OXFORD CAMBRIDGE AND RSA EXAMINATIONS

GCSE

A153/02

TWENTY FIRST CENTURY SCIENCE ADDITIONAL SCIENCE A

Modules B6 C6 P6 (Higher Tier)

THURSDAY 13 JUNE 2013: Morning

DURATION: 1 hour plus your additional time allowance

MODIFIED ENLARGED 24pt

Candidate forename		Candidate surname	

Centre number						Candidate number				

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)

READ INSTRUCTIONS OVERLEAF

DC (NF/CGW) 2455294080 80521

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. HB pencil may be used for graphs and diagrams only.**
- **Answer ALL the questions.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).**

INFORMATION FOR CANDIDATES

- **Your quality of written communication is assessed in questions marked with a pencil ().**
- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **A list of physics equations is printed on pages 4 and 5.**
- **The Periodic Table is printed on page 47.**
- **The total number of marks for this paper is 60.**
- **Any blank pages are indicated.**

TWENTY FIRST CENTURY SCIENCE EQUATIONS

USEFUL RELATIONSHIPS

THE EARTH IN THE UNIVERSE

distance = wave speed × time

wave speed = frequency × wavelength

SUSTAINABLE ENERGY

energy transferred = power × time

power = voltage × 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 Some countries allow soft fruit to be sterilised by radiation so that it has a much longer shelf-life in the shops.

Food is sterilised by radiation in a processing centre without harming the people who work there.

Explain how food is sterilised by radiation. Include safety aspects. [6]

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

[TOTAL: 6]

2 Technetium is often used as a radioactive tracer in hospitals.

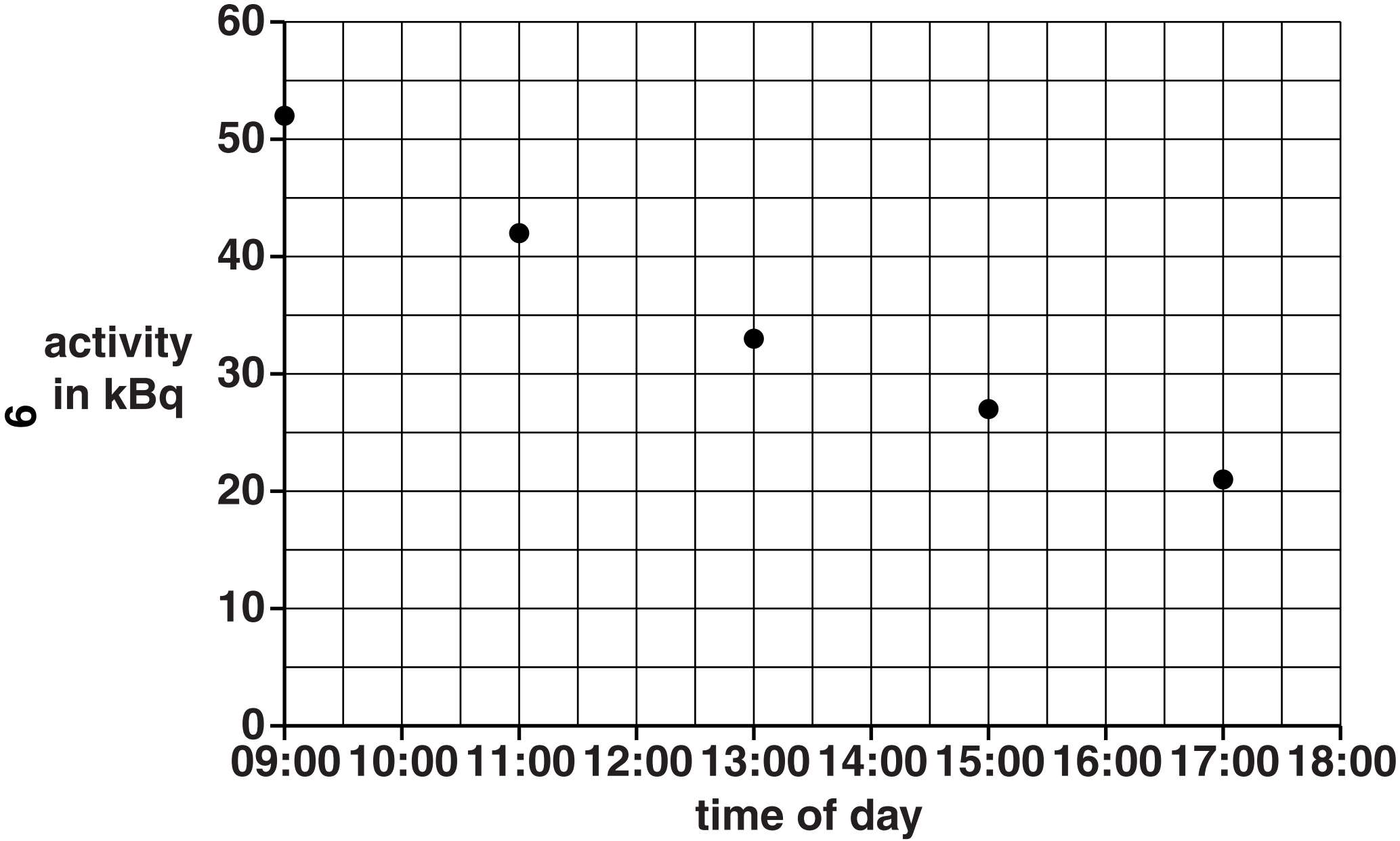
(a) Technetium comes from the radioactive decay of molybdenum.

It is important that the technetium is NOT contaminated with molybdenum.

Marie tests the purity of a sample of technetium.

She measures the activity of the sample at five different times.

Marie plots her results on a graph.


60
50
40
30
20
10
0
activity
in kBq
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
time of day

Marie uses this graph and the data in the table to make a conclusion.

Material	Half-life in hours
molybdenum	67
technetium	6

Marie concludes that the sample contains no molybdenum.

Is she correct? Justify your answer.

_____

_____

_____

_____ **[3]**

(b) **Explain the benefit AND risk to patients of being injected with technetium.**

_____

_____

_____ **[2]**

(c) **Technetium is an emitter of gamma radiation. This means that health workers at the hospital are at risk of contamination and irradiation when they use technetium.**

(i) **Health workers are required to wear rubber gloves when they handle technetium. Explain why this ONLY protects them from contamination.**

_____

_____

_____

_____ **[2]**

(ii) Suggest TWO reasons why health workers accept this risk.

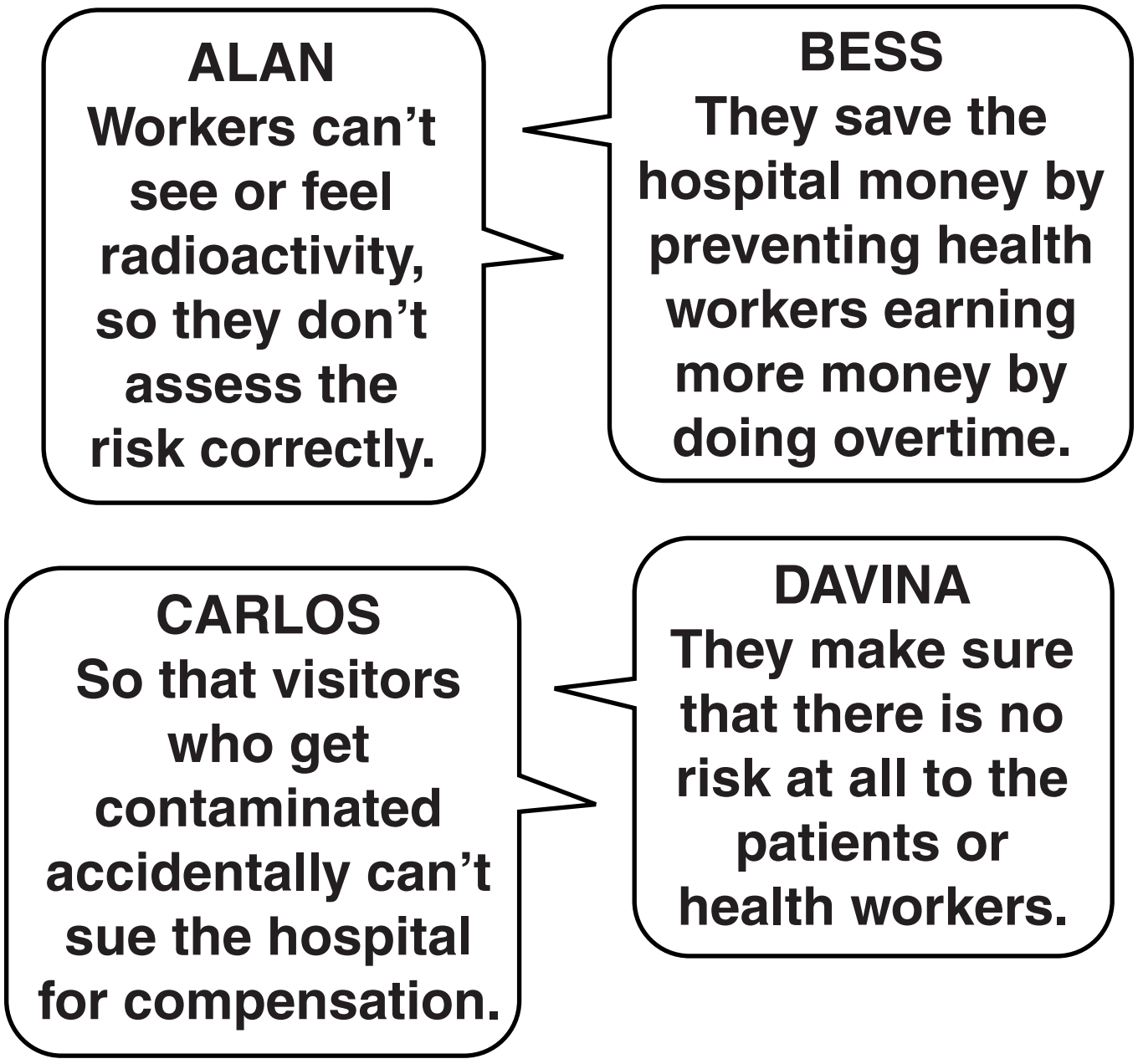
_____

_____

_____

_____ **[1]**

(iii) **The use of radioactive materials in hospitals is strictly controlled by the Government. Here are some ideas about why the regulations are necessary.**



Who is correct?

answer _____ **[1]**

[TOTAL: 9]

3 Your level of background radiation depends on where you live.

Region of UK	Background radiation dose mSv per year
East Anglia	0.5
Cornwall	8
London	2

(a) Adele lives in East Anglia for 20 years. The risk of her developing cancer from the background radiation in that time is 5 in 10 000.

Adele thinks that her risk of getting cancer is proportional to her dose from the background radiation.

Bill lives in Cornwall for only 10 years.

Calculate his risk of developing cancer from the background radiation using Adele's idea.

risk = _____ in 10 000 [1]

(b) The increased risk in Cornwall is from radon-222 gas seeping out of the ground.

(i) Each nucleus of radon-222 contains protons and neutrons.

How many neutrons are there in a single nucleus of $^{222}_{86}Rn$?

Put a (ring) around the correct answer.

86 136 222 308

[1]

(ii) Radon emits an alpha particle when it decays to an isotope of polonium. Complete the nuclear equation for the reaction.

$$^{222}_{86}Rn \longrightarrow \alpha + \,^{\_\_\_\_}_{\_\_\_\_}Po$$

[1]

[TOTAL: 3]

4 Nuclear reactors use the fission of uranium nuclei to release energy.

(a) State the name of the particle that causes the fission of a uranium nucleus.

_____ **[1]**

(b) A nuclear power station releases 2.7×10^{13} J of energy from its fuel when it operates for a day.

Calculate the change of mass of the fuel in that day.

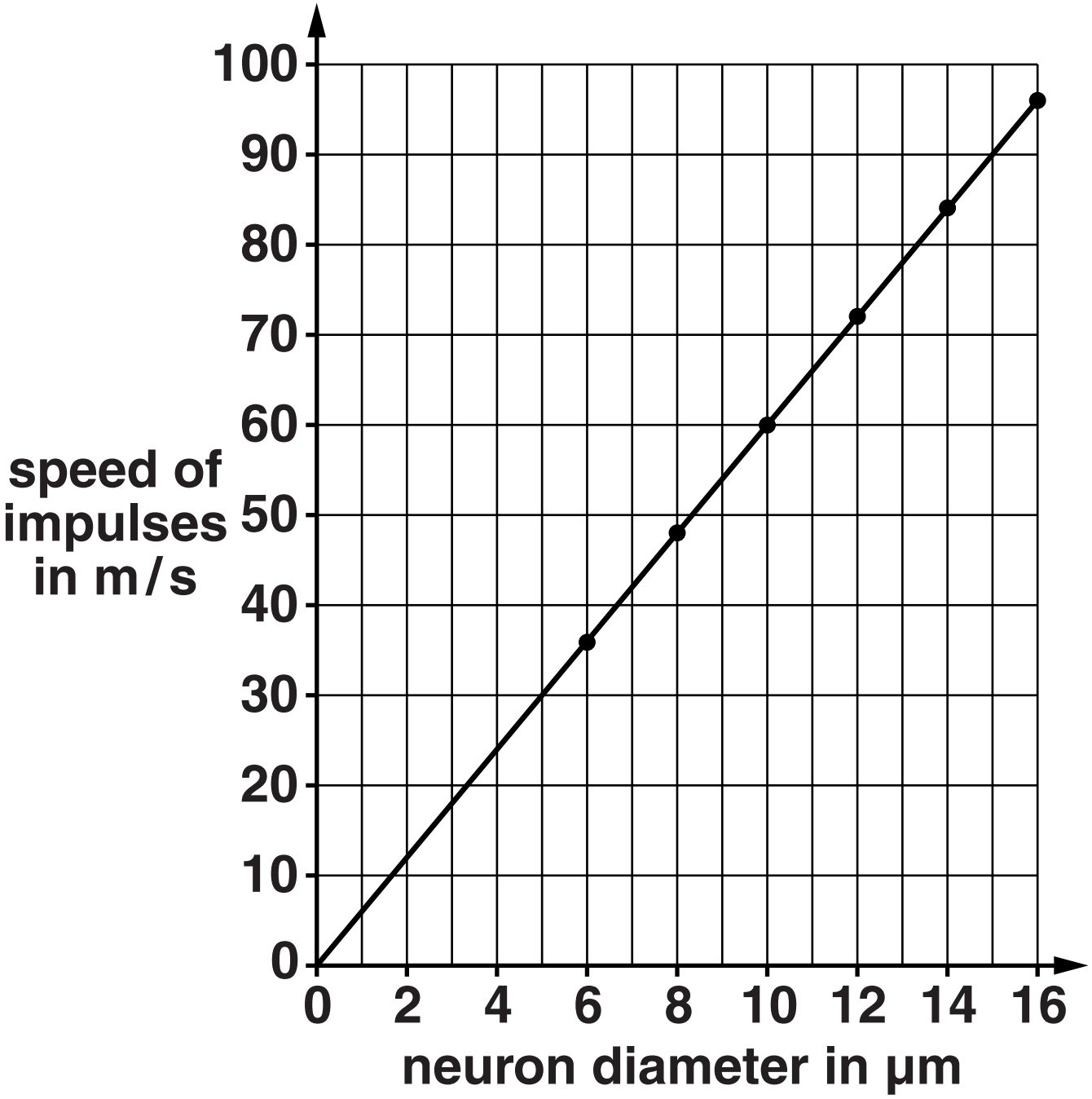
***c* (speed of light in a vacuum) = 3.0×10^{8} m/s**

mass change = _____ **kg [1]**

[TOTAL: 2]

5 Andy is learning about the speed of impulses in neurons.

He finds this graph in his textbook. It shows the speed of impulses in neurons of different diameter with fatty sheaths.



(a) Andy measures a neuron.

It has a diameter of 9 μm.

Use the graph to predict the speed of impulses in this neuron.

Show your working on the graph.

speed = _____ m/s [2]

(b) Andy checks the diameter of the neuron and confirms it is 9 μm.

He measures the speed of an impulse in this neuron and finds it is 0.6 m/s.

Both of these measurements are accurate.

Suggest why the measured speed does NOT match the predicted value from the graph.

_____

_____ **[2]**

[TOTAL: 4]

6 Simple animals rely on reflex actions for most of their behaviour.

(a) Write down ONE way that reflex actions help a simple animal to survive.

_____

_____ **[1]**

(b) Reflexes in more complex animals can be conditioned.

Put ticks (✓) in the boxes next to the TWO correct statements about conditioning.

A secondary stimulus

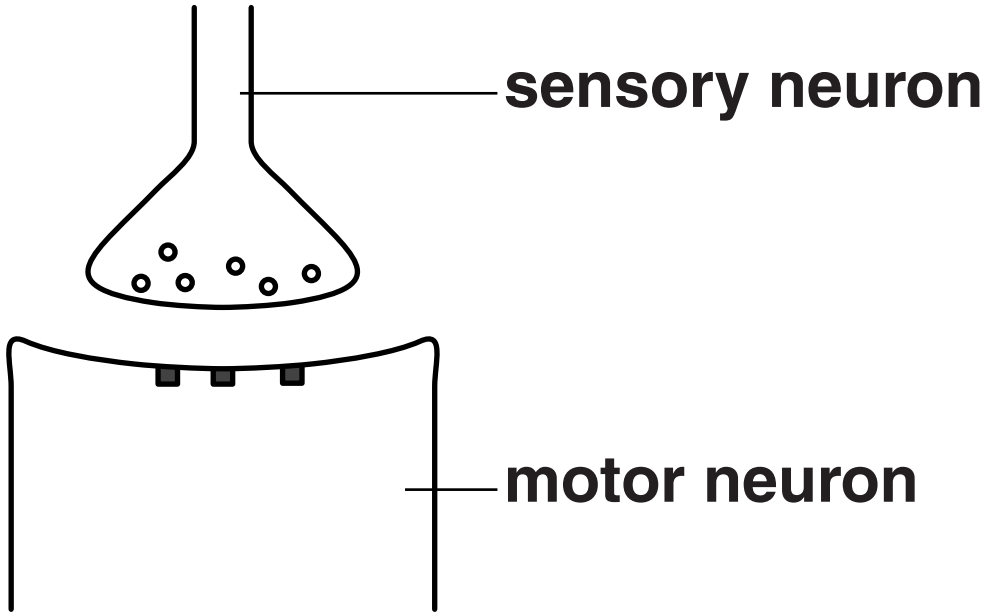
is given along with a primary stimulus.	☐
is always given on its own.	☐
is not needed for the conditioning.	☐
has no direct link to the final response.	☐
can only be used in dogs.	☐

[2]

[TOTAL: 3]

7 This question is about the transmission of a nerve impulse across a synapse.

The diagram shows a synapse between a sensory neuron and a motor neuron.



The sentences describe events at a synapse.

They are not in the correct order.

(a) Put a (ring) around the correct choice to complete each sentence.

A An electrical impulse travels towards the synapse along the SENSORY / MOTOR neuron.

B The transmitter substance binds to receptors on the SENSORY / MOTOR neuron.

C The transmitter substance is released by the SENSORY / MOTOR neuron.

D The TRANSMITTER SUBSTANCE / ELECTRICAL IMPULSE crosses the gap.

[1]

(b) Put the letters A, B, C and D in the boxes to show the correct sequence of events at a synapse.

[1]

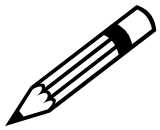
[TOTAL: 2]

8 Jenny has a stroke.

A small part of her brain is damaged and she loses the ability to speak.

Over many weeks Jenny's speech therapist helps her to learn to speak again by encouraging the brain to adapt.

(a) Describe the features and mechanisms in the brain that allow it to adapt so that Jenny can learn to speak again. [6]



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

(b) (i) **The risk of a woman of Jenny's age having a stroke is 1 in 200.**

There are 6 million women of this age in the UK.

How many of these women are likely to have a stroke?

answer = _____ [1]

(ii) Research shows that women who eat less salt in their diet have less chance of having a stroke.

The Government is considering an expensive public health campaign to encourage women to eat less salt.

Should the Government go ahead with the campaign?

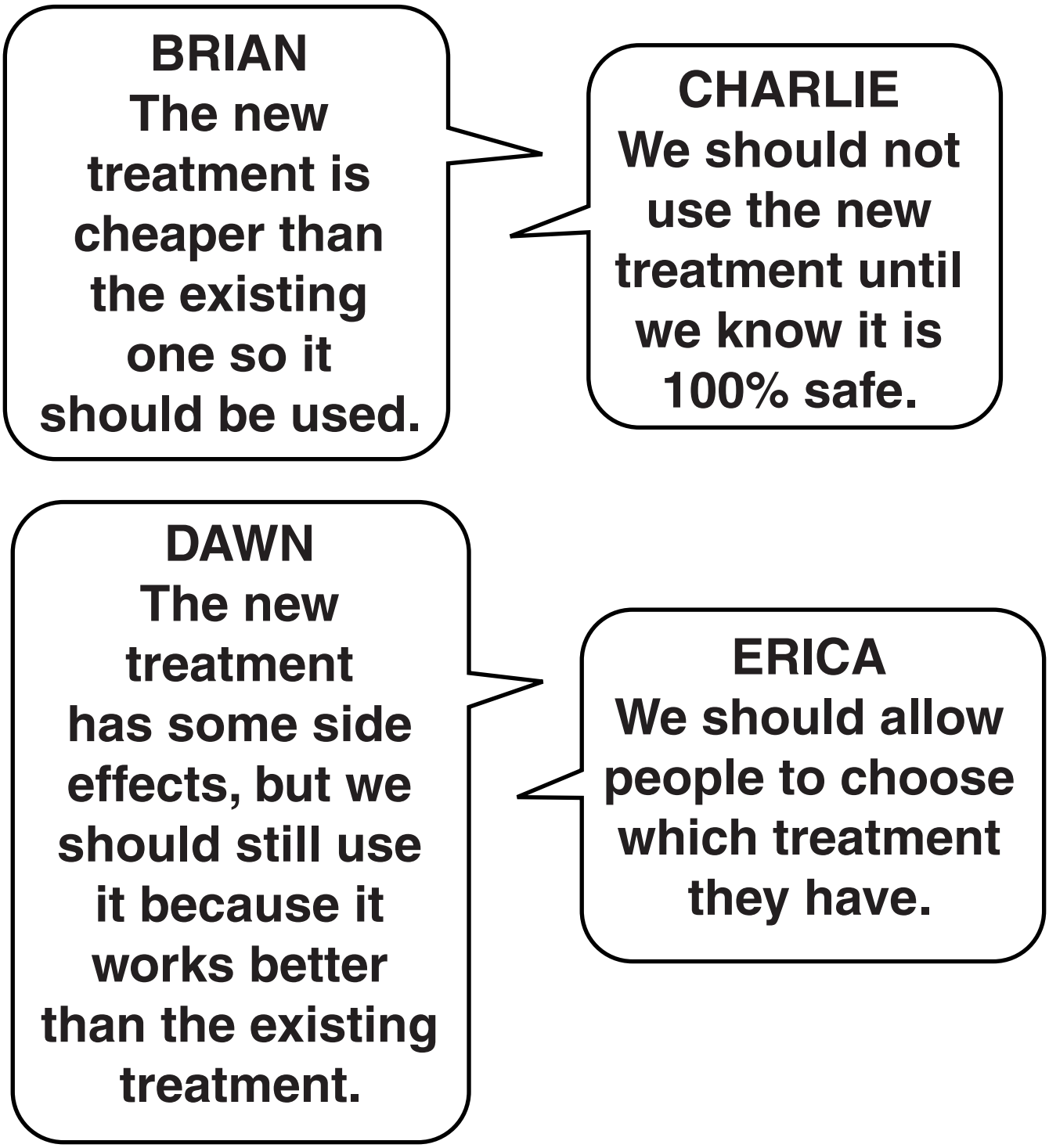
Justify your conclusion.

_____

_____

_____ **[2]**

(c) Scientists develop a new treatment for people who have had a stroke. They discuss whether the new treatment should replace the existing treatment.



(i) **Which scientist argues that the right thing to do is the one which leads to the best outcome for most people involved?**

answer _____ **[1]**

(ii) **Which scientist argues that it is right to do some things even if there are consequences?**

answer _____ **[1]**

[TOTAL: 11]

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QUESTION 9 BEGINS ON PAGE 32

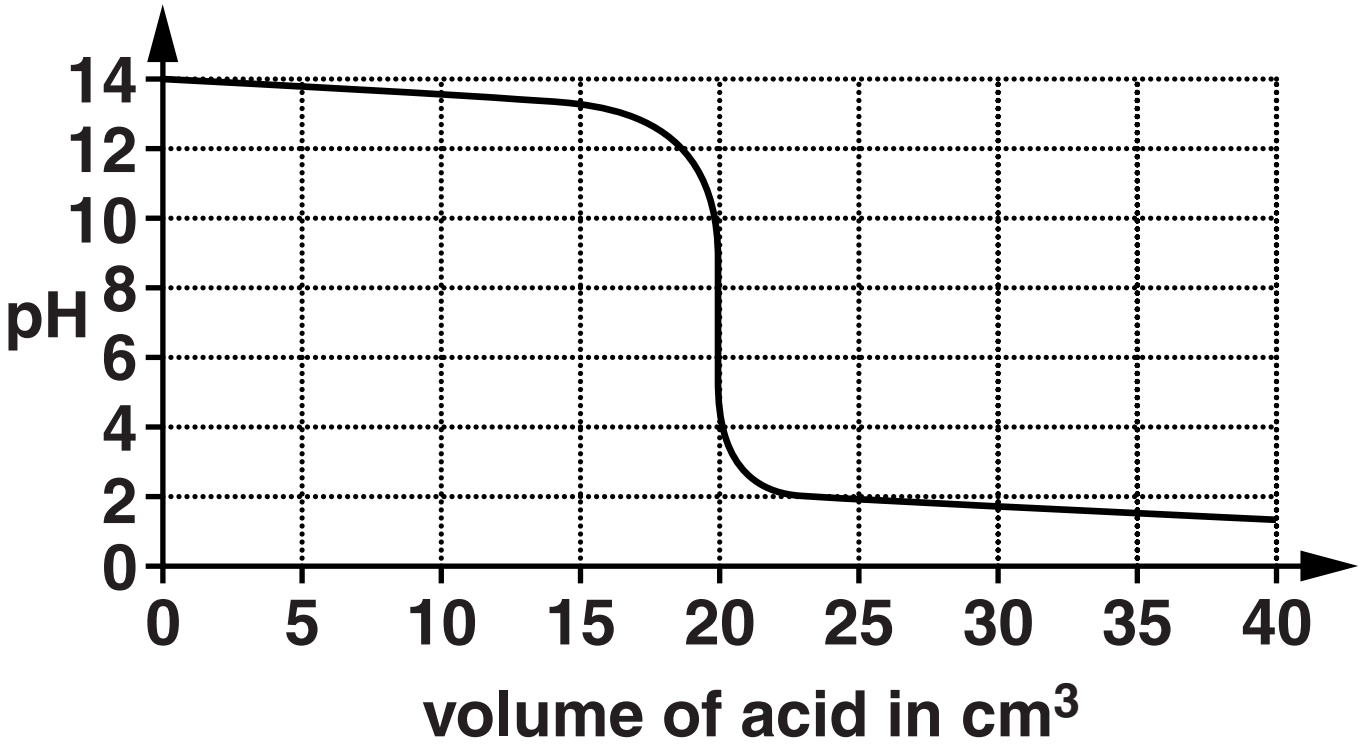
PLEASE DO NOT WRITE ON THIS PAGE

9 Mark is doing a titration between hydrochloric acid and sodium hydroxide.
In the equation for this reaction one formula of the acid reacts with one formula of the alkali.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

He slowly adds 40 cm^3 of acid to 25 cm^3 of alkali.

He measures the pH during his experiment.



(a) (i) What volume of acid is needed to neutralise the alkali? Explain how you can tell.

_____

_____

_____

_____ **[2]**

(ii) Mark uses the volume of acid that just neutralises the alkali solution to calculate the concentration of the alkali solution.

He uses the formula

$$\frac{\text{concentration} \times 25}{40} = 0.1 \times \text{acid volume}$$

Calculate the concentration of the alkali used in this experiment.

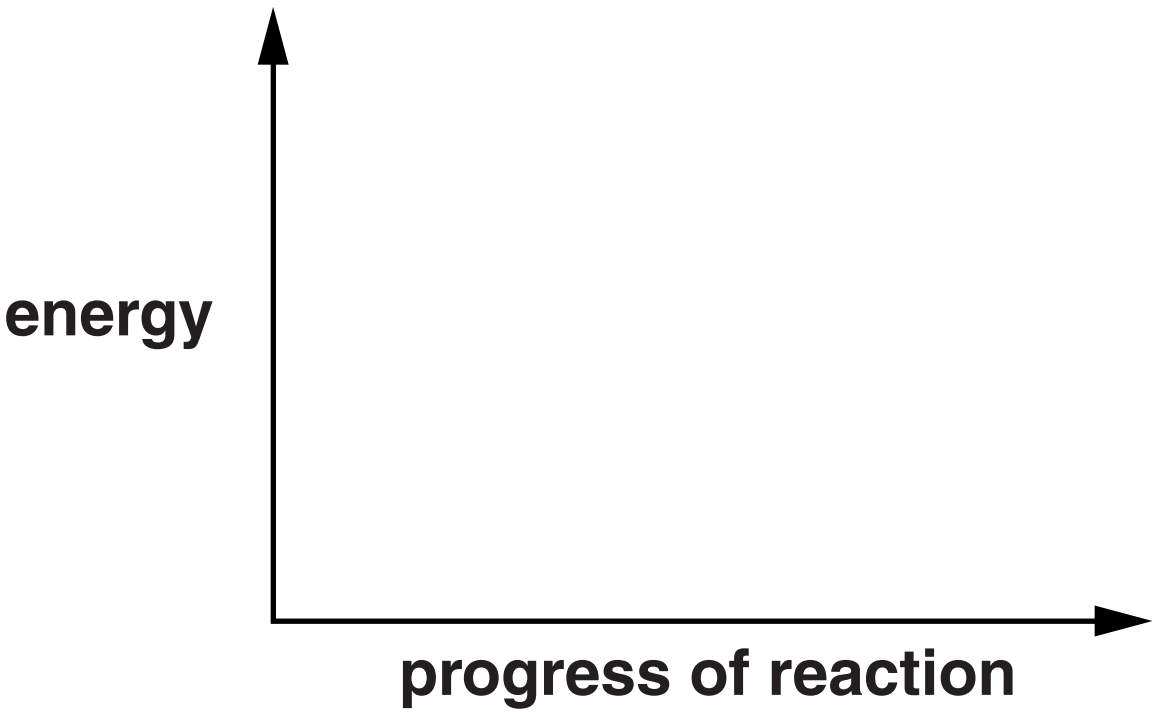
concentration = _____ g/dm^3 [1]

(b) Mark draws an energy level diagram for the reaction:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

He knows that this reaction is exothermic.

(i) Using the axes below, draw a labelled energy level diagram for this reaction.



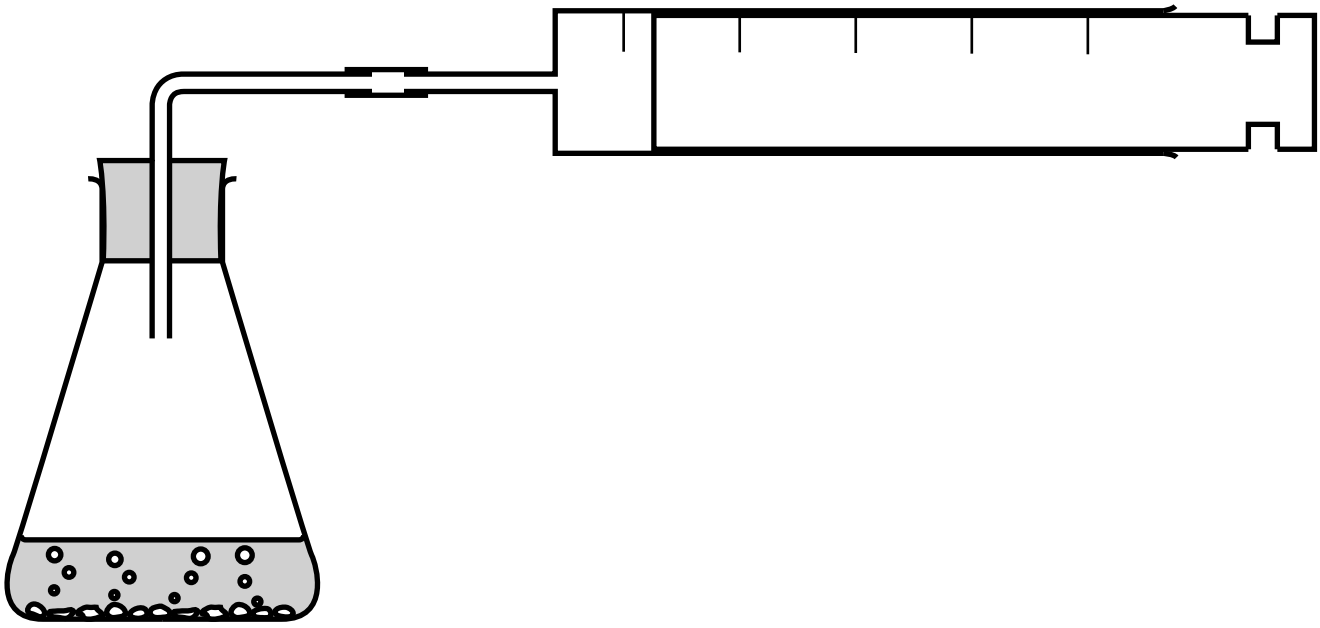
[3]

(ii) Write the ionic equation for the reaction that happens when ANY acid reacts with ANY alkali.

_____ **[2]**

[TOTAL: 8]

10 Sarah plans to investigate the rate of the reaction between marble chips and hydrochloric acid.



(a) She plans two experiments to investigate the effect of changing the concentration of the acid. This is what she wrote.

"In the first experiment I will use 10 g of marble chips in the flask.
I will add 25 cm^3 of the acid.
I will measure how fast the gas is given off.

In the second experiment I will use another 10 g of marble chips.
I will add 50 cm^3 of the same acid."

Evaluate this plan and suggest how the investigation could be improved.

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

[6]

(b) The reaction produces carbon dioxide gas and also calcium chloride.

Write the formula for calcium chloride.

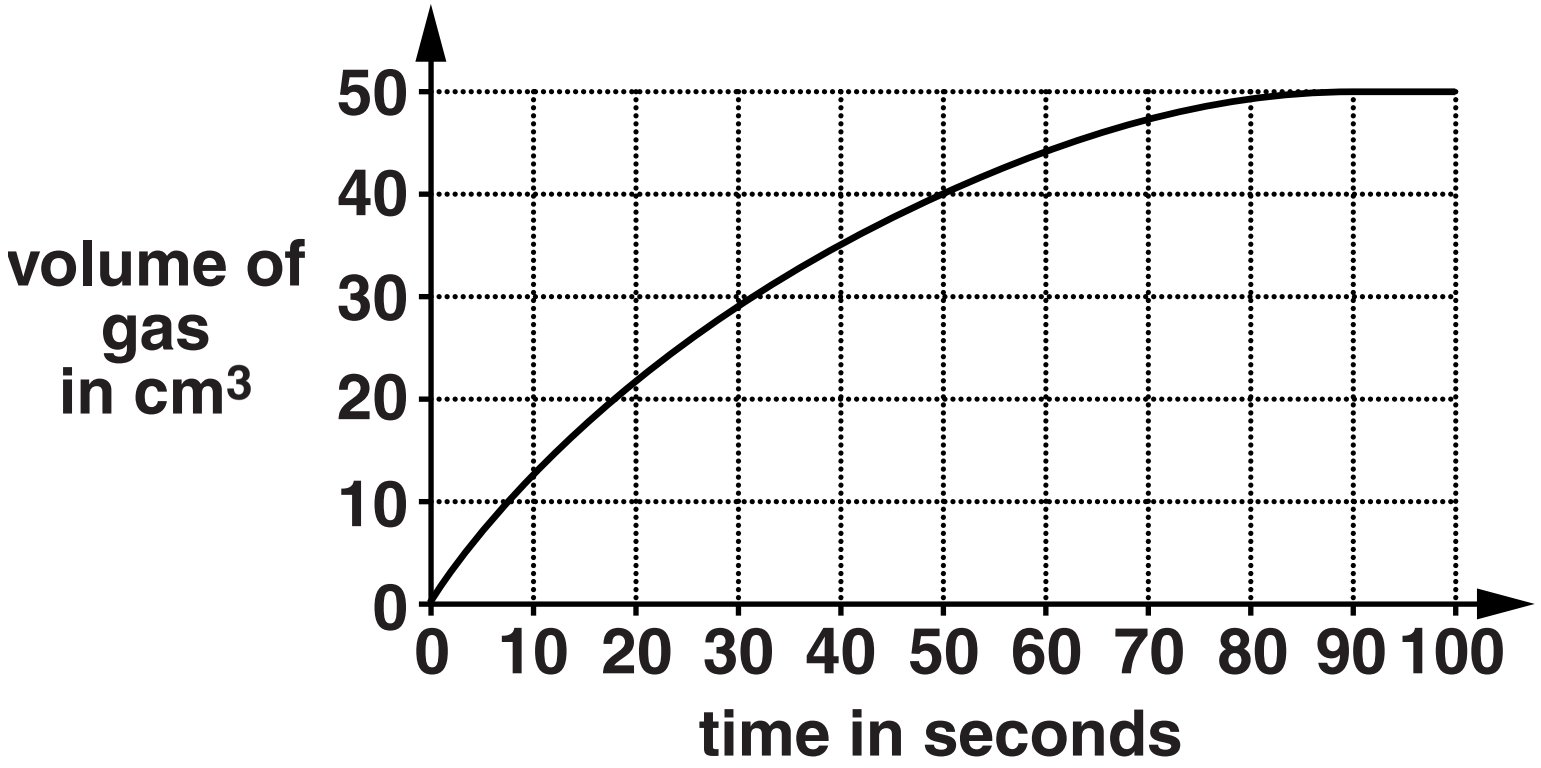
_____ **[1]**

(c) Sarah measures the gas given off.

(i) Calculate the average rate of the reaction over the first 50 seconds.
Show your working.

average rate _____ **[2]**

41


volume of gas in cm3
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
time in seconds

(ii) What units is this rate of reaction measured in?

units of rate _____ [1]

(d) Sarah doubles the acid concentration.

(i) What effect does this have?

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

twice as many collisions during the course of the reaction	☐
twice as many collisions per second	☐
collisions last a shorter time	☐
collisions are more violent	☐

[1]

(ii) She then increases the temperature for this reaction.

What effect does this have?

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

It makes the reaction quicker. ☐

It stops the reaction. ☐

It makes more product. ☐

It makes hydrogen. ☐

[1]

[TOTAL: 12]

END OF QUESTION PAPER

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The Periodic Table of the Elements

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.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.