

**GENERAL CERTIFICATE OF SECONDARY EDUCATION
TWENTY FIRST CENTURY SCIENCE
ADDITIONAL SCIENCE A**

A217/02

Unit 3 Modules B6 C6 P6
(Higher Tier)

**Tuesday 27 January 2009
Afternoon**

Duration: 40 minutes

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)



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.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **42**.
- A list of physics equations is printed on page two.
- The Periodic Table is printed on the back page.
- This document consists of **24** pages. Any blank pages are indicated.

FOR EXAMINER'S USE

Qu.	Max.	Mark
1	4	
2	5	
3	5	
4	4	
5	6	
6	5	
7	3	
8	10	
TOTAL	42	

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful Relationships

Explaining Motion

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

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

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

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

$$\text{change in energy} = \text{work done}$$

$$\text{change in GPE} = \text{weight} \times \text{vertical height difference}$$

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

Electric Circuits

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

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

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

$$\text{power} = \text{potential difference} \times \text{current}$$

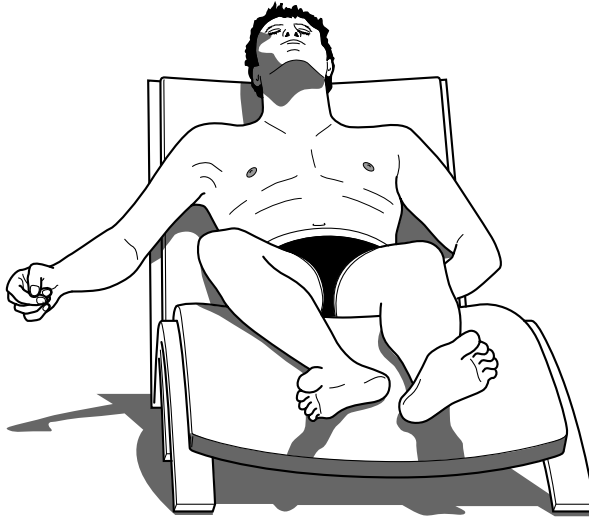
$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

The Wave Model of Radiation

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

Answer **all** the questions.

- 1 Sam sunbathes on the beach.



- (a) His skin absorbs photons of ultraviolet (UV) radiation.

Here is an incomplete diagram of the electromagnetic spectrum.

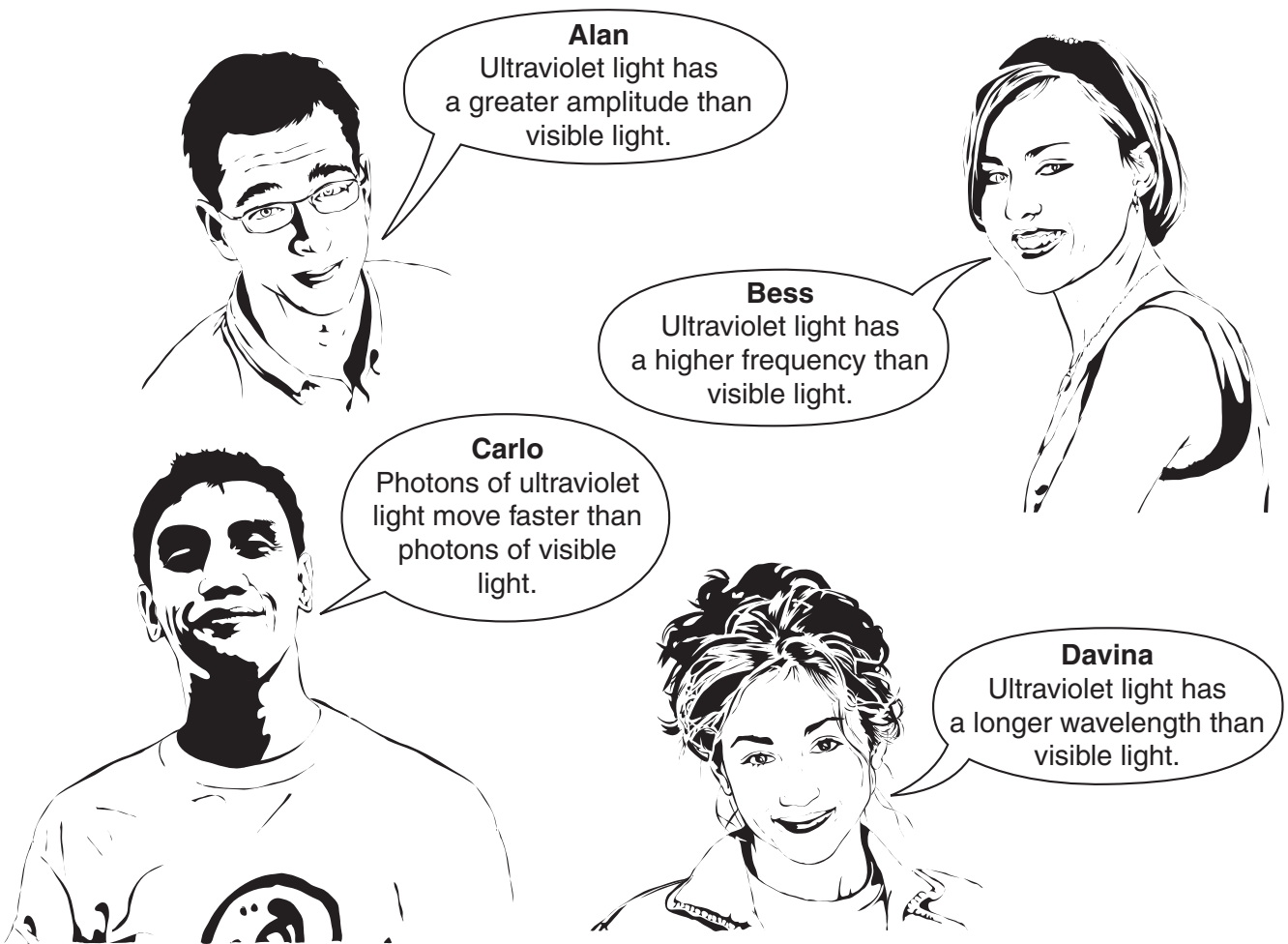
Write UV in the correct place.

	microwaves		visible		X-rays	
--	------------	--	---------	--	--------	--

[1]

(b) Photons of ultraviolet light carry more energy than photons of visible light.

Sam asks his friends the reason why.



Which of his friends gives the correct reason?

answer [1]

(c) Intensity and frequency are two different properties of sunlight.

Draw a straight line to link each **property** of sunlight to its correct **description**.

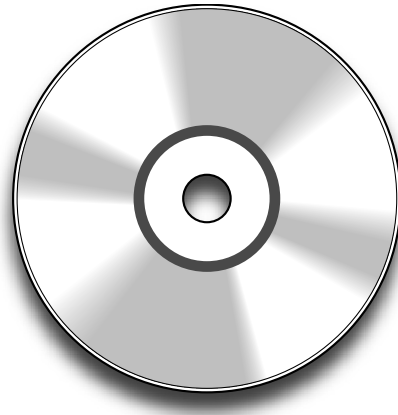
property	description
intensity	the rate at which photons are absorbed
frequency	the number of waves emitted per second
	the rate at which energy is delivered by photons
	the number of photons emitted per second

[2]

[Total: 4]

2 Alfred looks at a compact disc (CD) in white light.

He notices that some parts of the disc appear blue. Other parts appear red.



(a) Complete the sentence.

Red light and blue light have different

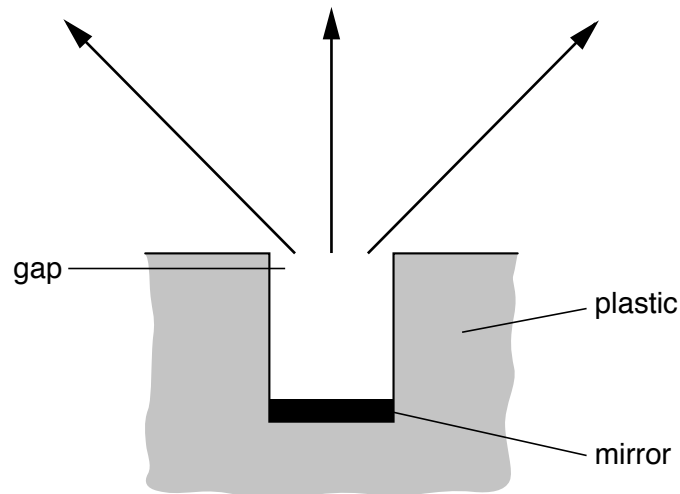
[1]

(b) This disc contains billions of tiny mirrors.

Each mirror is at the bottom of a hole in the plastic.

White light is reflected by each mirror.

This light then has to pass through the gap at the top of the hole.



What does the diagram show?

Put a ring around the answer.

absorption

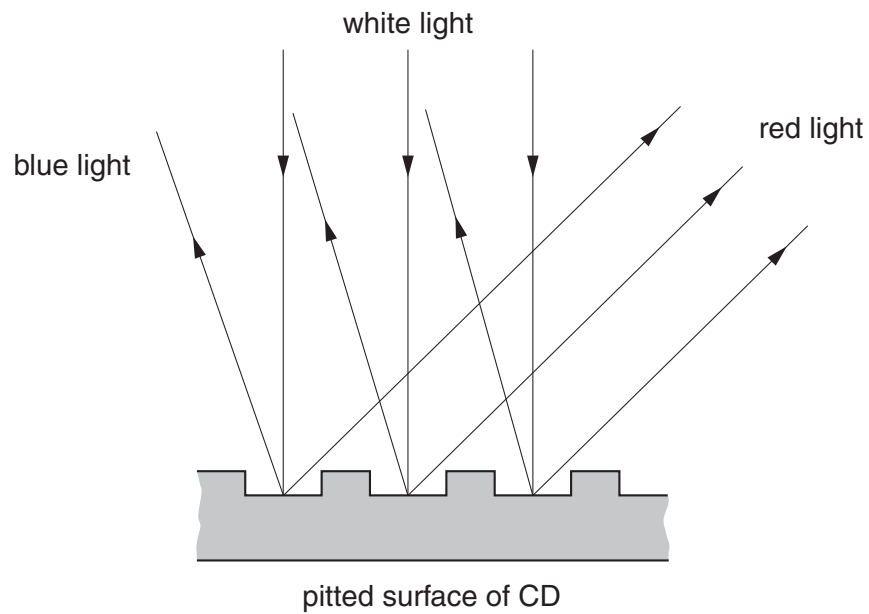
diffraction

refraction

transmission

[1]

(c) The diagram shows white light incident on the pitted surface of the CD.



Only red light leaves the CD at 45° to the surface, allowing that part to appear red.

The statements **A**, **B**, **C**, **D** and **E** explain why this happens.

They are in the wrong order.

- A** They reinforce when they meet in Alfred's eye.
- B** The rays of white light approach the CD in step.
- C** Only rays of red light are in step when they leave the CD at 45° .
- D** Only rays of white light which are out of step cancel each other out.
- E** This constructive interference allows photons of red light to be absorbed in Alfred's eye.

One of the statements is **not** needed for the explanation.

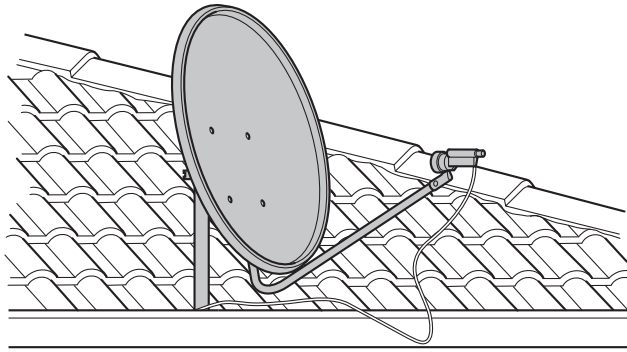
Complete the boxes to show the correct order of the other statements.

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[3]

[Total: 5]

3 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.

Write either **true** or **false** next to each statement.

statement	true or 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) The signal at the receiver has to be amplified.

Who gives the correct reason for this?



Andrew
The intensity of the microwaves decreases as they diffract from the satellite.



Bella
The microwave photons break up as they pass through the atmosphere.



Charlie
The dish absorbs most of the microwave photons.



Debbie
The dish slows down the microwaves too much.

The best answer was given by [1]

(c) Some people receive TV signals through optical fibres.

Draw a line to connect the **middle** of the sentence to its correct **start**, then another line to connect the **middle** of the sentence to its correct **end**.

start

middle

end

Radio

their photons are easily diffracted in the glass.

Sound

waves are used in optical fibres because

their photons travel faster than the others through glass.

Infrared

their photons don't carry enough energy to damage the glass.

Ultraviolet

their photons travel a long way through the glass before being absorbed.

[2]

[Total: 5]

4 The human nervous system can be divided into two parts.

- (a) Complete the table to show whether the **structures** are part of the **central nervous system** or the **peripheral nervous system** or **both**.

Put a tick (✓) in the correct box for each structure. You may decide to use all the columns or only some of them.

structures	only central nervous system	only peripheral nervous system	both central and peripheral nervous system
brain			
motor neuron			
sensory neuron			
spinal cord			

[2]

- (b) The nervous system coordinates an animal's reflex response to a stimulus.

The sentences show how the eye responds to a bright light.

They are in the wrong order.

- A** A motor neuron carries a nerve impulse to the muscles in the iris.
- B** A sensory neuron carries a nerve impulse to the brain.
- C** Light enters the eye through the pupil.
- D** Muscles in the iris contract to make the pupil smaller.

Put the letters **A**, **B**, **C** and **D** in the correct order in the boxes. The first one has been done for you.

C			
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[2]

[Total: 4]

5 (a) Nerve impulses pass from one neuron to another.

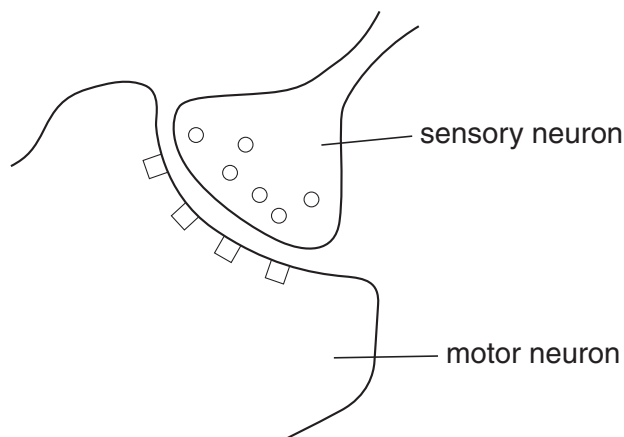
Various features of the nervous system are involved.

Draw straight lines to link each **feature** of the nervous system to its **function**.

feature	function
synapse	increases the speed of transmission of the impulse
axon	transmits a nerve impulse as an electrical signal
fatty sheath	gap between two adjacent neurons across which chemicals can diffuse
	detects a nerve impulse and responds to it

[3]

(b) Look at the diagram.



Draw an arrow on the diagram showing the direction of the nerve impulse.

[1]

- (c) Nerve impulses in the brain are often transmitted between neurons by the chemical serotonin.

The drug Ecstasy has an effect because it can interfere with this process.

Which of these statements explain why?

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

Ecstasy blocks the sites where serotonin is released.

Ecstasy blocks the sites where serotonin is removed.

Ecstasy activates the sites where serotonin is released.

The serotonin concentration decreases, which enhances mood.

The serotonin concentration increases, which enhances mood.

The serotonin concentration increases, which depresses mood.

[2]

[Total: 6]

6 Alan is learning to play the guitar.



(a) He practises the same tunes every day.

Which of the sentences explain how he learns?

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

Playing the right notes is a modified reflex.

Playing the right notes becomes a conditioned reflex.

There is a pattern in the notes that he can recognise.

He has always had the ability to play the guitar.

Repeating the same action makes new pathways in the brain.

[2]

(b) Which part of the nervous system is concerned with memory?

Put a tick (✓) in the correct box.

reflex arc

spinal cord

cerebral cortex

peripheral nervous system

[1]

(c) Reflex actions can be **simple**, **conditioned** or **modified**.

Draw straight lines to link each **action** to the **type of reflex**.

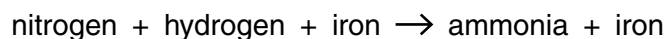
action	type of reflex
keeping hold of a hot plate	simple
producing saliva when a bell rings	modified
a baby grasping his mother's finger	conditioned

[2]

[Total: 5]

7 Chemical factories produce millions of tonnes of ammonia every year to make fertilisers.

Ammonia is a colourless gas made by the following reaction



(a) When ammonia is being formed, the volume of gas decreases.

What could the engineers measure to tell how fast the ammonia is being formed?

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

They could measure:

change in colour

change in cloudiness

time for solid iron to disappear

change in pressure

change in surface area

[1]

(b) Engineers are trying to improve the reaction process.

Here are two possible changes in the process.

Draw one line from each **change** in the process to its **improvement**.

change

improvement

use a lower pressure

less waste to dispose of

less acid rain is made

vessels don't have to be as strong

re-cycle unreacted gases

less damage to the ozone layer

less space is needed for the factory

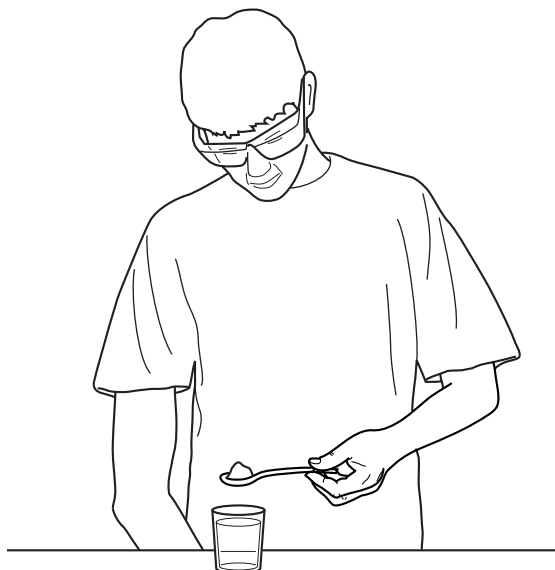
[2]

[Total: 3]

17
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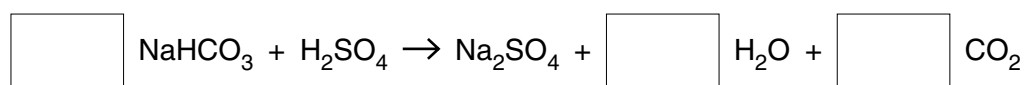
Question 8 starts on page 18
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- 8 Tony knows that the sodium hydrogencarbonate, NaHCO_3 , in his kitchen cupboard will react with acids.



- (a) Sodium hydrogencarbonate reacts with sulfuric acid.

Fill in the boxes to balance the equation for this reaction.



[2]

- (b) Tony wants to know how pure the sodium hydrogencarbonate is.

He dissolves it in water and carries out a titration.

He knows that every 10.0cm^3 of his acid reacts with 0.08g sodium hydrogencarbonate.

If the titration takes 25.0cm^3 of acid, what mass of sodium hydrogencarbonate is in the sample?

Use the formula

$$\frac{\text{mass in titration 1}}{\text{volume of titration 1}} = \frac{\text{mass in titration 2}}{\text{volume of titration 2}}$$

answer = g [1]

(c) He then uses his results to find out the percentage purity of his sample.

Here are his measurements.

- A** mass of watchglass
- B** final reading on the burette
- C** initial reading on the burette
- D** mass of impure sodium hydrogencarbonate
- E** mass of watchglass + impure sodium hydrogencarbonate
- F** mass of pure sodium hydrogencarbonate from the titration

Which **two** readings, **A** to **F**, should he use to work out the percentage purity of the sample?

He should use and [2]

(d) There is 95 g of sodium hydrogencarbonate in 110 g of the impure substance.

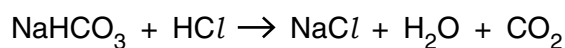
Put a (ring) around the **best** value for the percentage purity.

0% less than 95% 95% more than 95% 100%

[1]

(e) Tony reacts NaHCO_3 with HCl to produce 44 g of CO_2 .

Here is the equation for the reaction.



Calculate the mass of NaHCO_3 needed to make 44 g of CO_2 .

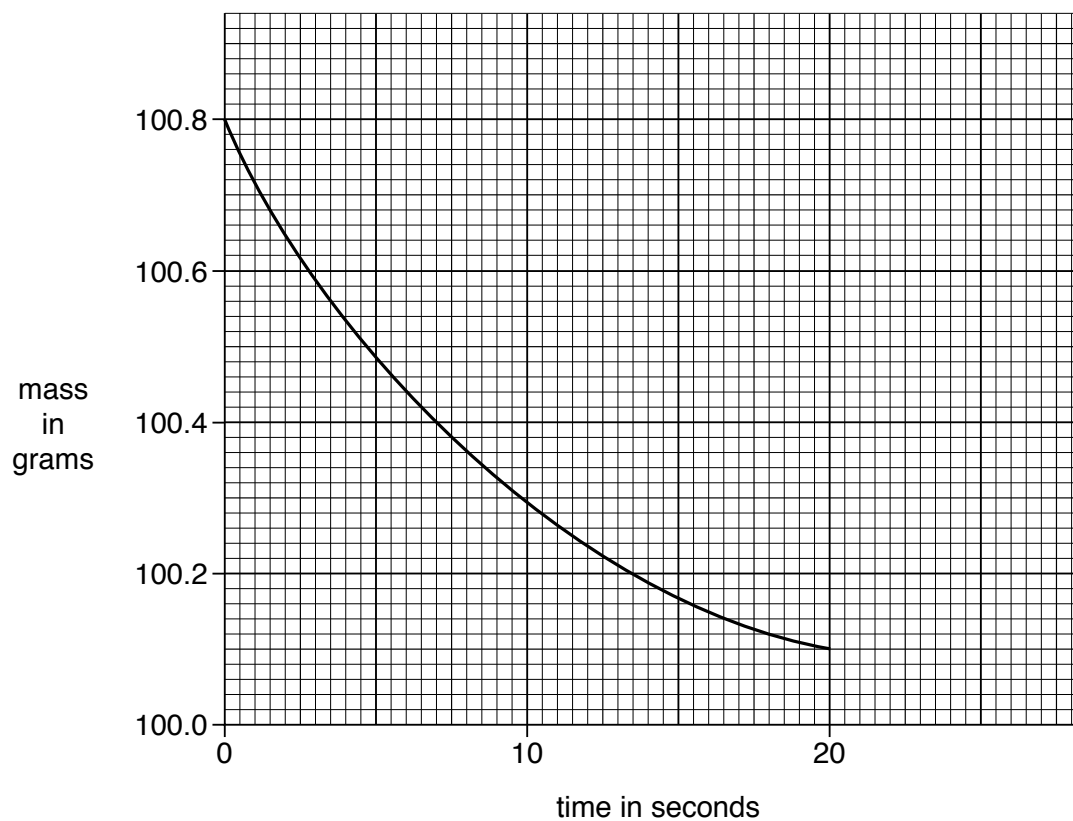
Relative atomic masses H=1, C=12, O=16, Na=23, Cl=35.5

mass of NaHCO_3 = g [1]

(f) Tony wonders how fast a teaspoon of the solid will react with acid.

He adds the solid to a flask of acid and he weighs it at regular intervals.

Here is a graph of some of his results.



He calculates the rate by measuring the change in mass per second.

(i) What is the **average** rate over the first twenty seconds in grams per second?

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

0.7 0.35 0.2 0.07 0.035 0.02

[1]

(ii) By the end of the reaction the solid is all used up and the mass reading is 100.0g.

How many seconds does it take for **half** the solid to react?

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

10 8 7 4 3.5

[1]

(iii) After five minutes the reaction rate is very slow.

All the following statements about the reaction after five minutes are true.

Put a tick (✓) in the box next to the statement that is the **best** explanation of why the rate has slowed down.

there is less acid

there is less solid

less gas is produced every second

there are fewer collisions between acid and the solid

the frequency of collisions between acid and the solid is lower

[1]

[Total: 10]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1 2 3 4 5 6 7 0

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

* 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.