OCR
Oxford Cambridge and RSA

Accredited

H

GCSE (9–1) Physics A (Gateway Science)
J249/04 Paper 4 (Higher tier)
Sample Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 45 minutes

Version 2.1

You must have:
• the Data Sheet

You may use:
• a scientific or graphical calculator
• a ruler

First name	
Last name	
Centre number		Candidate number	

INSTRUCTIONS
• Use black ink. HB pencil may be used for graphs and diagrams only.
• 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.
• Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
• Do not write in the bar codes.

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 **28** pages.

J249/04
D10013/5

Turn over

SECTION A

Answer **all** the questions.

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

1   A radio transfers 30 J of potential energy to 27 J of useful energy.

What is the efficiency and energy loss for the radio?

	efficiency	energy loss
A	10%	3 J
B	10%	27 J
C	90%	3 J
D	90%	27 J

Your answer [ ]   **[1]**

2   A boy kicks a football with a mass of 400 g.

What is the potential energy of the football when it is 0.8 m above the ground?

•   gravitational field strength (g) = 10 N/kg.

A   0.032 J

B   3.2 J

C   320 J

D   3 200 J

Your answer [ ]   **[1]**

3   The National Grid transfers energy efficiently using high voltages.

Why are high voltages more efficient?

A   High voltages produce a high current which heats wires less.

B   High voltages produce a high current which heats wires more.

C   High voltages produce a low current which heats wires less.

D   High voltages produce a low current which heats wires more.

Your answer [   ]   **[1]**

4   Which statement describes nuclear fusion?

A   A helium nucleus joins with a hydrogen nucleus to form an alpha particle.

B   Two helium nuclei join to form a hydrogen nucleus.

C   Two hydrogen nuclei join to form a helium nucleus.

D   Uranium nuclei split and produce high energy neutrons causing a chain reaction.

Your answer [   ]   **[1]**

5   Which row correctly describes the domestic electricity supply in the UK?

	a.c. or d.c.	Frequency (Hz)	Voltage (V)
A	a.c.	50	230
B	a.c.	230	50
C	d.c.	50	230
D	d.c.	230	50

Your answer [   ]   **[1]**

6 What is a typical weight of an empty single decker school bus?

A 1 200 N

B 12 000 N

C 120 000 N

D 1 200 000 N

Your answer ☐ **[1]**

7 How was the Sun formed?

A From dust and gas pulled together by gravity leading to a fission reaction.

B From dust and gas pulled together by gravity leading to a fusion reaction.

B From dust and gas pushed together by gravity leading to a fission reaction.

C From dust and gas pushed together by gravity leading to a fusion reaction.

Your answer ☐ **[1]**

8 An element has more than one isotope.

Which row correctly describes the atoms of **all** isotopes of this element?

	Numbers of electrons	Numbers of protons	Numbers of neutrons
A	different	different	different
B	same	different	different
C	same	same	different
D	same	different	same

Your answer ☐ **[1]**

9 Radium-226 is the most abundant isotope of radium.

Its nuclear mass is 226 and its nucleus contains 138 neutrons.

Which row is correct for another isotope of radium?

A nuclear mass 226; 137 neutrons

B nuclear mass 226; 139 neutrons

C nuclear mass 227; 138 neutrons

D nuclear mass 227; 139 neutrons

Your answer ☐   **[1]**

10 A sound wave travels from water into air.

Its wavelength in air is shorter than in water.

How do the frequency and speed of the wave in air compare with their values in water?

	Frequency in air	**Speed in air**
A	higher	slower
B	higher	same
C	same	slower
D	same	same

[1]

11 Red light refracts when it enters glass from air because its speed changes.
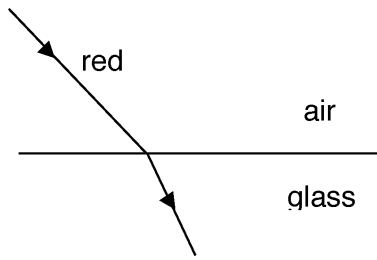
The red light is replaced by blue light.

Which statement is correct about the refraction of **blue** light?

A It refracts less than red because its speed in glass is greater than red.

B It refracts less than red because its speed in glass is less than red.

C It refracts more than red because its speed in glass is greater than red.

D It refracts more than red because its speed in glass is less than red.

Your answer ☐   **[1]**

12 Which row would result in an **increase** in the efficiency of a machine?

	Increase the energy losses due to friction	**Increase** the work output without changing the work input
A	Yes	Yes
B	Yes	No
C	No	No
D	No	Yes

Your answer ☐   **[1]**

13 A hockey player used pads on her legs to reduce injuries when hit by the ball.

How do the pads affect the ball?

A The acceleration and force of the ball is increased.

B The acceleration and force of the ball is decreased.

C The acceleration of the ball is decreased and the force is increased.

D The acceleration of the ball is increased and the force is decreased.

Your answer [   ] **[1]**

14 Radium-226, $^{226}_{88}$Ra, decays to become radon-222, $^{222}_{86}$Rn.

What is emitted when a nucleus of radium-226 decays?

A A beta particle

B An alpha particle

C Four neutrons

D Four protons

Your answer [   ] **[1]**

15 A radioactive source has a half-life of 80 s.

How long will it take for ⅞ of the source to decay?

A 10 s

B 70 s

C 240 s

D 640 s

Your answer [   ] **[1]**

Section B

Answer **all** the questions.

16 **(a)** A crowd makes a Mexican wave.

A Mexican wave **starts** with people lifting and lowering their arms.

The Mexican wave **continues** by people, next to them, lifting and lowering their arms.

Why is a Mexican wave an example of a transverse wave?

....

.... **[1]**

(b) In the classroom a teacher demonstrates waves using a rope.

Look at the diagram of the wave.
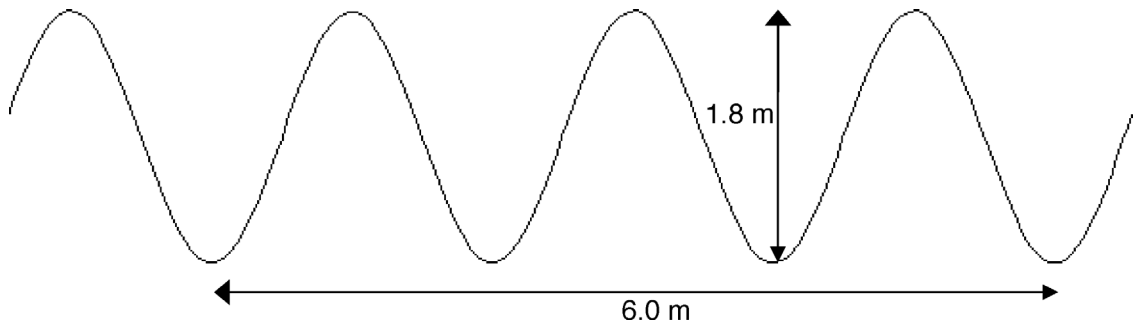
(i) The frequency of the wave is 2 Hz.

What does this statement mean?

....

.... **[2]**

(ii) How many seconds will it take for this wave to travel 12 m?

Show your working.

....

....

....

Answer = ………………………………… seconds **[3]**

(c) Ultrasound scans are used to produce images of tissues inside the body.

ultrasound scanner emits and
receives ultrasound

tissue layers in the body
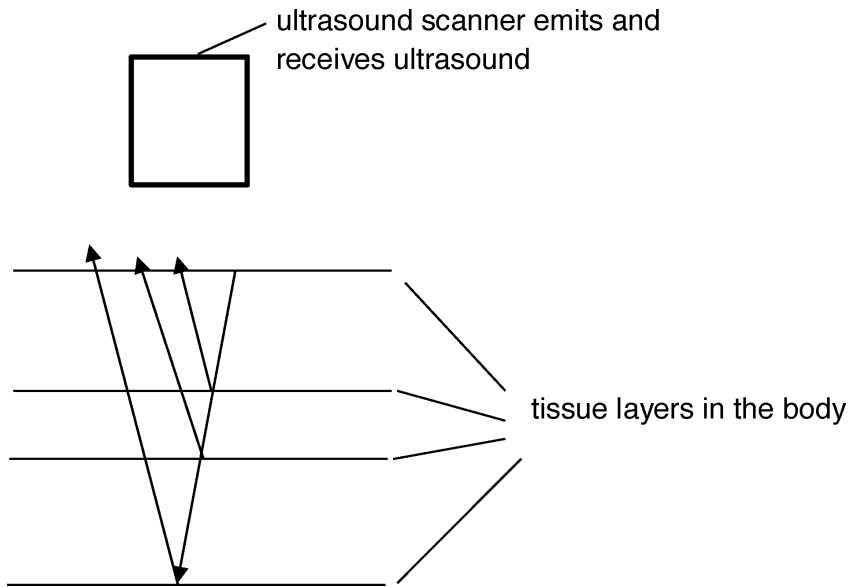
Ultrasound waves are emitted.

The waves reflect from layers of tissue inside the body.

Explain how the reflections are used to produce an image of the tissues.

....

....

....

....

.... **[3]**

(d) Ultrasound and X-rays are used to scan patients in hospitals.

Complete the table to show a medical use, benefits and risk of using these waves to scan patients.

Wave	Medical use	Example of a benefit	Risk
X-rays	Shows up hard tissues inside the body.	Takes images of broken bones.	Damages living cells by causing: ....
Ultrasound	....	....	None

[3]

17 A car on a roller coaster is stationary at the top of a slope.

The car has a weight of 6 500 N and a potential energy of 217 000 J.

(a) Calculate the cars height above the ground.

....

....

....

....

Answer = ……………………………….m **[2]**

(b) The diagram shows the roller coaster car moving down a slope.
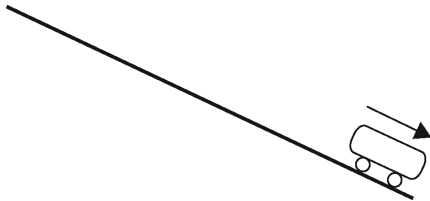
The energy at the bottom of the slope is less than expected.

Suggest **two** ways to improve the efficiency of the roller coaster car.

....

....

.... **[2]**

18 The table below shows information on radioactive isotopes.

Radioactive isotope	Type of radiation	Half-life	Penetration through human flesh
A	alpha	300 years	2 mm
B	beta	7 hours	60 mm
C	gamma	7 hours	> 10 m
D	alpha	9 seconds	2 mm
E	gamma	3 years	> 10 m

(a) A doctor injects a patient with isotope **C** to track blood flow through the body.

Use the information to suggest why the doctor uses isotope **C**.

....

.... **[1]**

(b) A doctor implants radioactive isotope **A** into a patient to treat a localised cancer which is a few mm in size. She intends to remove the isotope in a few weeks.

Use the data to suggest **two** reasons why the doctor uses isotope **A**.

....

.... **[2]**

(c) A doctor wants to irradiate a tumour using gamma rays.

Why does the activity of the source need to be checked before it is used on a patient?

....

.... **[2]**

19* Scientists collect evidence from the universe and develop theories to explain their observations.

The diagram shows three absorption spectra showing red shift.

The white arrows show the relative position of the same band in the absorption spectra of a distant galaxy, a nearby galaxy and a star.

Using your knowledge of red shift, describe how the information in the diagrams supports the idea of the Big Bang model.

....

....

....

....

....

....

....

....

....

....

....

.... **[6]**

20 Student **A** investigates how well different balls bounce.

- She drops five different balls from the same height and measures the height the ball bounce.
- She repeats the experiment three times for each ball.
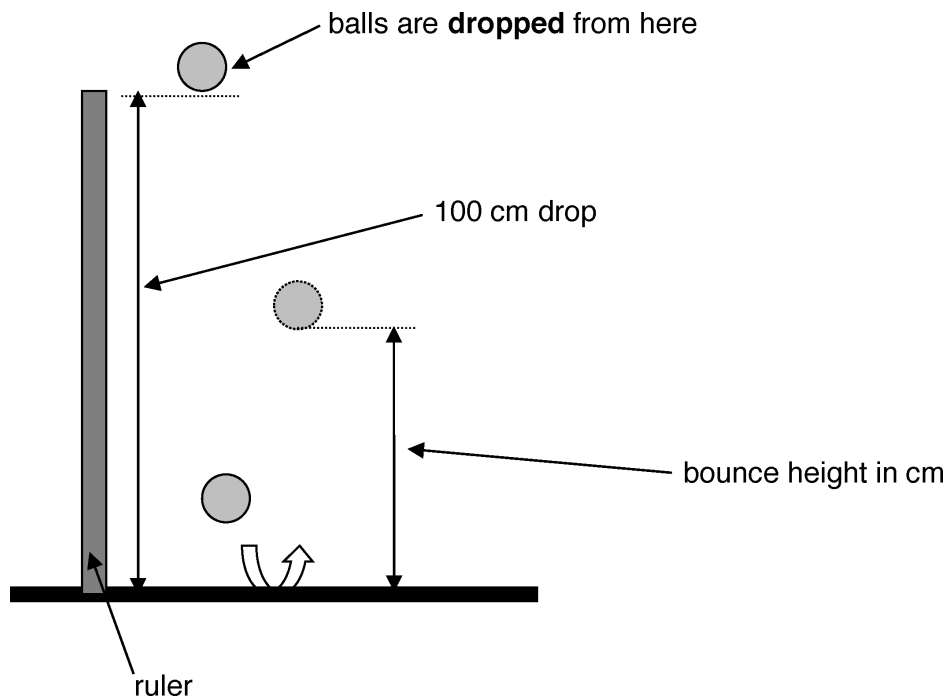
Her results are shown in **Table 20.1**.

Ball	Drop height (cm)	Bounce height (cm)			Mean bounce height (cm)
		1st reading	2nd reading	3rd reading	
Blue	100	61	62	60	61
Green	100	60	31	59	50
White	100	84	86	85	85
Yellow	100	26	24		26

Table 20.1

(a) Student **A** forgot to record one of the bounce heights for the **yellow** ball in **Table 20.1**.

Suggest the value of the **missing** result.

....

....

Answer ………………………………… cm   **[1]**

(b) Student **B** does an experiment with bouncing balls.

- He does his experiment with a drop height of **200 cm**.
- One ball bounces **100** cm.

Student **B** says that this ball is a better bouncer than any of Student **A**s balls.

Use **Table 20.1** and ideas about efficiency to explain why Student **B** is incorrect.

....

....

.... **[2]**

(c) Student **B** uses a new ball. He says this ball is an amazing bouncer.

He says if you drop it from **200** cm it will bounce to a height of **250** cm.

Explain why this is **not** possible.

....

....

.... **[2]**

Turn over

21 A student has two radiators in her home. They are filled with different liquids and have different power ratings.

The diagram shows information about the two heaters.

Oil radiator	Water radiator
Heater contains 10 kg of **oil**	Heater contains 10 kg of **water**
400 W heater Specific heat capacity for oil = 1 680 J/kg°C	**1000 W heater** Specific heat capacity for water = 4 200 J/kg°C

(a) The radiators are turned on and both radiators increase in temperature by 40 °C in 1 680 seconds.

Show, by calculation, that the heaters take the same time to heat up.

....

....

....

....

....

.... **[4]**

(b) The student has two fires in her home (**X** and **Y**) shown in the diagrams below.
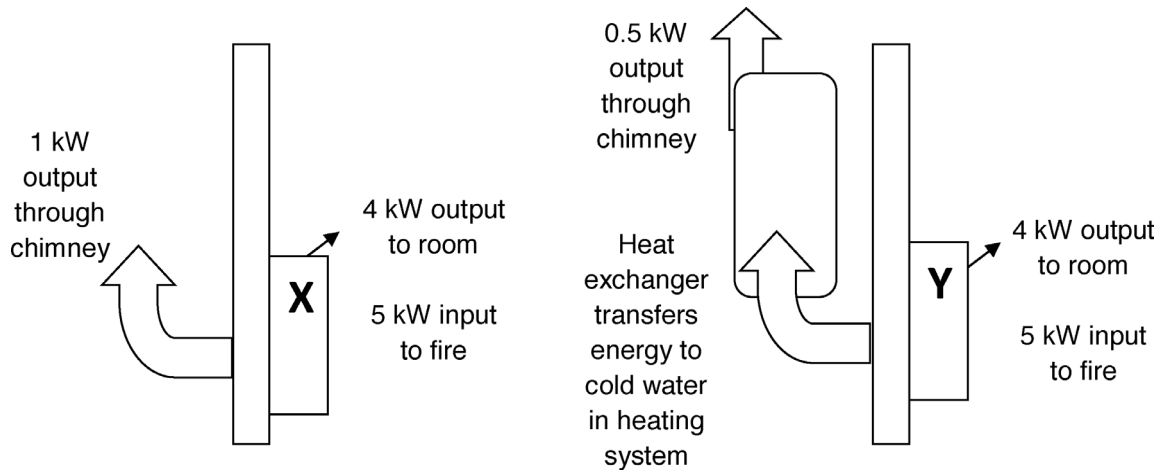
Why does fire **Y** help to save money on the energy bills for her home?

Use calculations of efficiency in your answer.

....

....

....

....

....

.... **[4]**

22 **(a)** State **two** features of a satellite in a **polar orbit**?

Suggest a use for a satellite in a polar orbit.

....

....

.... **[3]**

(b) An artificial satellite (**X**) is kept in a stable circular orbit around a planet by a centripetal force caused by gravity.
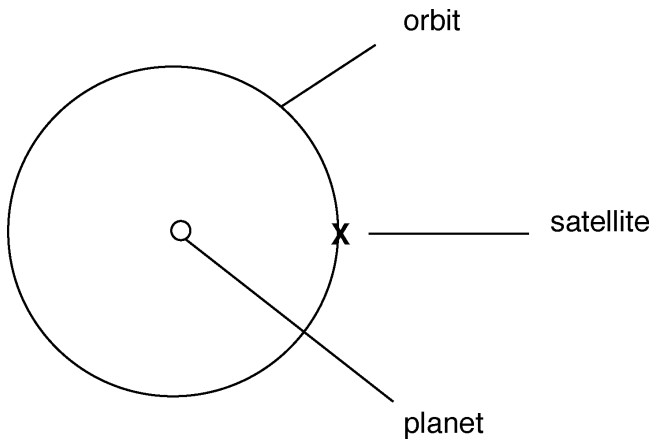
(i) Explain how the velocity of a satellite is constantly changing whilst its speed remains the same when it is in orbit.

....

....

.... **[2]**

(ii) The satellite is remotely controlled from Earth.

The scientists want the satellite to move slower.

What effect will this change in speed have on the height of its orbit?

Explain your answer.

....

....

.... **[2]**

23 The diagram below shows the structure of a transformer.

iron core

primary coil
230 V a.c.

27 600 turns

secondary coil
12 V

fewer turns
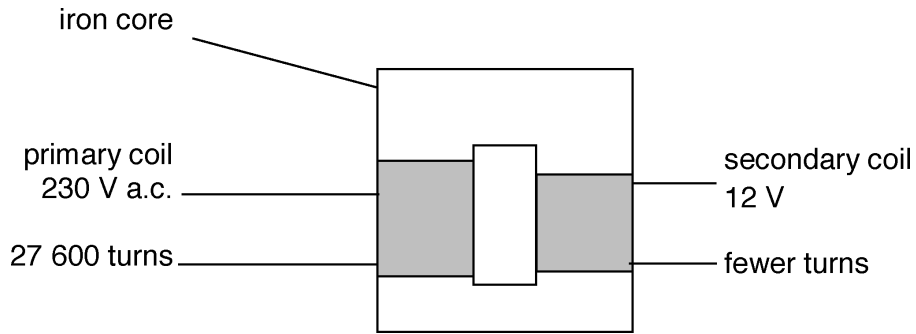
(a) The alternating current in the secondary coil is greater than in the primary coil.

Explain why.

....

....

....

.... **[3]**

(b) The secondary coil produces an output of 12 V.

Calculate the number of turns in the secondary coil.

Show your working.

....

....

.... **[2]**

(c) A transformer is used to increase voltage from 25 000 V up to 400 000 V before transmission through the National Grid. Therefore, the voltage increases by 16 times.

   (i) Explain how this increase in voltage would affect the current, assuming that the power remains constant.

     ....

     .... **[2]**

   (ii) The formula to work out power is:

       power = current^2 × resistance

     Explain, using a calculation, why this increase in voltage is important to power loss in transmission cables.

     ....

     ....

     .... **[2]**

24 A student does an experiment with radioactive materials.

- He investigates how the activity of radiation changes with distance.
- The radiation moves from the radioactive source to a detector.
- He measures the counts per minute at the detector.

radioactive source

distance in cm between material and detector

detector
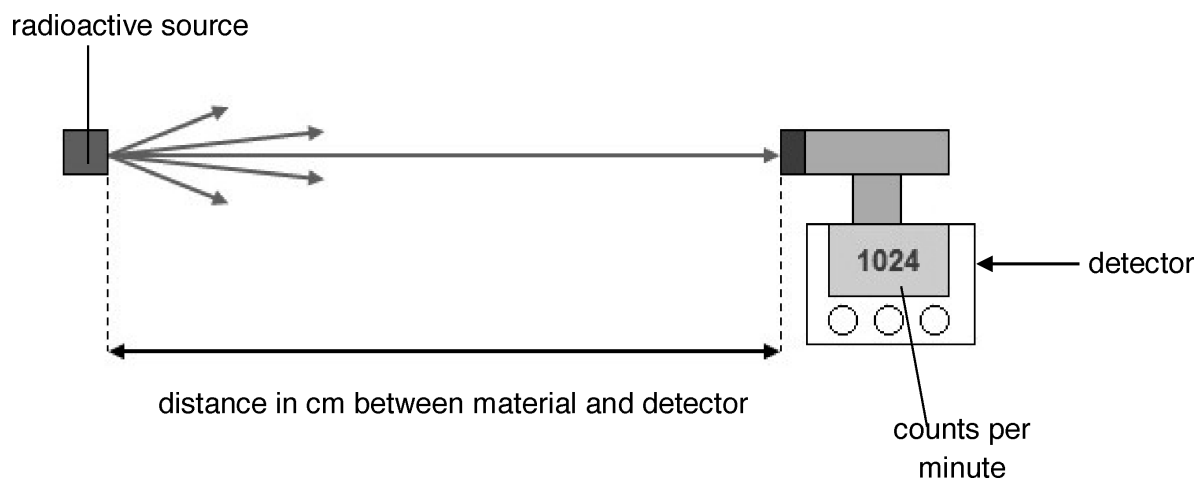
counts per minute

The table shows the results.

Distance between source and detector (cm)	Count rate (counts per minute)
10	1024
20	256
40	64
80	16

(a) Describe, using these results, how the count rate changes as the detector is moved away from the source.

....

.... **[2]**

(b) The student takes two further readings at 160 and 320 cm.

He adds these further readings to his table.

Distance between source and detector (cm)	Count rate (counts per minute)
10	1024
20	256
40	64
80	16
160	**6**
320	**0**

As the distance is increased to 160 and 320 cm, the results do **not** follow the same pattern as the other results.

Predict what these last two results should have been and explain the anomalies in the last two results.

....

....

....

....

....

.... **[3]**

(c) Gamma radiation is used to irradiate cancers in the brain.

Treatment is given for 15 minutes every 4 days.

Each patient receives a certain dose of radiation.

gamma source is rotated 360° around the head.

patient remains still during treatment.

Explain how this treatment reduces damage to healthy cells.

....

....

....

....

....

....

.... **[4]**
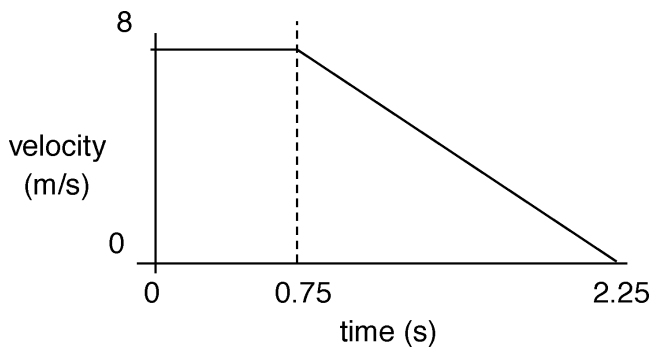
25 The table shows the stopping distances for a car.

Speed of car (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
4	3	1.5	4.5
8	6	6	12
16	12	24	36
32	24	....	....

(a) Add the missing results to the table at a speed of 32 m/s. **[2]**

(b) The car takes 6 m to brake when moving at 8 m/s.

Look at the graph of the car as it starts to brake and then stop.

Use the graph to show that the braking distance is 6 m.

....

.... **[2]**

(c) The formula to work out kinetic energy is:

kinetic energy = 0.5 × mass × (velocity^2)

A car has 30 000 J of energy and a mass of 1 tonne (1 tonne = 1 000 kg).

Calculate the velocity of the car and show your working.

....

....

....

Answer = ………………………………… m/s **[2]**

(d) Cars and lorries have different brakes.

- Brakes absorb the energy of the vehicle before it comes to rest.
- The brakes on lorries have larger brake discs and brake pads than cars.
- Brakes are designed to increased air flow.

Explain why increased air flow is more important for lorries than cars.

....

....

....

....

....

....

.... **[4]**

END OF QUESTION PAPER