OCR
RECOGNISING ACHIEVEMENT

SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A142/02**

SCIENCE A

Unit A142: Modules B2, C2, P2 (Higher Tier)

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

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

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 included 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	**3**	
2	**8**	
3	**2**	
4	**5**	
5	**2**	
6	**9**	
7	**7**	
8	**4**	
9	**4**	
10	**5**	
11	**5**	
12	**6**	
TOTAL	**60**	

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

distance = wave speed x time

wave speed = frequency x wavelength

Sustainable Energy

energy transferred = power x time

power = voltage x current

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

Explaining Motion

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

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

momentum = mass x velocity

change of momentum = resultant force x time for which it acts

work done by a force = force x distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight x vertical height difference

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

Electric Circuits

power = voltage x 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

energy = mass x [speed of light in a vacuum]^2

Answer **all** the questions.

1 Some strains of the bacterium *E. coli* can make us ill if they enter our body.

Read this information about one particular strain of *E. coli*.

- Bacteria of this strain can enter the body on contaminated food.
- A person may develop symptoms of food poisoning if the number of bacteria of this strain in the stomach is $\geq 1 \times 10^4$.
- A single bacterium of this strain can reproduce itself every 20 minutes in optimum conditions.

A piece of food is contaminated with 200 bacteria of this strain. The food is left at room temperature for 2 hours.

Jenny concludes that anybody who eats this piece of food will get food poisoning.

Discuss whether this conclusion is correct.

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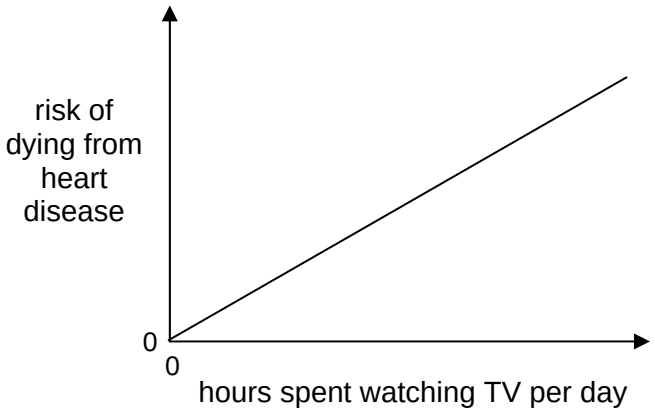
..... …**[3]**

[Total: 3]

2 Toby sees this article in a newspaper.

> Heart disease is one of the most common causes of death in the UK.
>
> Some scientists claim that there is a correlation between the amount of time spent watching TV each day and the risk of dying from heart disease.
>
> They concluded that watching TV increases the risk of dying from heart disease.

(a) Toby draws a sketch graph to represent the correlation described in the article.



Discuss whether Toby's graph correctly represents the correlation described in the article.

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

(b) Toby watches TV every night after work. He is worried about the correlation reported in the article. He decides to stop watching TV because he believes it will cause heart disease.

What advice would you give Toby about this?

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 8]

3 This question is about how vaccines work.

Draw **one** straight line from the correct **content of a vaccine** to its **effect**.

Draw **one** straight line from this **effect** to the **reason for immunity**.

There should only be **two** straight lines in your answer.

content of a vaccine	**effect**	**reason for immunity**
antibodies against the disease-causing microorganism	more red blood cells are produced	the person already has the disease
a dose of antibiotics	white blood cells destroy the antibiotics	antibodies can be made quickly on reinfection
a safe form of the disease-causing microorganism	white blood cells make antibodies against microorganisms in the vaccine	stops microorganisms re-entering the body

[2]

[Total: 2]

4 This question is about antibiotics.

(a) Some antibiotics are becoming less effective.

This is because microorganisms are becoming resistant to antibiotics.

Which two reasons, when put together, can cause antibiotic resistance?

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

increased use of antibiotics	☐
random changes in the genes of microorganisms	☐
increased use of disinfectants in hospitals	☐
increased use of vaccines	☐
people always finishing a course of antibiotics	☐
development of new antibiotics	☐

[1]

(b) New antibiotics have to be developed.

Before new antibiotics can be used to treat humans they must be tested.

Some of the tests are done on groups of healthy human volunteers.

Some of the tests are done on groups of people with the illness that the drug will treat.

(i) What are the reasons for using these groups of people?

Put a tick (✓) in the correct box for each group of people.

There should be one tick in each row.

	to test for safety only	**to test for effectiveness only**	**to test for safety and effectiveness**
healthy volunteers			
people with the illness			

[2]

(ii) Some drugs trials in humans are called double-blind trials.

Explain what is meant by a double-blind trial.

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

[Total: 5]

5 The volume of urine produced by the body is controlled by the hormone ADH.

Damon drinks some beer.

How will the alcohol in the beer affect the amount of ADH released into Damon's bloodstream, and how will this affect the volume of urine Damon produces?

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

[Total: 2]

6 The table shows the Olympic record height of the pole vault event has increased over the last 60 years.

It also shows the material used to make the pole.

year that record was broken	Olympic record in metres	material used to make the pole
1948	4.45	bamboo
1952	4.55	bamboo
1960	4.70	bamboo
1964	5.10	polymer and glass fibre
1968	5.40	polymer and glass fibre
1972	5.50	polymer and glass fibre
1980	5.80	polymer and glass fibre
1988	5.90	polymer and glass fibre
2004	5.95	polymer and glass fibre
2008	5.96	polymer and glass fibre

(a) Here are four statements about the pole vault Olympic record height.

Use the evidence in the table to evaluate each statement.

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

	true	**false**
The Olympic record increased at least 0.5 m every 20 years.	☐	☐
The biggest increase in the Olympic record was when the material used to make the poles changed.	☐	☐
The Olympic record increased more between 1988 and 2008 than between 1948 and 1960.	☐	☐
The average increase in the Olympic record over the period of the table is about 0.1 m every 4 years.	☐	☐

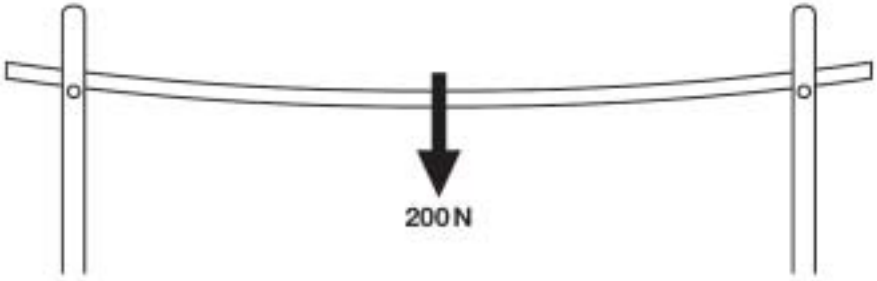
[2]

(b) Anna and Nick are investigating the properties of vaulting poles.

They know that flexibility (how far the pole bends) is an important property.

They support a pole at both ends as shown in the diagram.

They hang a 200 N weight from the centre of the pole and measure how far the pole bends.



(i) They repeat this measurement five times.

Suggest reasons why.

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

Here are their results.

test number	**1**	**2**	**3**	**4**	**5**
how far the pole bends in cm	11.4	10.9	11.5	11.0	11.2

(ii) Suggest why the results of the five tests are different.

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

(c) Anna and Nick use the same test on a different vaulting pole.

Here are the results for the second pole.

test number	**1**	**2**	**3**	**4**	**5**
how far the pole bends in cm	12.4	12.9	11.9	11.8	12.5

(i) Work out the best estimate of how far each pole bends.

first pole = ... cm

second pole = ... cm

[1]

(ii) Anna looks at the best estimates for both poles and concludes that the two poles have different flexibility.

Comment on whether Anna is correct to come to this conclusion. Justify your answer.

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

[Total: 9]

7 Read the newspaper article.

Skincare creams use nanotechnology

Nanoparticles are put in face creams and sunscreens.

These creams are easy to apply and invisible on the skin.

Some scientists are worried about the effects of nanoparticles on the body.

At the moment it is impossible for consumers to tell if the creams contain nanoparticles.

(a) Which statement is the best description of nanotechnology?

Put a tick (✓) in the box next to the **best** description.

Nanotechnology…

…involves structures that are about the same size as one oxygen atom. ☐

…is the use and control of structures that are no bigger than 1 nanometre in size. ☐

…involves structures that are about the same size as some molecules. ☐

…is the synthesis of polymer chains. ☐

…is the use and control of structures that are smaller than 1 nanometre in size. ☐

[1]

(b) Use your knowledge of nanoparticles to explain why some scientists may be worried about the effects of using these particles in creams.

Suggest what actions should be taken to reduce the concerns of experts and consumers.

The quality of written communication will be assessed in your answer to this question.

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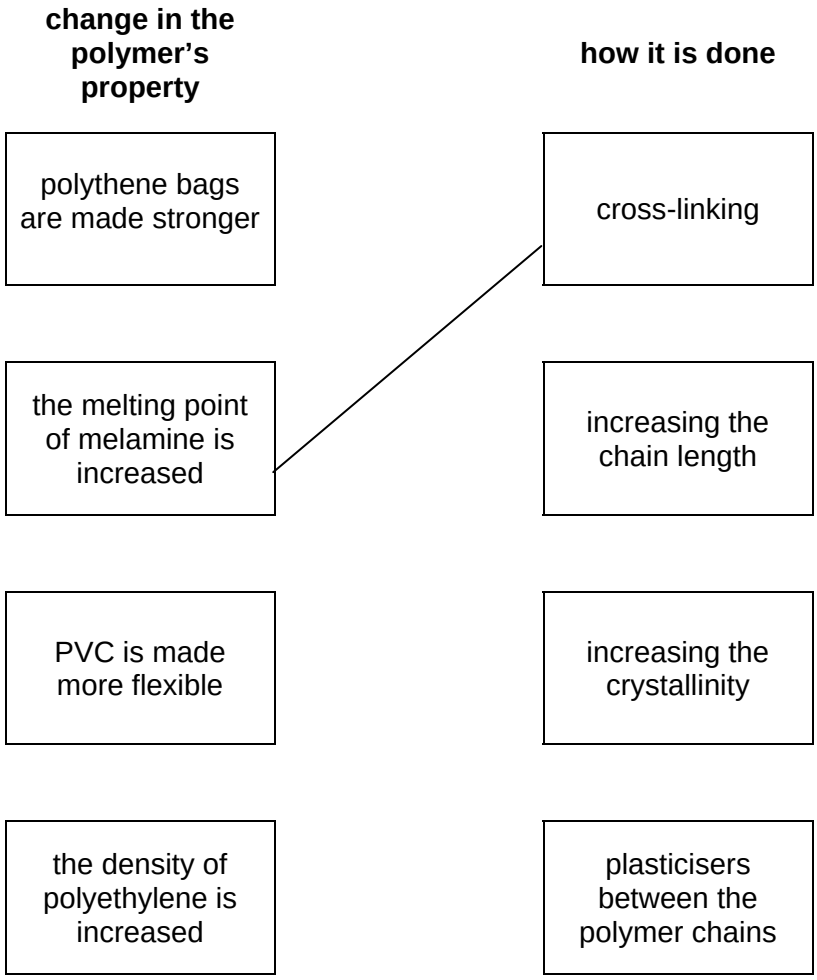
..... **[6]**

[Total: 7]

8 This question is about changing the properties of a polymer by changing its molecules.

(a) Draw straight lines to link each **change in the polymer's property** to **how it is done**.

One has been done for you.



[2]

(b) ‘Vulcanised’ rubber is made by heating natural rubber with sulfur.

The sulfur atoms form cross-links between the polymer chains.

The more cross-links between the polymer chains, the higher the melting point of the ‘vulcanised’ rubber, and the harder it becomes.

Why does the increase in **cross-linking** have these effects?

Put a tick (✓) in the correct box next to each possible reason, to show whether the reason is **true** or **false**.

	true	**false**
There are larger forces between the polymer chains.	☐	☐
There are smaller forces within the polymer chains.	☐	☐
The polymer chains are increased in length.	☐	☐
The polymer chains are forced further apart.	☐	☐
It becomes more difficult for the polymer chains to break away from one another.	☐	☐
The polymer chains become tangled.	☐	☐
The polymer chains can slide past one another more easily.	☐	☐

[2]

[Total: 4]

9 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.

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

[Total: 4]

10 This question is about carbon dioxide data.

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) One student calculates the mean concentration as 245 parts per million.

Explain, without doing any calculation, how you can be sure that the student must have made a mistake.

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

(b) 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.

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

(c) 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.

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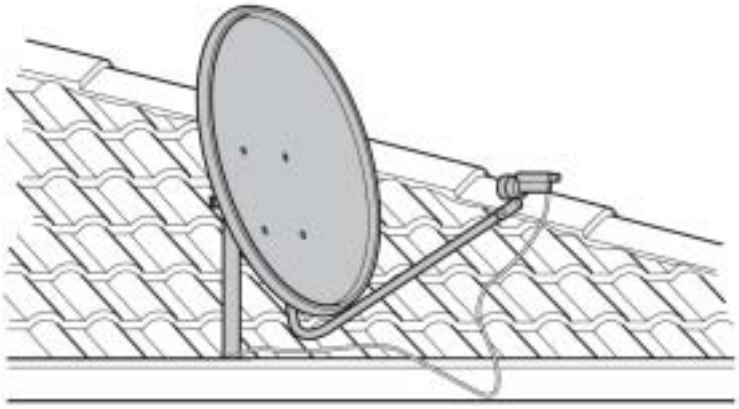
..... **[2]**

[Total: 5]

11 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.

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..... **[3]**

[Total: 5]

12 This question is about global warming and ozone.

Many people get confused between 'the greenhouse effect' and 'holes in the ozone layer'.

Explain the difference between the two and the scientific processes involved in each.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 6]

END OF QUESTION PAPER

OCR
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SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

SCIENCE A **A142/02**

Unit A142: Modules B2, C2, P2 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

This document consists of 20 pages

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
words	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

E.g. 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.

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

Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.
☐	☐	✓
☐	☐	✓
✓	✓	✓
✓	✓	✓
☐	☐	☐
This would be worth 0 marks.	This would be worth one mark.	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.

E.g. 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	✓	×	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	×		✓		✓	✓		✓	
Score:	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**NR**

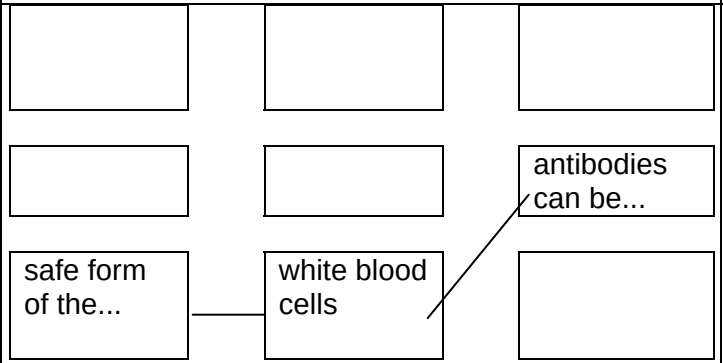
10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:

- 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.

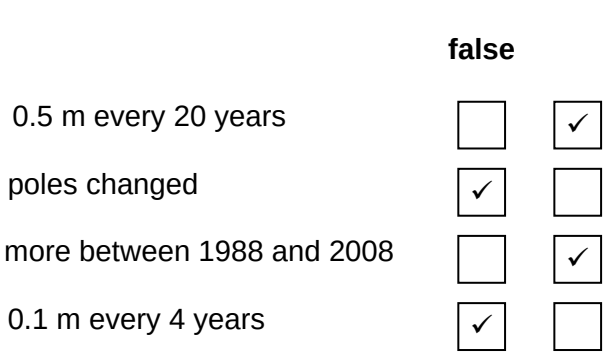
Question			Expected answers	Marks	Additional guidance
1			**any three from:** number of bacteria after 2 hours is 12 800 (or 1.28 x 10^4), which is a sufficient number to cause food poisoning idea that if conditions were not optimum the actual number may be lower than this idea that not enough data/evidence/information, or would need to measure more things, to conclude that person will definitely get food poisoning idea of immune response against bacteria or toxins / acid in stomach destroying bacteria or toxins	**[3]**	
			Total	**[3]**	

Question			Expected answers	Marks	Additional guidance
2	(a)		**any two from:** correlation is in the correct direction (positive); should not start at zero as your risk of dying from heart disease can never be 0 / not watching TV will not stop you getting heart disease; not enough evidence to assume linear correlation;	[2]	

Question			Expected answers	Marks	Additional guidance
2	(b)	✎	**[Level 3]** Answer clearly explains the links between the ideas of correlation, factors and cause, and considers genetic **and** lifestyle factors. 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) **[Level 2]** Answer shows limited understanding of correlation, factors and cause, and gives examples of relevant factors. 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) **[Level 1]** Answer only gives examples of factors without considering ideas of correlation and cause **OR** only states that TV does not necessarily cause heart disease without considering other factors. 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) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** • idea that an observed correlation does not necessarily mean that watching TV (the factor) causes heart disease (the outcome) • idea that the factor might increase the probability of the outcome, but does not necessarily lead to it (does not make it certain to happen) • idea that other factor(s) may be just as important, or more important • Toby might , be able to / need to , change other factors (to lower his risk of developing heart disease) **ignore** refs. to the article not being trustworthy **ignore** refs. to the study needing to be repeated, etc. examples of other factors: • genetic factors / family history of disease • lifestyle factors, e.g. lack of exercise, poor/fatty diet, stress, smoking / excessive nicotine, drinking / excessive alcohol **accept** economic factors if linked to poor diet etc.
			Total	**[8]**	

Question	Expected answers	Marks	Additional guidance
3		[2]	1 mark for each correct line any other lines between sections = 0 marks for that section
	Total	**[2]**	

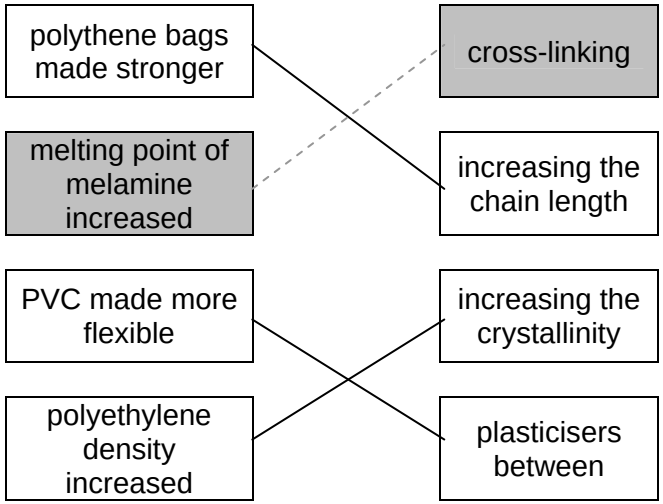
<table>
<tr><th colspan="3">Question</th><th>Expected answers</th><th>Marks</th><th>Additional guidance</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td>increased use of antibiotics ☑
random changes in the genes… ☑
☐
☐
☐
☐</td><td>[1]</td><td>both ticks = 1 mark
tick in any other box = 0 marks</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td><table><tr><th></th><th>safety</th><th>effective-ness</th><th>both</th></tr><tr><td>healthy</td><td>✓</td><td></td><td></td></tr><tr><td>illness</td><td></td><td></td><td>✓</td></tr></table></td><td>[2]</td><td>1 mark for each correct tick
more than one tick in any row = 0 marks for that row</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>doctor does not know who receives the drug
patient does not know who receives the drug</td><td>[2]</td><td>accept “nobody knows who receives the drug”, for two marks</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>[5]</td><td></td></tr>
<tr><td>5</td><td></td><td></td><td>alcohol in beer suppresses ADH production
resulting in a greater volume of (more dilute) urine</td><td>[2]</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>[2]</td><td></td></tr>
</table>

Question			Expected answers	Marks	Additional guidance
6	(a)			[2]	all 4 correct = 2 marks 3 or 2 correct = 1 mark
	(b)	(i)	**any two from:** find the best estimate of the true value identify outliers discard outliers ensure results are reliable	[2]	
		(ii)	**any two from:** human error in measuring weight not placed in middle / weight hung from a different place supports move apart or together / pole in a different position on supports pole does not straighten after weight hung on it	[2]	
	(c)	(i)	11.2 12.3	[1]	both correct for 1 mark

Question			Expected answers	Marks	Additional guidance
6	(c)	(ii)	the ranges of the two data sets do not overlap / the mean of each data set is outside the range of the other data set indicating that the true values/best estimates/means/flexibilities are likely to be different / Anna's conclusion is likely to be correct **OR** the sample size is too small and the ranges too close together to be sure that the true values/best estimates/means/flexibilities are different / to be sure that Anna's conclusion is correct	**[2]**	maximum of 1 mark if answer implies that Anna's conclusion is definitely correct or incorrect
			Total	**[9]**	

Question			Expected answers	Marks	Additional guidance
7	(a)			[1]	
			…one oxygen atom. ☐		
			…no bigger than 1 nanometre… ☐		
			…some molecules. ☑		
			…synthesis of polymer chains. ☐		
			…smaller than 1 nanometre… ☐		

Question			Expected answers	Marks	Additional guidance
7	(b)	✎	**[Level 3]** Detailed and clear explanation of why experts have concerns about the use of silicon dioxide nanoparticles and suggestion of how consumers may be protected. 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) **[Level 2]** A partial explanation of why experts have concerns about silicon dioxide nanoparticles and a suggestion of how consumers may be protected. 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) **[Level 1]** Answer only refers to either why experts are worried or how consumers can be protected. Little detail is provided. 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) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** • nanoparticles of silicon dioxide will show different properties to larger particles of it • because their surface area : volume ratio is very large • therefore even if we know the (long-term) effects of putting silicon dioxide on the skin, this will be different for nanoparticles • long-term effects of silicon dioxide nanoparticles have not been fully investigated • may be harmful • more research needed • labelling to show when silicon dioxide nanoparticles are present in the cream
			Total	**[7]**	

Question			Expected answers	Marks	Additional guidance
8	(a)			[2]	3 lines correct = 2 marks 2 or 1 line correct = 1 mark

Question			Expected answers			Marks	Additional guidance
8	(b)			true	false	[2]	evaluate every row all 7 rows correct = 2 marks 6 rows correct = 1 mark
			larger forces between …	✓			
					✓		
					✓		
					✓		
			becomes more difficult for …	✓			
					✓		
					✓		
			Total			**[4]**	

Question			Expected answers		Marks	Additional guidance
9	(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, whereas light molecules are not.		[1]	
			Total		[4]	

Question			Expected answers	Marks	Additional guidance
10	(a)		mean must be in the range of the data/cannot be bigger than the biggest value	[1]	**ignore** any actual calculation of the mean (= 215 ppm)
	(b)		**any two from:** 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]	
	(c)		360 ppm/present concentration is far above the range 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]	must refer explicitly/implicitly to maximum of data (240 ppm) significance of increase needs to refer to range/variability of data
			Total	[5]	

<table>
<tr><th colspan="3">Question</th><th>Expected answers</th><th>Marks</th><th>Additional guidance</th></tr>
<tr><td>11</td><td>(a)</td><td></td><td>
<table>
<tr><th>statement</th><th>true</th><th>false</th></tr>
<tr><td>dish increases intensity</td><td>✓</td><td></td></tr>
<tr><td>strongly absorbed by air</td><td></td><td>✓</td></tr>
<tr><td>dish removes noise</td><td></td><td>✓</td></tr>
<tr><td>metal good reflector</td><td>✓</td><td></td></tr>
</table>
</td><td>[2]</td><td>all 4 correct = 2 marks
2 or 3 correct = 1 mark</td></tr>
<tr><td></td><td>(b)</td><td></td><td>prediction is wrong because radio has more energy than infrared

any two 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</td><td>[3]</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>[5]</td><td></td></tr>
</table>

Question			Expected answers	Marks	Additional guidance
12			**[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) **[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) **[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) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** *greenhouse effect* • incoming solar radiation is absorbed by the Earth • Earth re-remits 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 *holes in ozone layer* • ozone layer absorbs ultraviolet radiation • chemical changes in ozone result • these changes are reversible so $[O_3]$ is usually constant • extra loss of ozone results in 'holes' **accept** 'lower frequency radiation emitted by Earth' for infrared CFCs as agents of ozone loss **ignore** CFCs as greenhouse gases effects of global warming or depleted ozone layer
			Total	**[6]**	

Assessment Objectives (AO) Grid

(includes quality of written communication✎)

Question	AO1	AO2	AO3	Total
1		1	2	3
2(a)			2	2
2(b) ✎	2	3	1	6
3	2			2
4(a)		1		1
4(b)(i)	1	1		2
4(b)(ii)	1	1		2
5	1	1		2
6(a)		1	1	2
6(b)(i)	1	1		2
6(b)(ii)	1	1		2
6(c)(i)		1		1
6(c)(ii)			2	2
7(a)	1			1
7(b) ✎	3	3		6
8(a)	1	1		2
8(b)		2		2
9(a)	2	1		3
9(b)	1			1
10(a)		1		1
10(b)		1	1	2
10(c)		1	1	2
11(a)		2		2
11(b)			3	3
12 ✎	5	1		6
Totals	**22**	**25**	**13**	**60**