

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

A181/02

PHYSICS A

Unit A181: Modules P1, P2, P3 (Higher Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:

None

Duration: 1 hour

Other Materials Required:

- Pencil
- Ruler (cm/mm)

Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✎).
- A list of useful relationships is printed on page 2.
- The number of marks for each question is given in brackets [] at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	Mark
1	6	
2	5	
3	7	
4	3	
5	4	
6	4	
7	5	
8	6	
9	2	
10	4	
11	2	
12	6	
13	6	
TOTAL	60	

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

$$\text{distance} = \text{wave speed} \times \text{time}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Sustainable Energy

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining Motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{change of momentum} = \text{resultant force} \times \text{time for which it acts}$$

$$\text{work done by a force} = \text{force} \times \text{distance moved in the direction of the force}$$

$$\text{amount of energy transferred} = \text{work done}$$

$$\text{change in gravitational potential energy} = \text{weight} \times \text{vertical height difference}$$

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric Circuits

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive Materials

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

2 Read the article.

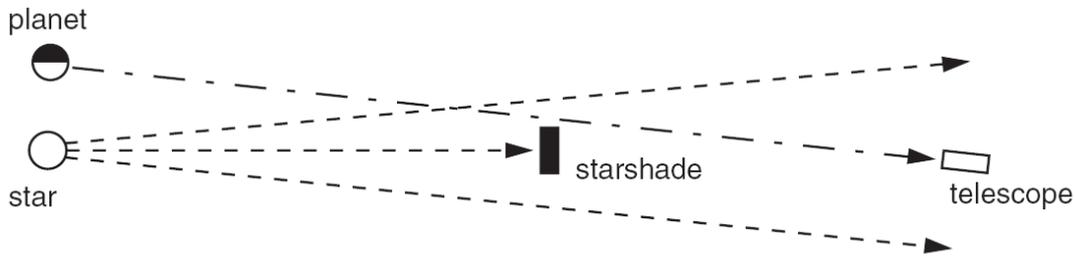
'Starshade' could help us see planets around other stars

An idea for an orbiting 'starshade' could help astronomers in the search for alien life.

The giant 'starshade' would be launched into space together with a space telescope, and would orbit the Earth at a distance of around 1 million kilometres. The 'starshade' and the telescope would be around 15 000 kilometres apart from each other.

Small thruster rockets, fired by remote control from Earth, would allow scientists to move the 'starshade' in front of a star they wanted the telescope to look at. The 'starshade' would allow light reflected from planets orbiting the star to be seen.

Scientists would be able to use the reflected light to analyse the planet's atmosphere for chemicals such as oxygen, water and methane. The presence of these chemicals could be interpreted as signs of life.

**(a)** Read the following statements.

Put a tick (✓) in the box next to each of the three correct statements.

- The 'starshade' will block light from certain stars.
- The 'starshade' will be fixed to a space telescope.
- The 'starshade' is designed to block light from distant planets.
- The telescope is designed to study planets in our Solar System.
- The light from a planet is much dimmer than the light from its star.
- The light from a distant planet may show the gases in its atmosphere.

[3]

(b) Most telescopes are on the Earth's surface.

This telescope and 'starshade' will be put into orbit a long way from the Earth.

Which of these statements are correct reasons for doing this?

Put a tick (✓) in the box next to each of the **two** correct statements.

There will be no light pollution.

The 'starshade' will not corrode or rot.

Telescopes do not need power to stay in orbit.

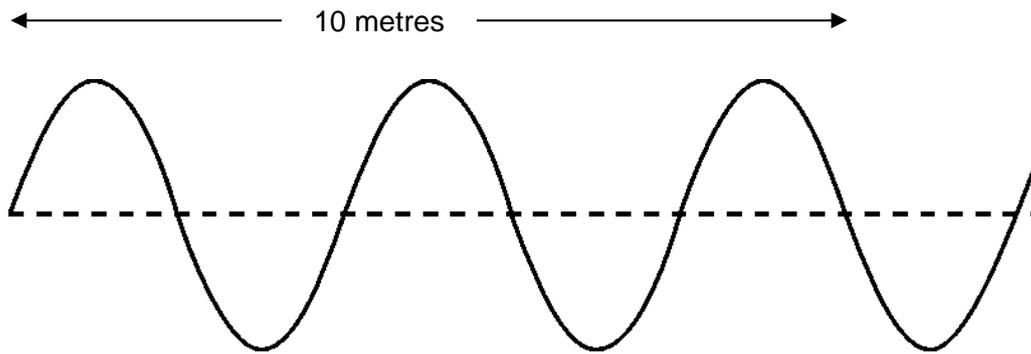
They will be closer to the distant planets that they need to observe.

The Earth's atmosphere absorbs part of the electromagnetic spectrum.

[2]

[Total: 5]

3 The diagram shows a wave.



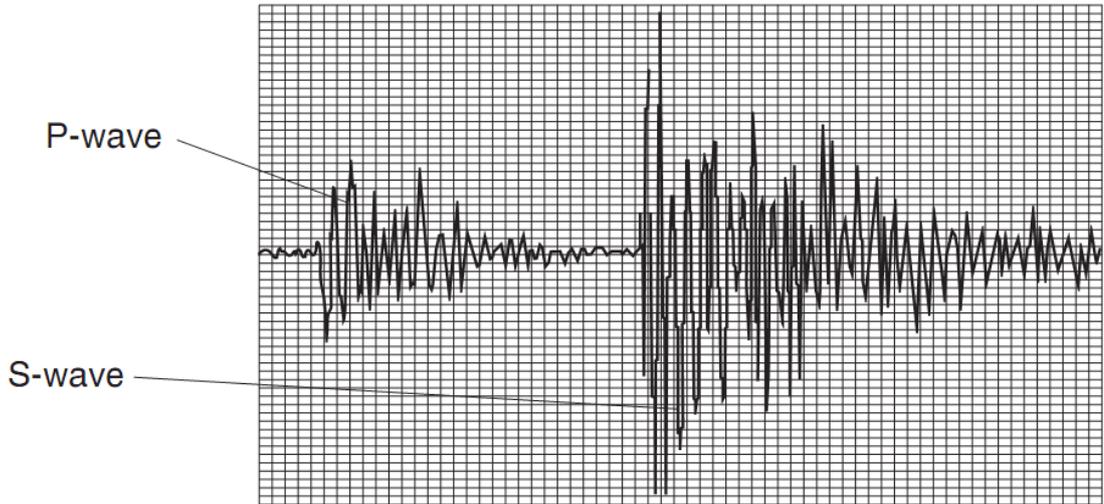
(a) Calculate the wavelength of this wave.

wavelength = m [1]

(b) Another wave has a wavelength of 5 metres.
Calculate its frequency if it has a speed of 4 m/s.

frequency = Hz [2]

- (c) The diagram shows a recording from an earthquake detector. It has detected a P-wave and an S-wave from an earthquake.



The P-wave travels at a speed of 8000 m/s, and the S-wave travels at 3000 m/s.

The two waves started at the same time from an earthquake 360 km away from the detector.

- (i) Calculate the time delay between the arrival of the two waves at the detector.

delay = s [2]

- (ii) Use the graph to explain why the delay between the arrival of the two waves can help save lives in the event of an earthquake.

.....

.....

..... [2]

[Total: 7]

4 Scientists think that mountains must be forming all the time.



Some of the statements below are used to explain this.

- A Mountains are part of the Earth's crust.
- B Erosion causes mountains to be worn down.
- C The Earth is older than its oldest rocks.
- D If no new mountains were formed the continents would be flat.
- E Mountains exist today.
- F Mountains are only formed on drifting continents.

Three of the statements, when taken together, explain why mountains must be forming all of the time.

Write down the letters of these statements.

..... and and [3]

[Total: 3]

5 The properties of microwaves mean that they are used for many purposes.

(a) Which of the following statements about microwaves are true?

Put a tick (✓) in the box next to each **correct** statement.

Microwaves can be used to heat food by causing particles to vibrate.

Microwaves are ionising radiation.

The screen on a microwave oven lets light through but blocks microwaves.

Mobile phones produce microwaves.

Microwaves are blocked by the ozone layer.

The higher the intensity of microwaves in a microwave oven, the less the food is heated.

[3]

(b) Microwave photons transfer less energy than light photons.

However, microwaves can be used to cook many foods but light cannot.

Explain why.

.....

.....

..... [1]

[Total: 4]

6 This question is about carbon dioxide in the atmosphere.

The table shows how the concentration of carbon dioxide in the atmosphere has changed in the past 100 000 years.

years before present	100 000	80 000	60 000	40 000	20 000
carbon dioxide concentration in parts per million	240	190	213	210	222

- (a) Scientists say that the concentration of carbon dioxide in the atmosphere has been approximately constant for hundreds of thousands of years.

Discuss whether this statement is true, with reference to the data in the table.

.....

.....

..... [2]

- (b) In the present time, the concentration of carbon dioxide in the atmosphere is 360 parts per million.

Explain why this evidence convinces some scientists that the level of carbon dioxide in the atmosphere has risen significantly in recent times.

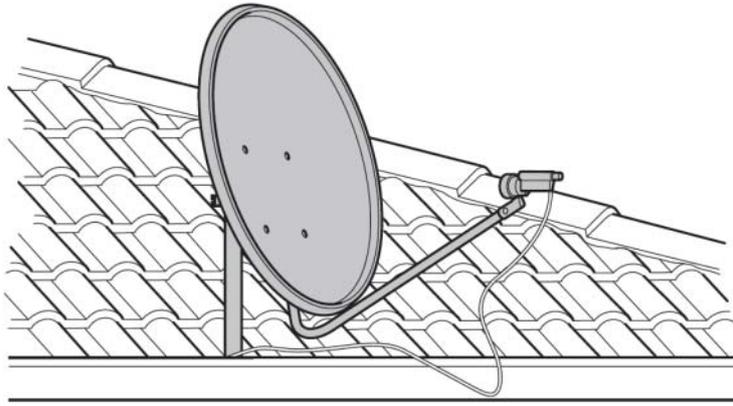
.....

.....

..... [2]

[Total: 4]

7 Microwaves carry TV signals from satellites to our homes through the atmosphere.



(a) A dish on the roof of a house guides the microwaves onto a receiver.

Here are some statements about the signals picked up at the receiver.

Put a tick (✓) in the box next to each statement to show whether it is **true** or **false**.

statement	true	false
The dish increases the intensity of the waves absorbed by the receiver.		
Microwave signals are very strongly absorbed by air molecules.		
The dish removes noise picked up by the waves from the satellite.		
The dish is made of metal because it is a good reflector of microwaves.		

[2]

(b) Adam is investigating the energy of photons.

He measures the amount of energy that beams of radio, microwaves, infrared and visible light deliver to a detector.

He predicts that there will be more energy in the infrared beam than the radio beam.

Adam bases this prediction on the frequency of the different beams.

Here are his results.

electromagnetic radiation	energy detected in beam in microjoules
radio	71
microwave	95
infrared	60
visible light	120

Discuss Adam's prediction.

Suggest why the results might be like this.

.....

.....

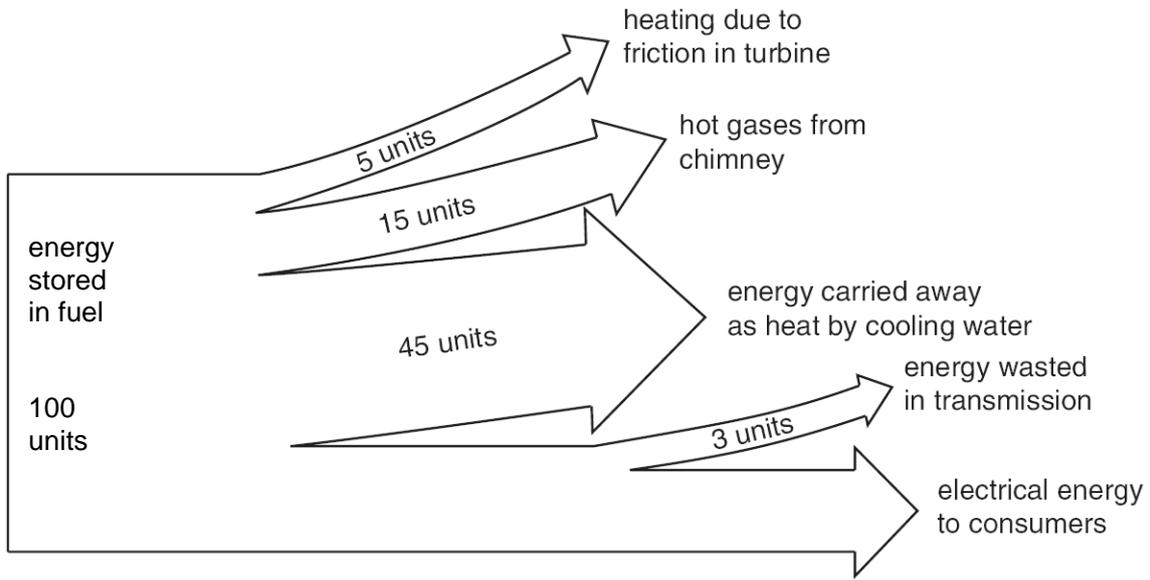
.....

..... [3]

[Total: 5]

9 Generating and distributing electricity is not 100% efficient.

Look at this diagram for electricity generation by a fossil fuel power station.



(a) How many units of electricity go to the consumers?

answer units [1]

(b) What is the efficiency of the power station?

Put a ring around the correct answer.

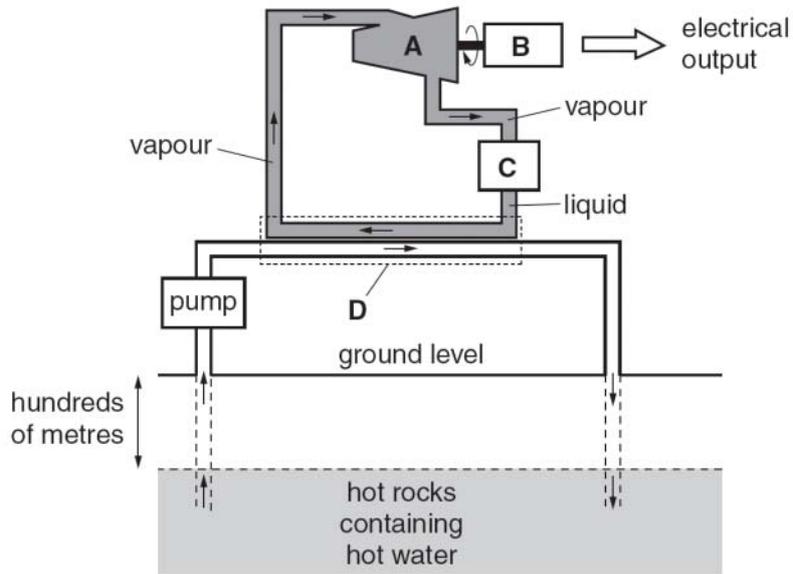
- 3% 35% 45% 54% 65%

[1]

[Total: 2]

10 (a) The diagram shows one type of geothermal power station.

The power station gets its energy from hot rocks deep underground.



The following statements describe the energy flow in a geothermal power station.

They are not in the correct order, and they are not all correct.

- V** A condenser, **C**, turns vapour into a liquid.
- W** A magnet rotates inside the turbine, producing a voltage across a coil of wire.
- X** Vapour turns a turbine, which turns a generator.
- Y** Hot water passes along pipes into a heat exchanger, **D**, where it boils an organic liquid.
- Z** Water is pumped from hot rocks deep underground.

Choose the correct statements and write the letters in the correct order in the boxes below.

--	--	--	--

[1]

(b) The Government is planning to build a new power station.



The table gives some information about three different types of power station.

type of power station	efficiency	cost of generating electricity per kWh in pence	environmental factors
coal	38%	2 to 3	produces carbon dioxide
nuclear	34%	2 to 2.5	produces radioactive waste
wind	35%	4 to 5.5	can damage local wildlife (eg birds)

Which type of power station would you recommend building?

Justify your choice, using **only** information from the table.

.....

.....

.....

..... [3]

[Total: 4]

11 A kettle transfers much more energy in a day than a light bulb, but both have the same mains voltage.

Explain how this is possible when the kettle is on for a few minutes only, while the light bulb is on for several hours.

.....

.....

.....

..... [2]

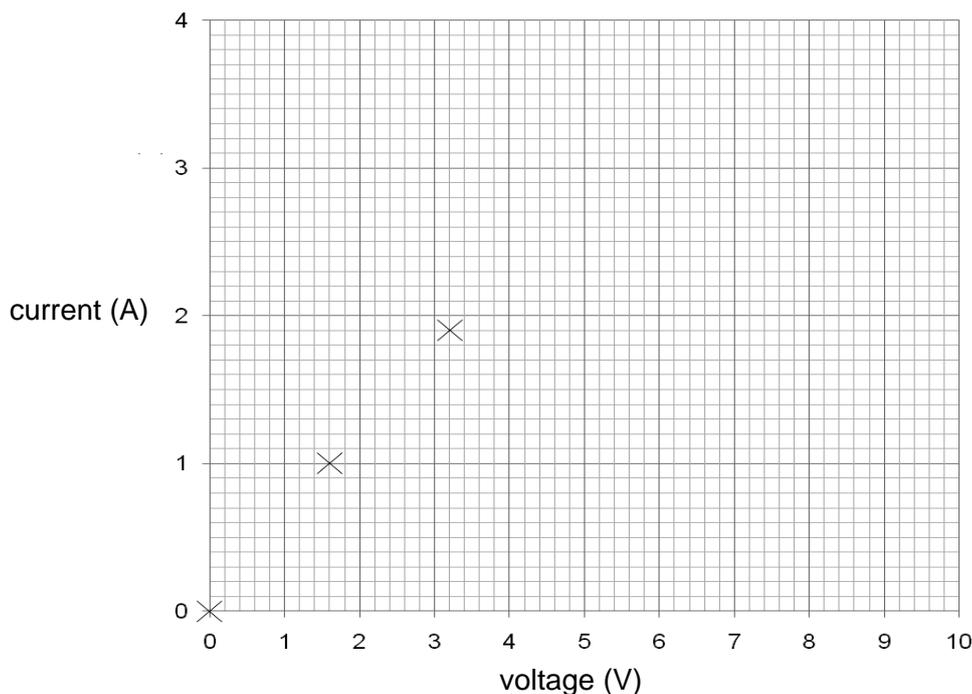
[Total: 2]

13 Mary and John are doing an experiment to measure the power in a wire.

They measure the electrical current through a wire at different voltages.

voltage in V	0	1.6	3.2	6.2	8.0	9.4
current in A	0.0	1.0	1.9	3.0	3.3	3.4

(a) Plot the data onto the graph. The first three points have been plotted for you.



[1]

(b) Draw a best fit curve for the data, and describe the pattern shown.

.....

.....

..... [3]

(c) Use your graph to find the electrical power of the lamp when the voltage is 5 V.

power = W [2]

[Total: 6]

[Paper Total: 60]

END OF QUESTION PAPER

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GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

PHYSICS A

A181/02

Unit A181: Modules P1, P2, P3 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant – applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)

work done = 0 marks
 work done lifting = 1 mark
 change in potential energy = 0 marks
 gravitational potential energy = 1 mark

5. Annotations:
 The following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt not given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject

6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

Eg

For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth 0 marks.

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth one mark.

Put ticks (✓) in the two correct boxes.

<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth one mark

8. The list principle:
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, eg one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:

Always check the additional guidance.

If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.

If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, eg shading or crosses.

Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

Eg If a question requires candidates to identify a city in England, then in the boxes

Edinburgh	
Manchester	
Paris	
Southampton	

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	x	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	x		✓		✓	✓		✓	
Score:	2	2	1	1	1	1	0	0	0	NR

10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:
- Read the question in the question paper, and then the list of relevant points in the 'Additional guidance' column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.
 - Read the level descriptors in the 'Expected answers' column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.
 - *For a general correlation between quality of science and QWC:* determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.
 - *For high-level science but very poor QWC:* the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.
 - *For very poor or totally irrelevant science but perfect QWC:* credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.

Question	Expected answers	Marks	Additional guidance
1 	<p>[Level 3] Includes most relevant points in each category in the answer. Explains Wegener's ideas, objections to his theory, and acceptance following further evidence in terms of a causal mechanism. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)</p> <p>[Level 2] Outlines Wegener's ideas with some evidence, and make reasonable suggestions why his contemporaries did not accept it. The idea of a mechanism for continental drift likely to be absent. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p>[Level 1] Outlines Wegener's ideas with little supporting evidence. Objections by contemporaries likely to be personal rather than scientific. 1960s evidence likely to be missing. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include:</p> <p>Wegener's evidence:</p> <ul style="list-style-type: none"> • continents 'fit together' • similar rock layers in different continents • similar fossils in different continents <p>His contemporaries' objections:</p> <ul style="list-style-type: none"> • Wegener was an outsider/not a geologist • no continental movement detectable • existing theories (land bridges) explained fossils • no mechanism proposed for movement <p>For subsequent acceptance:</p> <ul style="list-style-type: none"> • idea that a plausible mechanism is reasonable grounds for accepting the theory • sea-floor spreading provided a mechanism • movements in mantle as underlying cause <p>accept description of magnetic stripes on seabed as evidence for seafloor spreading</p> <p>ignore references to mountain chains, unless specifically to chains on the West coast of North and South America</p> <p>reject objections to Wegener based on personality</p>
	Total	6	

Question		Expected answers	Marks	Additional guidance
2	(a)	starshade will block light ... <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> light from a planet is much ... <input checked="" type="checkbox"/> light from a distant planet ... <input checked="" type="checkbox"/>	[3]	2 marks for correct pattern 1 mark for just one mistake 0 marks for more than one mistake (mistake = tick in incorrect box, missing tick or extra tick)
	(b)	there will be no light ... <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> the Earth's atmosphere ... <input checked="" type="checkbox"/>	[2]	2 marks for correct pattern 1 mark for just one mistake 0 marks for more than one mistake (mistake = tick in incorrect box, missing tick or extra tick)
Total			[5]	

Question		Expected answers	Marks	Additional guidance
3	(a)	wavelength = $10 \text{ m} / 2.5$ = 4 m	[1]	correct answer with no working gets 2 marks division of 10 m by an incorrectly counted number of wavelengths gets 1 mark if done consistently
	(b)	frequency = speed/wavelength = $4 \text{ m/s} \div 5 \text{ m} = 0.8 \text{ Hz}$	[2]	correct answer with no working gets 2 marks
	(c) (i)	time taken for P-wave to arrive = $360\,000 \text{ m} / 8000 \text{ m/s} = 45 \text{ s}$ time taken for S-wave to arrive = $360\,000 \text{ m} / 3000 \text{ m/s} = 120 \text{ s}$, therefore the delay = $120 \text{ s} - 45 \text{ s} = 75 \text{ s}$	[2]	if distances and speeds are correctly converted to compatible units but one arithmetic slip is made, award 1 mark max
	(ii)	P-wave has lower amplitude than S-wave so will cause less damage therefore the early arrival of the P-wave gives a warning that allows people time to take precautions before the more damaging S-wave arrives	[2]	for 'take precautions', accept any reasonable action that could be completed in 75 seconds, eg escape from building / get under table/doorway / switch off gas appliance / etc.
Total			[7]	

4		B D E	[3]	any order
Total			[3]	

Question		Expected answers	Marks	Additional guidance	
5	(a)	Microwaves can be used to heat food by causing particles to vibrate.	✓	[3]	
		Microwaves are ionising radiation.			
		The screen on a microwave oven lets light through but blocks microwaves.	✓		
		Mobile phones produce microwaves.	✓		
		Microwaves are blocked by the ozone layer.			
		The higher the intensity of microwaves in a microwave oven, the less the food is heated.			
	(b)	(some/certain) microwaves are strongly absorbed by water molecules but light waves are not	[1]		
Total			[4]		

6	(a)	the data support/increase confidence in the statement because (although the value is changing) there is no trend of increase or decrease however, data for more than 100 000 years before present would be needed in order to make a statement about 'hundreds of thousands of years' / insufficient data points to determine whether statement is true	[2]	
	(b)	360ppm/present concentration is far above the <u>range</u> of the data in the table in addition, the change in concentration in the last 20 000 years is much larger than the changes seen in the previous 20 000-year intervals	[2]	
Total			[4]	

Question		Expected answers			Marks	Additional guidance
7	(a)	statement	true	false	[2]	All 4 correct = (2) 2 or 3 correct = (1)
		dish increases intensity	✓			
		strongly absorbed by air		✓		
		dish removes noise		✓		
		metal good reflector	✓			
	(b)	<p>prediction is wrong because radio has more energy than infrared</p> <p>any 2 from: infrared does not fit the trend of the data so may be due to measurement error number of photons in beam may not have been controlled area of beams may not have been controlled area of detector may not have been controlled air absorbs different amounts at different frequencies</p>			[3]	
Total					[5]	

Question	Expected answers	Marks	Additional guidance
8 	<p>[Level 3] Includes most relevant points in the answer. Explains greenhouse effect in terms of radiation imbalance, and holes in ozone layer in terms of reversible reaction rates not balancing. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)</p> <p>[Level 2] Will recognise that carbon dioxide is a greenhouse gas producing global warming and that ozone blocks ultraviolet, and will give a clear mechanism for one of the two processes. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p>[Level 1] Will recognise that carbon dioxide is a greenhouse gas producing global warming and that ozone blocks ultraviolet, but will give no details of a scientific mechanism for either. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include: <i>Greenhouse effect</i></p> <ul style="list-style-type: none"> • incoming solar radiation is absorbed by the Earth • Earth re-emits infrared radiation • reflected radiation is lower frequency/longer wavelength than the radiation (from the Sun) absorbed by the Earth • carbon dioxide absorbs infrared radiation • greenhouse effect describes this effect • water and methane are also greenhouse gases • increased greenhouse effect is producing global warming <p><i>Holes in ozone layer</i></p> <ul style="list-style-type: none"> • ozone layer absorbs ultraviolet radiation • chemical changes in ozone result • these changes are reversible so [O₃] is usually constant • extra loss of ozone results in ‘holes’ <p>accept ‘lower frequency radiation emitted by Earth’ for infrared CFCs as agents of ozone loss</p> <p>ignore CFCs as greenhouse gases effects of global warming or depleted ozone layer</p>
	Total	[6]	

Question		Expected answers	Marks	Additional guidance
9	(a)	32	[1]	
	(b)	35%	[1]	
		Total	[2]	

10	(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Z</td> <td>Y</td> <td>X</td> <td>V</td> </tr> </table>	Z	Y	X	V	[1]	all correct for the mark
Z	Y	X	V					

Question	Expected answers	Marks	Additional guidance
(b)	<p><i>coal:</i> because it is the most efficient and has one of lowest costs / is cheaper than wind power</p> <p>and these benefits outweigh the disadvantage/environmental cost of producing carbon dioxide</p> <p>OR</p> <p><i>nuclear:</i> because it has the lowest cost / is cheaper than coal and wind power and this benefit outweighs the disadvantage/environmental cost of producing radioactive waste and outweighs the low efficiency</p> <p>OR</p> <p><i>wind:</i> because it is more efficient than nuclear highest costs / expensive to produce but does not significantly harm the environment / is least damaging to the environment and these benefits outweigh the high cost of generation</p>	[3]	<p>candidates may choose any type of power station; no marks are awarded for the choice itself, only for the justification of the choice</p> <p>ignore references to any factors not described in the table (eg carbon capture in coal power stations, production of radioactive materials for medical use in nuclear power stations, wind turbines being a 'blot on the landscape', etc.)</p>
	Total	[4]	

Question		Expected answers	Marks	Additional guidance
11		the power of the kettle must be much greater than the light bulb because energy transferred depends on power and time / $E = Pt$	[2]	accept reference to larger current through kettle (as power = current x voltage)
Total			[2]	

Question	Expected answers	Marks	Additional guidance
12 	<p>[Level 3] Most relevant points are present. A balanced argument is provided recognising the different points of view of local people, environmentalists and energy providers. The difference between real risk and perceived risk is discussed. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)</p> <p>[Level 2] A balanced discussion is attempted, but significant aspects of the 'pros' or 'cons' in the views of different groups, and the difference between real and perceived risk, may be omitted. May confuse chemical and radioactive poisoning. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p>[Level 1] Recognises that waste is hazardous, but does not explain why. A balanced answer is not attempted. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include:</p> <ul style="list-style-type: none"> • uranium/nuclear fuel is a non-renewable energy source • waste is radioactive • radiation can cause cell damage/cancer • remains radioactive for a very long time • large amounts of energy from little fuel • little CO₂ produced • small environmental impact (compared to coal/oil etc) • Government responsible for regulation • perceived risk may seem high to people near waste sites • real risk may seem low to people far away • radiation is 'invisible' <p>accept hazards of terrorist attack waste can contaminate water supplies/soil/etc. must be kept securely for a long time in eg deep secure sites</p> <p>ignore arguments based on safety of power stations (Chernobyl, Japan etc)</p> <p>reject explosion or other confusion with nuclear bomb</p>
	Total	[6]	

Question		Expected answers	Marks	Additional guidance
13	(a)	points at (6.2, 3.0), (8.0, 3.3) & (9.4, 3.4)	[1]	all within one minor scale division along each axis for the mark
	(b)	best fit curve current increases <u>non-uniformly</u> as voltage increases increase in current becomes less and less as voltage increases	[3]	by eye; should be smooth with no inflections 'current increases' is not enough second and third marking points could be earned in a single statement.
	(c)	current = 2.6 (A) power = 2.6 A × 5.0 V = 13 W	[2]	consistent with candidate's own graph ecf own current reading
Total			[6]	

Assessment Objectives (AO) Grid
(includes quality of written communication )

Question	AO1	AO2	AO3	Total
1 	4	2		6
2(a)	2	1		3
2(b)	1	1		2
3(a)		1		1
3(b)		2		2
3(c)(i)		2		2
3(c)(ii)			2	2
4	2	1		3
5(a)	2	1		3
5(b)	1			1
6(a)		1	1	2
6(b)		1	1	2
7(a)		2		2
7(b)			3	3
8 	5	1		6
9(a)		1		1
9(b)		1		1
10(a)		1		1
10(b)			3	3
11	1	1		2
12 	4	2		6
13(a)		1		1
13(b)	1	2		3
13(c)	1	1		2
Totals	24	26	10	60