Accredited

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

J249/04 Paper 4 (Higher tier)

Sample Question Paper

H

Date – Morning/Afternoon

Time allowed: 1 hour 45 minutes

You must have:
- the Data Sheet

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

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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.

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.

The football has a mass of 400 g.

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

Use the constant: 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 low current which heats wires more.

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

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

Your answer ☐

[1]

4 Which statement describes nuclear fusion?

A Two hydrogen nuclei join to form a helium nucleus.

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

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

D Two helium nuclei join to form a hydrogen nucleus.

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 pushed together by gravity leading to a fission reaction.

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

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

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

Your answer ☐

[1]

8 An element has more than one isotope.

Which 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 The most abundant form of radium is radium-226.

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

Which is an **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.

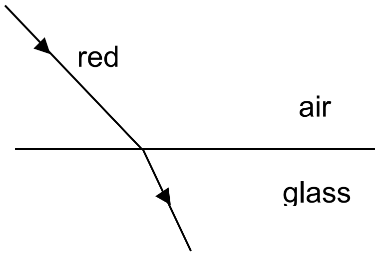
Its wavelength in air is longer than in water.

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	faster
B	higher	same
C	same	faster
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 **increases** the efficiency of a machine?

	increase 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 reduced.

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

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

D The acceleration and force of the ball is increased.

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 $^{7}/_{8}$ 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 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.

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

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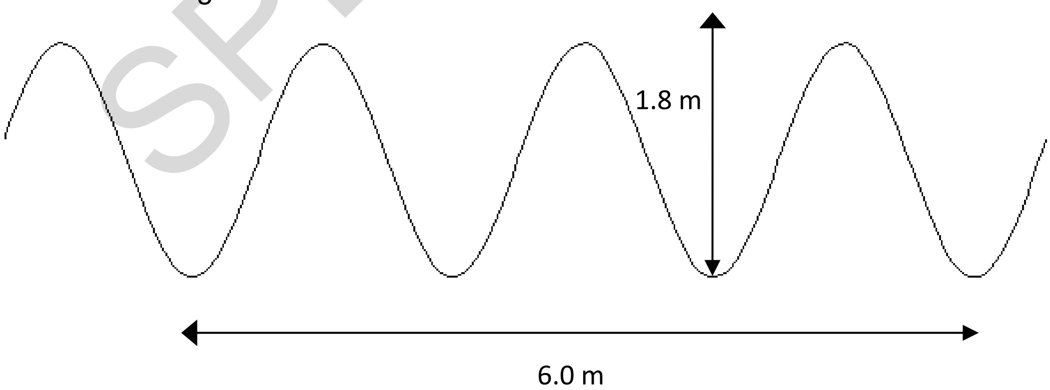
.... **[1]**

(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?

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.... **[2]**

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

Show your working.

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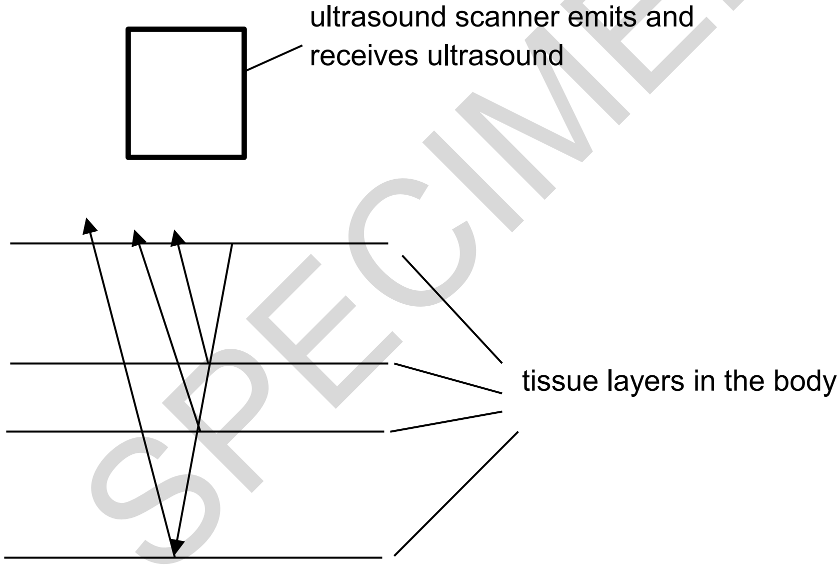
answer: .... seconds **[3]**

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



Ultrasound waves are emitted.

They reflect from layers of tissue inside the body.

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

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.... **[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.

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

(a) Calculate how high above the ground it is.

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answer: ………………m **[2]**

(b)

The energy at the bottom of the slope is lower than expected.

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

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

18 The information below shows information on radioactive isotopes.

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

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

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

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.... **[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**.

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.... **[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?

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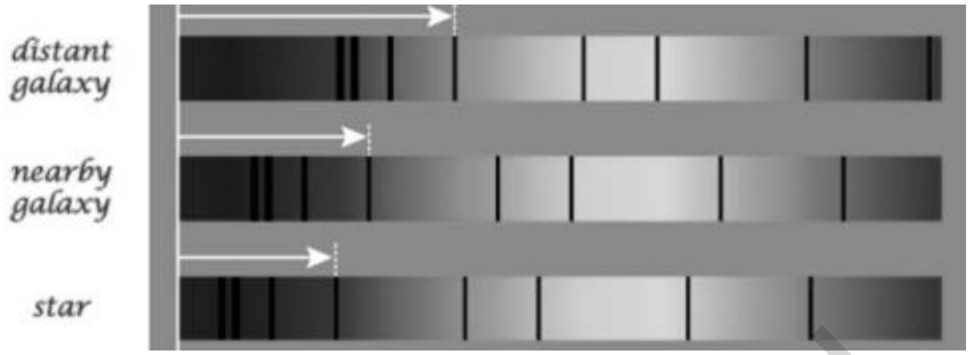
.... **[2]**

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

Here are three absorption spectra showing red shift. The white arrows show the relative position of the same band in the absorption spectra of a star, a nearby galaxy and a distant galaxy.



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

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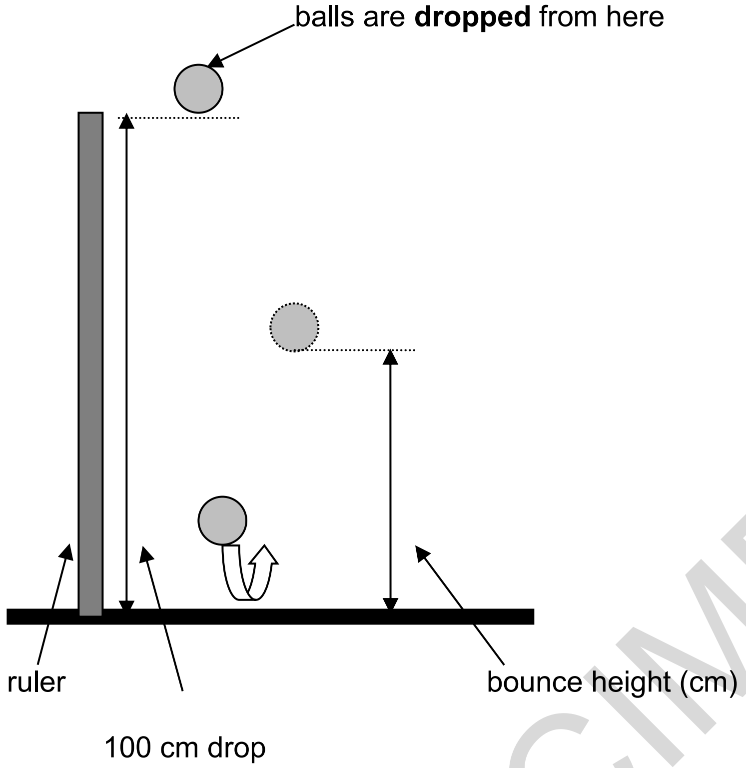
.... **[6]**

20 Kate investigates how well different balls bounce.

She drops different balls from the same height and measures the height the balls bounce.

She repeats the experiment 3 times for each ball.



Her results are shown in the table.

Ball	Drop height (cm)	1st reading bounce height (cm)	2nd reading bounce height (cm)	3rd reading bounce height (cm)	Mean bounce height (cm)
blue	100	61	62	60	61
green	100	60	31	59	50
white	100	84	86	85	85
yellow	100	26	24		26

(a) Kate forgot to record one of the results for the **yellow** ball.

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

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answer: ……………………… cm

[1]

(b) Josh does an experiment with bouncing balls.

He does his experiment with a drop height of **200 cm**.

One ball bounces **100** cm.

Josh says that this ball is a better bouncer than any of Kate's.

Use the data and ideas about efficiency to explain why Josh is incorrect.

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……………………………………………………………………………………………… **[2]**

(c) Josh 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.

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

21 Alex has two radiators in her home. They are filled with 10 kg of different liquids.

The radiators have different power ratings.

oil-filled radiator	**water-filled radiator**
Heater contains 10 kg of oil **400 W heater** **Specific heat capacity for oil is 1680 J/kg^{0}C**	**Heater contains 10 kg of water** **1000 W heater** **Specific heat capacity for water is 4200 J/kg^{0}C**

(a) The heaters are turned on and the temperature of each rises by 40 ºC in 1 680 seconds.

Use the data to show that the heaters take the same time to heat up.

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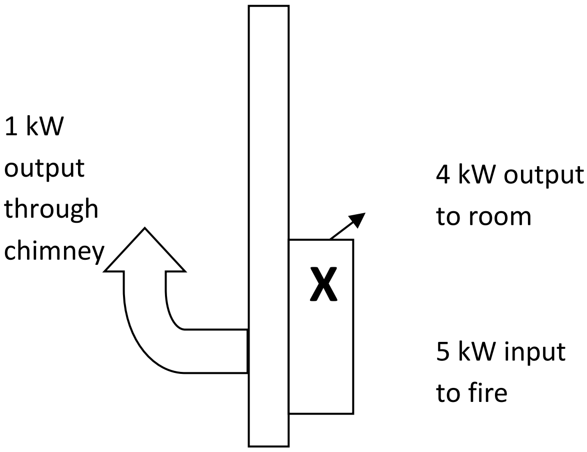
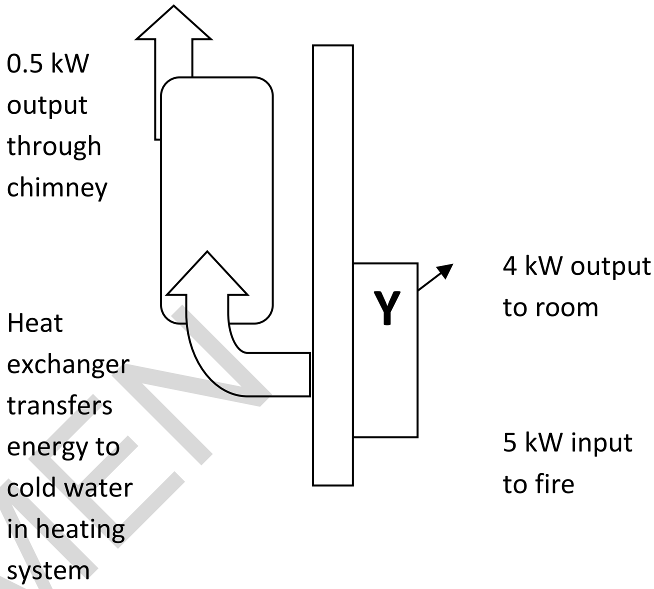
.... **[4]**

(b) Alex has two fires in her home, **X** and **Y** shown in the diagrams below.





Why does Fire **Y** helps save money on the energy bills for her home?

Use calculations of efficiency in your answer.

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.... **[4]**

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

Suggest a use for a satellite in a polar orbit.

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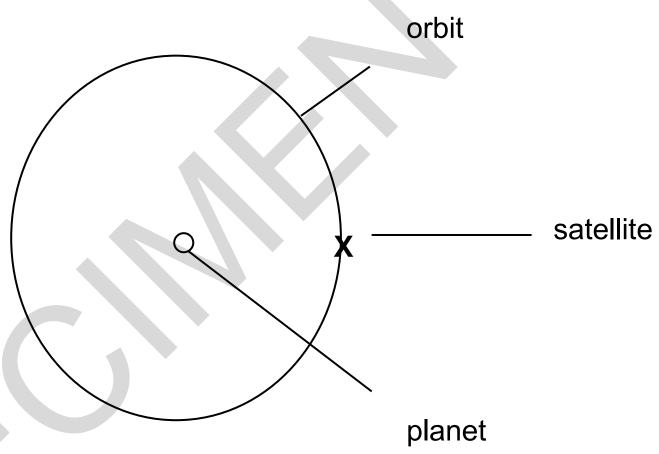
.... **[3]**

(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.

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.... **[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.

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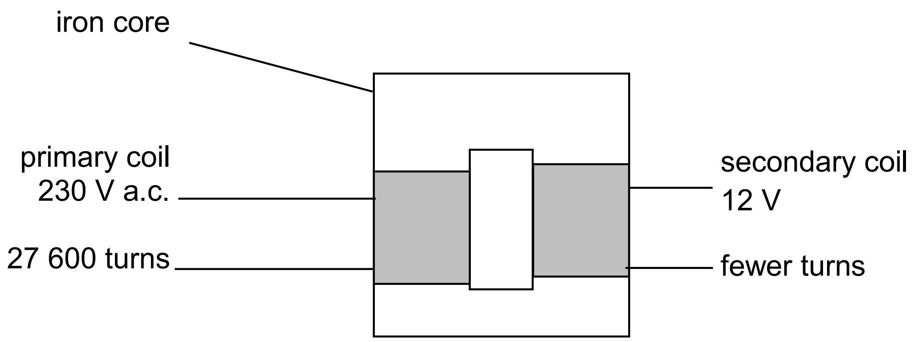
……………………………………………………………………………………… **[2]**

23 The diagram below shows the structure of a transformer.



(a) Explain why there is more alternating current in the secondary coil than in the first.

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.... **[3]**

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

Calculate the number of turns needed on the secondary coil.

Show your working.

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.... **[2]**

(c) Voltage is increased before transmission through the National Grid.

It is increased from 25 000 V up to 400 000 V. This increases the voltage 16 times.

(i) How much would this increase in voltage affect the current?

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.... **[2]**

(ii) Use the formula: **power = current^2 x resistance**

to explain why this voltage increase is important to power loss in transmission cables.

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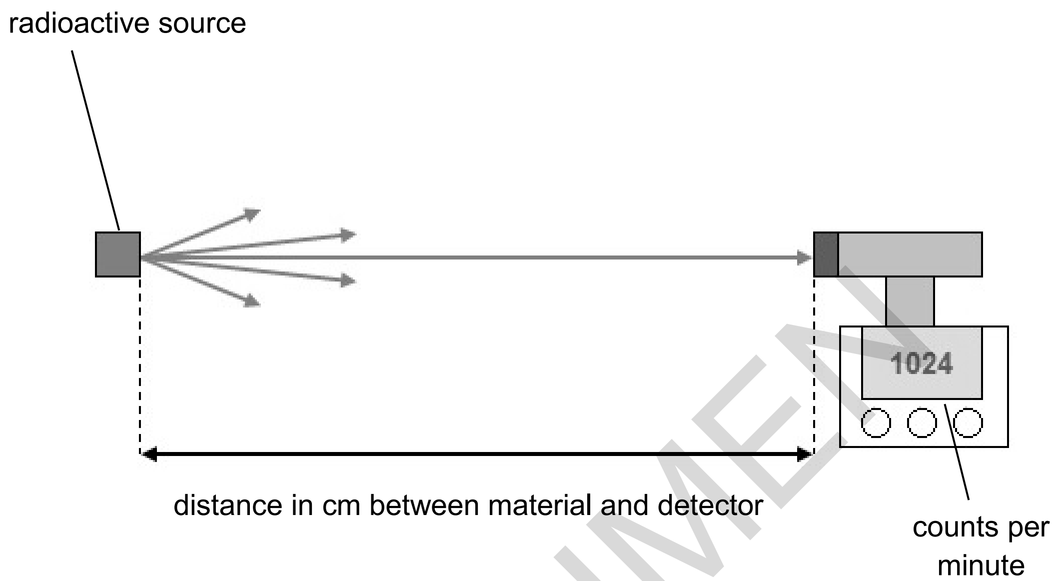
.... **[2]**

24 Matt experiments with radioactive materials.

He investigates how the activity of radiation changes with distance.

The radiation moves from the source to the detector.

He measures the counts per minute from a radioactive source.



The table shows the results from the experiment.

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

(a) Describe using the data in the table how the count rate changes as the detector is moved away from the source.

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………………………………………………………………………………………………… **[2]**

(b) Matt does two further readings at 160 cm and 320 cm.

His results are in the table below.

Distance between the source and the 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 cm and 320 cm the results do not follow the same pattern as the other results.

What do you think these results should have been?

Explain the anomalies in the last two results.

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.... **[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.

Explain how this treatment reduces damage to healthy cells.

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.... **[4]**

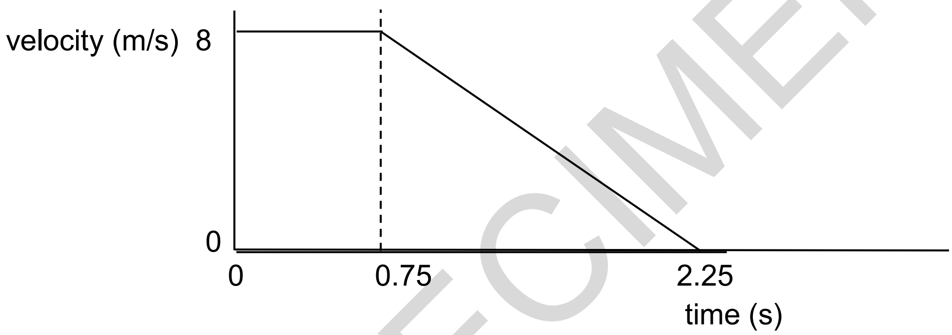
25 The table shows the stopping distances for a car.

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

(a) Use the data given to fill in the information missing 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 stopping.



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

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…………………………………………………………………………………………… **[2]**

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

kinetic energy = 0.5 x mass x (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.

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……………………………………………………………………………………………

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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 for increased air flow.

Explain why this is more important for lorries than cars.

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.... **[4]**

END OF QUESTION PAPER

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