OCR
RECOGNISING ACHIEVEMENT

H

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

A217/02

Unit 3 Modules B6 C6 P6
(Higher Tier)

CUP/T60801

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)

Tuesday 27 January 2009
Afternoon

Duration: 40 minutes

A217/02

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.
- 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

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

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

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

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

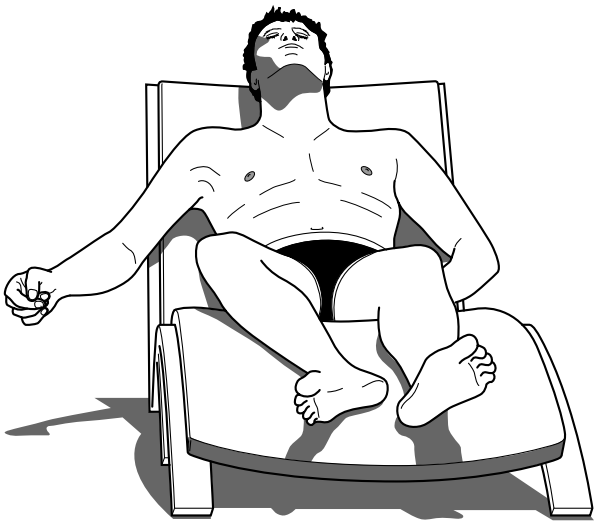
$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

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.

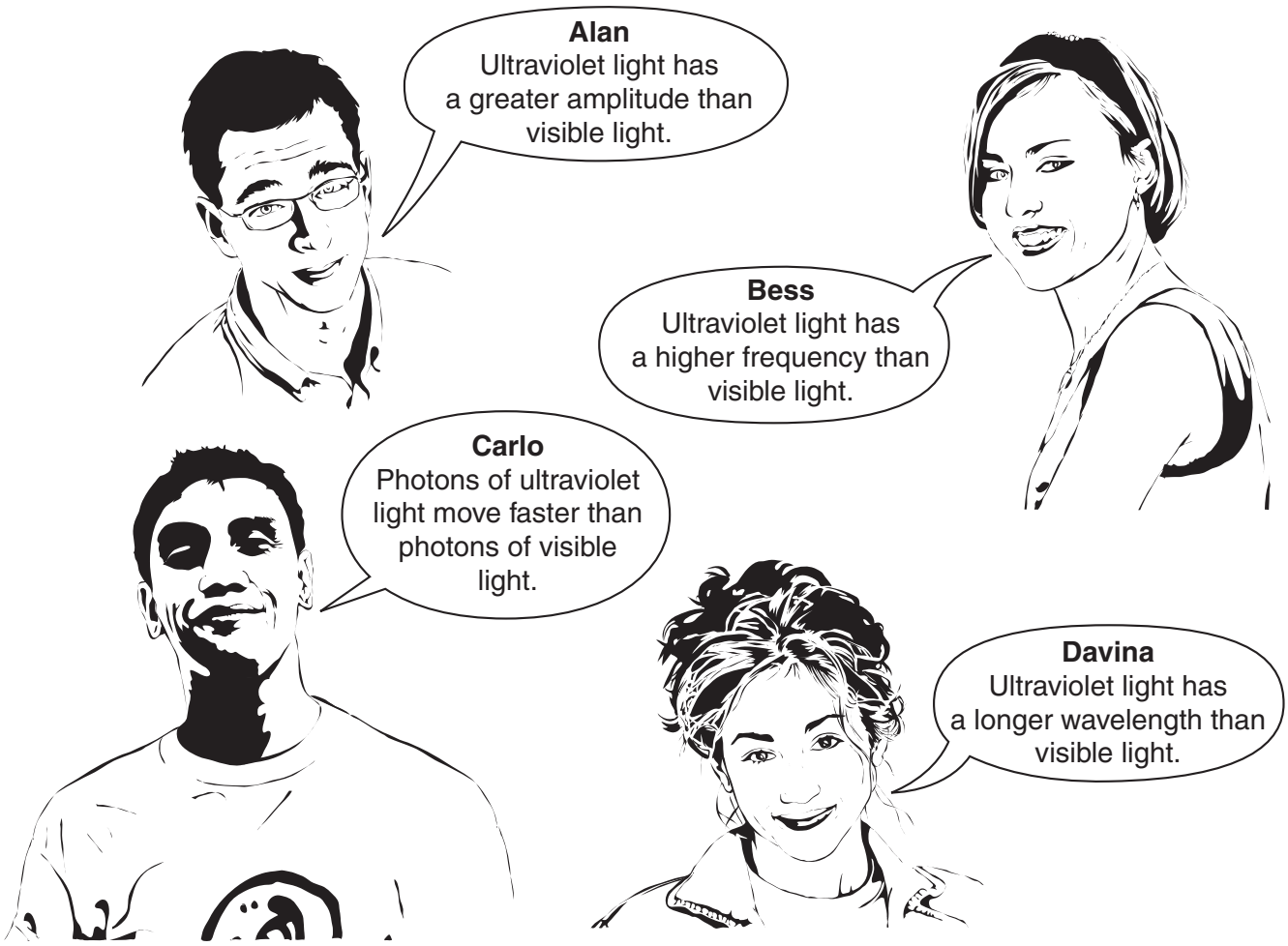
Write UV in the correct place.

	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**.

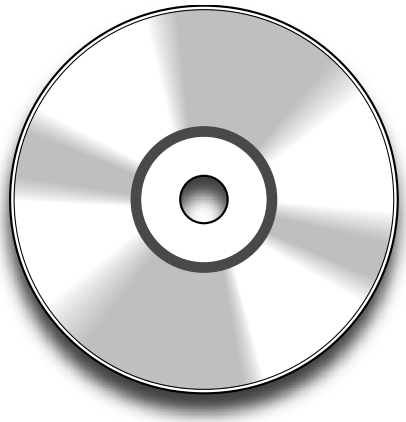
property	description
	the rate at which photons are absorbed
intensity	the number of waves emitted per second
frequency	the rate at which energy is delivered by photons
	the number of photons emitted per second

[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.

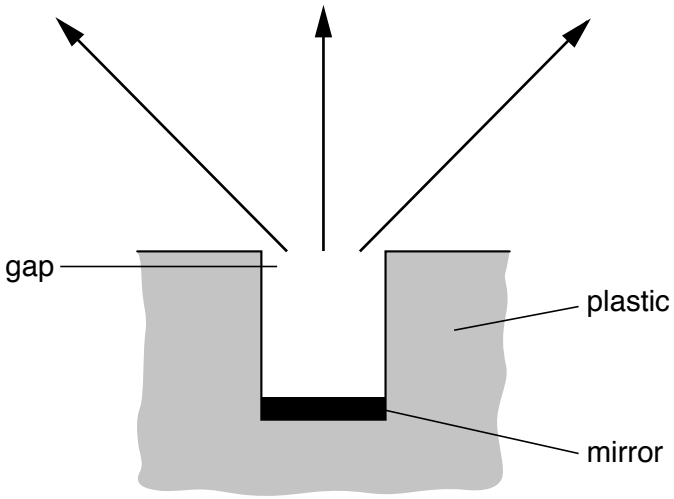
Red light and blue light have different …… . **[1]**

(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.



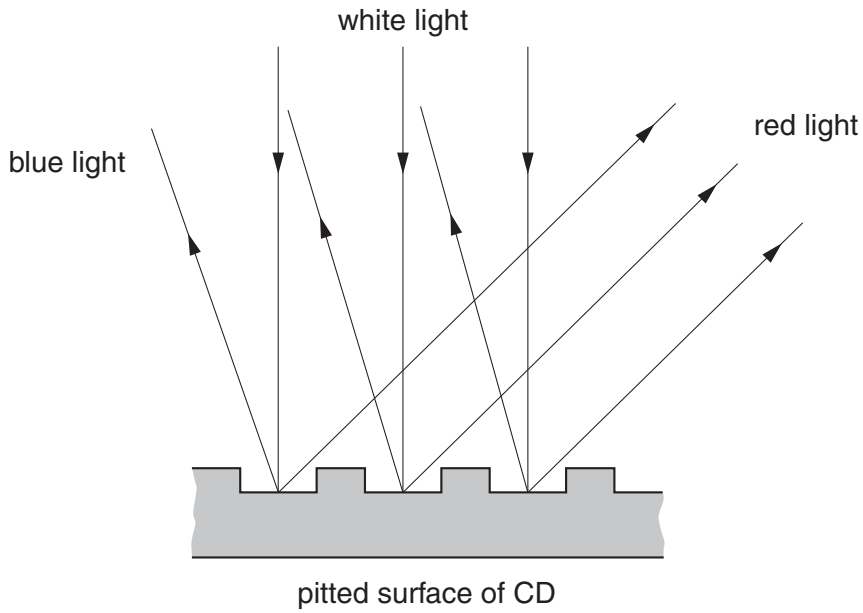
What does the diagram show?

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.

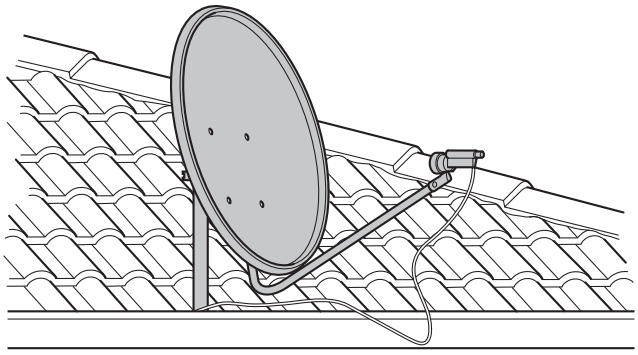
One of the statements is **not** needed for the explanation.

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

[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.

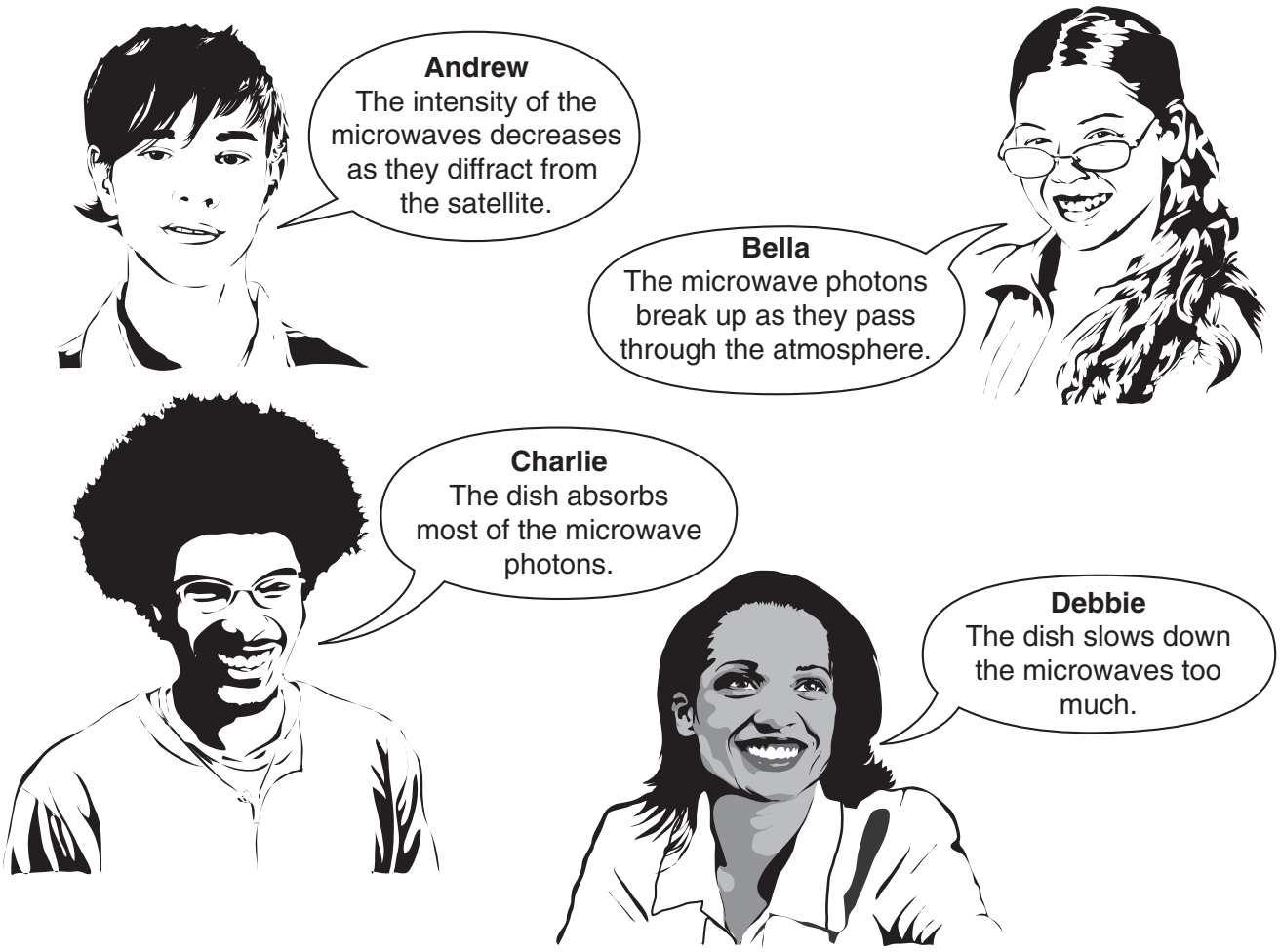
Write either **true** or **false** next to each statement.

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?



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			

[2]

[Total: 4]

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

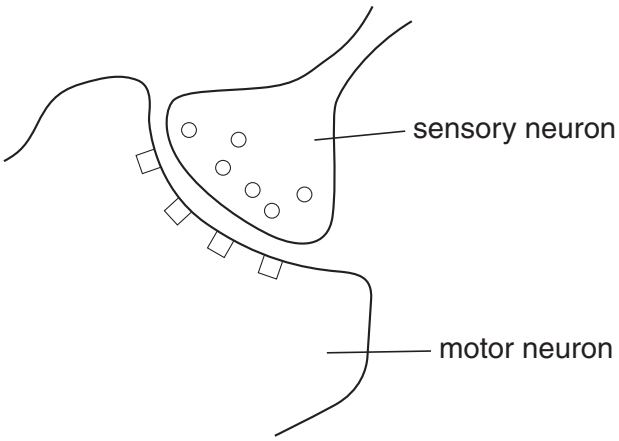
Various features of the nervous system are involved.

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

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

$$\text{nitrogen} + \text{hydrogen} + \text{iron} \longrightarrow \text{ammonia} + \text{iron}$$

(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
	less waste to dispose of
use a lower pressure	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]

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Question 8 starts on page 18

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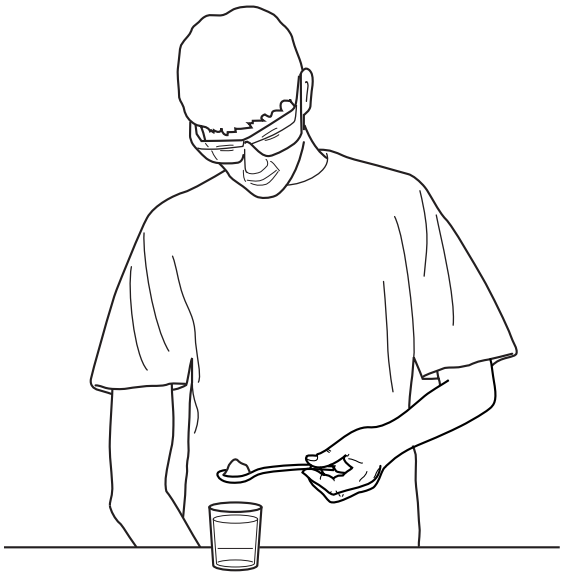
8 Tony knows that the sodium hydrogencarbonate, $NaHCO_3$, in his kitchen cupboard will react with acids.



(a) Sodium hydrogencarbonate reacts with sulfuric acid.

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

$$\square\ NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + \square\ H_2O + \square\ CO_2$$

[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 10.0 cm^3 of his acid reacts with 0.08 g sodium hydrogencarbonate.

If the titration takes 25.0 cm^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.

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$$

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

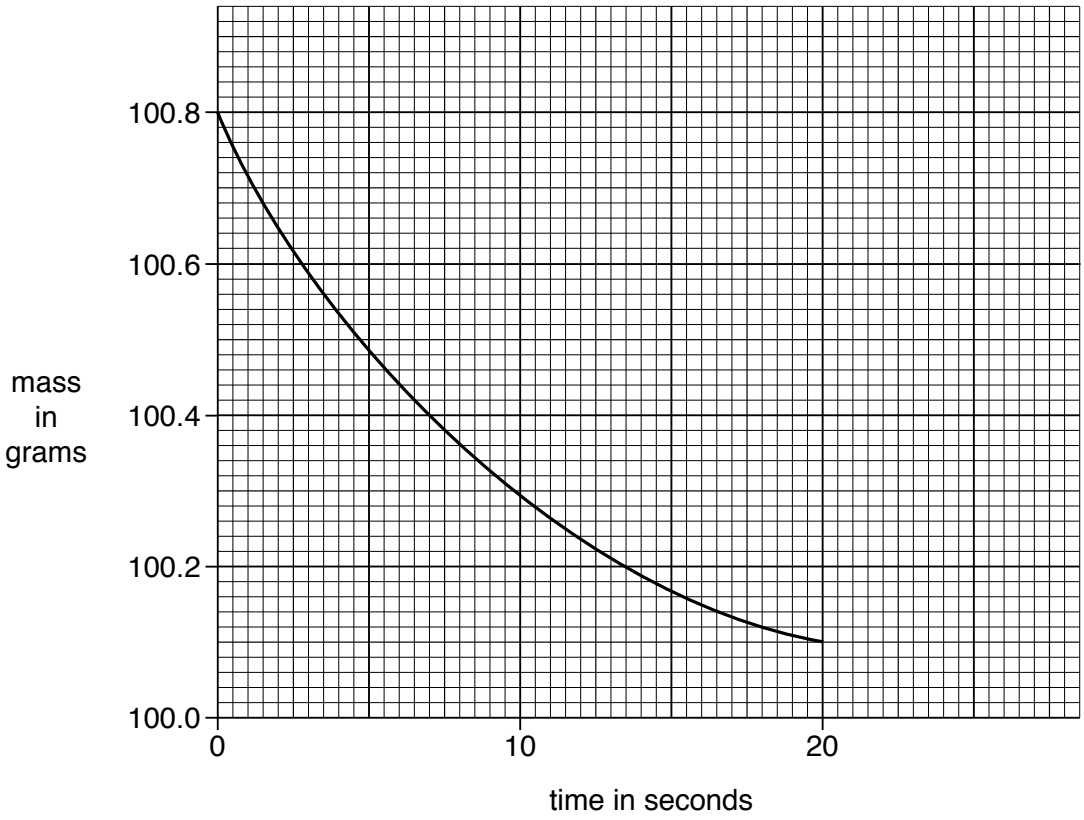
Relative atomic masses H=1, C=12, O=16, Na=23, Cl =35.5

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 100.0 g.

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
							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.