OCR
RECOGNISING ACHIEVEMENT

SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

ADDITIONAL SCIENCE A

A153/02

Unit A153: Modules B6, C6, P6 (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

- A list of physics equations is printed on page **2**.
- The Periodic Table is printed on the back page.
- Your quality of written communication is assessed in questions marked with a pencil (✎).
- 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	4	
3	6	
4	3	
5	4	
6	2	
7	2	
8	12	
9	4	
10	6	
11	3	
12	3	
13	3	
14	5	
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

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

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

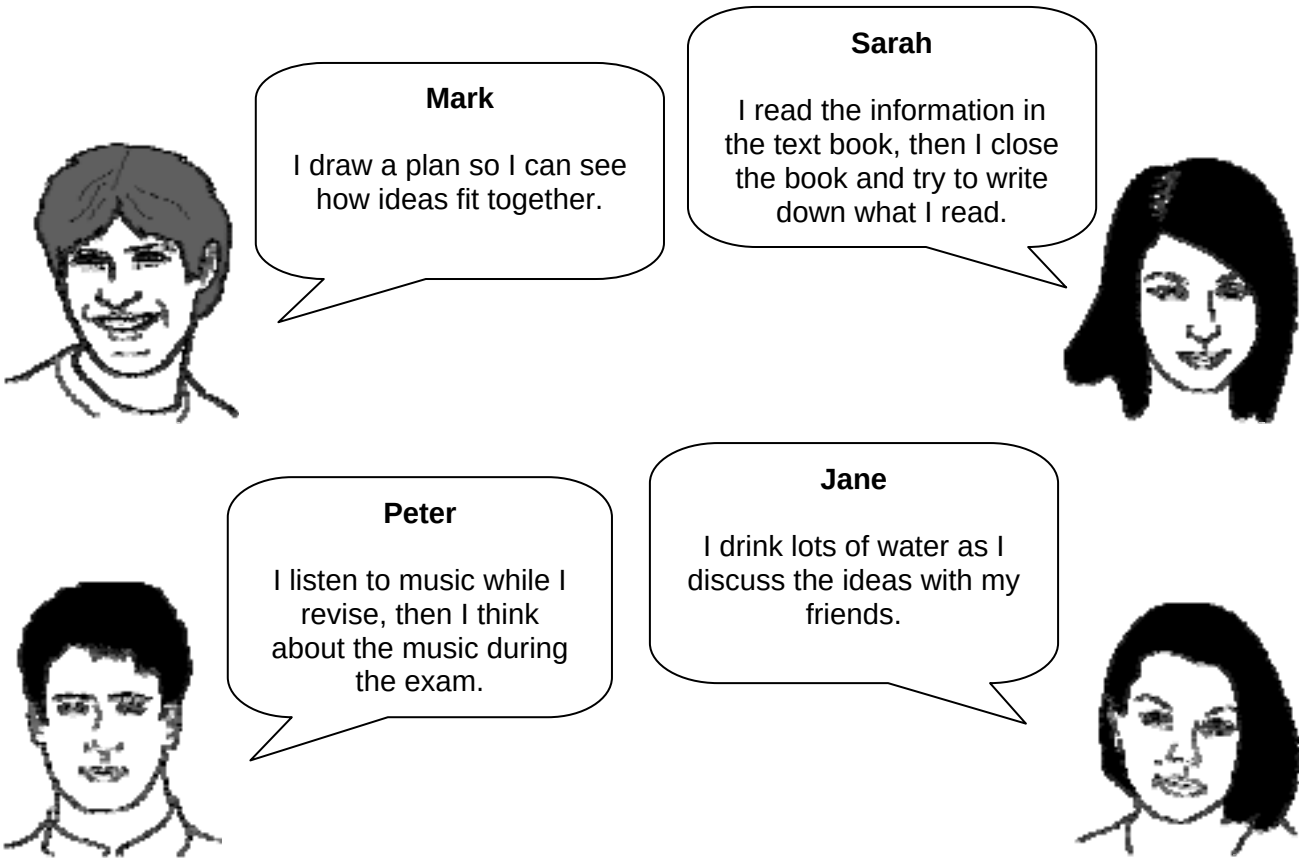
Radioactive materials

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

Answer **all** the questions.

1 Four friends are revising for their exams.

They talk about the methods they use.



(a) Which person is using a stimulus to help them remember?

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

(b) Memory depends on two different processes.

Which person describes the use of both of these processes? Explain why you have chosen this person.

.....

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

[Total: 3]

2 Brian walks out of the cinema into bright sunshine.

The bright light dazzles his eyes, and at first he cannot see properly.

Then his eyes adjust as his pupils get smaller. This is the pupil reflex.

(a) Draw straight lines to join each **component** to the correct **part of the reflex**.

component	part of the reflex
muscle cells in iris	processor
light sensitive cells in retina	effector
central nervous system	receptor

[2]

(b) Newborn babies have some reflexes that disappear after time.

Write down two newborn reflexes.

1 .....

2 .....

[2]

[Total: 4]

3 Pujitha is reading about an anti-depressant drug called paroxetine.

He reads that paroxetine increases the transmission of nerve impulses in the brain by increasing the concentration of serotonin.

Suggest how paroxetine could cause this change in serotonin concentration and the increase in transmission of nerve impulses in the brain.

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

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

[Total: 6]

4 Some scientists are investigating the speed at which nerve impulses travel along different human neurons.

They measure the length of four different neurons and record how long it takes for a nerve impulse to travel from one end of each neuron to its other end.

They repeat the experiment five times for each neuron. Here are their results.

neuron	length of neuron in m	mean time taken for impulse to travel along neuron in seconds
A	1.3	1.25
B	1.0	0.05
C	1.2	0.06
D	0.1	0.06

(a) How far would a nerve impulse travel along neuron **A** in 1 second?

answer = ... m **[1]**

(b) One of these neurons was a motor neuron that connected the spinal cord to a muscle in the big toe. The neuron was in a patient with multiple sclerosis (MS).

MS is a disease in which the patient's own immune system breaks down the fatty sheath on their neurons.

Which neuron was the motor neuron in the patient with MS? Justify your answer.

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.....

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

[Total: 3]

5 Stuart is a doctor. He has a patient with a brain injury.

Stuart wants to do research on this patient's brain.

Some people think he should be allowed to do this, while other people think he should not be allowed.

Discuss reasons in **support** of Stuart's plan to study this patient's brain.

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..... **[4]**

[Total: 4]

6 This question is about solids and liquids.

(a) Which is the solid acid in this list?

Put a (ring) around the correct answer.

ethanoic acid **nitric acid** **sulfuric acid** **citric acid**

[1]

(b) Baking powder contains small grains of a solid acid and of a solid alkali.

The acid in baking powder does not react with the alkali until water is added.

Explain why the reaction only starts when water is added.

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.....

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

[Total: 2]

7 Mary does a titration.

She puts 25.0 cm^3 of alkali solution in a conical flask. She adds a few drops of indicator to the alkali and then adds acid from the burette.

She does a rough titration first. She then does an accurate titration.

Describe one thing Mary should do to make her second titration as accurate as possible, and explain why this increases the accuracy.

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

[Total: 2]

8 Bobby reacts 3g of magnesium pieces with an excess of sulfuric acid until all the magnesium has reacted.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

(a) What mass of magnesium sulfate will be produced by the reaction?

Show your working.

mass of magnesium sulfate = ... g **[2]**

(b) Bobby collects the hydrogen gas produced by the reaction. Every 10 seconds he records the volume of gas that has been collected.

Here are his results.

time after start of reaction in s	**volume of gas collected in cm^3**
0	0
10	20
20	30
30	35
40	35
50	35

What was the rate of reaction during the first 10 seconds?

Show your working and include appropriate units in your answer.

rate of reaction = ... **[1]**

(c) Bobby does the experiment a further four times.

Each time he makes **one** change to the way he does the experiment.

experiment	**volume of gas collected after 10s, in cm^3**	**volume of gas collected after 30s, in cm^3**	**volume of gas collected after 50s, in cm^3**
original experiment	20	35	35
experiment **A**	35	40	40
experiment **B**	30	35	35
experiment **C**	20	30	35
experiment **D**	25	35	35

In which experiment did Bobby use a larger mass of magnesium pieces?

Explain your answer.

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

(d) Bobby does the experiment one more time. This time, he uses smaller pieces of magnesium.

How will this change the rate of the reaction?

Explain your answer.

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

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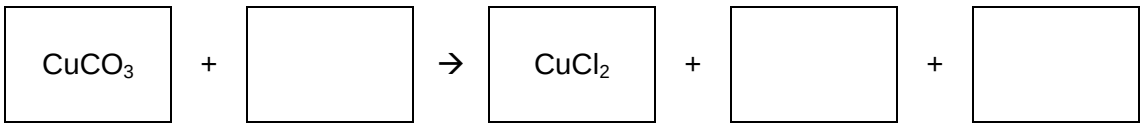
..... **[6]**

[Total: 12]

9 Geoff reacts copper carbonate with hydrochloric acid.

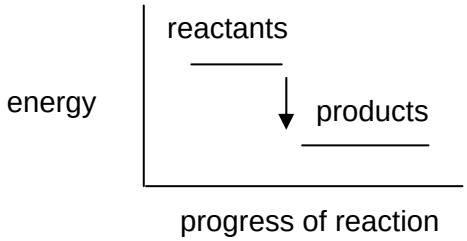
He knows that this will produce a salt and two other products.

(a) Write the formula of each chemical in the correct box, then balance the equation.



[3]

(b) Geoff draws an energy level diagram for the reaction.



What is the name given to this type of reaction?

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

[Total: 4]

10 A nuclear reactor produces radioactive materials for use in hospitals. The radioactive materials are used to treat patients.

Identify the different types of radioactive waste generated by the production and use of these radioactive materials and describe how the waste should be dealt with.

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

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

[Total: 6]

11 Hospitals use a generator containing a radioactive substance called Mo – 99 to make an isotope called Tc – 99 m.

Mo – 99 has a half life of 66 hours.

Tc – 99 m has a half life of 6 hours.

The technician tests a sample from the generator to find out what it contains.

He measures its activity at seven different times.

Here are the results.

time of measurement	activity of sample in Bq
08:00 h	5624
10:00 h	4603
12:00 h	3740
14:00 h	3078
16:00 h	2598
18:00 h	2083
20:00 h	1757

What does the sample contain? Use the data from the table to justify your answer.

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

[Total: 3]

12 Read the newspaper article about a new treatment for breast cancer.

> **New treatment for breast cancer**
>
> The cancer is cut out by the surgeon. Then a radioactive rod is placed in the wound by the radiographer. Ionising radiation from the rod kills any cancer cells that the surgeon has missed. After a few hours the rod is removed and the wound is stitched up. No further treatment is needed.

Discuss the risks and benefits of the new treatment to **all** the people involved.

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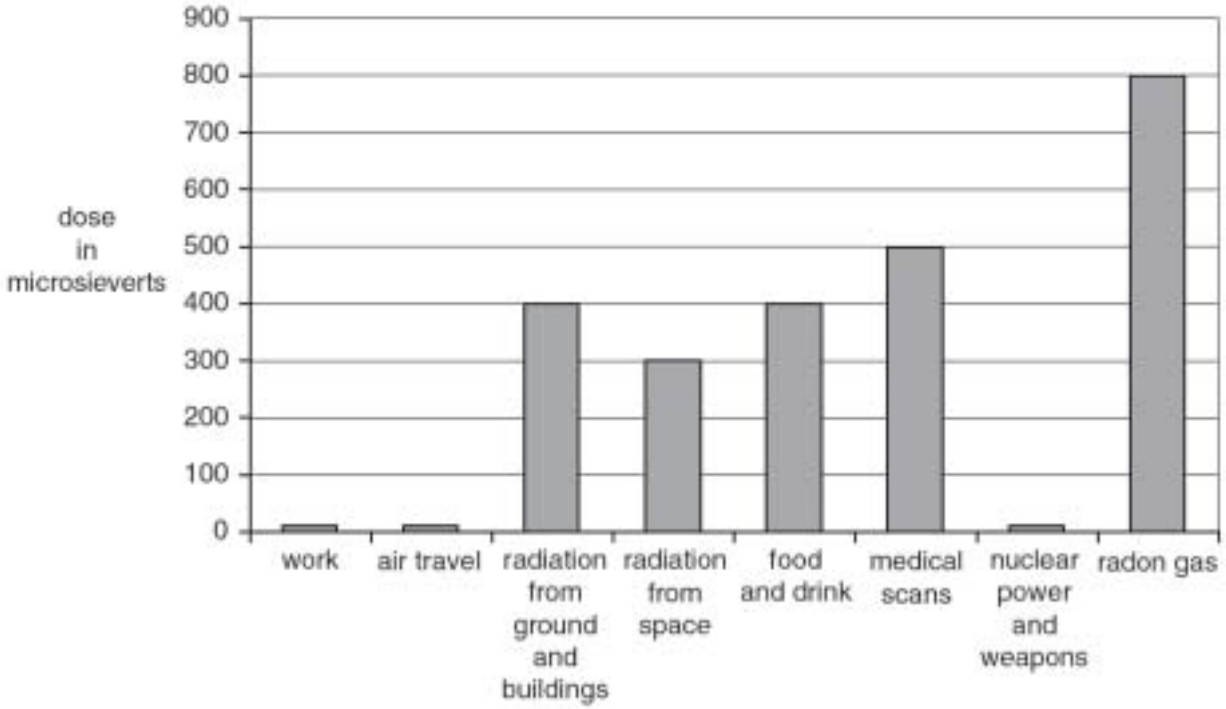
..... **[3]**

[Total: 3]

13 The bar chart shows the typical yearly radiation dose for a person in Britain from different sources.



(a) Radon gas provides the largest percentage of the total yearly dose of radiation.

What percentage of the total yearly dose comes from radon gas?

Write down your answer to the nearest whole number.

answer = ...% **[1]**

(b) The total for all sources is 2430 microsieverts.

Which of the following statements are correct conclusions **from the bar chart**?

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

Not everyone will have medical scans. ☐

Radon gas provides more than half the total dose. ☐

The fraction of dose received from nuclear power stations is very small. ☐

The dose from radon gas will be different in different parts of Britain. ☐

The dose from food and drink is less than a quarter of the total dose. ☐

[2]

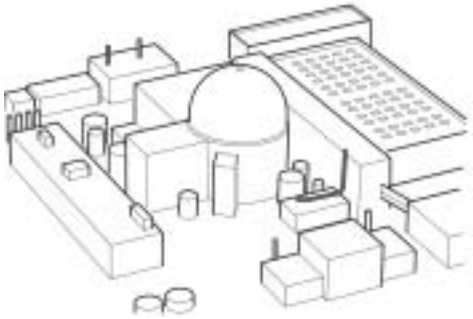
[Total: 3]

14 Read the article about nuclear power stations.

Nuclear power stations use uranium as a fuel.

Energy is released from the uranium by the process of nuclear fission.

Some people object to nuclear power stations because they produce radioactive waste.



(a) The nuclear fission process needs to be controlled to release the energy safely.

The following statements describe this control process. They are in the wrong order.

A Coolant is used to carry the heat energy away from the reactor.

B More neutrons are released.

C The uranium undergoes fission.

D Neutrons in the reactor collide with uranium.

E Some of these neutrons are absorbed by control rods.

Fill in the boxes to show the correct order. One has been done for you.

				A

[2]

(b) The process of nuclear fission can continue unaided once it has started.

Write the name for this type of reaction.

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

(c) A nuclear power station has to release 4.5×10^7 J of energy to provide one person with their daily electricity needs. Use the formula $m = \frac{E}{c^2}$ to calculate the mass of fuel which must be lost to provide this energy.

$c = 3.0\times10^8$ m/s

mass of fuel lost = ... kg **[1]**

(d) The maximum annual risk of developing cancer from exposure to radiation for a worker in a nuclear reactor is 0.1%. This is approximately 40 times greater than the annual risk for a member of the public.

Why might this increased risk not be seen as a problem for the owners of the power station?

Put a tick (✓) in the box next to the correct answer.

The owners are not required to consider the safety of their workers.	☐
The risk to a worker would still be very low.	☐
The owners supply their workers with protective clothing.	☐
The power stations are normally built far from major centres of population.	☐

[1]

[Total: 5]

[Paper Total: 60]

END OF QUESTION PAPER

Periodic Table

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

OCR
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SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

A153/02

ADDITIONAL SCIENCE A

Unit A153: Modules B6, C6, P6 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

This document consists of 16 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

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

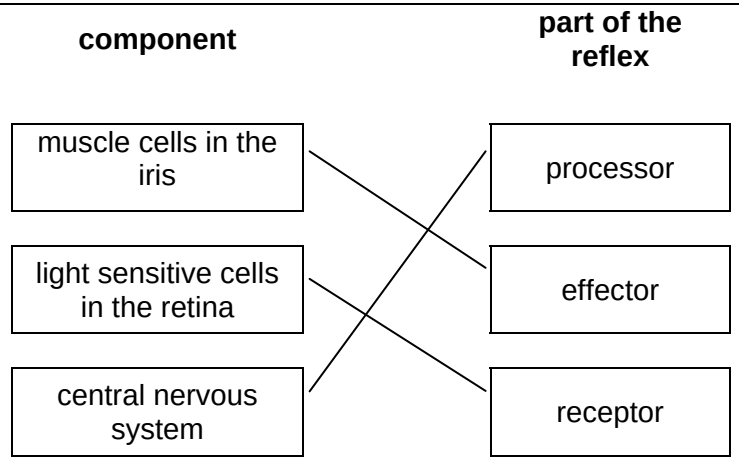
Edinburgh	
Manchester	
Paris	
Southampton	

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	✓	×	✓	✓	✓				✓	
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	(a)		Peter	[1]	
	(b)		Sarah because she is using storage and retrieval of information	[2]	
			Total	[3]	

2	(a)			[2]	
	(b)		**any two from:** stepping grasping sucking	[2]	**accept** 'suckling' for sucking
			Total	[4]	

Question			Expected answers	Marks	Additional guidance
3			**[Level 3]** Answer clearly links paroxetine to serotonin synapses, describes the blocking of serotonin removal sites, and attributes the subsequent propagation of nerve impulses to the increased concentration of serotonin allowing increased binding to receptors on the next neuron. 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) **[Level 2]** Answer describes the correct mode of action but does not provide all of the details, or does not get the order quite right, or does not use all of the correct 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) **[Level 1]** Answer may compare the action of paroxetine to the action of Ecstasy/MDMA but does not provide many details of how it works. 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:** • paroxetine could work in the same way as Ecstasy/MDMA • at synapses (in the brain) • that use serotonin as a transmitter substance • by blocking sites where serotonin is removed from the synapse • when a nerve impulse is transmitted across the synapse, serotonin is released from the first neuron and binds to receptors on the membrane of the second/next/relay neuron • this causes nerve impulses in the second neuron • serotonin is not removed from the synapse, which leads to an increased concentration of serotonin in the synapse • more serotonin molecules are able to bind to receptors on the second neuron • and this causes more nerve impulses in the second neuron
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
4	(a)		1.04	[1]	**accept** "104" if the candidates has clearly given the unit as "cm"
	(b)		*neuron **A** because:* the speed of the nerve impulse is slow (which indicates that it does not have/has lost the fatty sheath) and it is long enough to reach from the toes to the spinal cord / neuron **D** would not be long enough to reach from the toes to the spinal cord	[2]	no marks for neuron **A**, only for the justification of the choice
			Total	[3]	

Question			Expected answers	Marks	Additional guidance
5			**any four from:** the patient could benefit if a treatment for the brain injury is developed the knowledge gained may help to treat other people / benefit to society outweighs cost to individual / more people will benefit in the long term Stuart could use (non-invasive) procedure(s) that will not cause damage/pain to the patient research that uses human participants can yield more useful information than research that uses models/simulations/animals/other organisms if Stuart wants to study the effects of brain damage on language/intelligence/etc. this can only be done using humans the patient may have given their consent / volunteered to be part of the research a study that uses humans can get consent from the participants, but a study that uses other organisms/animals can not	[4]	**accept** named procedure (eg MRI, PET, CAT scan)
			Total	[4]	

6	(a)		**citric acid**	[1]	
	(b)		The acid and alkali need to dissolve in water in order to produce H^+ (aq) and OH^- (aq) and so react	[1]	
			Total	[2]	

Question			Expected answers	Marks	Additional guidance
7			she should add acid in small amounts near the end point so that she does not add more acid than necessary to neutralise the alkali **OR** she should swirl the flask between each addition of acid so that the acid mixes completely before adding any more **OR** she should look carefully for first (permanent) colour change so that she does not add more acid than necessary to neutralise the alkali	**[2]**	**ignore** "do it (more) carefully" for full marks the action Mary takes should be coherently linked to the resulting improvement in accuracy
			Total	**[2]**	

8	**(a)**		gram formula mass of $MgSO_4$ = 24 + 32 + 64 = 120 g gram formula mass of Mg = 24 g $\frac{3}{24}$ x 120 = 15	**[2]**	
	(b)		20 ÷ 10 = 2 cm^3/s	**[1]**	correct working, answer and units required for the mark
	(c)		experiment **A** because a larger mass of magnesium pieces will give a higher rate of reaction, so more gas will have been produced by 10s and a larger mass of reactant will produce a greater volume of product/gas/hydrogen	**[3]**	for full marks the explanation must be expressed in a logical and coherent order

Question			Expected answers	Marks	Additional guidance
8	(d)	✎	**[Level 3]** Answer demonstrates an understanding of the nature of the particles involved and the effect of their collisions on the rate of reaction. 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) **[Level 2]** Answer deals with one aspect, eg collision frequency, but does not discuss the nature of the colliding species. 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 shows an awareness of the basic premise, that of collisions, but has difficulty identifying the reacting species and sees the reaction in terms of number of collisions rather than frequency. Detail of what constitutes a low-level answer. 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:** • hydrogen/H^+ ions from the acid • react with magnesium atoms • at the surface of the magnesium • using smaller pieces of magnesium gives a larger surface area • allowing the hydrogen/H^+ ions to collide more frequently with the magnesium atoms • which will increase the rate of reaction **reject** references to increased speed of movement **reject** references to increased concentration of the acid
			Total	**[12]**	

Question			Expected answers	Marks	Additional guidance
9	(a)		$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$	[3]	HCl formula correct H_2O and CO_2 formulae correct – in either order equation correct overall, including balancing.
	(b)		Exothermic	[1]	
			Total	[4]	

10		✎	**[Level 3]** Evaluates production and use of the radioactive materials, and correctly identifies sources for all three types of waste. Suggests how to dispose of them safely. Will give a valid reason why waste needs to be stored carefully. 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) **[Level 2]** Evaluates production and/or use of the radioactive materials, and correctly identifies sources for at least two types of waste, perhaps omitting some important details. 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]** Refers to at least one type of waste and valid disposal method for it. May not give a reason for the need for careful disposal. 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:** • high level only produced in reactor • high level waste is very radioactive • so is stored in ponds of water • until it becomes intermediate waste / less radioactive • hospital produces mostly intermediate • intermediate waste is encased in concrete / glass • and stored in metal drums • under guard / in secure conditions • low level produced at both hospital and reactor • low level waste is put in landfill • with waterproof linings • to keep radioactivity out of ground water • all radioactive waste is harmful / cancerous • becoming less harmful as time goes on **accept** descriptions of type / source of waste instead of names eg nuclear power station giving high level waste. **accept** references to underground burial for intermediate waste
			Total	[6]	

Question			Expected answers	Marks	Additional guidance
11			3078/5624 = 0.55 1757/3078 = 0.57 mostly Tc-99m because half-life much shorter than 66 h / close to 6 h	[3]	**accept** attempt to calculate half-life by considering activities 6 h apart **accept** cannot say whether Mo is present, as sample only tested for 12 hours
			Total	[3]	

12			health/cancer risk for all participants due to irradiation by the rod the risk is greatest for the radiographer who will repeat the procedure many times patient will benefit if their existing cancer is cured, but the risk of patient and radiographer developing a new cancer may outweigh the benefits of the procedure	[3]	
			Total	[3]	

13	(a)		33	[1]	
	(b)		The fraction of dose … ☐ ☐ ✓ ☐ The dose from food and drink … ✓	[2]	
			Total	[3]	

Question			Expected answers	Marks	Additional guidance
14	(a)		**D C B E**	[2]	ecf **C** before **B** before **E** for (1)
	(b)		chain reaction	[1]	
	(c)		5.0×10^{-10} kg	[1]	**allow** 0.5×10^{-9} kg
	(d)		… still be very low … ☐ ✓ ☐ ☐	[1]	
			Total	[5]	

Assessment Objectives (AO) Grid

(includes quality of written communication ✎)

Question	AO1	AO2	AO3	Total
1(a)		1		**1**
1(b)	2			**2**
2(a)	1	1		**2**
2(b)	2			**2**
3✎	4	2		**6**
4(a)		1		**1**
4(b)			2	**2**
5		4		**4**
6(a)	1			**1**
6(b)		1		**1**
7	2			**2**
8(a)		2		**2**
8(b)		1		**1**
8(c)		2	1	**3**
8(d)✎	4	2		**6**
9(a)	2	1		**3**
9(b)	1			**1**
10✎	3	2	1	**6**
11			3	**3**
12	1	2		**3**
13(a)		1		**1**
13(b)			2	**2**
14(a)		2		**2**
14(b)	1			**1**
14(c)		1		**1**
14(d)		1		**1**
Totals	**24**	**27**	**9**	**60**

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