

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**TWENTY FIRST CENTURY SCIENCE**

**A143/01**

**SCIENCE A**

Unit A143: Modules B3, C3, P3 (Foundation 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.

<b>For Examiner's Use</b>		
	<b>Max</b>	<b>Mark</b>
<b>1</b>	<b>2</b>	
<b>2</b>	<b>7</b>	
<b>3</b>	<b>3</b>	
<b>4</b>	<b>5</b>	
<b>5</b>	<b>3</b>	
<b>6</b>	<b>10</b>	
<b>7</b>	<b>4</b>	
<b>8</b>	<b>6</b>	
<b>9</b>	<b>4</b>	
<b>10</b>	<b>6</b>	
<b>11</b>	<b>5</b>	
<b>12</b>	<b>5</b>	
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

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

Answer **all** the questions.

1 Read the newspaper article.



**Are birds dinosaurs?**

*Tyrannosaurus rex* (*T. rex*) is the most famous of all dinosaurs.

A 68-million-year-old fossil of a *T. rex* bone was found that still contained seven proteins.

Three of the proteins were very similar to proteins found in birds and chickens.

Some scientists have suggested that this agrees with the idea that birds evolved from dinosaurs.

(a) Put a tick (✓) in the box next to the **explanation** reported in the article.

- T. rex* was the same as a chicken.
- Chickens evolved from dinosaurs.
- Dinosaurs evolved from chickens.
- T. rex* is not related to chickens.
- Chickens evolved from *T. rex*.

[1]

(b) Put a tick (✓) in the box next to the one piece of data that supports this explanation.

- Seven proteins were found in a *T. rex* fossil.
- A 68-million-year-old *T. rex* fossil was found.
- Three proteins from *T. rex* matched proteins found in chickens.

[1]

[Total: 2]



3 (a) The amount of carbon dioxide in the atmosphere has increased during the past 200 years.

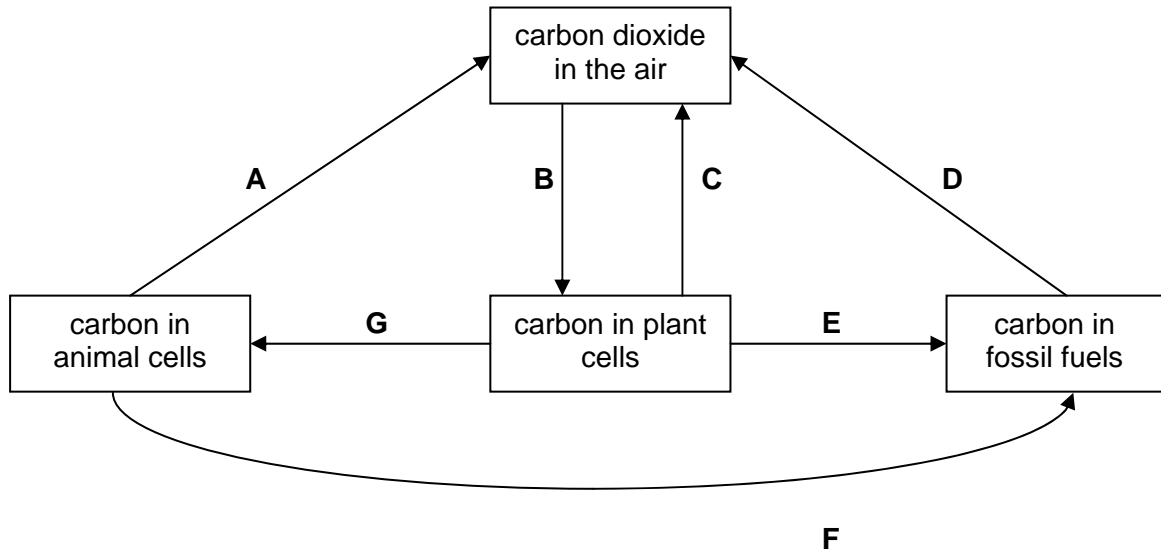
Which of the following changes would slow down the increase of carbon dioxide in the atmosphere?

Put a tick (✓) in the box next to the **two** correct answers.

- Stop burning forests to clear the land.
- Plant more grassland for cattle and sheep.
- Cut back on the use of fossil fuels as a source of energy.
- Use wind power instead of nuclear power to generate electricity.
- Find new sources of oil and gas to replace the ones that are running out.

[2]

(b) The diagram shows part of the carbon cycle.

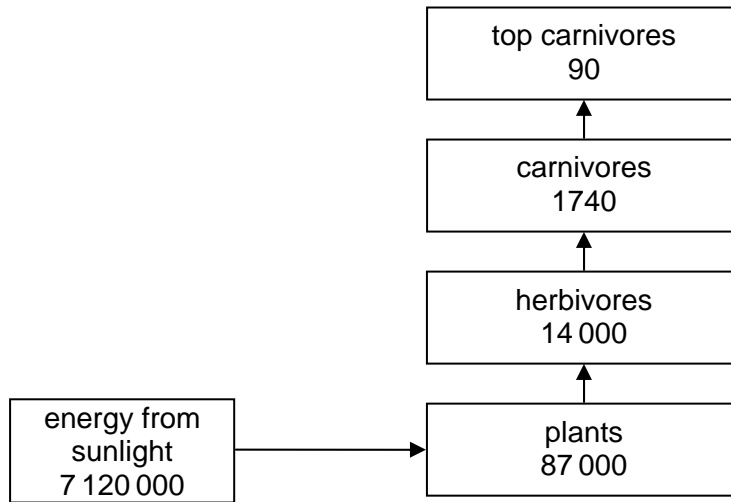


Which **two** arrows, from **A, B, C, D, E, F** and **G**, show respiration?

arrows ..... and ..... [1]

[Total: 3]

- 4 A scientist studied food chains in a river system in Florida, USA.  
She calculated the energy in each level in  $\text{kJ} / \text{m}^3 / \text{year}$ .  
The values she calculated are shown in the diagram.



- (a) At which stage does most energy pass out of the ecosystem?

from ..... to ..... [1]

- (b) The scientist calculated the percentage of energy in the plants that was transferred to the herbivores.

$$\frac{14\,000 \times 100}{87\,000} = 16\%$$

- (i) What percentage of the energy in the plants was transferred to the carnivores?  
Show your working.

answer = ..... % [2]

(ii) Put a tick (✓) in the box next to the correct choice to complete each sentence.

The percentage of energy in the plants transferred to the herbivores is

<b>more than</b>	<input type="checkbox"/>
<b>less than</b>	<input type="checkbox"/>
<b>the same as</b>	<input type="checkbox"/>

the percentage of energy in the plants transferred to the carnivores.

One reason for this is because

<b>carnivores do not get any energy from sunlight.</b>	<input type="checkbox"/>
<b>herbivores cannot digest plants.</b>	<input type="checkbox"/>
<b>energy is lost by the herbivores when they move around.</b>	<input type="checkbox"/>
<b>plants get their energy from sunlight.</b>	<input type="checkbox"/>

[2]

[Total: 5]

5 Scientists are studying an island in the Pacific Ocean. Some species living on the island are found nowhere else on Earth.

Several years ago, an area of forest on the island was chopped down. A palm oil plantation was created in place of the forest.

The palm oil plantation is an example of a monoculture.

The table gives information about the island before and after the palm oil plantation was created.

	before plantation was created	after plantation was created
number of animal species	12 142	10 673
number of plant species	9562	8134
unemployment (% of total population)	14	9
income to the island (millions of dollars per year)	132	156

Roshan lives on the island. He has two children and is currently unemployed. He wants the Government to create more palm oil plantations on the island.

Do you agree with Roshan?

Explain your answer.

.....

.....

.....

.....

..... [3]

[Total: 3]



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6 A website gives information about salt in the diets of children.

The daily maximum amount of salt for children depends on their age.

1 to 3 years old	–	2 g salt per day
4 to 6 years old	–	3 g salt per day
7 to 10 years old	–	5 g salt per day
11 years old and over	–	6 g salt per day

The mean mass of children at different ages is also given in a table.

<b>age in years</b>	1	2	3	4	5	6	7	8	9	10	11
<b>mean mass in kg</b>	9.9	12.9	14.5	16.1	18.5	21.0	23.0	25.9	28.5	31.9	35.4

Use this information to answer the following questions.

(a) What is the relationship between the age of the children and the daily maximum amount of salt?

Complete the sentence by putting a tick (✓) in the box next to the correct answer.

As children get older, the daily maximum salt intake ...

... keeps increasing.

... increases gradually until age 11.

... stays the same.

... decreases gradually.

[1]

(b) (i) Tom is surprised by these figures.

He suggests that the limit of salt for a 1-year-old should be lower than the limit of salt for a 3-year-old.

What evidence in the table supports his suggestion?

..... [1]

(ii) A health advisor reassures Tom that the figures are safe, although they are not as precise as they could be.

What are possible reasons for this?

Put ticks (✓) in the boxes next to the **two** correct reasons.

Providing that the figure is safe for the youngest children in the range, it will also be safe for older children.

Salt is a preservative so is needed in some foods.

All of the figures are very low anyway.

It is better to keep the figures as simple as possible so that they can be remembered more easily.

Salt improves flavour so encourages children to eat a variety of healthy foods.

[1]

(c) John is 5 years old.

For his dinner he eats

- one 200 g hamburger, which contains 1.89 g salt
- 225 g baked beans, which contain 2.98 g salt.

What advice would you give to John's mother about his salt intake from this meal?

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



7 Some students are talking about the Life Cycle Assessment (LCA) of poly(ethene) bags and paper bags.

Here is what they say.

**Anwar**  
Burning plastics puts harmful gases into the air.

**Barry**  
Life Cycle Assessment only looks at the use and disposal of the bags.

**Carly**  
Large amounts of water are needed to make paper from wood.

**David**  
Plastics are made from crude oil that is non-renewable.

**Ella**  
Plastic bags are stronger than paper bags.

(a) Which two students are talking about resources?

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

(b) Which person is talking about the environmental problems of disposal?

..... [1]

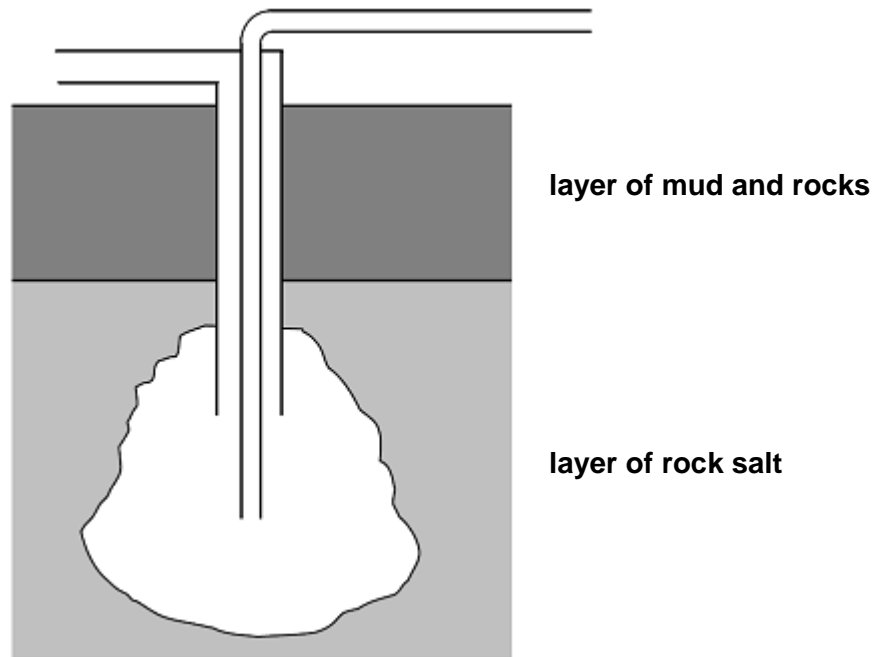
(c) Which one of these people is making an incorrect statement?

..... [1]

[Total: 4]

8 Salt is found underneath the ground in some parts of the UK.

The diagram shows one way in which salt can be obtained from underground.



(a) Use the diagram to describe how salt is obtained from underneath the ground.

.....

.....

.....

.....

..... [3]

(b) What effect might solution mining have on the environment?

Include in your answer

- the effect on the land above the mine
- how this affects people who live there.

.....

.....

.....

..... [3]

[Total: 6]

- 9 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	3	4	5
current in A	0.0	1.6	4.8	6.4	8.0

- (a) Calculate the power when the current is 4.8 amps.

power = .....W [2]

- (b) Mary notices that the wire gets very hot when the power is 40 W.

She says 'We have only had this on for 30 seconds! I wonder how much energy we have transferred?'

Calculate the energy transferred.

energy = ..... J [2]

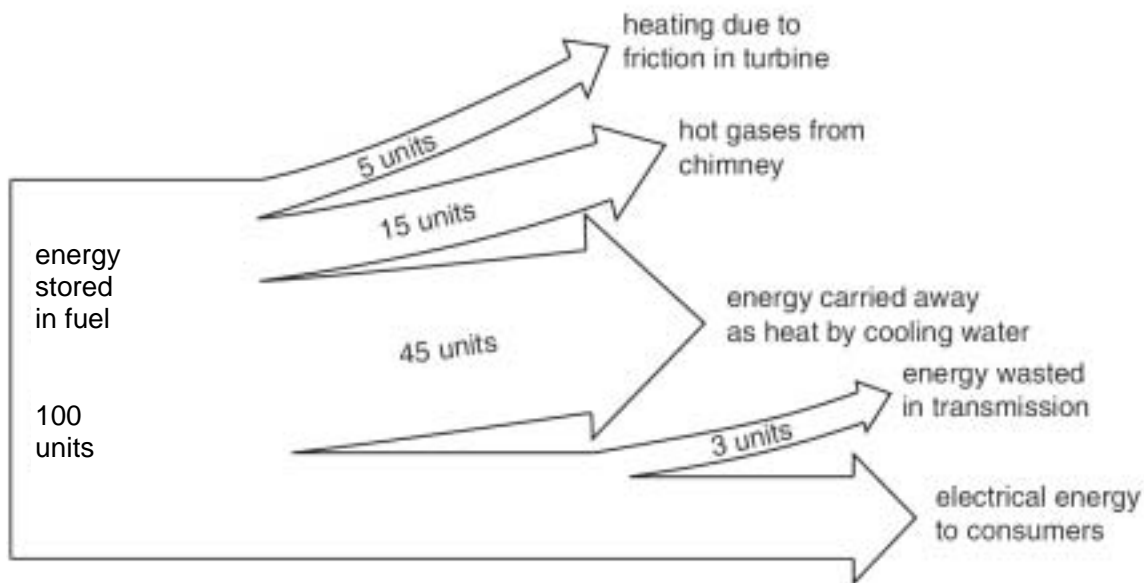
[Total: 4]





11 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?

Put a **ring** around the correct answer.

- 3      32      35      68      100

[1]

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

Put a **ring** around the correct answer.

- 3 %      35 %      45 %      54 %      65 %

[1]

(c) Some fossil fuel power stations provide hot water to heat houses in nearby towns.

Discuss how this would affect the efficiency of a fossil fuel power station.

.....

.....

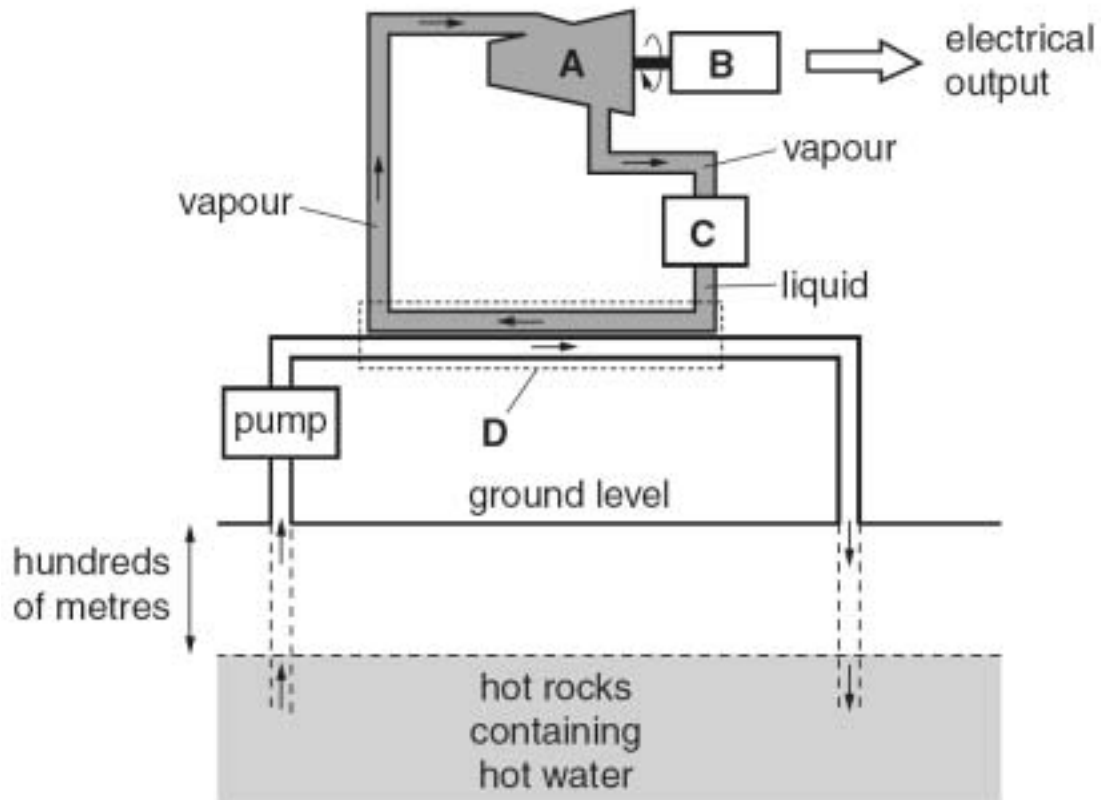
.....

..... [3]

[Total: 5]

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

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



The four parts labelled **A**, **B**, **C** and **D** in the diagram are a condenser, a generator, a heat exchanger and a turbine.

Draw a line to join each part of the power station to the correct description of what happens there.

One part has been done for you.

part	description
<b>A</b>	Hot water from underground is pumped through a <b>heat exchanger</b> which boils liquid into vapour. The cooled water then goes back underground.
<b>B</b>	The vapour goes into a <b>turbine</b> .
<b>C</b>	A <b>generator</b> makes electricity.
<b>D</b>	A <b>condenser</b> turns the vapour back into a liquid ready to be used again.

[2]

(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: 5]

[Paper Total: 60]

**END OF QUESTION PAPER**

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**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**TWENTY FIRST CENTURY SCIENCE**

**SCIENCE A**

**A143/01**

Unit A143: Modules B3, C3, P3 (Foundation 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
<b>not/reject</b>	=	answers which are not worthy of credit
<b>ignore</b>	=	statements which are irrelevant – applies to neutral answers
<b>allow/accept</b>	=	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 <b>not</b> 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 checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<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

<b>Edinburgh</b>	
<b>Manchester</b>	
<b>Paris</b>	
<b>Southampton</b>	


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).

<b>Edinburgh</b>			✓			✓	✓	✓	✓	
<b>Manchester</b>	✓	x	✓	✓	✓				✓	
<b>Paris</b>				✓	✓		✓	✓	✓	
<b>Southampton</b>	✓	x		✓		✓	✓		✓	
<b>Score:</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NR</b>

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	(a)	<p>Chickens evolved from dinosaurs.</p> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	[1]	tick in any other box = 0 marks
	(b)	<p>Three proteins from <i>T. Rex</i> ...</p> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/>	[1]	tick in any other box = 0 marks
<b>Total</b>			[2]	
2	(a)	<p>the arrival of a new disease</p> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	[1]	tick in any other box = 0 marks


Question	Expected answers	Marks	Additional guidance
2 (b) 	<p><b>[Level 3]</b>            Answer correctly uses technical terms such as natural selection, variation, mutation, competition and inheritance to explain the increase in numbers of black squirrels. All information in the 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><b>[Level 2]</b>            Answer mostly explains the increase in black squirrel numbers, but omits some elements or technical terms. 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><b>[Level 1]</b>            Answer only partially explains the increase in black squirrel numbers and omits technical terms. 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><b>[Level 0]</b>            Insufficient or irrelevant science. Answer not worthy of credit.            (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>• process is called natural selection</li> <li>• there is variation in the (genes coding for) colour</li> <li>• mutation (in genes) leads to, variation / different colours</li> <li>• ref. to any selective advantage of black fur (<b>accept</b> any reasonable suggestion that would convey an advantage, eg preferential selection by females / camouflage / warmer / thicker)</li> <li>• (grey) females, select / choose, black males</li> <li>• (allele/gene for) black colour is, passed on / inherited</li> <li>• offspring are black, so number of black squirrels increases</li> <li>• grey squirrels, not born / die out</li> </ul>
	<b>Total</b>	<b>[7]</b>	

Question		Expected answers	Marks	Additional guidance
3	(a)	Stop burning forests ... <input checked="" type="checkbox"/>  Cut back on the use of fossil fuels... <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	[2]	one mark for each correct tick three ticks deduct one mark four or five ticks = 0 marks
	(b)	<b>A and C</b>	[1]	either order both required for one mark
<b>Total</b>			<b>[3]</b>	


4	(a)	energy from sunlight (to) plants	[1]	both required for one mark
	(b) (i)	$1740 \times 100/87000$ 2	[2]	correct answer on its own = 2 marks
	(ii)	more than energy is lost by the herbivores when they move around	[2]	
<b>Total</b>			<b>[5]</b>	

Question	Expected answers	Marks	Additional guidance
5	<p><i>No because:</i>  <b>any three from:</b>            biodiversity has decreased / numbers of plants/animals has decreased;            idea that extinction is permanent / some of the lost species may be unique to the island;            increase in jobs/income is not enough to justify loss of species;            idea that Roshan may be biased because he is unemployed (and so wants to get a job in the plantation or wants the increased income to the island);</p> <p><b>OR</b></p> <p><i>Yes because:</i>  <b>any three from:</b>            plantation has increased the number of jobs;            plantation has increased the income to the island;            loss of species is relatively small (still lots left);            idea that humans are more important than animals/plants.</p>	<b>[3]</b>	no mark for yes or no
	<b>Total</b>	<b>[3]</b>	

Question		Expected answers	Marks	Additional guidance
6	(a)	<p>... increases gradually until age 11.</p> <p><input type="checkbox"/></p> <p><input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>	[1]	
	(b) (i)	idea that a 1-year-old is much smaller than a 3-year-old (so needs less salt)	[1]	<b>accept</b> quoted figures of mass and age from table to make this comparison
	(ii)	<p>Providing that the figure is ... <input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p>It is better to keep the ... <input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p>	[1]	both required for the mark
	(c)	John's salt intake should be reduced / choose foods lower in salt / owtte	[1]	mark is for advice, not for calculation

Question	Expected answers	Marks	Additional guidance
6 (d) 	<p><b>[Level 3]</b> Answer clearly considers (perceived) risks versus (perceived) benefits in the argument <i>against</i> lowering salt, and in the argument <i>for</i> lowering salt. All information in the 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><b>[Level 2]</b> Answer for the most part considers (perceived) risks and (perceived) benefits on both sides of the argument. 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 may be occasional errors in grammar, punctuation and spelling. (3 – 4 marks)</p> <p><b>[Level 1]</b> Answer shows a limited consideration of (perceived) risks and (perceived) benefits, but may not address both sides of the argument. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling may be intrusive. (1 – 2 marks)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <p>Food companies may not want to lower the amount of salt in their food because</p> <ul style="list-style-type: none"> <li>• (the companies think) the cost of reformulating recipes / cost of removing salt / risk of decreased sales (due to poorer taste / shorter shelf life) outweighs benefits to health</li> <li>• (the companies think) the benefits of taste and preservative outweigh (perceived) risk(s) to health</li> </ul> <p>Food companies should be made to lower the amount of salt in their foods because</p> <ul style="list-style-type: none"> <li>• too much salt in a diet increases the risk of high blood pressure, heart disease and strokes</li> <li>• risk / cost of ill health outweighs benefits of adding salt</li> <li>• benefit to population outweighs risk / cost to food companies</li> </ul>
	<b>Total</b>	<b>[10]</b>	

Question		Expected answers	Marks	Additional guidance
7	(a)	David Carly	[2]	answers in either order
	(b)	Anwar	[1]	
	(c)	Barry	[1]	
<b>Total</b>			<b>[4]</b>	
8	(a)	water is pumped to the salt layer (down the outer pipe) salt dissolves in the water pressure pushes salt solution back to surface (through middle pipe)	[3]	points must be coherently and logically linked for three marks
	(b)	<b>any three from:</b> land above mine is unsupported/less stable so land could sink into the mine / subsidence which causes damage to buildings and roads meaning people can't live in houses / have to pay cost of repair	[3]	for full marks answer must be coherent and logically link points <b>accept</b> danger from falling into cracks / owtte
<b>Total</b>			<b>[6]</b>	
9	(a)	selects 3 V 14.4 (W)	[2]	
	(b)	40 x 30 1200 (J)	[2]	
<b>Total</b>			<b>[4]</b>	

Question	Expected answers	Marks	Additional guidance
10 	<p><b>[Level 3]</b> Most relevant points are present. A balanced argument is provided recognising risk/benefit analysis. All information in the 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><b>[Level 2]</b> A balanced discussion is attempted, but significant aspects of the ‘pros’ or cons’ are 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><b>[Level 1]</b> Recognises that waste is hazardous, but does not explain why. Will not accept that circumstances could make nuclear power necessary. 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><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	<b>[6]</b>	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>• uranium/nuclear fuel is a non-renewable energy source</li> <li>• waste is radioactive</li> <li>• radiation can cause cell damage/cancer</li> <li>• little CO<sub>2</sub> produced</li> <li>• Government responsible for regulation</li> <li>• radiation is 'invisible'</li> </ul> <p><b>accept</b> hazards of terrorist attack waste can contaminate water supplies/soil/etc. must be kept securely for this long time in eg deep secure sites comments on perceived risk versus actual risk</p> <p><b>ignore</b> arguments based on safety of power stations (Chernobyl, Japan etc)</p> <p><b>reject</b> explosion or other confusion with nuclear bomb</p>
	<b>Total</b>	<b>[6]</b>	






Question		Expected answers	Marks	Additional guidance
11	(a)	32	[1]	
	(b)	35 %	[1]	
	(c)	<p><b>any three from:</b>            use waste energy            so increases efficiency</p> <p>most energy/45% is lost/wasted as hot water            so will have big affect on efficiency</p> <p>no information about how much of the heat is used            so difficult to say just what affect is on efficiency</p>	[3]	
		<b>Total</b>	<b>[5]</b>	

Question		Expected answers	Marks	Additional guidance	
12	(a)	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">A</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">B</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; background-color: #cccccc;">C</div> <div style="border: 1px solid black; padding: 5px;">D</div> </div>	[2]	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">heat exchanger boils liquid into vapour</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">The vapour goes into a turbine</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">A generator is turned to make electricity</div> <div style="border: 1px solid black; padding: 5px; background-color: #cccccc;">condenser turns vapour back to liquid</div> </div>	three links correct = 2 marks one or two links correct = 1 mark

Question	Expected answers	Marks	Additional guidance
12 (b)	<p><i>coal:</i> because it is the most efficient (1) and has one of lowest costs / is cheaper than wind power (1) and these benefits outweigh the disadvantage/environmental cost of producing carbon dioxide (1)</p> <p><b>OR</b></p> <p><i>nuclear:</i> because it has the lowest cost / is cheaper than coal and wind power (1) and this benefit outweighs the disadvantage/environmental cost of producing radioactive waste (1) and outweighs the low efficiency (1)</p> <p><b>OR</b></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 (1) and these benefits outweigh the high cost of generation (1)</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><b>ignore</b> 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>
	<b>Total</b>	<b>[5]</b>	

## Assessment Objectives (AO) Grid

(includes quality of written communication )

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