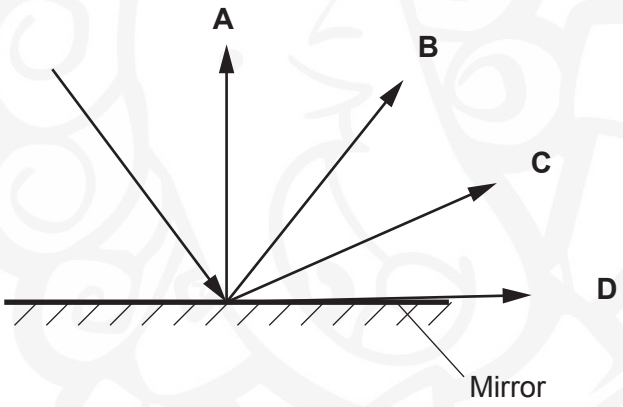
B Ultrasound waves are used to scan an unborn baby.

C Ultra-violet is used to scan for cancer.

D X-rays are used to scan for broken bones.

Your answer ☐ **[1]**

2 Which light ray shows the correct reflection from the plane (flat) mirror?



Your answer ☐ **[1]**

3 Which statement is true about the **nucleus** of an atom?

A It contains neutrons and ions and has a negative charge.

B It contains neutrons and ions and has a neutral charge.

C It contains neutrons and protons and has a neutral charge.

D It contains neutrons and protons and has a positive charge.

Your answer ☐ **[1]**

4 Estimate the typical cruising speed of a jet airliner.

A 25 m/s

B 250 m/s

C 2 500 m/s

D 25 000 m/s

Your answer ☐ **[1]**

5 A student experiments with a model parachute and collects some results.

She drops the parachute from a height of 4 m three times and takes **three** results of the time taken.

The three results are:

3.25 s
3.00 s
3.08 s

What is the mean of the three results?

A 3.00 s

B 3.08 s

C 3.11 s

D 3.25 s

Your answer ☐ **[1]**

6 A student wants to find out which heater produces the largest temperature rise.

Look at the results she collects and the calculations she makes.

Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)
A	18	28	20
B	18	36	16
C	18	44	26
D	18	51	23

Which heater has results that are correctly calculated?

Your answer ☐ **[1]**

7 Which row **A**, **B**, **C** or **D**, is true for electromagnetic waves?

	Transmission	Type	Movement in space
A	Transmit energy from absorber to source	Longitudinal	Travel through space at different velocities
B	Transmit energy from absorber to source	Transverse	Travel through space at different velocities
C	Transmit energy from source to absorber	Longitudinal	Travel through space where all have the same velocity
D	Transmit energy from source to absorber	Transverse	Travel through space where all have the same velocity

Your answer ☐ **[1]**

8 A vehicle has an input power from fuel of 20 kW and a useful output power of 6 kW.

Calculate the power it wastes.

A 3 kW

B 6 kW

C 14 kW

D 20 kW

Your answer ☐ **[1]**

9 Which statement is **correct** about geostationary satellites?

A They are above the equator and they orbit the Earth in about 90 minutes at a high orbit.

B They are above the equator and they orbit the Earth in 24 hours at a high orbit.

C They are above the equator and they orbit the Earth in 24 hours at a low orbit.

D They are above the poles and they orbit the Earth in 24 hours at a low orbit.

Your answer ☐ **[1]**

10 A student measures the time it takes for the sound from a firework to reach the observer.

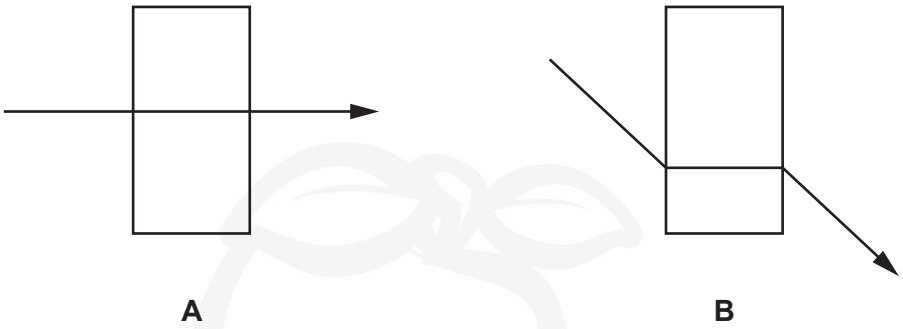
She takes 3 measurements of the time taken for four different distances, **A**, **B**, **C** and **D**.

Distance	Time taken (s)		
	1st measurement	2nd measurement	3rd measurement
A	2.16	2.19	2.17
B	1.99	2.02	1.97
C	1.80	1.81	1.89
D	1.69	1.68	1.71

Which distance **A**, **B**, **C** or **D**, has the largest range of values?

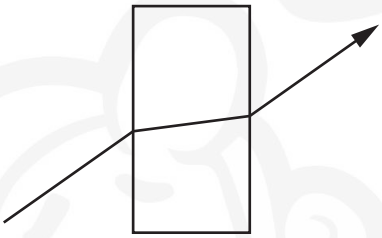
Your answer ☐ **[1]**

11 Look at the diagrams of a light ray as it passes from air through a glass block.

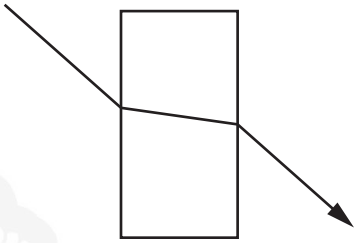


A

B



C



D

Which diagram shows an **incorrect** refraction?

Your answer ☐ **[1]**

12 A radio wave has a wavelength of 100 m. It has a speed of 3×10^8 m/s.

Use the equation: Wave speed = Frequency × Wavelength

Calculate the frequency of the wave.

A 3 MHz

B 30 MHz

C 300 MHz

D 3000 MHz

Your answer ☐ **[1]**

13 Which equation shows a correct alpha decay?

A $^{241}_{95}\text{Am} \rightarrow {}^{239}_{91}\text{Np} + {}^{2}_{4}\text{He}$

B $^{241}_{95}\text{Am} \rightarrow {}^{237}_{93}\text{Np} + {}^{0}_{2}\text{He}$

C $^{241}_{95}\text{Am} \rightarrow {}^{237}_{93}\text{Np} + {}^{4}_{2}\text{He}$

D $^{241}_{95}\text{Am} \rightarrow {}^{237}_{93}\text{Np} + {}^{0}_{1}\text{He}$

Your answer ☐ **[1]**

14 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]**

15 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

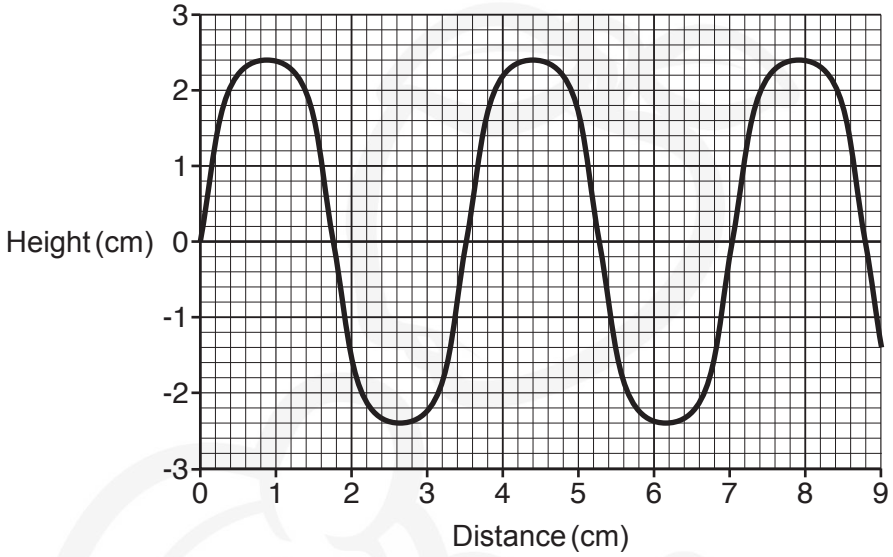
D 3 150 000 J

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16 Look at the diagram of a water wave.



(a) (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

Calculate the speed of the wave.

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

(b) Water waves are transverse and sound waves are longitudinal.

(i) Describe how water particles move in a **transverse** water wave.

.....

..... **[1]**

(ii) Describe how air particles move in a **longitudinal** sound wave.

.....

..... **[1]**

(c) Look at the diagram of the electromagnetic spectrum.

Radio	Microwave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays

(i) Name a wave that has a longer wavelength than red light.

..... **[1]**

(ii) Name a wave that has a higher frequency than violet light.

..... **[1]**

(iii) State two **uses** of gamma-rays.

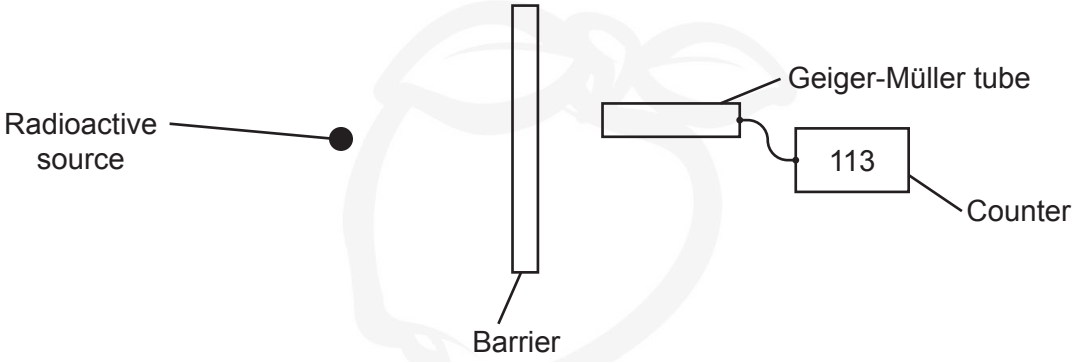
1. .....

2. .....

[2]

17 A teacher demonstrates an experiment about radioactivity. He demonstrates how different types of radiation can be absorbed.

He puts different barriers between the source and the Geiger-Müller tube. He uses four different radioactive sources **A**, **B**, **C** and **D**.



(a) Suggest two safety **precautions** that the teacher should use when demonstrating this experiment.

1. .....

.....

2. .....

.....

[2]

(b) The teacher chooses source **A** and uses the Geiger-Müller tube to measure the count rate (counts per minute) for different barriers. He repeats the experiment with source **B**, source **C** and then source **D**.

Look at his results.

Source	Count rate using different barriers			
	Paper	**Aluminium**	**Lead**	**No barrier**
A	113	112	22	112
B	20	21	20	182
C	162	23	21	164
D	282	78	24	280

He also finds that the **average count rate** with **no** sources and **no** barriers is 20.

(i) Which source **A**, **B**, **C** or **D** emits **gamma** radiation only?

Explain your answer.

Source ..... because .....

.....

..... **[2]**

(ii) Which source **A**, **B**, **C** or **D** emits **alpha** radiation only?

Explain your answer.

Source ..... because .....

.....

..... **[2]**

(iii) Which source **A**, **B**, **C** or **D** could emit both **beta and gamma** radiation?

Explain your answer.

Source ..... because .....

.....

..... **[2]**

(c) The teacher notices that the count rate behind the lead barrier ranges from 20 to 24.

Give **two** reasons why there are a wide range of results around 22 counts per minute.

1. .....

.....

2. .....

.....

[2]

(d) The teacher decides to repeat the experiment.

This time he records the number of counts for a much longer time interval for each source.

Explain why this is an improvement to the experiment.

.....

.....

..... **[2]**

18 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	

(a) (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.

.....

..... **[1]**

(v) Suggest how this 'wasted' energy can be reduced in an electric motor.

.....

..... **[1]**

(b) Calculate the **%** efficiency of electric motor **E**.

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

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

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

19 A student watches a ball game on the school field.

The student sees the ball being hit with a bat but he hears the sound a short time after. This is because the speed of light is greater than the speed of sound.

He decides to do an experiment to measure the speed of sound waves in air.

(a) Describe which measurements he needs to measure this speed.

.....

.....

..... **[2]**

(b) Which equation is used to calculate speed?

..... **[1]**

(c) Describe one way he could get valid results for this experiment.

.....

..... **[1]**

20 **Fig. 20.1** shows thinking, braking and stopping distances for the same car travelling at different speeds.

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

(a) Describe how the **thinking distance** changes when the speed doubles.

Use data from the table in your answer.

.....

.....

..... **[1]**

(b) Calculate the reaction time of the person driving the car.

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

(c)* Explain why the stopping distances are different for each speed in **Fig. 20.1**.

.....

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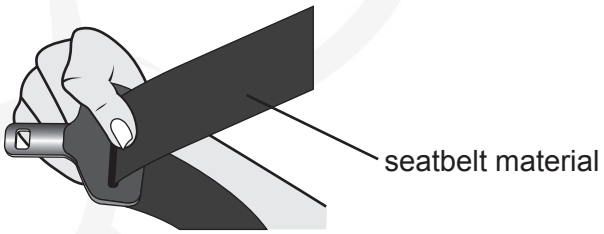
..... **[6]**

21 **(a)** A car has a total weight of 12 000 N. It has four tyres which each have an area of 25 cm^2 in contact with the road.

Calculate the pressure of the car on the road.

Answer = ... N/cm^2 **[3]**

(b) Seatbelts in cars are made of a wide material that stretches in a crash.



(i) Explain why it is important that the material is **wide**.

.....

..... **[1]**

(ii) Explain why it is important that the material is **stretchy**.

.....

..... **[1]**

(c) Children in cars use special seats with their own seatbelts.

The seatbelts for children are narrower than adult seatbelts.

Why is it safe for children's seatbelts to be **narrower** than adult seatbelts?

.....

.....

..... **[2]**

22 This question is about force, mass and acceleration.

(a) 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.

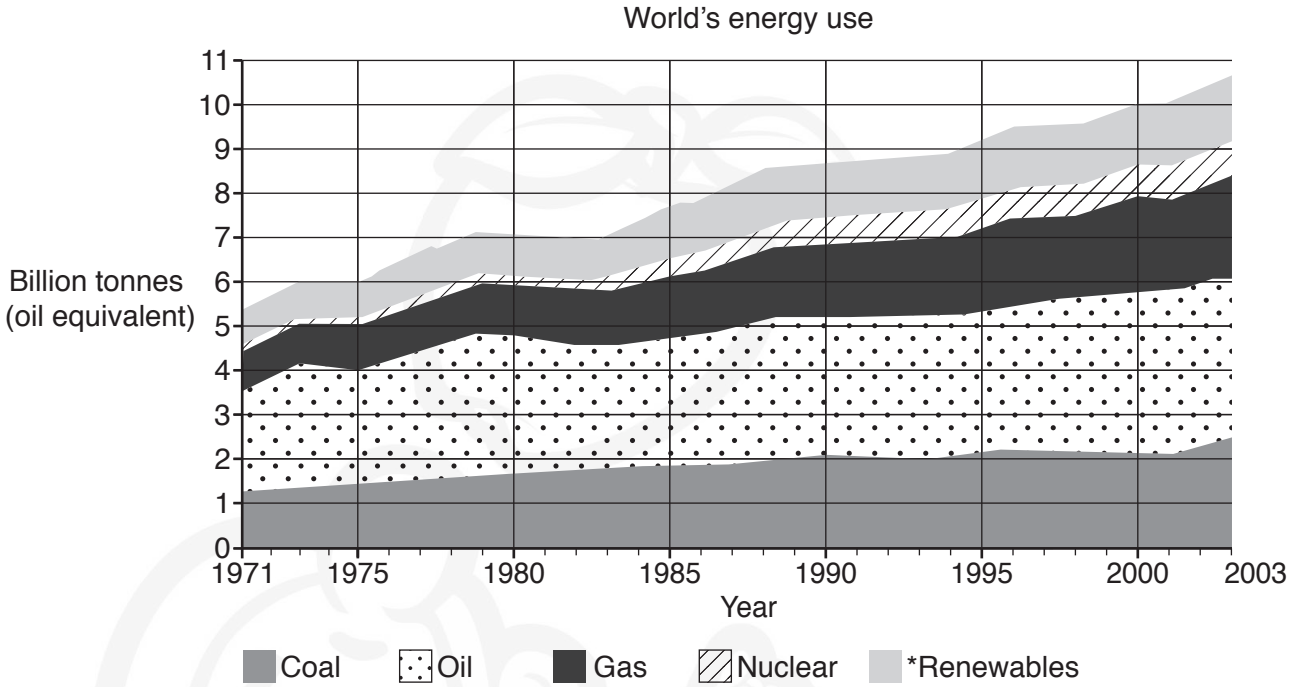
The force on the roller coaster car is 4000 N.

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

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

23 The graph shows how the World's energy use has changed from the year 1971 to the year 2003.

It also shows the amount of different energy sources used.



*Includes hydroelectric, combustible renewables, geothermal, solar, wind, etc.

(a) (i) Approximately how much did the total World's energy use increase from the year 1971 to the year 2003?

Answer = ... billion tonnes (oil equivalent) **[1]**

(ii) Which energy source had the **greatest** use in the year 2003?

..... **[1]**

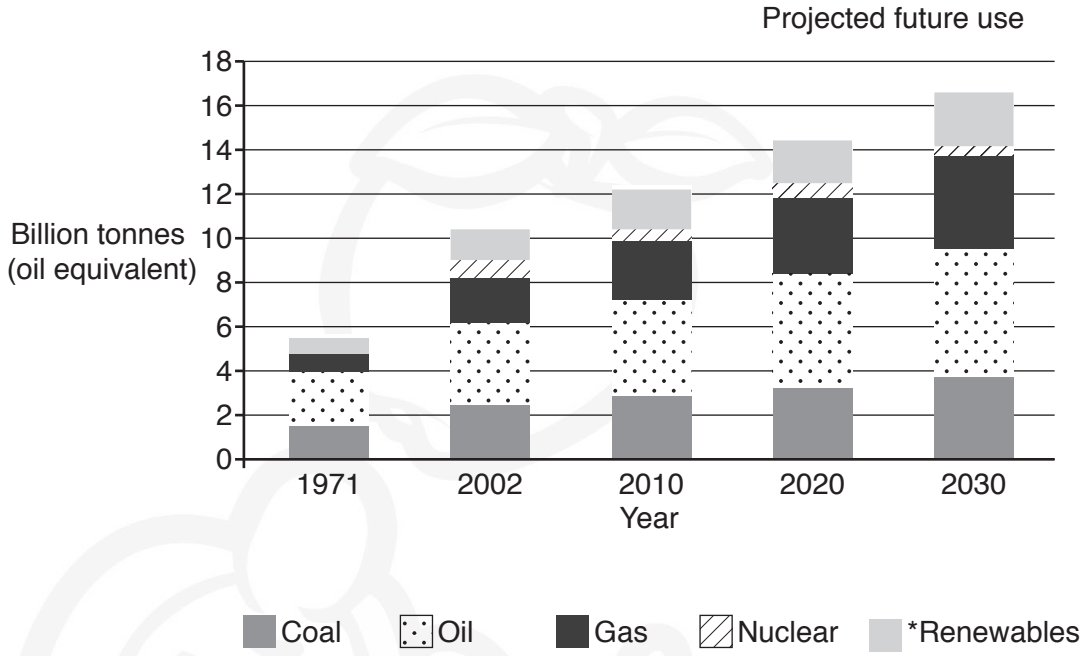
(iii) The total energy use in the year 2003 was 10.6 billion tonnes (oil equivalent).

Approximately what percentage of this amount was due to fossil fuel use?

Answer = ...% **[2]**

(b) Scientists are researching the World's energy use for the future.

The graph shows some of their research.



*Includes hydroelectric, geothermal, solar, wind etc.

(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

1. .....

.....

2. .....

..... **[2]**

(ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to be built.

Suggest why the government wants more nuclear power stations.

.....

.....

..... **[2]**

(c) Power stations in the UK generate electricity at 25 kV a.c.

The voltage is then increased to 400 kV a.c. and distributed by power lines.

(i) Write down the full name of the device used to **increase** the voltage.

..... **[1]**

(ii) Why is it important to increase the voltage in these power lines?

..... **[1]**

(iii) The high voltages across the power lines are reduced to 230 V a.c. for use in the home.

A phone charger changes the 230 V a.c. to a 5 V d.c.

Explain the difference between d.c. and a.c.

.....

.....

..... **[2]**

(d) 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]**

(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]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).