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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P8: Global challenges (F)

GCSE Physics A Foundation Tier (J249) · Topic P8

37 questions · 207 marks · Mark schemes included

OCR GCSE (9–1) Physics A (Gateway Science) J249, June 2018 – June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

37 questions · 207 marks · grouped by sub-topic, lowest tariff first



SUB-TOPIC P8.1

PHYSICS ON THE MOVE

10 questions in this sub-topic · 75 marks · lowest tariff first



3 Which factor can affect the **braking** distance of a car?

- A Age of driver
- B Consumption of alcohol
- C Mass of car
- D Tiredness

Your answer

[1]



- 5 The table shows the stopping distances for a car travelling at two different speeds.

Speed (miles per hour)	Stopping distance (metres)
30	23
70	96

The car now travels at 50 miles per hour.

Estimate the stopping distance.

- A** 28 m
B 53 m
C 73 m
D 88 m

Your answer

[1]

10 When a car crashes, it undergoes a very large **deceleration**.

Which row describes the crash?

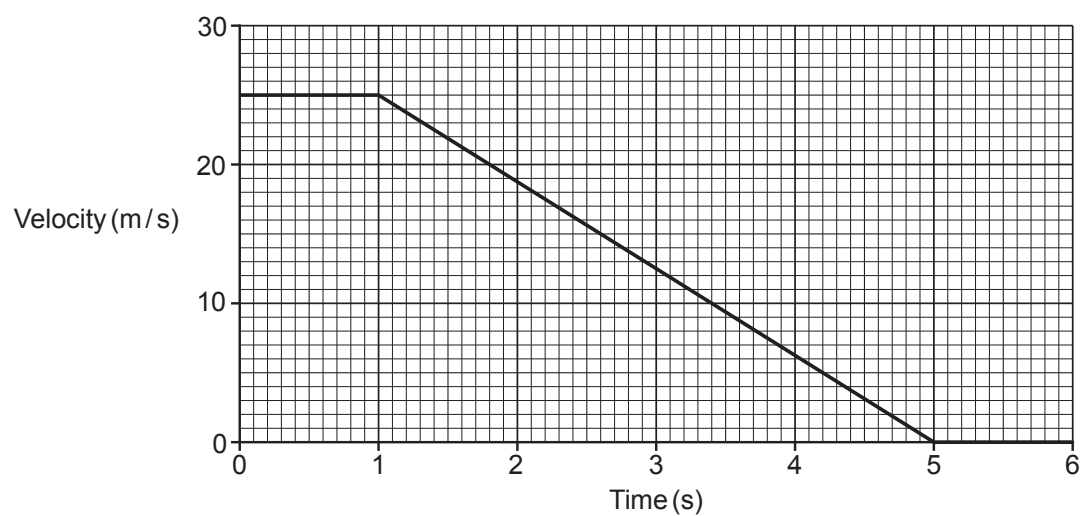
	Forces involved	Time for the car to decelerate
A	large	large
B	large	small
C	small	large
D	small	small

Your answer

[1]



- 4 The graph shows how the velocity of a car changes when the driver sees a hazard in the road at time = 0 seconds.



Which statement is correct?

- A The driver brakes for 1 second.
- B The driver brakes for 5 seconds.
- C The driver takes 1 second to react.
- D The driver takes 5 seconds to react.

Your answer

☐

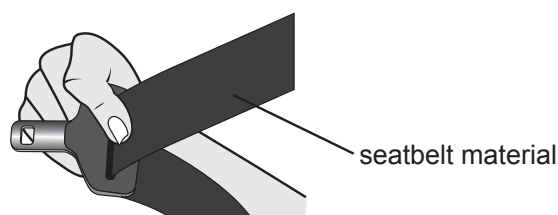
[1]

- 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]

- 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]

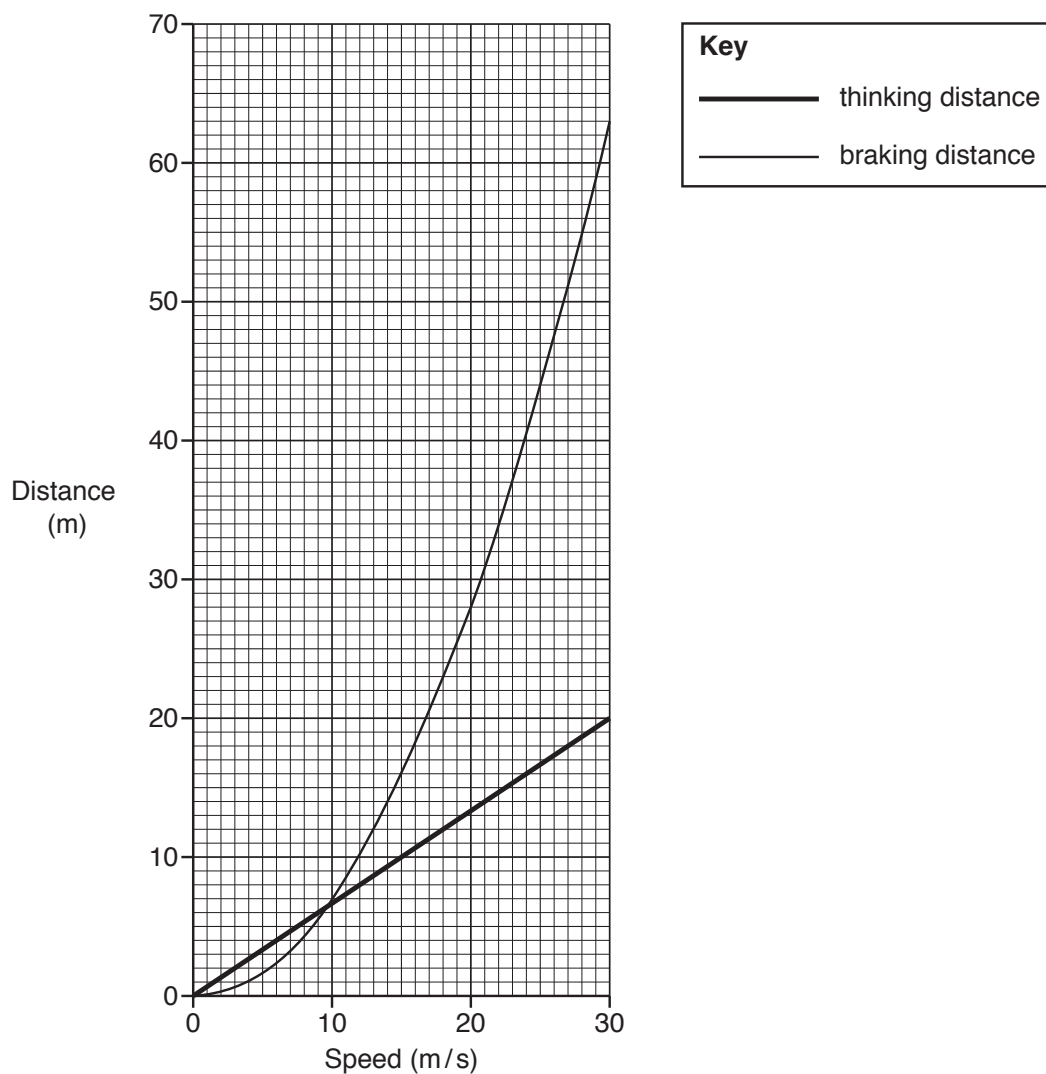
- (c)*** Explain why the stopping distances are different for each speed in **Fig. 20.1**.

.....

 [6]



25 The graph shows thinking and braking distances for a car at different speeds.



(a) Describe how **thinking distance** varies with increasing speed.

Use data from the graph in your answer.

.....

.....

.....

..... [2]

- (b) (i) Use the graph to find the **thinking distance** at 24 m/s.

Thinking distance = ... m [1]

- (ii) Calculate the **thinking time** at 24 m/s.

Use your answer to (b)(i) and the equation: distance travelled = speed $\times$ time

Give your answer to **2** decimal places.

Thinking time = ... s [3]

- (c) (i) State **one** factor that could **increase** thinking distance.

..... [1]

- (ii) Calculate the **stopping distance** at 15 m/s.

Use the graph to help you.

Stopping distance = ... m [2]

- (d) How does the speed affect the **kinetic energy** and **braking distance** of the car?

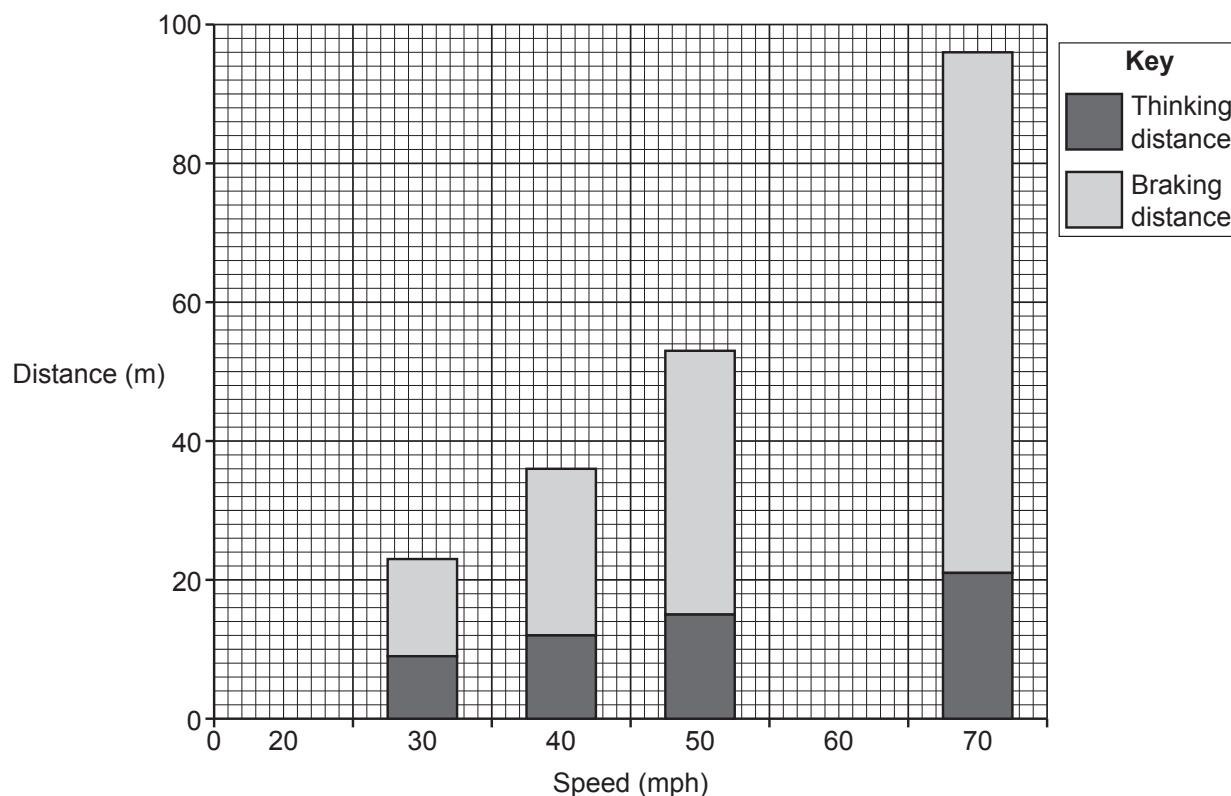
Use the graph in your answer.

.....

 [3]



- 21 The bar chart shows thinking distances and braking distances for a car moving at different speeds.



- (a) For a car moving at 20 mph:
- The thinking distance is 6 m.
 - The braking distance is 6 m.

Complete the bar chart for a car moving at 20 mph.

[2]

- (b) Use the bar chart to estimate the thinking distance and braking distance for a car moving at 60 mph.

Thinking distance = ... m

Braking distance = ... m

[2]

- (c) Give the name of the distance represented by the **total** height of each bar.

..... [1]



- (d) Complete the table below to describe how each factor changes the thinking distance and braking distance.

Use the words in the list.

decreases	increases	no effect
-----------	-----------	-----------

Factor	Thinking distance	Braking distance
Drinking alcohol		
Higher speed		
Wet road		

[3]

- (e) (i) A car decelerates to a stop. The braking force is 5600 N.

The braking distance is 20 m.

Calculate the work done by the brakes. Include the correct unit.

Use the equation: work done = force $\times$ distance

Work done = ... Unit [3]

- (ii) A double-decker bus is travelling at the same speed as the car.

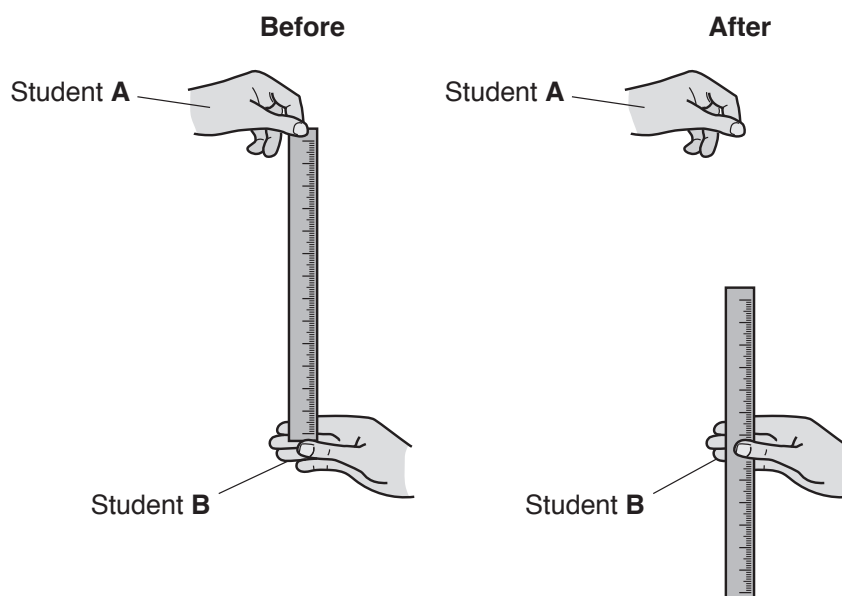
The double-decker bus stops in the same distance as the car.

Suggest why the double-decker bus needs a larger braking force than the car.

.....
 [1]



19 (a) The diagram shows a ruler being used to estimate a student's reaction time.



(i) Describe how the ruler can be used to estimate student **B**'s reaction time.

.....

.....

.....

..... [2]

(ii) Why do the students repeat the experiment several times?

.....

..... [1]

(iii) Student **B** is very tired when they try this experiment.

Suggest how this might affect student **B**'s reaction time.

.....

..... [1]

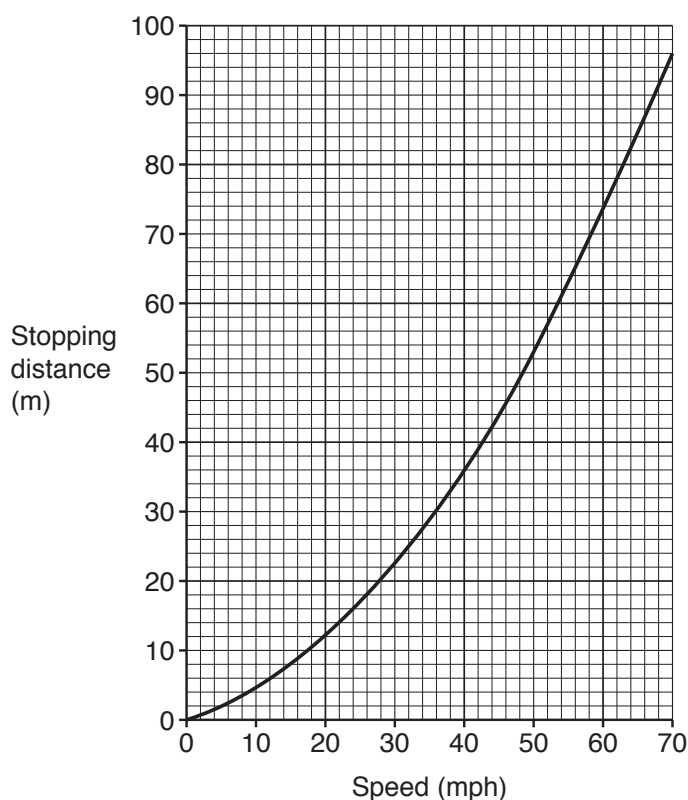
(b) The driver of a car makes an emergency stop.

The thinking distance is 9 m. The braking distance is 14 m.

(i) Calculate the total stopping distance of the car.

Stopping distance = ... m [1]

(ii) This graph shows how this driver's stopping distance changes with speed.



- A car is travelling at 50 mph.
- There is a barrier in the road 40 m in front of the car.
- The driver makes an emergency stop.

Use the graph to work out if the car hits the barrier.

Explain how you obtained your answer.

.....

.....

.....

..... [2]



- (iii) State one factor, other than speed, that affects braking distance.

Explain how this factor changes braking distance.

Factor

Explanation

.....

.....

[3]

- (c) (i) A car travels at a speed of 13 m/s. The car takes 4 s to stop after the brakes are applied.

Calculate the deceleration of the car.

Use the equation: acceleration = change in velocity ÷ time

Deceleration = ... m/s² [2]

- (ii) The braking system of the car in (c)(i) is changed. The same car travelling at 13 m/s now takes 0.4 s to stop after the brakes are applied.

The driver says, 'The new braking system is ten times safer.'

Do you agree with the driver? Explain your answer.

Yes ☐

No ☐

.....

.....

.....

..... [2]

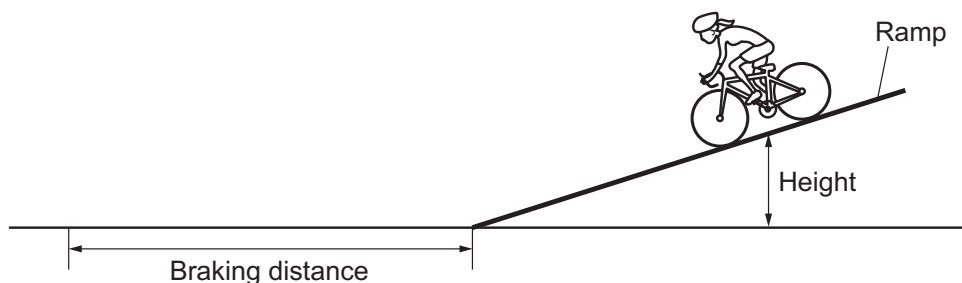
- (iii) Suggest **one** safety feature in a car that can reduce injury in a crash.

..... [1]



17 Student **A** is investigating braking distance using a bicycle. This is their method:

- Freewheel down a ramp **without** pedalling.
- At the bottom of the ramp, press the brakes until the bicycle comes to a stop.
- Measure the braking distance of the bicycle from the bottom of the ramp.



(a) Student **A** repeats the investigation three times. Each time they start at the same height. Their results are shown in the table.

Measurement number	Braking distance (m)
1	4.4
2	8.0
3	5.6

(i) Suggest what equipment student **A** can use to measure the braking distance.

..... [1]

(ii) Use the results from the table to calculate the **mean** braking distance.

Mean braking distance = ... m [2]

(iii) Suggest why the values of the braking distance are **not** the same.

.....
 [1]

(b) Student **B** repeats the investigation using the same method.

The mass of student **B** and the bicycle is 80 kg.

The height of student **B** and the bicycle at the top of the ramp is 2.0 m.

Gravitational field strength = 10 N/kg.

Calculate the gravitational potential energy of student **B** and the bicycle at the top of the ramp.

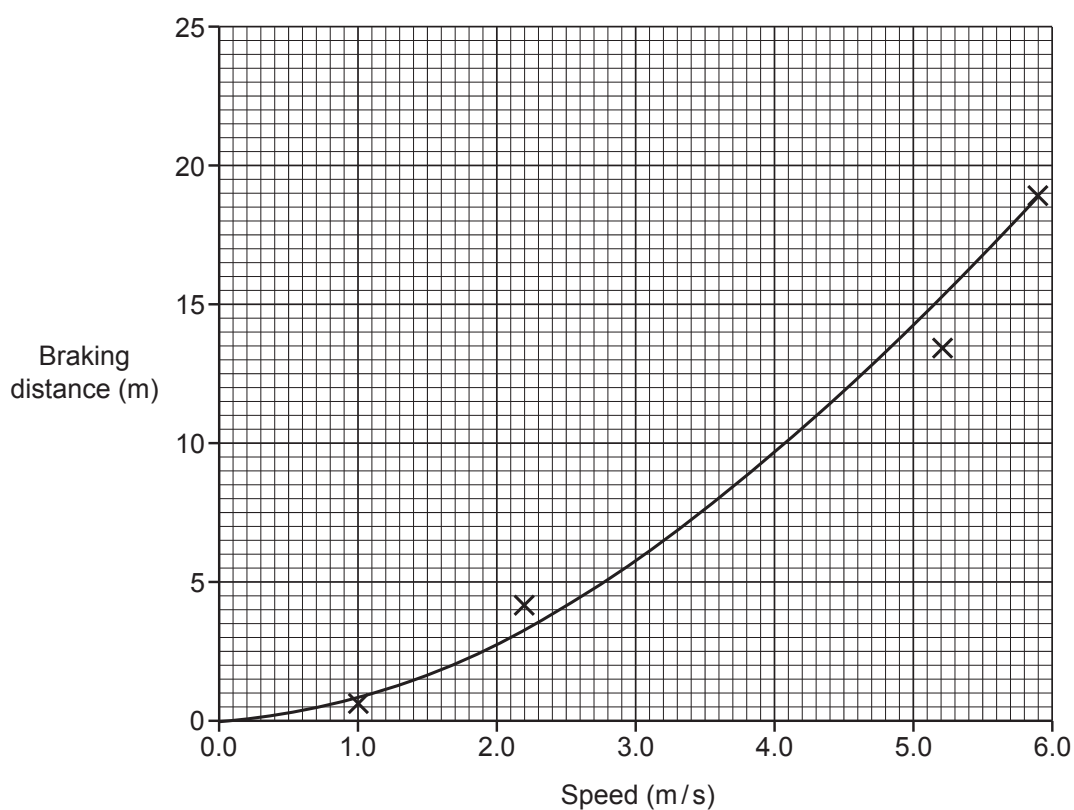
Use the Data Sheet.

Gravitational potential energy = ... J [3]



(c) Student **C** measures the braking distance for different speeds at the bottom of the ramp.

The graph shows student **C**'s results.



(i) Use the graph to find the braking distance when the speed is 4.3 m/s.

Braking distance = ... m [1]

(ii) It can be more dangerous to cycle quickly.

Use data from the graph to explain why.

.....

.....

.....

..... [2]

(iii) Suggest how student **C**'s investigation could be improved.

.....
 [1]

(d) The students increase the mass of the bicycle.

What happens to the braking distance?

Tick (✓) **one** box.

Decreases

☐

Increases

☐

Stays the same

☐

[1]

(e) Student **D** pedals the bicycle on a level surface.

They start from rest and reach a velocity of 6 m/s.

Estimate the acceleration of student **D** on the bicycle.

Use the equation: $\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$

Acceleration = ... m/s² [3]



SUB-TOPIC P8.2

POWERING EARTH

11 questions in this sub-topic · 68 marks · lowest tariff first



1 Which statement describes the domestic electricity supply in the UK?

- A 50 V a.c. at 230 Hz
- B 50 V d.c. at 230 Hz
- C 230 V a.c. at 50 Hz
- D 230 V d.c. at 50 Hz

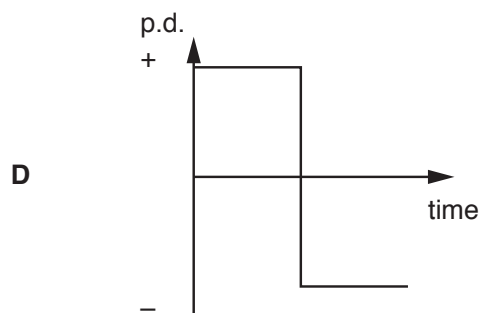
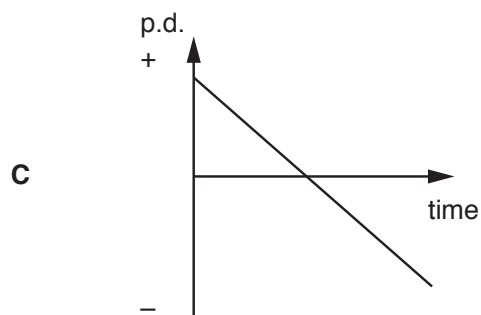
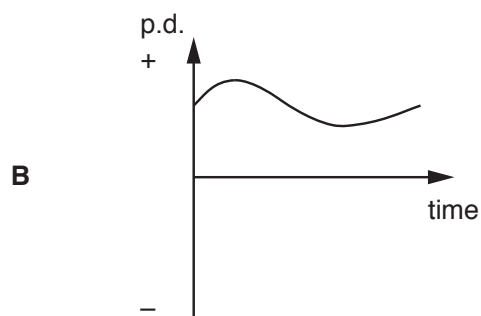
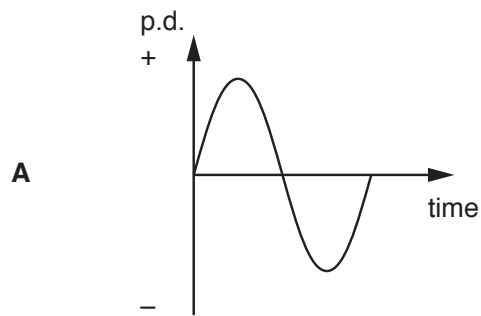
Your answer

[1]



6 Here are some graphs for the potential difference (p.d.) of four electrical supplies.

Which graph shows a direct voltage?



Your answer

[1]

- 10** Which row in the table correctly describes how the national grid transfers electrical energy efficiently?

	Voltage	Current	Reason
A	High	High	To increase heating in wires.
B	High	Low	To reduce heating in wires.
C	Low	High	To reduce heating in wires.
D	Low	Low	To reduce heating in wires.

Your answer

[1]

13 The table shows the current and potential difference (p.d.) for four different transformers.

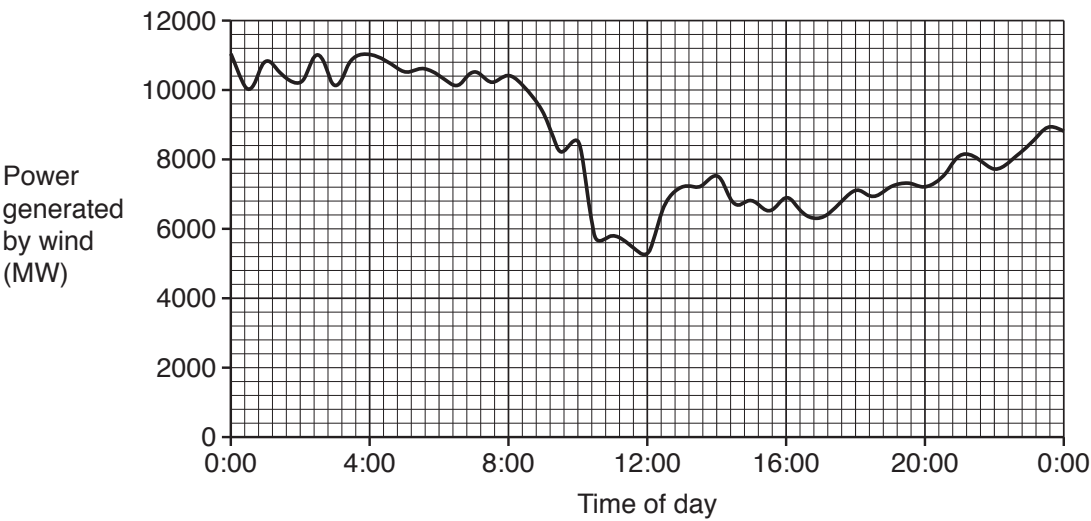
Which row shows the correct data for a **step-up** transformer?

	Primary coil		Secondary coil	
	p.d. (V)	Current (A)	p.d. (V)	Current (A)
A	6	4	12	2
B	12	2	3	8
C	12	2	12	2
D	12	2	24	1.5

Your answer

[1]

4 The graph shows how the power generated by the wind in the UK varied over one day.



Which row in the table is correct?

	Maximum power generated (MW)	Reliability of wind power
A	5200	Reliable
B	5200	Unreliable
C	11 000	Reliable
D	11 000	Unreliable

Your answer

[1]

2 Which of the following is a renewable energy source?

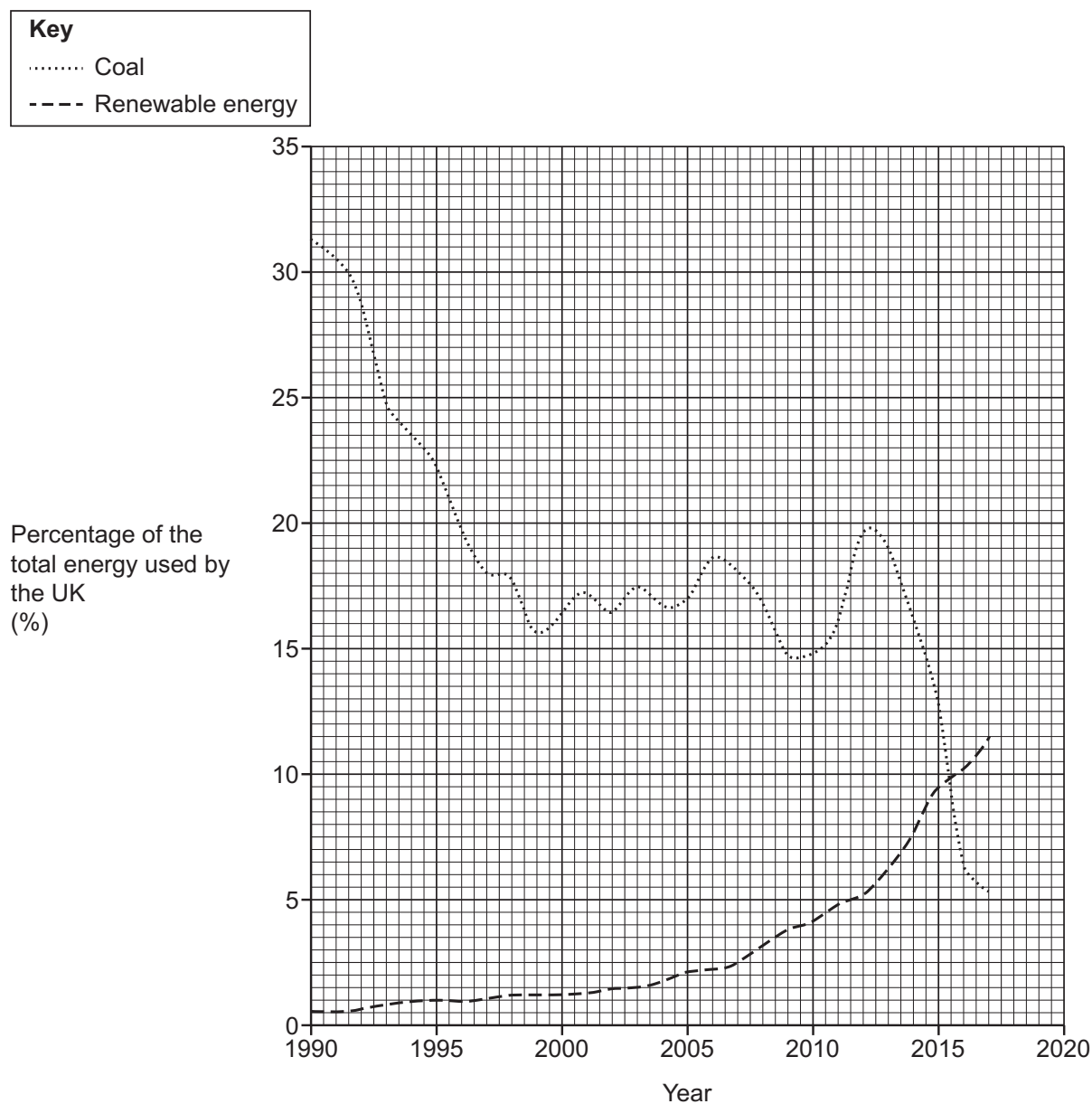
- A** Coal
- B** Hydro-electricity
- C** Nuclear fuel
- D** Oil

Your answer

[1]

20 (a)* The use of coal and renewable energy resources has changed in the UK over time.

The graph shows these changes.



23 A solar cell changes light into electricity. Solar panels contain solar cells.

(a) A student investigates a solar cell:

- They change the intensity of the light.
- They measure the potential difference across the solar cell.

(i) **Table 23.1** shows the student's results:

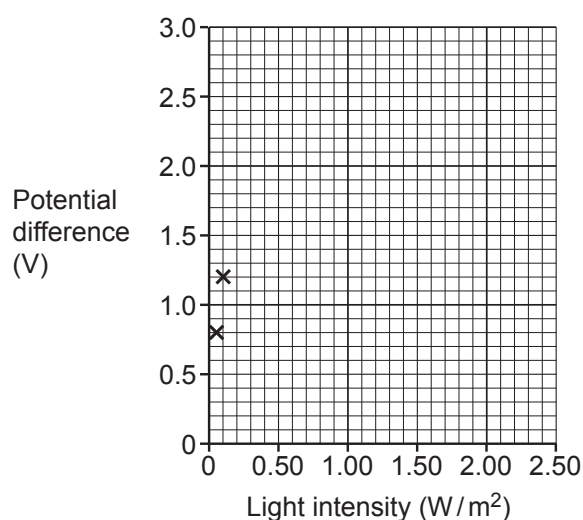
Light intensity (W/m^2)	Potential difference (V)
0.05	0.8
0.10	1.2
0.20	1.5
0.40	1.8
0.80	2.2
1.60	2.5

Table 23.1

Plot a graph of the results from **Table 23.1**. Two results have already been plotted for you.

Draw a line of best fit.

[3]



(ii) The light intensity is changed to $2.00 \text{ W}/\text{m}^2$.

Use your graph to predict the potential difference of the solar cell.

Show your working on the graph.

Potential difference = ... V [2]



(iii) Suggest **one** way the student could improve their investigation.

.....
 [1]

(b) (i) More people use solar panels to generate electricity compared to twenty years ago.

Suggest **two** reasons why.

1

 2
 [2]

(ii) A homeowner fits solar panels to the roof of their house.

Table 23.2 gives the energy values for the house for **one** day:

Area of one solar panel	1.6 m ²
Area of roof that can be used	24 m ²
Maximum energy output of one solar panel	26 MJ
Energy needed by all appliances in the house	364 MJ

Table 23.2

Explain whether the energy needed by all the appliances can be generated using **only** solar panels.

Use **Table 23.2** and your knowledge of solar panels to explain your answer.

.....

 [3]



16 Energy sources are used to generate electricity.

(a) The list shows some energy sources.

coal	hydroelectric	nuclear	
oil	solar	tidal	wind

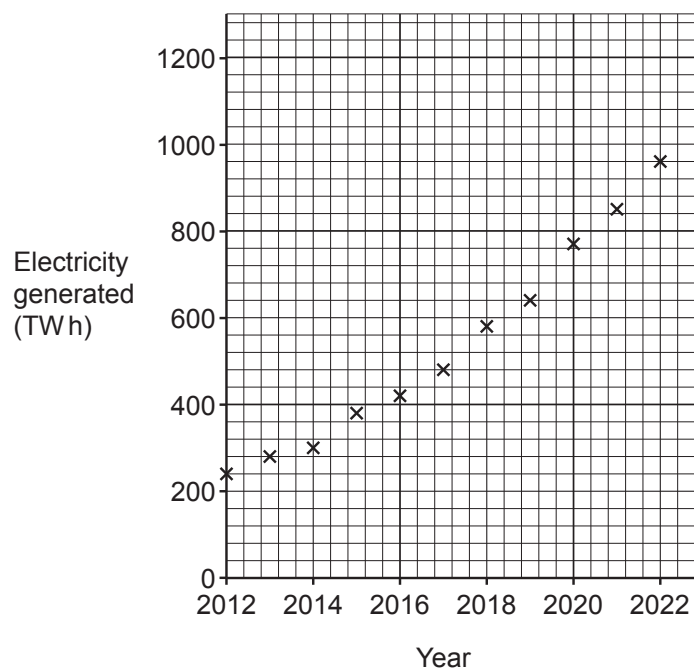
(i) Write down the name of **one renewable** energy source from the list.

..... [1]

(ii) Write down the name of **one non-renewable** energy source from the list.

..... [1]

(b) The graph shows the electricity generated by some renewable energy sources in the UK between 2012 and 2022.



(i) Draw a curve of best fit on the graph.

[1]

- (ii) Describe how the electricity generated by these renewable energy sources has changed between 2012 and 2022.

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

- (iii) Give **two** reasons why it is important that the trend shown on the graph continues.

1
.....
2
..... [2]

- (iv) Calculate the change in the electricity generated between 2012 and 2022.

Use the graph.

Change in electricity generated = ... TWh [3]

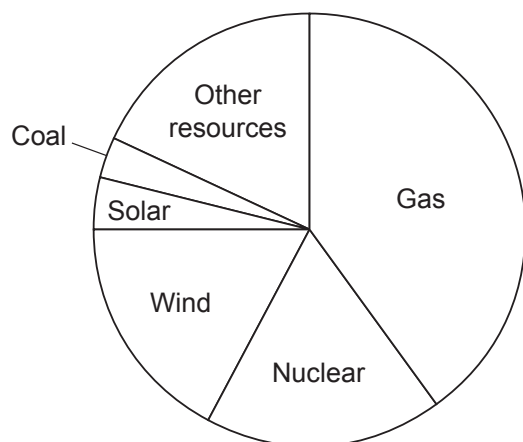
- (v) Calculate the average change in the electricity generated by these renewable energy sources **per year** between 2012 and 2022.

Average change per year = ... TWh/year [2]

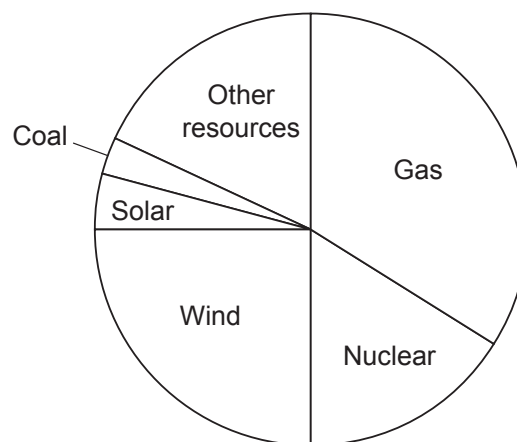


18 The diagrams show how electricity was generated in the UK in 2019 and in 2020.

2019



2020



(a) Which **two** energy resources generated the **least** electricity in **2019**?

..... and [2]

(b) Estimate the percentage of electricity generated using wind in **2020**.

Electricity generated using wind = ... % [3]

(c) **Two** energy resources showed a significant change between 2019 and 2020.

Give the names of these **two** energy resources.

1

2

[2]

- (d) From 2019 to 2020, the use of solar power changed from 3.9% to 4.2%.

Calculate the percentage change in the use of solar power.

Use the equation:

$$\text{percentage change} = \frac{(\text{new value} - \text{old value})}{\text{old value}} \times 100\%$$

Give your answer to **1** decimal place.

Percentage change = ... % **[3]**

- (e) Since 2013, the use of coal power stations to generate electricity has decreased.

- (i) Suggest why.

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

- (ii) In 2020, a news article stated:

‘The UK started up an old coal power station on Monday to meet the demand for electricity. The national grid confirmed coal was providing 3% of the UK’s power.’

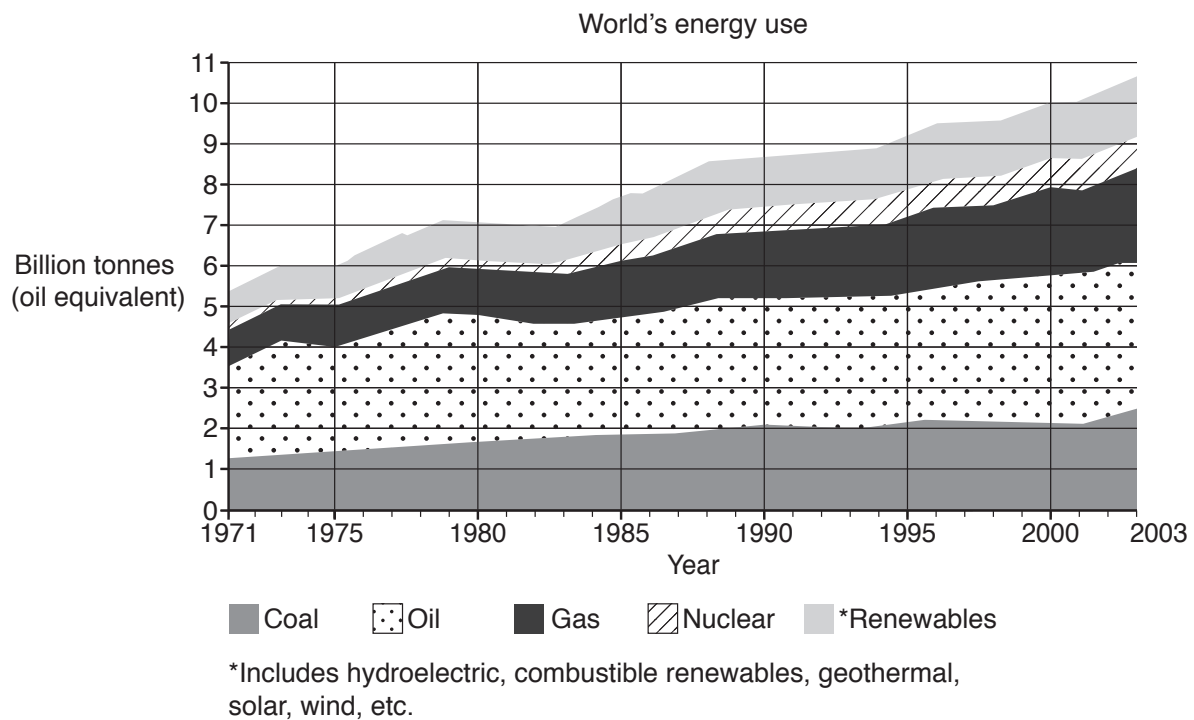
Suggest **two** reasons why the national grid had to use a **coal** power station to meet demand for electricity.

1

 2
 **[2]**



- 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.



- (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).

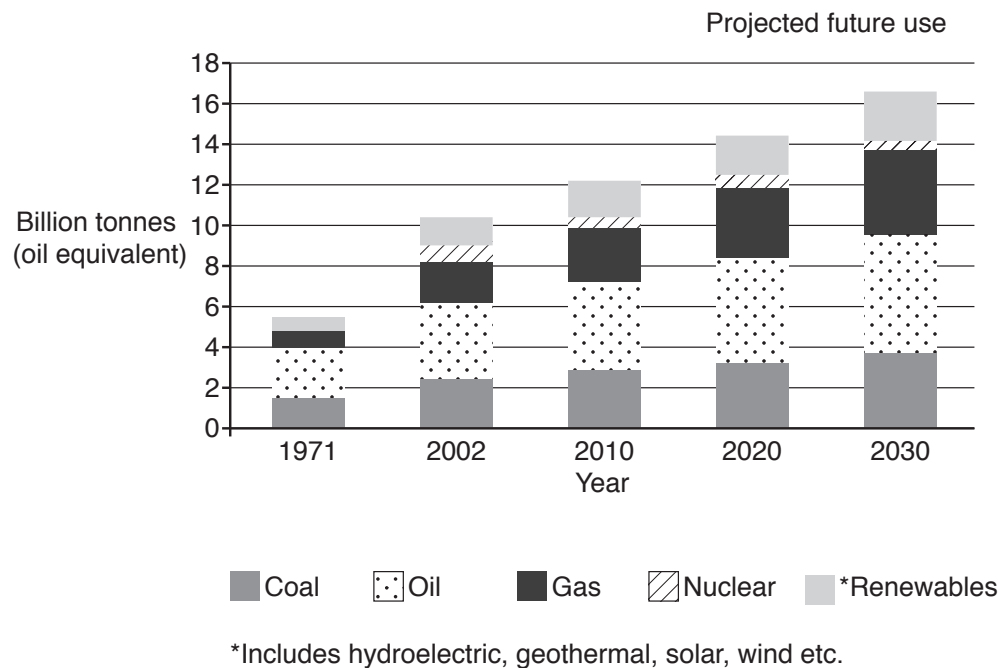
Approximately what percentage of this amount was due to fossil fuel use?

Answer = ...% [2]



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

The graph shows some of their research.



(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 $23\ \Omega$.

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]



SUB-TOPIC P8.3

BEYOND EARTH

16 questions in this sub-topic · 64 marks · lowest tariff first



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]



3 An astronomer observes a red-shift of light from a distant galaxy.

What does red-shift of light mean?

- A** The speed of the light has decreased.
- B** The speed of the light has increased.
- C** The wavelength of the light has decreased.
- D** The wavelength of the light has increased.

Your answer

[1]



4 Which row describes nuclear **fusion**?

	What happens	Where it occurs
A	heavy nuclei split	in nuclear power stations
B	heavy nuclei split	in the Sun
C	light nuclei combine	in nuclear power stations
D	light nuclei combine	in the Sun

Your answer

[1]

8 Which statement about the Solar System is correct?

- A** Mars is a star.
- B** Mercury is the planet closest to the Sun.
- C** Neptune is the planet closest to the Earth.
- D** Saturn is a moon.

Your answer

[1]



11 An astronomer observes that light from a distant galaxy is **red-shifted** compared to the same wavelength of light observed on the Earth.

Which row correctly describes the astronomer’s conclusion?

	Observed wavelength of light from the galaxy	Movement of the galaxy
A	longer than on the Earth	moving away from the Earth
B	longer than on the Earth	moving towards the Earth
C	shorter than on the Earth	moving away from the Earth
D	shorter than on the Earth	moving towards the Earth

Your answer

[1]

13 In May 2021, SpaceX launched sixty Starlink satellites into our solar system.

Which row correctly describes objects in our solar system?

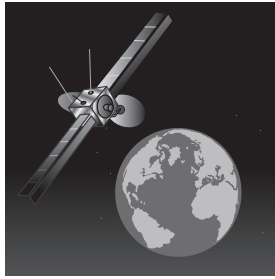
	Natural satellite of the Earth	Artificial satellite
A	Mars	Starlink
B	the Moon	Starlink
C	Starlink	Mars
D	Starlink	the Moon

Your answer

[1]



- 2 The diagram shows an object in orbit around the Earth.



not to scale

What is the name of the object?

- A A moon
- B A natural satellite
- C An artificial satellite
- D An asteroid

Your answer

[1]

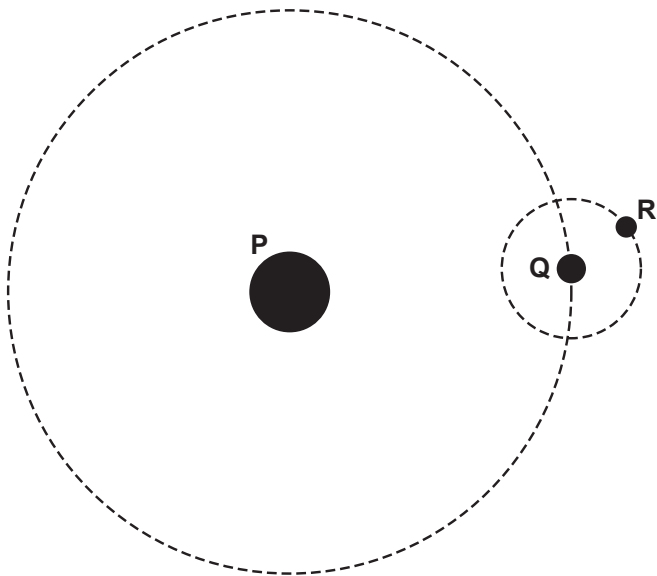
- 1 Which statement describes how the Sun was formed?
- A By the electromagnetic attraction of dust and gas
 - B By the gravitational attraction of dust and gas
 - C By the heating of gas in a large cloud of dust and gas
 - D By the nuclear fission of gas in a large cloud of dust and gas

Your answer

[1]



5 The diagram shows a model of the Sun, the Earth and the Moon.
The dashed lines show the orbits of object **Q** and object **R**.



Not to scale

Which row identifies each object?

	Object P	Object Q	Object R
A	the Earth	the Moon	the Sun
B	the Moon	the Earth	the Sun
C	the Sun	the Earth	the Moon
D	the Sun	the Moon	the Earth

Your answer

Turn over [1]

9 Redshift provides evidence for the Big-Bang model of the universe.

Which statement describes redshift of light from a galaxy that is moving away from the Earth?

- A** The observed speed of light on the Earth is greater than the speed of light emitted by the galaxy.
- B** The observed speed of light on the Earth is smaller than the speed of light emitted by the galaxy.
- C** The observed wavelength of light on the Earth is greater than the wavelength of light emitted by the galaxy.
- D** The observed wavelength of light on the Earth is smaller than the wavelength of light emitted by the galaxy.

Your answer

[1]



16 This question is about the life cycle of the Sun.

(a) (i) Draw lines to connect each **stage** in the life cycle of the Sun with its correct **description**.

Stage	Description
nebula	A star producing no radiation formed from a white dwarf.
red giant	A low temperature star with a diameter much larger than the Sun.
white dwarf	A mass of interstellar dust and gas.
black dwarf	A star that has used most of its nuclear fuel and has collapsed.

[2]

(ii) Which stage in the lifecycle of the Sun is missing from part **(a)(i)**?

Put a ring around the correct option.

black hole main sequence star neutron star

[1]

(b) (i) What causes a nebula to collapse to form a star?

Put a ring around the correct option.

fission fusion gravity radiation

[1]

(ii) Complete the sentence to describe the forces acting in the Sun at the current stage in its lifecycle.

Use words from the list.

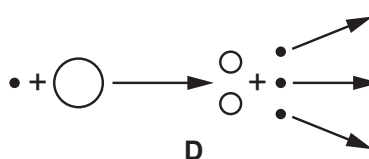
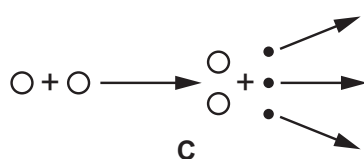
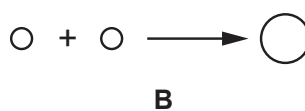
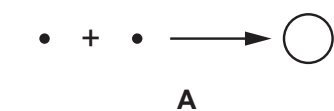
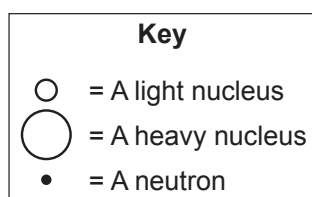
equal to greater than less than

The gravitational force is the outward force.

[1]



(c) The diagrams show possible nuclear processes for fission and fusion.



(i) Which diagram shows nuclear fusion?

Answer = ...

[1]

(ii) Which diagram shows nuclear fission?

Answer = ...

[1]

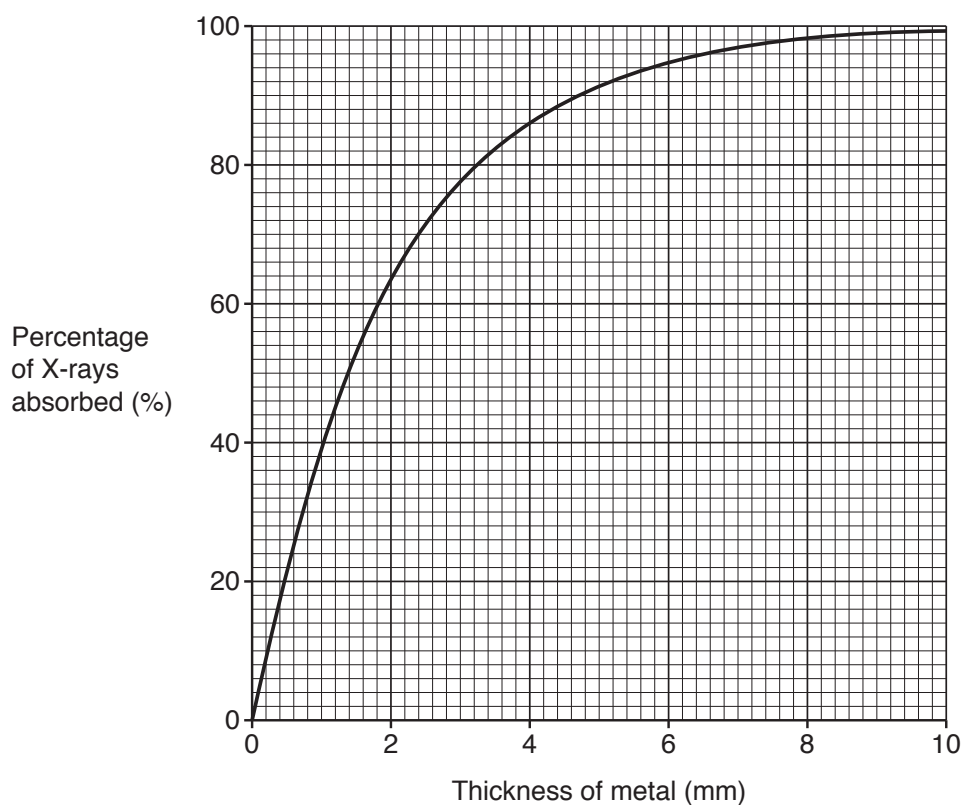
16 This question is about X-rays and visible light.

(a) State one **similarity** and one **difference** between X-rays and visible light.

Similarity

Difference [2]

(b) This graph shows how the absorption of X-rays changes with the thickness of metal.



(i) What percentage of X-rays is absorbed by 4 mm of metal?

Percentage of X-rays absorbed = ... % [1]

- (ii) Calculate the percentage of X-rays passing **through** 4 mm of metal.
Use your answer to **16(b)(i)** to help you.

Percentage of X-rays = ... % **[2]**

- (c) Use the words from the list to complete the sentences about the Universe.

You may use each word once, more than once, or not at all.

Big-Bang

Contracting

CMBR

Expanding

LDR

Red giant

Red shift

Solar system

The is a model of how the universe began.

Light from distant galaxies has a longer wavelength when it reaches Earth than when it was emitted.

This is called

Distant galaxies are moving away faster so the universe is

.....

[3]



16 This question is about the solar system.

(a) Describe how a planet's orbit is different compared to a moon's orbit.

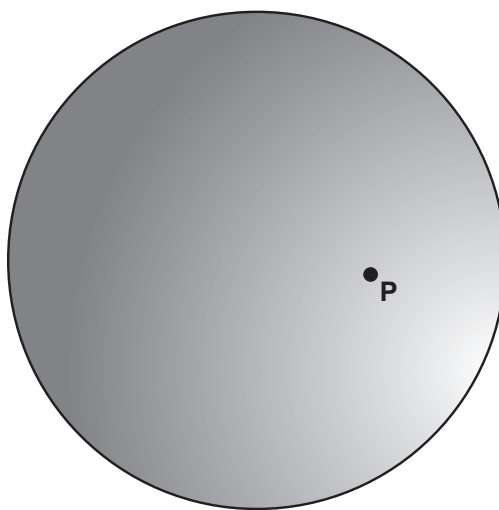
.....

.....

.....

..... [2]

(b) The diagram shows the Sun.



Point **P** is inside the Sun.

(i) Draw an arrow at **P** to show the direction of the force of gravity at **P**.

Label the arrow **F**.

[1]

(ii) Nuclear fusion reactions take place in the Sun. The energy released creates a force.

Draw an arrow at **P** to show the direction of this force.

Label the arrow **R**.

[1]

- (iii) Explain why the size of the Sun does **not** change.

Write about force **F** and force **R** in your answer.

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

- (iv) Complete the sentences using the words below.

You can use each word once, more than once, or not at all.

black hole **neutron star** **planetary nebula** **red giant**
red super giant **supernova** **white dwarf**

Towards the end of its life the Sun will expand.

The Sun becomes a

The Sun then gives off its outer layers of gas. This is called a

.....

After this, the Sun will become a

[3]



19

- (a) Hydrogen gas is placed in a glass tube in a laboratory.

Fig. 19.1 shows the emission spectrum of hydrogen.

Each line in the emission spectrum has a different colour.

Fig. 19.1



- (i) Complete the sentences to explain the cause of the lines in the emission spectrum.

Use words from the list.

atoms

electrons

light

protons

sound

..... move from a higher energy level to a lower energy level

and emit

[2]

- (ii) There is a potential difference of 3000 V across the tube.

A charge of 0.08 C flows in the tube.

Calculate the energy transferred.

Use the equation: energy transferred = charge $\times$ potential difference

Energy transferred = ... J [2]

- (iii) A special power supply is needed to provide the high potential difference of 3000 V.

Describe **one** risk of using this power supply.

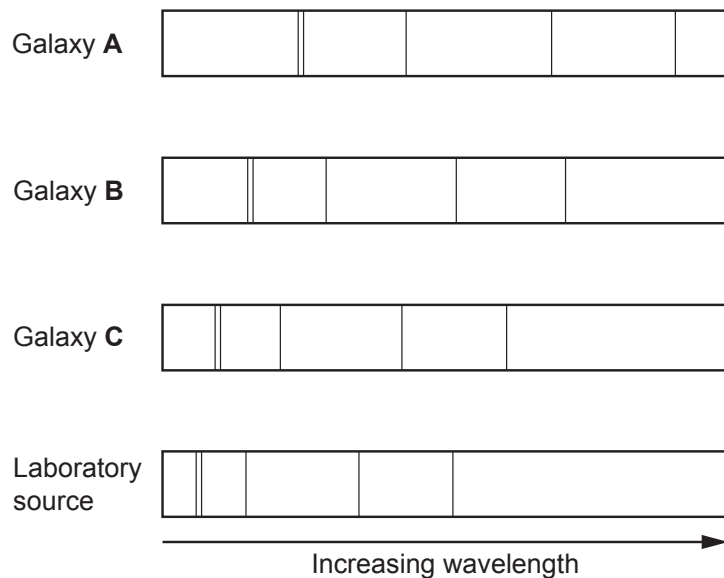
.....

..... [1]

(b) **Fig. 19.2** shows the emission spectrum for each of three different galaxies.

The same emission spectrum is also shown for an equivalent laboratory source on the Earth.

Fig. 19.2



(i) The emission spectrum for each galaxy shows red-shift.

Use **Fig. 19.2** to explain what is meant by the term **red-shift**.

.....
 [1]

(ii) Which galaxy in **Fig. 19.2** is furthest from the Earth?

Give a reason for your answer.

Galaxy

Reason

..... [2]

(iii) State which theory the spectra from each galaxy in **Fig. 19.2** gives evidence for.

..... [1]

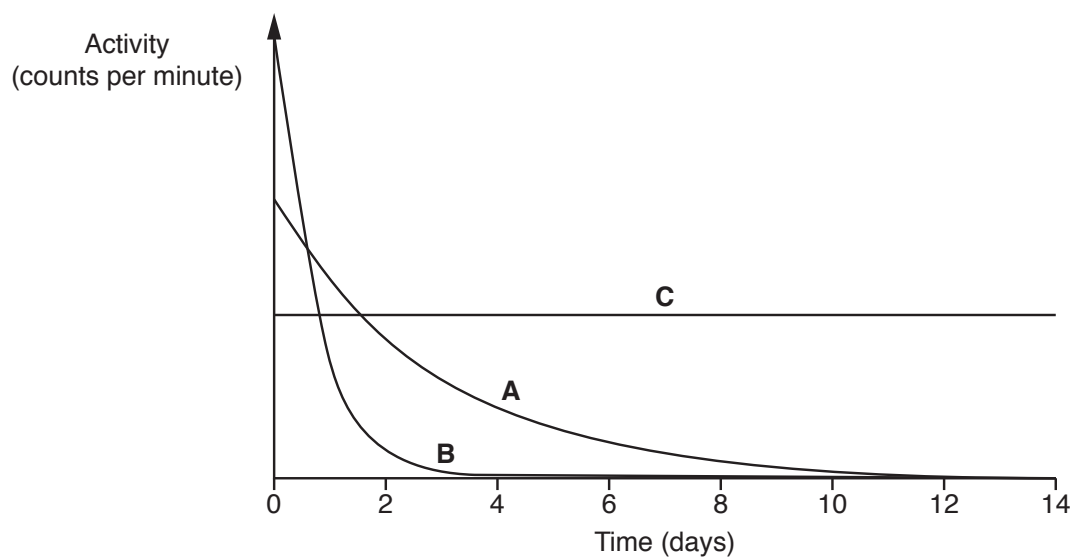
23 (a) A radioactive isotope has a half-life of 6 hours.

50g of the isotope are put in a container.

What mass of the isotope is left after 6 hours?

Mass = ... g [1]

(b) This is a graph showing the radiation emitted from samples of three different isotopes **A**, **B** and **C**.



(i) Which isotope, **A**, **B** or **C**, takes the longest time to decay?

[1]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

(ii) Two scientists discuss the isotopes in the graph.

Scientist 1	Scientist 2
'I think isotope A is more hazardous than B . A has a higher activity than B .'	'I think isotope B is more hazardous than A . B has a longer half-life than A .'

Do you agree with the views of scientist 1 and scientist 2?
Use the graph and ideas about radioactivity and half-life to explain your answer.

Scientist 1

.....

.....

.....

Scientist 2

.....

.....

.....

[4]



(iii) **Scientist 1** wants to identify the type of radiation emitted by isotope **A**.

This is a list of equipment **Scientist 1** has in his laboratory:

- radiation detector
- piece of thick lead
- piece of cardboard
- piece of aluminium.

Describe how **Scientist 1** does the experiment and explain how they can work out the type of radiation emitted.

You may include a diagram in your answer.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) This is a diagram to show a nuclear fusion reaction:



(i) Explain why this is nuclear fusion.

.....
 [1]

(ii) It is difficult for nuclear fusion reactions to occur on Earth.

Explain why nuclear fusion reactions occur in the Sun.

.....

 [2]

(iii) What will happen to our Sun when it runs out of hydrogen?

.....
 [1]

(d) Some scientists say nuclear fission is renewable. Other scientists say it is non-renewable.

Suggest why the scientists disagree.

.....

 [1]

MARK SCHEMES

official Pearson Edexcel mark schemes



Question			Answer	Marks	AO element	Guidance
3			C ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
5			B ✓	1	1.2	



Question				Answer	Marks	AO element	Guidance
10				B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
4	C	1	2.2	



21	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (N/cm²) award 3 marks Recall: pressure = force ÷ area ✓ 12000 ÷ 100 OR 40000 ÷ 25 ✓ = 120 (N/cm ²)	3	1.2 2.1 2.1	 ALLOW 12000÷25 for one mark ALLOW for two marks 480 (N/cm ²)
	b	i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	1	1.1	
		ii	Absorb energy (in a crash) ✓	1	1.1	ALLOW higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop
	c		Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	2	2.1 1.1	ALLOW weight of child is lower/child is smaller



20	a	Thinking distance doubles ✓	1	1.1	ALLOW higher level answer: thinking distance is (directly) proportional to speed
	b	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.75 (s) award 3 marks Recall: (Reaction) time = (Thinking) distance ÷ Speed ✓ 6÷8 or 12÷16 or 24÷32 ✓ = 0.75 (s) ✓	3	1.2 2.1 2.1	IGNORE correct substitutions if NOT rearranged

Question	Answer	Marks	AO element	Guidance
c*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Explains quantitatively why the stopping distances are different for each speed in the table in terms of braking distance and thinking distance. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Explains qualitatively why the stopping distances are different for each speed in the table in terms of braking distance or thinking distance increasing with speed from the table <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) States basic ideas about thinking distance / braking distance / stopping distance OR identifies variation of thinking distance / braking distance / stopping distance with speed <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks - No response or no response worthy of credit.	6	2 x 1.1 2 x 2.1 2 x 3.2b	AO1.1a Demonstrates knowledge and understanding of thinking, braking and stopping distance - Thinking distance is the distance the car travels while the driver reacts - Braking distance is the distance travelled while the brakes are applied - Stopping distance is thinking distance + braking distance AO2.1 Applies knowledge and understanding of thinking, braking and stopping distance in relation to the details in the table - Increasing the speed, increases the thinking distance - Increasing the speed, increases the braking distance - Increasing the speed, increases the stopping distance AO3.2b Analyses information to make judgements and draw detailed conclusions from table - Thinking distance is directly proportional to the speed - When speed doubles, thinking distance doubles - Braking distance is proportional to speed² - When speed doubles, braking distance quadruples



25	(a)	As speed increases, (thinking) distance increases / ORA ✓ BUT (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓✓	2	3.1a 3.2b	ALLOW numerical values from graph, e.g. at 15 (m/s), $t_d = 10\text{m}$ but at 30 (m/s) $t_d = 20\text{m}$. ALLOW numerical values from graph, e.g. at 15 (m/s), $t_d = 10\text{ (m)}$ but at 30 (m/s) $t_d = 2 \times 10 = 20\text{ (m)}$ for 2 marks
	(b)	(i) 16 (m) ✓	1	3.1a	
		(ii) FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.67 (s) award 3 marks Rearrangement to give Time = distance / speed ✓ Time = $16 / 24$ ✓ Time = 0.67 (s) (2 decimal places) ✓	3	1.2 2.1 2.1	ALLOW ECF from (b)(i) ALLOW 0.6 or 0.7 or 0.66(6...) (s) for 2 marks ALLOW one mark for any calculated answer to 2dp
	(c)	(i) (Driver under influence of) alcohol / drugs / tired / (named) distraction / ill / <u>old</u> -age / intoxication / high(er) speed ✓	1	1.1	IGNORE just age ALLOW increase in driver's reaction time
		(ii) FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 26 (m) award 2 marks (Stopping distance =) braking (distance) + thinking (distance) OR 16 OR 10 ✓ (sd =) 26 (m) ✓	2	2×2.2	

Question	Answer	Marks	AO element	Guidance
(d)	Maximum 2 marks from: Higher speed increases braking distance ✓ BUT Double speed quadruples braking distance / braking distance is (directly) proportional to the speed squared AW ✓✓ Maximum 2 marks from: (Idea that) higher speed (car has) more KE ✓ BUT Double speed quadruples KE / KE is (directly) proportional to the speed squared / AW ✓✓	3	2.1 3.1a x2 2.1 3.1a x2	ALLOW numerical values from graph, e.g. at 10 (m/s), $bd = 7.5\text{ (m)}$ but at 20 (m/s) $bd = 30\text{ (m)}$. ALLOW numerical values from graph, e.g. at 10 (m/s), $bd = 7.5\text{ (m)}$ but at 20 (m/s) $bd = 4 \times 7.5 (= 30\text{m})$ for 2 marks

21	(a)	Thinking distance bar plotted correctly to within $\pm \frac{1}{2}$ square ✓ Braking distance bar plotted correctly to within $\pm \frac{1}{2}$ square ✓	2	2 × 1.2													
	(b)	Thinking distance in range 17 - 19 m ✓ Braking distance in range 44 - 64 m ✓	2	2 × 3.2a													
	(c)	(Overall) <u>stopping</u> distance ✓	1	1.1													
	(d)	<table border="1"><thead><tr><th>Factor</th><th>Thinking distance</th><th>Braking distance</th></tr></thead><tbody><tr><td>Drinking alcohol</td><td>increases</td><td>no effect</td></tr><tr><td>Higher speed</td><td>increases</td><td>increases</td></tr><tr><td>Wet road</td><td>no effect</td><td>increases</td></tr></tbody></table> ✓✓✓	Factor	Thinking distance	Braking distance	Drinking alcohol	increases	no effect	Higher speed	increases	increases	Wet road	no effect	increases	3	3 × 2.1	1 mark for each correct row
Factor	Thinking distance	Braking distance															
Drinking alcohol	increases	no effect															
Higher speed	increases	increases															
Wet road	no effect	increases															
	(e) (i)	First check the answer on answer line If answer = 112 000 J award 3 marks (Work done =) 5600 × 20 ✓ (Work done =) 112 000 ✓ J OR N m ✓	3	2.1 2.1 1.1	Unit mark is independent												
	(ii)	Double-decker bus has more mass ✓	1	2.1	ALLOW more kinetic energy / heavier / greater weight / greater load												

19	(a)	(i)	Any two from: First student drops the ruler and second student catches as quick as possible ✓ Measure the distance on the ruler where it was caught ✓ Use look-up table/equation to find time to travel this distance ✓	2	2 × 1.2	1
		(ii)	Any one from: To check the precision or repeatability of the readings ✓ to find the uncertainty in the measurement ✓ to find an average or mean ✓	1	3.3a	
		(iii)	Student B's reaction times will be longer / increases ✓	1	3.2a	ALLOW B will be slower
	(b)	(i)	(9 + 14) = 23 (m) ✓	1	2.2	
		(ii)	Stopping distance at 50 mph = 53 m ✓ Stopping distance is greater than 40 m / Car hits the barrier ✓	2	3.1a 3.2a	ALLOW 52-54m

Question	Answer	Marks	AO element	Guidance
19 (b) (iii)	Factor: larger mass (of car) ✓ Reason: Braking distance is increased ✓ because deceleration is less / larger KE to dissipate ✓ OR Factor: Poor quality brakes / tyres ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ OR Factor: Icy / wet / slippery road ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ OR Factor: Going uphill ✓ Reason: Braking distance is decreased ✓ Weight of car increases deceleration ✓ OR Factor: Going downhill ✓ Reason: Braking distance is decreased ✓ Weight of car decreases deceleration ✓	3	1.1 2 × 2.1 1.1 2 × 2.1 1.1 2 × 2.1 1.1 2 × 2.1	DO NOT ALLOW distance for braking/thinking distance DO NOT ALLOW stopping distance

Question	Answer	Marks	AO element	Guidance
19 (c) (i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.25/3.3 (m/s²) award 2 marks 13 ÷ 4 ✓ = 3.3 (m/s ²) ✓	2	2 × 2.1	ALLOW 3.25 (m/s ²)
	(ii) Any two from: Yes / No (no mark) (agree with driver) stopping distance is shorter ✓ Less likely to hit obstacles / safer ✓ Attempt to quantify, e.g. 4 s / 0.4 s = 10 ✓ OR (disagree with driver) ($F = ma$ / so) the force (acting on the people in the car) is 10x greater ✓ This can lead to injury / 10× more dangerous ✓ Other factors involved (so cannot quantify) ✓	2	2.1 2 × 3.1b 2.1 2 × 3.1b	1
	(iii) Seat belt / airbag / crumple zone ✓	1	1.1	

17	(a)	(i)	Use a tape-measure / trundle wheel ✓	1	1.2	IGNORE ruler ALLOW metre rule / stick
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.0 (m) award 2 marks Mean = $(4.4 + 8.0 + 5.6) \div 3$ ✓ (Mean =) 6.0 (m) ✓	2	2 × 1.2	ALLOW 8(.0) is an anomaly so Mean = $(4.4 + 5.6) \div 2$ ✓ (Mean =) 5(.0) (m) ✓ working must be seen ALLOW 6 (m)
		(iii)	Any one from: They did not use the same force when braking / AW ✓ They did not measure height to the same part of the bike each time ✓ They did not start at the same place on the ramp ✓ They did not apply the brakes at the same place / time ✓	1	3.2a	ALLOW wind may affect braking IGNORE They did not measure distance correctly. IGNORE They used the pedals (instead of freewheeling) IGNORE reaction time / human error
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1600 (J) award 3 marks potential energy = mass × gravitational field strength × height ✓ (potential energy =) $80 \times 10 \times 2.0$ ✓ (potential energy =) 1600 (J) ✓	3	1.2 2 × 2.1	

Question	Answer	Marks	AO element	Guidance
(c) (i)	11(m) ✓	1	2.2	
(ii)	Use of data to show as speed increases, braking distance increases ✓ OR (As speed increases,) (braking) distance increases ✓ At higher speeds more likely to hit an obstacle (in front) as you travel further before stopping / cause more damage / AW ✓	2	3.1a 3.1b	<u>Example</u> at 1m/s, bd = 1m but at 2m/s, bd = 4m. ALLOW stopping for braking ALLOW longer time to stop
(iii)	Any one from: Repeat for more speeds / heights ✓ Make sure constant force when braking / press brakes by same amount each time / AW ✓	1	3.3b	IGNORE repeats experiment / averages results
(d)	Increases ✓	1	1.1	
(e)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 – 3.0 (m / s²) award 3 marks Estimate for time = 2 – 12 seconds ✓ Acceleration = $6 \div$ their estimate of time ✓ (Acceleration =) 0.5 – 3(.0) m / s ² ✓	3	3 × 2.1	

Question	Answer	Marks	AO element	Guidance
1	C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
6	B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
10	B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
13	A ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
4			D ✓	1	2.2	



Question			Answer	Marks	AO element	Guidance
2			B ✓	1	1.1	



20	(a)	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of the changes using data for both coal and renewables AND a detailed explanation of why the changes occurred in terms of advantages of renewable resources and disadvantages of coal. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description of the changes for both coal and renewables AND an explanation of the changes in terms of advantages of renewable resources and disadvantages of coal. OR Detailed description of the changes using data for both coal and renewables with basic explanation for coal and/or renewables. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Simple relationship from the graph with basic explanation for coal and/or renewables. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i>	6	3 × 3.1a 3 × 2.1	AO3.1a – Analyses information by interpreting the graph • Use of coal has (generally) decreased. • Use of renewable has increased. • Coal decreased from 31% in 1990 to 5% in 2017. • Between 1999 and 2012 use of coal increased several times. • Renewables increased from 0.5% in 1990 to 11% in 2017. • Rate of increase of renewables is greater in more recent years. • Use of coal and renewables was the same in 2015-16 at 10%. AO2.1a – Applies knowledge and understanding of renewable and non-renewable energy resources. • Population has a greater awareness of environmental issues today. • UK government committed to 'greener' energy resources. • Coal is a non-renewable / finite energy resource. • Coal produces greenhouse gases / CO₂. • CO₂ contributes to global warming / climate change. • Coal produces other named pollutants e.g. SO₂ • Named renewable energy resources (solar / wind / biomass / tidal / wave) • More wind turbines / solar panels have been built • Cost of wind turbines / solar panels have reduced over time. • Renewable energy resources produce less greenhouse gases / less pollution / less CO₂. • Renewables energy resources are sustainable / have low fuel costs once set up.
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Question	Answer	Marks	AO element	Guidance
	0 marks <i>No response or no response worthy of credit.</i>			

Question	Answer	Marks	AO element	Guidance
(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6×10^6 (kWh) award 2 marks Energy transferred = $3 \times 2 \times 10^6$ ✓ (Energy transferred =) 6×10^6 (kWh) ✓	2	2 × 2.1	ALLOW 6000000 (kWh)



23	(a)	(i)	2 or 3 correctly plotted points to within $\frac{1}{2}$ small square ✓ 4 points correctly plotted to within $\frac{1}{2}$ small square ✓ Smooth curved line of best fit through most points ✓	3	3 × 2.2	DO NOT ALLOW a straight line of best fit ALLOW ECF from incorrectly plotted points
		(ii)	Candidate's line of best fit extended to 2.00 AND their value of p.d. is correct for their graph ✓ Value of p.d. = 2.55 – 2.70 ✓	2	2 × 3.2b	IGNORE line of best fit past 2.00
		(iii)	Any one from: Repeat readings and calculate the mean/discard anomalies ✓ Carry out investigation in the dark / reduce ambient light ✓ Use a greater range / more values of light intensity ✓ Use higher light intensities ✓ Use a light meter to check light intensity ✓	1	3.3b	
	(b)	(i)	Any two from: To reduce energy bills / sell electricity (back to national grid) ✓ People are more aware of environmental issues / they are better for the environment ✓ To reduce reliance on/use of fossil fuels / fossil fuels are running out ✓ To reduce CO ₂ / greenhouse emissions / global warming ✓ They are cheaper (than 20 years ago) ✓ The government has encouraged people to install them / grants available to fit them ✓ More efficient / better/newer panels/technologies are now available ✓	2	2 × 3.2a	IGNORE people are more environmentally friendly/green. ALLOW they use a renewable energy resource IGNORE they weren't available twenty years ago.

Question		Answer	Marks	AO element	Guidance
23	(ii)	Maximum two from: (24 ÷ 1.6 =) 15 panels ✓ (15 × 26 =) 390 MJ / maximum energy he could generate > energy required / maximum energy is 26 MJ greater ✓ OR (364 ÷ 26 =) 14 panels ✓ (14 × 1.6 =) 22.4 m ² / area of panels required < area of roof / area of panels is 1.6 m ² greater ✓ And any one from: When it is night/cloudy/dark/sun not at highest point energy output would/could be too low ✓ Would need (batteries) to store energy / to obtain energy at night / may need back-up power/generator ✓ Amount of energy generated can change with weather/seasons so may be less ✓	3	3 × 3.1b	ALLOW 390 MJ / maximum energy is 26 MJ greater for 2 marks ALLOW 22.4 m ² / area of panels is 1.6 m ² greater for 2 marks

16	(a)	(i)	Any one from: hydroelectric ✓ solar ✓ tidal ✓ wind ✓	1	1.1	IGNORE sources not on the list
		(ii)	Any one from: coal ✓ oil ✓ nuclear ✓	1	1.1	IGNORE sources not on the list
	(b)	(i)	Smooth curve drawn with balance of points about the line ✓	1	2.2	DO NOT ALLOW straight line DO NOT ALLOW curve with all points above or below
		(ii)	(electricity generated has) increased (over time) ✓ at an increasing rate ✓	2	2 × 3.1a	ALLOW idea of increasing more in later years
		(iii)	Any two from: demand for electricity / energy is increasing ✓ reduce the need to use non-renewables ✓ renewables do not emit greenhouse gases ✓	2	2 × 3.2a	IGNORE climate change / better for the environment IGNORE using more renewable sources ALLOW non-renewables will run out ALLOW idea of reducing impact on global warming / greenhouse effect / carbon emissions / acid rain / nitrogen oxide / sulphur oxide IGNORE pollution unqualified

Question			Answer	Marks	AO element	Guidance
16	(b)	(iv)	First check the answer on the answer line If answer = 720 award 3 marks Read off from 2012 = 240 ✓ Read off from 2022 = 960 ✓ (change in electricity = 960 – 240 =) 720 ✓	3	3 × 2.2	ALLOW read off from line ±20 if not 240 ALLOW read off from line ±20 if not 960 ALLOW correct calculation using candidate's values for the read off IGNORE sign “–”
		(v)	First check the answer on the answer line If answer = 72 award 2 marks 720 ÷ 10 ✓ (average change per year =) 72 (TWh/year) ✓	2	2 × 2.2	ALLOW ECF from (iv) for both marks



18	(a)	Coal ✓ Solar ✓	2	2 x 3.2b	In either order
	(b)	First check the answer on answer line If answer = 24 - 26 (%) award 3 marks Angle is approximately 90 ° ✓ (% =) 90 / 360 or 1 / 4 or 0.25 ✓ (% =) 25 (%) ✓	3	3 x 1.2	 ALLOW one mark for $(62 \pm 2) / 360$ (2019 data) ALLOW two marks for 17% or 18% (2019 data)
	(c)	Gas ✓ Wind ✓	2	2 x 2.2	In either order IGNORE direction of change
	(d)	First check the answer on answer line If answer = 7.7 (%) award 3 marks 0.3 ✓ (% change =) $(0.3 \div 3.9) \times 100$ or $((4.2 - 3.9) \div 3.9) \times 100$ or 7.692... (%) ✓ (% change =) 7.7 (%) (1dp) ✓	3	3 x 2.1	 ALLOW one mark for $((4.2 - 3.9) \div 4.2) \times 100$ ALLOW two marks for 7.1 (%) ALLOW two marks for 7.6 (%) ALLOW this mark for clear evidence of an incorrect answer correctly rounded to one decimal place (not a bald answer to 1 d.p.)

Question	Answer	Marks	AO element	Guidance
(e) (i)	Any one from: Public opinion / government committed to renewable / green energy resources ✓ Coal is a non-renewable / finite energy resource ✓ Reduces pollution / named pollutant e.g., CO ₂ / SO ₂ ✓ Reduces global warming / climate change / greenhouse gases ✓	1	1.1	 ALLOW Coal produces pollution / named pollutant CO ₂ / SO ₂ ALLOW Coal contributes to global warming / climate change / greenhouse gases ✓
(ii)	Any two from: Not enough sun (for photovoltaic cells) ✓ Not enough wind (for turbines) ✓ To avoid power cuts ✓ Increase in demand with reason e.g., it may have been colder on that day ✓ Some power stations may have broken down ✓	2	2 x 3.2a	IGNORE costs e.g., coal is cheap IGNORE meeting demand / gap IGNORE there is a high demand for electricity

23	a	i	5.2 (billion tonnes oil equivalent) ✓	1	3.1a	ALLOW answers between 5.0 and 5.5 IGNORE wrong units
		ii	Oil ✓	1	3.1a	
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 78 (%) award 2 marks 8.3 / 10.6 (x 100) ✓ =78 (%) ✓	2	2 x 3.1a	ALLOW answers that round between 77(%) and 80(%) ✓✓ ALLOW 8.2 / 10.6 (x 100) OR 8.4 / 10.6 (x 100) OR 8.5 / 10.6 (x 100) OR answers that round between 0.77 and 0.80
	b	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2	3.1b 3.1b	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO ₂ / carbon emissions IGNORE just pollution or bad for the environment / more CFCs
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less named damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / OR a for coal ✓	2	1.2 1.2	ALLOW will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) ALLOW less polluting gases / carbon emissions / ice caps melting / droughts and storms IGNORE just less pollution or just better for the environment / less CFCs

Question			Answer see separate sheet	Marks	AO element	Guidance
	c	i	Step-up transformer ✓	1	1.1	
		ii	Reduce energy wastage / loss ✓	1	1.1	ALLOW less heat loss / reduce current / reduce power loss / more useful power out / more efficient / less heating of wires DO NOT ALLOW no energy losses / prevent energy loss / AW
		iii	d.c – (current / voltage / charge flow / it) has one direction or polarity ✓ a.c.- (current / voltage / charge flow / it) (continually) changes direction or polarity ✓	2	1.1 1.1	ALLOW dc only positive / only negative IGNORE electricity ALLOW current / voltage alternates OR positive and negative
	d	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks (P =) I ² x R ✓ 11 x 11 x 23 or 11 ² x 23 or 121 x 23 ✓ = 2783 ✓ Conversion to kW = 2.8 (kW) ✓	4	1.2 2.1 2.1 2.1	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓ ALLOW equation in any form ALLOW ecf candidates answer to 3 rd marking point converted to kW
		ii	Wind speed varies / AW ✓	1	2.1	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1	2.1	ALLOW (it) may not generate enough power / energy / AW

Question				Answer	Marks	AO element	Guidance
9				B ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
3				D ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
4				D ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
8				B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
11	A	1	1.1	



Question	Answer	Marks	AO element	Guidance
13	B	1	1.1	



Question	Answer	Marks	AO element	Guidance
2	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
1	B	1	1.1	



Question	Answer	Marks	AO element	Guidance
5	C	1	2.1	



Question	Answer	Marks	AO element	Guidance
9	C	1	1.1	



20	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) States that greater orbital distance goes with a longer time period but that the relationship is not proportional. Attempts to explain orbital motion in terms of gravity. AND Relates data from the graph to at least two named planets. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) States that greater orbital distance goes with a longer time period. AND Relates the curve to different named planets in the solar system. OR Reads data from the graph. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) States that greater orbital distance goes with a longer time period. OR Relates the curve to the properties of at least one planet in the solar system. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	3 × 2.1 3 × 3.1a AO3.1a Analyses information and ideas by interpreting graph • As distance increases, orbit time increases. • Time read correctly for a specific distance. • Comparison of two data points. • Recognises that the data for the Earth is very close to the origin • Outermost planets have periods of over a century • Time is not proportional to distance. • Time increases faster than distance. • Gradient of line increases. • Calculation using data to show non-proportionality, e.g. when distance doubles from 1 to 2, time more than doubles. AO2.1 Applies knowledge and understanding of the solar system • Inner planets are Mercury, Venus, Earth and Mars. • Outer planets are Jupiter, Saturn, Uranus and Neptune. • As distance from Sun increases, orbital period of planet increases. • Period of Earth's orbit is 1 year • Distance planet travels in one orbit increases with distance from the Sun. • If distance is larger, time will be greater (for same speed) • As speed is smaller, time will be greater by a greater factor.
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16	(a)	(ii)	✓✓	2	2 × 1.1	All 4 correct = 2 marks Any 2 or 3 correct = 1 marks
		(ii)	Main sequence star ✓	1	1.1	
	(b)	(i)	Gravity ✓	1	1.1	
		(ii)	Equal to ✓	1	1.1	
	(c)	(i)	B ✓	1	1.1	
		(ii)	D ✓	1	1.2	

16	(a)	Any one from: Similarity ✓ Both transverse waves ✓ Both electromagnetic waves ✓ Both travel at the same speed/speed of light (in a vacuum) ✓ Both can travel through space / vacuum ✓ Any one from: Difference ✓ X-ray has higher frequency / shorter wavelength / ORA ✓ X-rays have higher energy / ORA ✓ X-rays are more penetrating / ORA ✓	2	2 × 1.1	1 DO NOT ALLOW we can see visible light/we cannot see X-rays
	(b)	(i) 86 (%) ✓	1	2.2	ALLOW 85-87 %
		(ii) FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 14 (%) award 2 marks 100 – 86 ✓ = 14 (%) ✓	2	2 × 2.2	ALLOW ECF from (b)(i)
	(c)	Big Bang ✓ Red shift ✓ Expanding ✓	3	3 × 1.1	

16	(a)		A moon orbits a planet ✓ Planets orbit the sun / a star ✓	2	2 × 1.1	
	(b)	(i)	Mark with (b)(ii) Arrow drawn from P pointing to the centre of the Sun, labelled F ✓	1	1.1	For both marks at least one of the forces must be labelled correctly. If no labels, award 1 mark if both arrows are in the correct direction
		(ii)	Arrow from P pointing away from the centre of the Sun, labelled R ✓	1	1.1	IGNORE relative lengths of arrows
		(iii)	(F and R are) equal (in size) ✓ And opposite in direction so (resultant / overall force is zero) ✓	2	2 × 2.1	ALLOW F and R are balanced for two marks
		(iv)	Red giant ✓ Planetary nebula ✓ White dwarf ✓	3	3 × 1.1	Must be in the correct order

19	(a)	(i)	Electrons✓ Light✓	2	2 × 1.1	
		(ii)	First check the answer on the answer line If answer = 240 (J) award 2 marks (E ⇒) 0.08×3000 ✓ (E ⇒) 240 (J) ✓	2	2 × 2.1	
		(iii)	(Risk of) an (electric) shock / electrocution / AW ✓	1	3.2a	IGNORE dangerous / injury / death unqualified
	(b)	(i)	Increase in wavelength (of light) ✓	1	1.1	
		(ii)	A ✓ greater red-shift ✓	2	2 × 2.1	dependent on first mark wavelengths are further apart / longest / wavelengths move further to the right ALLOW lines for wavelengths
		(iii)	Big-Bang (model / theory) or expanding Universe ✓	1	1.1	

23	(a)		25(g) ✓	1	1.2	
	(b)	(i)	C ✓	1	2.2	ALLOW answer from diagram if clear
		(ii)	Any four from: A is more hazardous / B is safer (for most of the time on the graph) ✓ A has a higher activity (for most of the time) ✓ B is more hazardous at the beginning OR ✓ B has a higher activity at the beginning OR ✓ A has a longer half-life / B has a shorter half-life ✓	4	4×3.1b	
		(iii)	Maximum two from: One absorber placed between detector and isotope A ✓ (Idea of) change absorber and repeat experiment ✓ Measures (background) count with no source ✓ Maximum two from: Drop in count rate with cardboard indicates alpha ✓ Drop in count rate with aluminium indicates beta ✓ Drop in count rate with lead OR cardboard and aluminium / all materials are penetrated indicates gamma ✓	4	2×2.2 2×1.2	May be described or drawn in a diagram ALLOW stopped / absorbed for drop in count rate

Question			Answer	Marks	AO element	Guidance
	(c)	(i)	Nuclei join (in fusion) ✓	1	1.1	ALLOW fuse / combine
		(ii)	Any two from: High temperature ✓ High pressure ✓ Large gravitational forces (due to large mass) ✓	2	2×2.1	IGNORE heat
		(iii)	The sun will expand / become a red giant / (ultimately) become a white dwarf ✓	1	1.1	ALLOW fusion of helium / heavier elements
	(d)		Any one from: supplies of uranium are large enough / will not run out to consider it renewable / AW ✓ Uranium is not being replaced / used quicker than it is being replaced to consider it non-renewable	1	2.1	

