Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3440U10-1

Z22-3440U10-1

WEDNESDAY, 15 JUNE 2022 – MORNING

APPLIED SCIENCE (Single Award)
UNIT 1: Science in the Modern World

FOUNDATION TIER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**4**	
2.	**15**	
3.	**15**	
4.	**9**	
5.	**13**	
6.	**19**	
Total	**75**	

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01

ADDITIONAL MATERIALS

In addition to this paper you will require a calculator, pencil and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **5**(a) is a quality of extended response (QER) question where your writing skills will be assessed.

You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

A Periodic Table is printed on page 20.

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Answer **all** questions.

1. Hard water contains dissolved calcium and magnesium compounds. Calcium and magnesium are group 2 elements.

Use the Periodic Table on page 20 to answer the following questions.

(a) Tick (✓) the box next to the correct number of protons in a magnesium nucleus. [1]

12 ☐

24 ☐

36 ☐

(b) Tick (✓) the box next to the correct number of particles in a calcium nucleus. The mass number of calcium is the same as the relative atomic mass. [1]

20 ☐

40 ☐

60 ☐

(c) The magnesium atom has the electronic configuration 2,8,2.
Tick (✓) the box next to the correct electronic configuration of the calcium atom in the list below. [1]

2,2,8,8 ☐

2,8,8,2 ☐

8,8,2,2 ☐

(d) Owain says calcium and magnesium are both isotopes of the same element. Explain whether you agree. [1]

.....

.....

4

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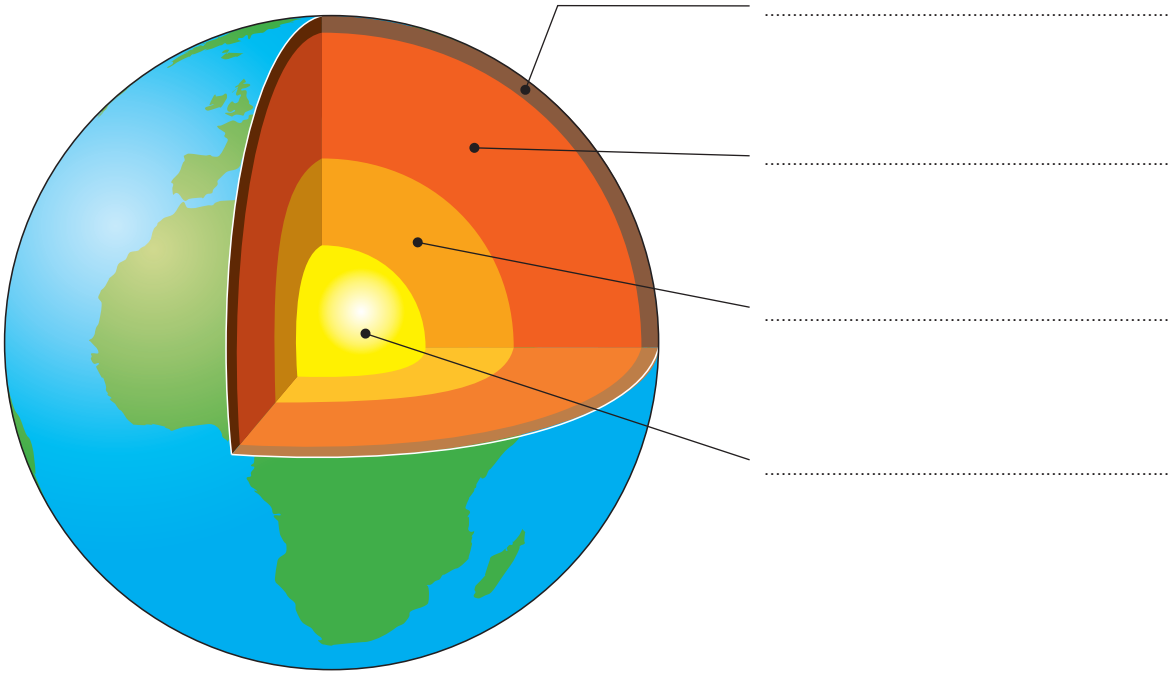
2. The surface and atmosphere of the Earth has changed over time.

(a) Use words from the box to label the diagram. [4]

solid iron inner core	**mantle**	**molten iron outer core**
	crust **lava**	



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03

Turn over.

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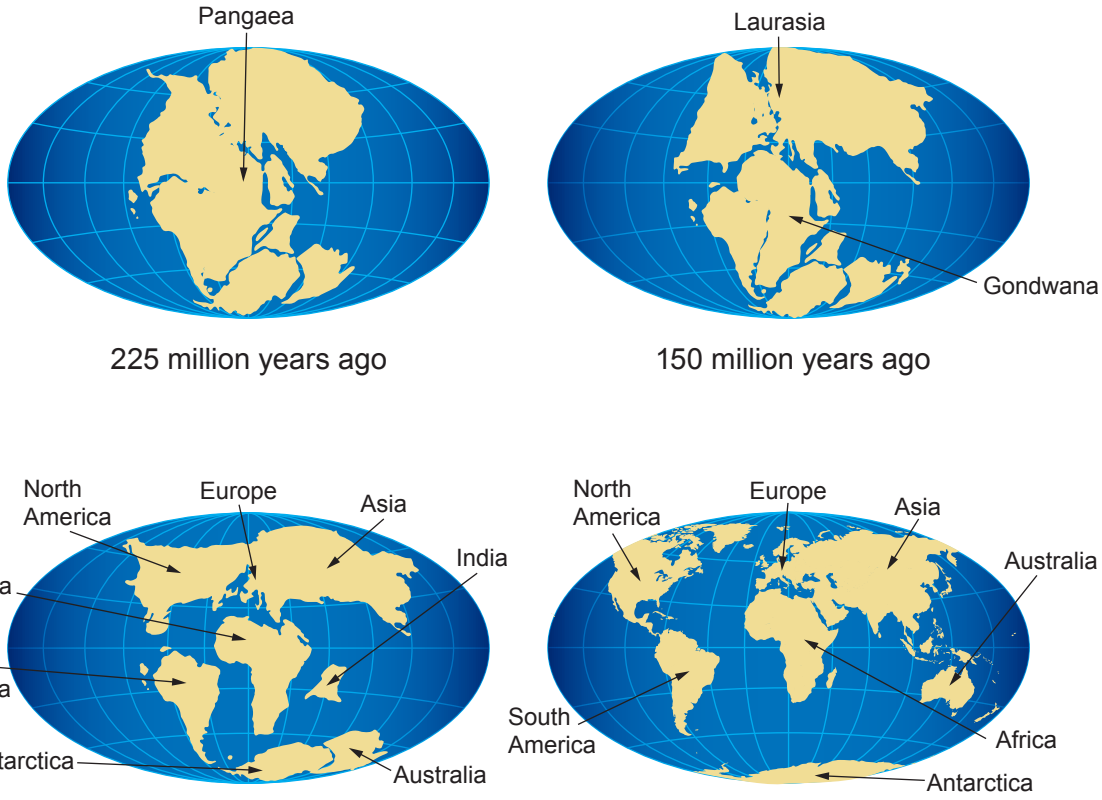
(b) The diagrams below show how the surface of the Earth has changed over millions of years. Alfred Wegener developed a theory to describe the changes that took place. The theory of **plate tectonics** was later developed from Wegener's theory.



(i) Complete the following sentence by underlining the correct word in the brackets.

Alfred Wegener's theory is called continental **(drift / expansion / travel)**. [1]

(ii) Describe **two** observations that supported this theory. [2]

1. .....

.....

2. .....

.....

(iii) The theory of plate tectonics developed from Wegener's earlier theory.

Describe the theory of plate tectonics. [2]

.....

.....

.....

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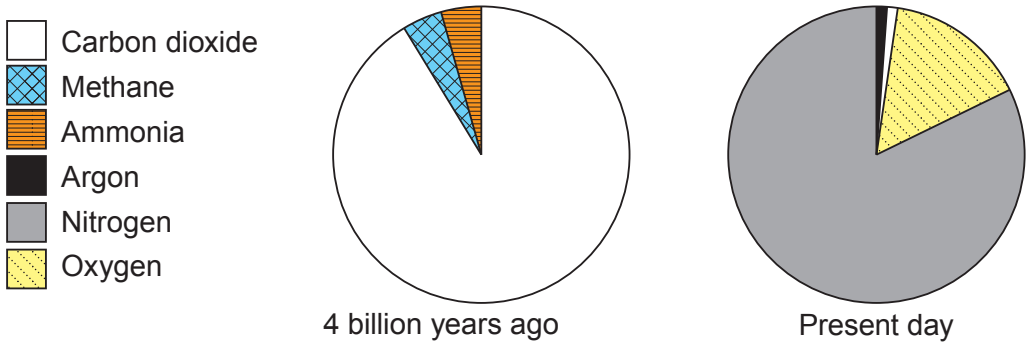
(iv) Name **two** natural disasters that may occur near the boundaries between tectonic plates. [2]

1. .....

2. .....

(c) The diagram shows how the Earth's atmosphere today compares with the atmosphere 4 billion years ago.



(i) State **three** differences between the present day atmosphere and the atmosphere 4 billion years ago. [3]

1. .....

2. .....

3. .....

(ii) Green plants were involved in bringing about changes. Name the process green plants use to make their food. [1]

.....

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3. The Sun emits radiation from all parts of the electromagnetic (em) spectrum.

(a) (i) All em waves transfer energy. The shortest waves are the most energetic. The table below shows Aled's attempt at putting some em waves in order. He made mistakes.

Arrange the em waves in the correct order. [3]

	Aled's order	Correct order
Highest Energy ↓ **Lowest Energy**	X-rays	.....
	gamma rays	.....
	radio waves	.....
	visible light	.....
	microwaves	.....

(ii) Name **two** parts of the em spectrum not included in the table. [2]

..... and .....

(b) A photograph of the Sun taken with radio waves of wavelength 1.5 m is shown below.

Use the equation

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

to calculate the frequency of radio waves used to take the image above and state the unit. [3]
Speed of em waves in space = 300 000 000 (3×10^8) m/s

frequency = ... unit .....

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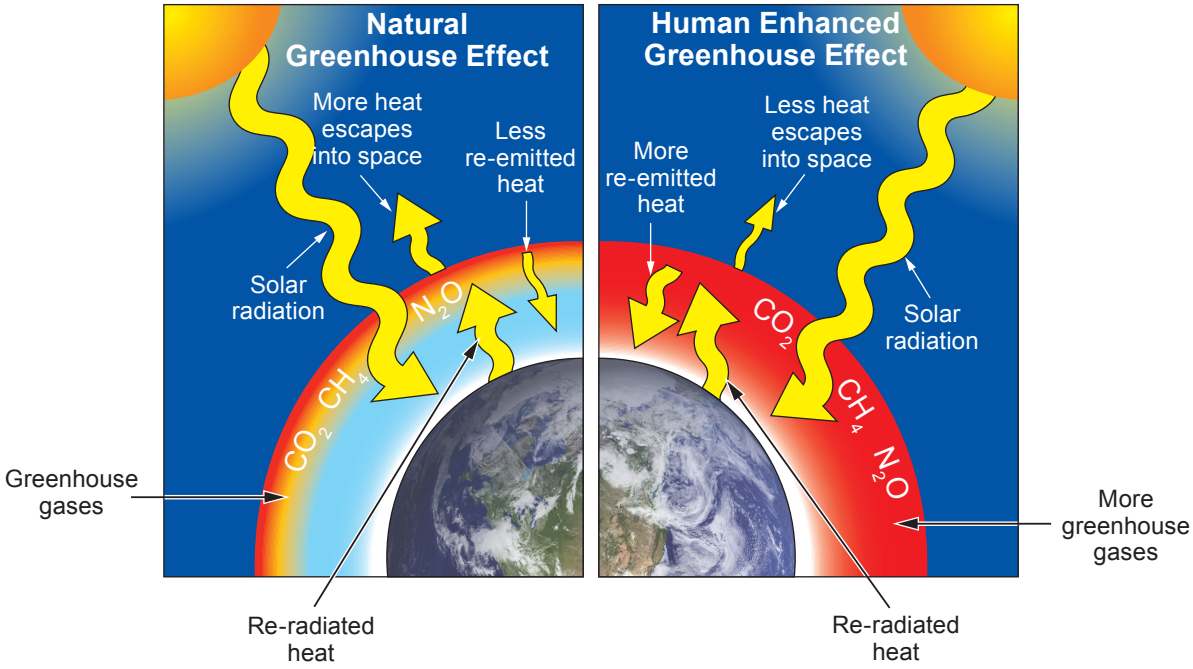
(c) The diagram below shows that the greenhouse effect in the atmosphere is increasing due to human activities.



(i) State **two** environmental effects of an increased greenhouse effect. [2]

1. .....

2. .....

(ii) State **three** ways that humans can reduce their contribution to the greenhouse effect. [3]

1. .....

2. .....

3. .....

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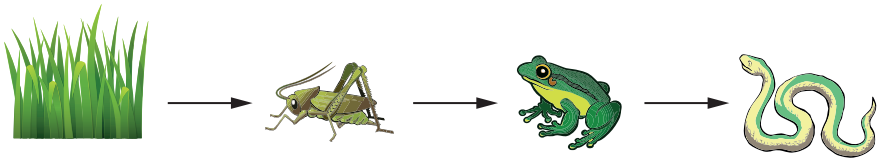
(d) Radiation from the Sun is the source of energy for all living things. It can be transferred through the food chain such as the one shown below.



State **two** reasons why there is a loss in energy at each stage of the food chain. [2]

1. .....

2. .....

15

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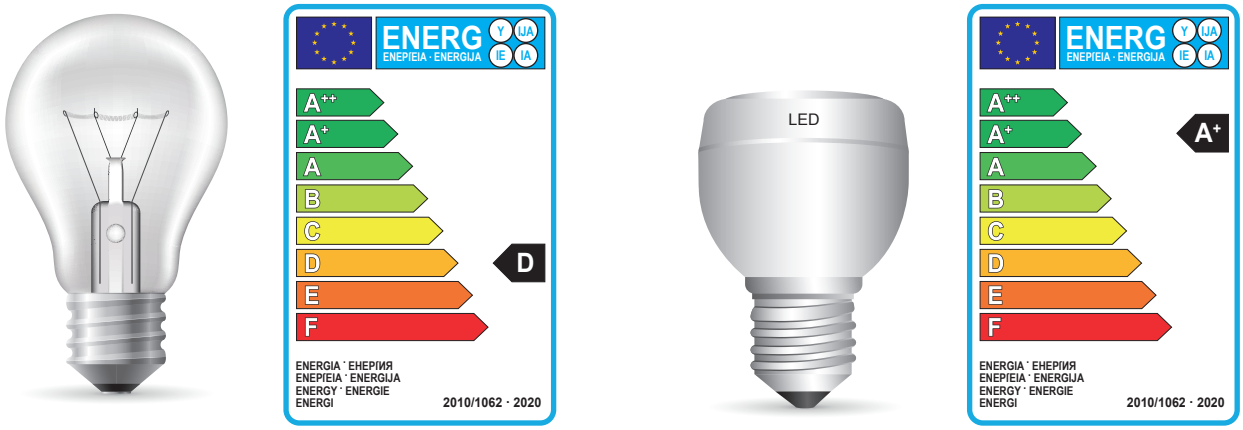
4. Halogen lamps are rated D on energy performance certificates. They are being replaced by LED lamps which are rated A^{+} or A^{++}.



(a) Use the equation

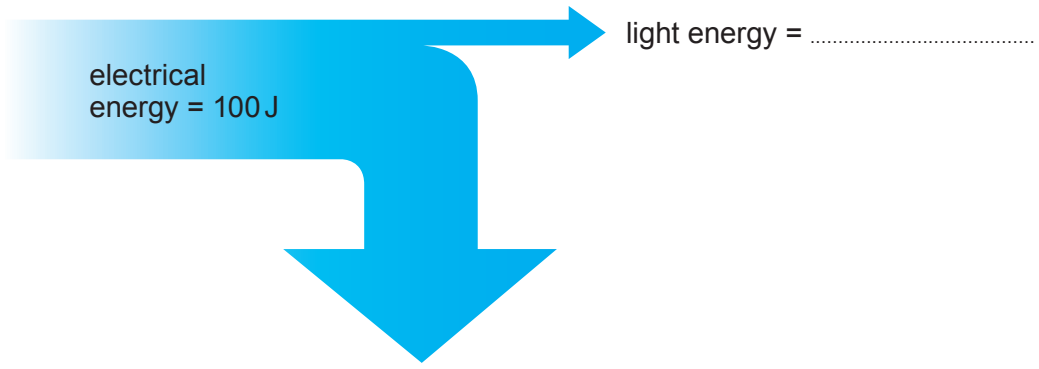
power = voltage × current

to calculate the power of a 230 V mains LED lamp that operates on a current of 0.02 A. [2]

power = ... W

(b) (i) LED lamps have an efficiency of 30%.

Complete the Sankey diagram below for an LED lamp. [2]



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(ii) Use the equation

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

to calculate the efficiency of a 44 W halogen lamp that produces 2.2 W of light. [2]

% efficiency = ...

(c) An LED lamp is used to replace the halogen lamp.

Over 50 000 hours of use, the halogen lamp uses 2300 kWh of energy while the LED lamp uses 600 kWh.

Each 1 kWh of electricity used produces 0.35 kg of carbon dioxide.

Use the information above to answer the following questions.

(i) Calculate the energy saved by using an LED lamp instead of the halogen lamp. [1]

energy saved = ... kWh

(ii) Calculate the saving in the mass of CO_2 emitted. [1]

mass of CO_2 = ... kg

(iii) The global warming potential of CO_2 is 1.
Use the equation

equivalent mass of carbon dioxide = mass of gas × global warming potential of the gas

to calculate the reduction in the carbon footprint caused by changing one lamp. [1]

equivalent mass of carbon dioxide = ... kgCO2eq

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5. The table below shows the amount of heat energy lost through different parts of a house. It also shows information about types of insulation that could be used.

Part of house	Type of insulation	Cost of insulation (£)	Energy lost per second from a house at a temperature of 20°C (J/s)
cavity walls	none		670
	foam filled	1300	210
windows	single glazed	1400	460
	double glazed	2600	310
loft	none		830
	fibre glass	800	250

(a) Explain how double-glazed windows reduce heat loss from a house **and use the data to explain** whether you would advise a homeowner to install this type of insulation first. [6 QER]

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(b) John has bought a house which does not have any loft insulation or cavity wall filling. It only has old single glazed windows.

He decided to install **fibre glass** in the loft and fill the cavity walls with **foam insulation**.

Use the data in the table to answer the following questions.

(i) I. Calculate the heat energy saved per second because of these changes. [3]

heat energy saved per second = ... J/s

II. Use the answer above to state the power saving to the home in watts. [1]

power saving = ... W

(ii) I. Calculate the total cost of installing both types of insulation. [1]

cost = £ .....

II. After installing the insulation, the fuel bill drops by £150 per year. Calculate the payback time. [2]

payback time = ... years

13

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6. Different techniques can be used to monitor the quality of water.

(a) Good river water quality is needed to support fish, vegetation, wetlands and birds.

The table below shows the results of tests carried out by students on two compounds, **A** and **B**, found in river water. The compounds were known to contain four of the following ions:

- sulfate
- calcium
- carbonate
- sodium
- chloride
- potassium
- iodide

Compound	Test used to identify positive ion		Test used to identify negative ion	
	Test using solid	Result	Test using solution	Result
A	Flame test	Lilac flame	Add dilute nitric acid followed by silver nitrate solution.	Yellow precipitate
B	Flame test	Brick red flame	Add dilute hydrochloric acid. Bubble gas through limewater.	Fizzing and limewater turns milky

Use the information in the table above to identify compounds **A** and **B**. [4]

Compound **A**: .....

Compound **B**: .....

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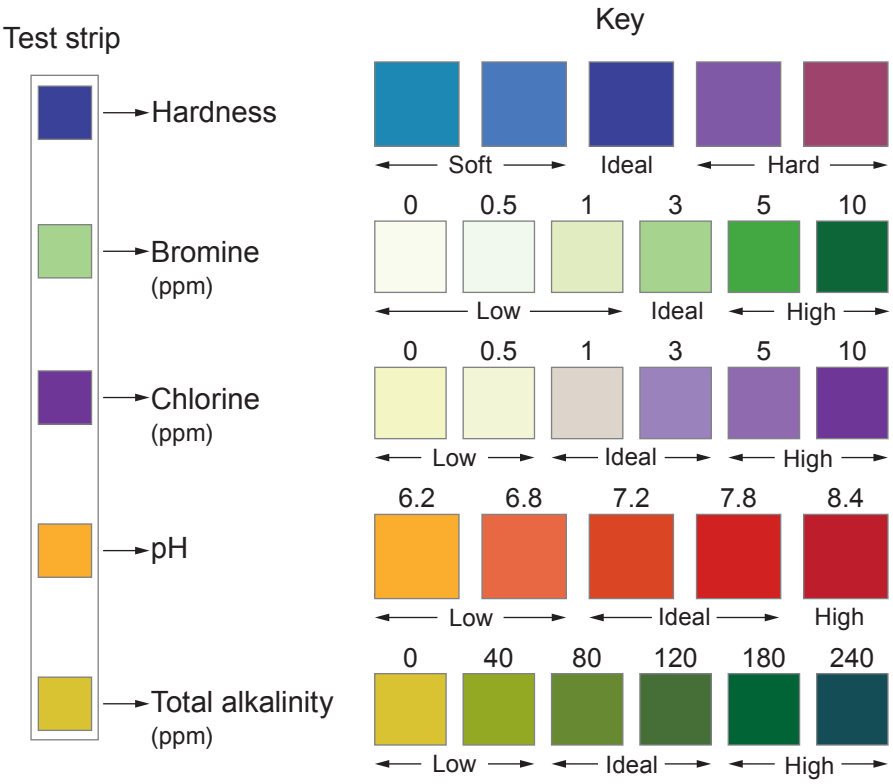
(b) Colour test strips can also be used to identify pollutants in water. They can also provide other information.

Ideal water quality in swimming pools and hot tubs is essential to prevent harm to people using them.

The colour test strip below has been produced from a swimming pool water sample. It is alongside a key.



One opinion suggests that it is safe for people to use the pool. Use the information above to explain whether you agree. [3]

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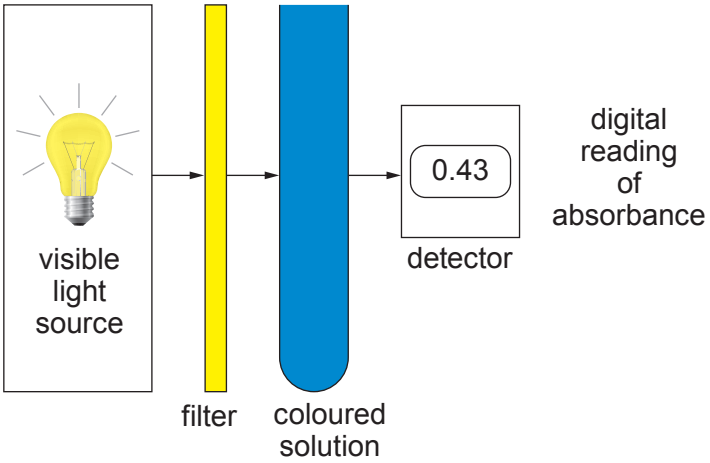
(c) Colorimetry is a method of determining the concentration of a substance in a solution by measuring the absorption of light. The instrument which is used to make these measurements is called a colorimeter. The diagram below shows how a colorimeter works.



Light is passed through a filter to select the most appropriate wavelength of light, some of which is then absorbed by the solution. The amount of light absorbed is measured and is called the absorbance.

A calibration graph using known concentrations of the tested solution is produced. The results of a calibration test using copper sulfate solutions of known concentrations are shown below.

Concentration (mol / dm^3)	Absorbance (units)
0.00	0.00
0.01	0.11
0.02	0.22
0.05	0.55
0.06	0.66
0.08	0.88

(i) Use the data to plot a graph on the grid opposite and draw a suitable line. [4]

(ii) Describe the relationship between absorbance and the concentration of the solution. [2]

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.....

(iii) A copper sulfate solution of unknown concentration was tested in the colorimeter and the absorbance was found to be 0.35 units. Use your graph to find the concentration of the solution. [1]

concentration = ... mol / dm^3

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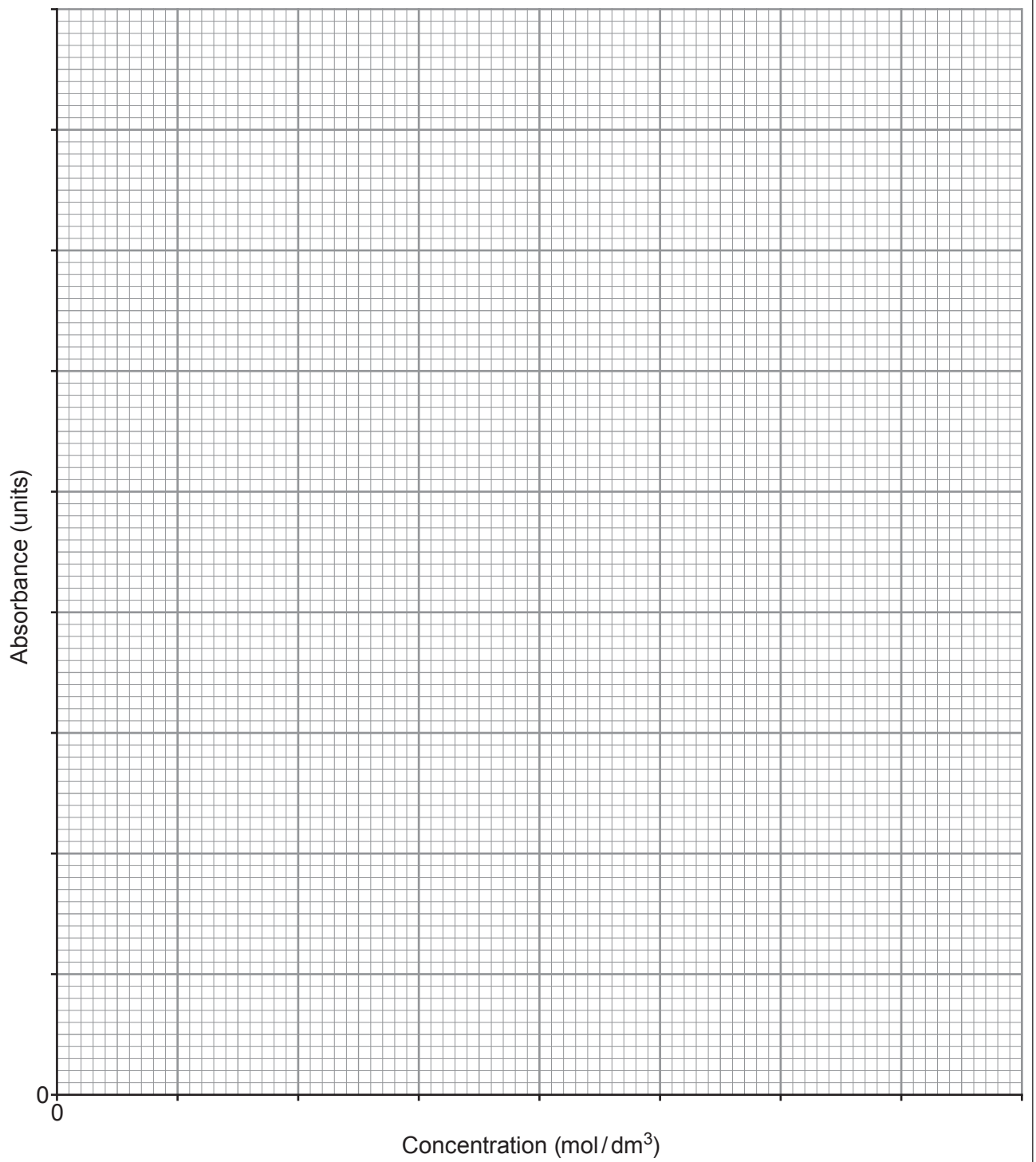

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(iv) The filter used in the colorimeter is chosen to select the band of wavelengths which are most strongly absorbed by the coloured solution. When testing copper sulfate solution a yellow filter is used.

Wavelength band (nm)	Colour of the solution	Colour of the filter
400–435	violet	yellowish-green
435–480	blue	yellow
500–560	green	purple
580–595	yellow	blue
595–610	orange/brown	greenish-blue
610–750	red	bluish-green

I. Iodine dissolved in potassium iodide solution is yellow at low concentrations and brown at higher concentrations. Explain how you would change the experiment to find the unknown concentration of iodine. [3]

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II. Zinc sulfate solution is colourless. Explain whether the concentration of a zinc sulfate solution can be found by using coloured filters. [2]

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.....

.....

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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THE PERIODIC TABLE

1	2	Group										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
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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	179 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key