Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S23-3440UA0-1

3440UA0-1

TUESDAY, 13 JUNE 2023 – MORNING

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

HIGHER TIER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**19**	
2.	**9**	
3.	**8**	
4.	**4**	
5.	**14**	
6.	**12**	
7.	**9**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator 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 **6**(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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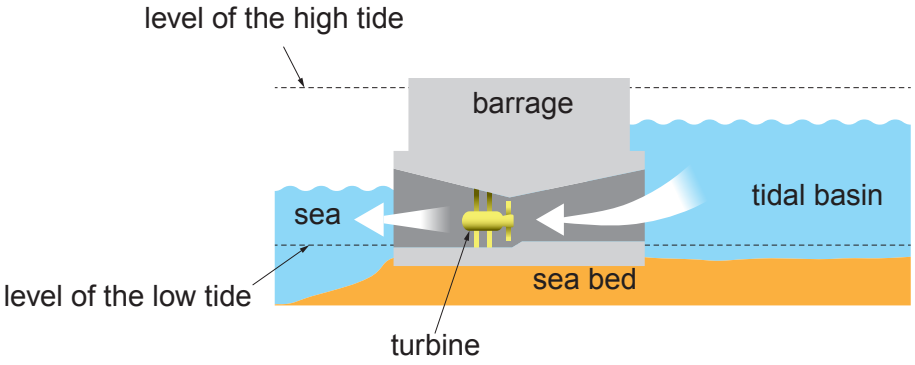
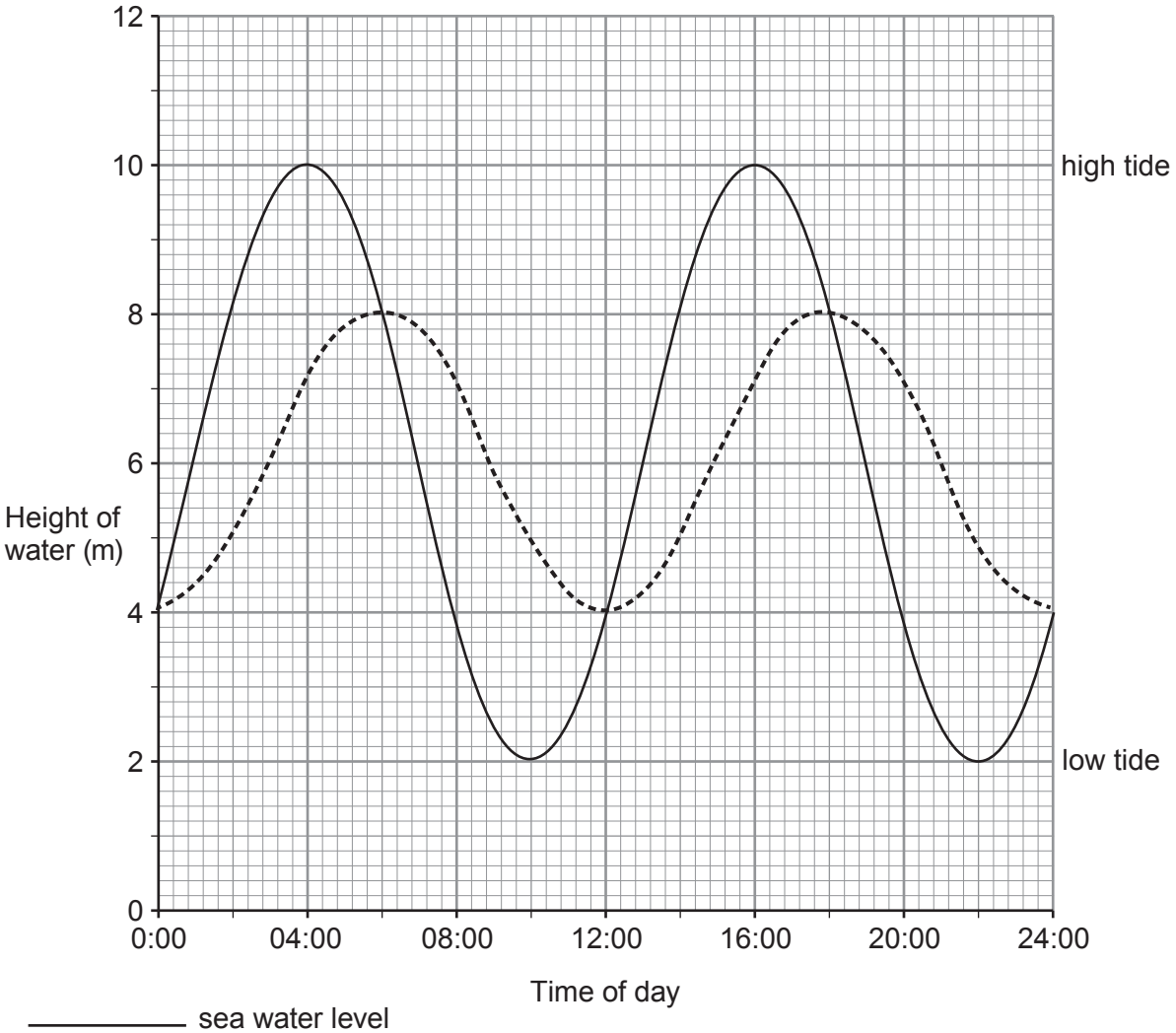
Answer **all** questions.

1. There are proposals to build a tidal barrage between Wales and England across the River Severn. Water flows into the barrage when the sea is at a higher level than the water in the tidal basin. The water flows out again when the sea level is lower than the water in the tidal basin.



(a) On one particular day, the water levels each side of the barrage are predicted to change in the way shown by the lines on the graph below.



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Use the information in the graph to answer the following questions.

(i) Calculate the difference in height of the sea water between high tide and low tide. [1]

height = ... m

(ii) State the time of the first sea water high tide of the day. [1]

time = ...

(iii) Calculate the time between the sea water low tides. [1]

time = ... hours

(iv) It is claimed that the barrage will produce electrical power 24 hours a day. Explain, using information from the graph, whether you agree with this claim. [3]

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(b) One engineer suggests the barrage could include **25** turbines. Information about **each** turbine is given in the table.

For **each** turbine	
Water flow volume through each turbine per second	200 to 800 m^3/s
Mean water power input	3125 kW
Maximum water power input	15 000 kW
Mean electrical power output	2500 kW
Maximum electrical power output	12 000 kW
Maximum output voltage	4.8 kV

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

(i) It is claimed that the use of a barrage is four times as efficient as using solar panels. The generation of electricity using solar panels is 20% efficient.
Use the equation:

$$\% \text{ efficiency} = \frac{\text{maximum electrical power output}}{\text{maximum water power input}} \times 100$$

to explain whether you agree. [3]

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(ii) Use the following equation:

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

to calculate the maximum output current for **each** turbine. [3]

current = ... A

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(iii) The **mean** electrical power used by each UK household is 0.4 kW. Assuming all 25 of the turbines are operating, it has been calculated that this barrage could supply more than 150 000 homes with electrical power.
Explain whether you agree with this calculation. [3]

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.....

(c) 410 kg of carbon dioxide is produced by the manufacture of 1 m^3 of concrete.
There are no accurate figures for the volume needed to construct the Severn barrage.
On a smaller scale, 135 000 m^3 of concrete was used to build the Cardiff Bay barrage.
Calculate the carbon footprint of making 135 000 m^3 of concrete. Equivalent mass of carbon dioxide is given by the equation: [2]

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

(Global warming potential of carbon dioxide = 1)

equivalent mass of carbon dioxide = ... kgCO2eq

(d) Apart from initial costs, state **one advantage** and **one disadvantage** of using a tidal barrage rather than wind turbines to generate electricity. [2]

Advantage: .....

.....

Disadvantage: .....

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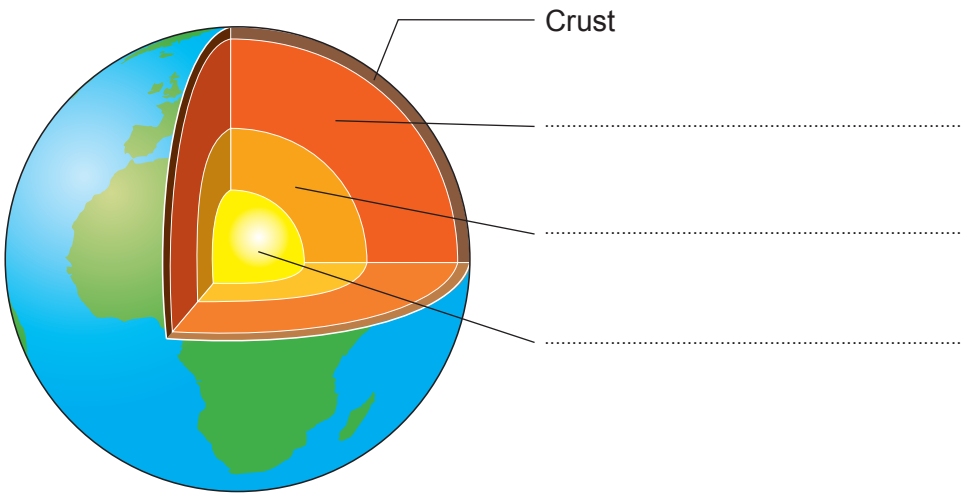
2. The diagram shows the structure of the Earth. [3]

(a) Label the diagram.



(b) Alfred Wegener suggested that all the continents were once joined in one supercontinent called Pangaea.

Describe the evidence that supports this idea. [3]

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(c) Complete the table below to show **three other** methods of extracting raw materials from within the Earth's crust and a raw material obtained for each. [3]

Extraction method	Raw material
solution mining	salt
.....	.....
.....	.....
.....	.....

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Turn over.

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3. (a) Potassium nitrate can be made by neutralising nitric acid (HNO_3) with potassium hydroxide.

Potassium hydroxide + Nitric acid ⟶ Potassium nitrate + Water

Write the balanced symbol equation for this reaction. [2]

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(b) Use information in the Periodic Table on page 20 to answer the following questions.

(i) Calculate the relative molecular mass of nitric acid. [3]

M_r = ...

(ii) Compare the structure of the atoms of group 1 elements, sodium and potassium, in terms of electrons, protons and neutrons. [3]

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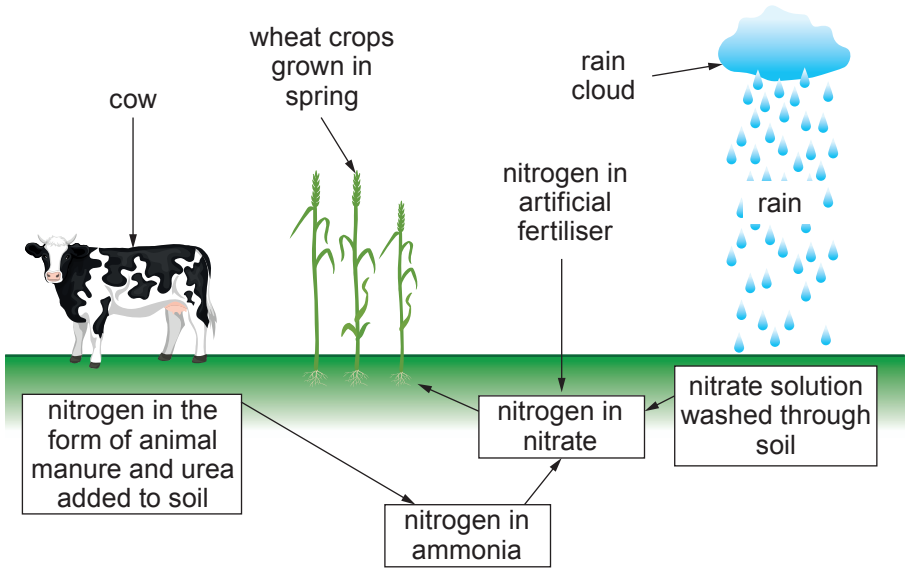
4. The diagram shows how crops absorb nitrogen.



Explain why adding nitrate-based fertiliser in spring, when crops are growing, rather than in the autumn, is better for the **environment**. [4]

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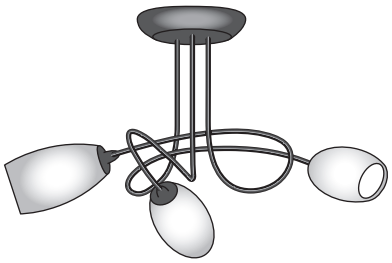
5. A homeowner is replacing a fluorescent lamp fitting with a fitting that requires three lamps.



He is considering whether to buy halogen lamps or LED lamps.
The table gives information about halogen lamps and LED lamps.

	Halogen lamp	LED lamp
Power (W)	50	5
Lifetime (h)	2500	15000
Cost to buy 3 (£)	2	12

(a) The homeowner decides to buy replacement halogen lamps because he doesn't think it is worth spending an extra £10 to buy LED lamps instead.

Use the equations

$$\text{lifetime units used (kWh)} = \text{power (kW)} \times \text{lifetime time (h)}$$

$$\text{lifetime cost} = \text{lifetime units used} \times \text{cost per unit}$$

to explain to the homeowner whether he is correct. [6]

One unit of electricity costs 30p.

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(b) Each LED has a resistor connected in series with it. These combinations are connected in parallel to each other.

(i) Draw a circuit diagram to show the three LED and resistor combinations connected in parallel to a power supply. [3]

(ii) Each LED and resistor combination has a resistance of 240 Ω.
Use the equation

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$$

to calculate the total resistance of three LED and resistor combinations in parallel. [3]

total resistance = ... Ω.

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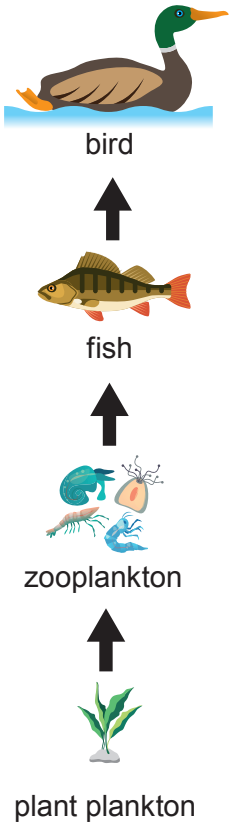
(c) Fluorescent lamps should not be disposed of in waste sent to landfill because they contain small amounts of mercury.

If mercury leaks into water it is harmful to living things that depend on water.
A water-based food chain is shown below.



Explain why mercury is more harmful to birds than zooplankton or fish in the food chain shown. [2]

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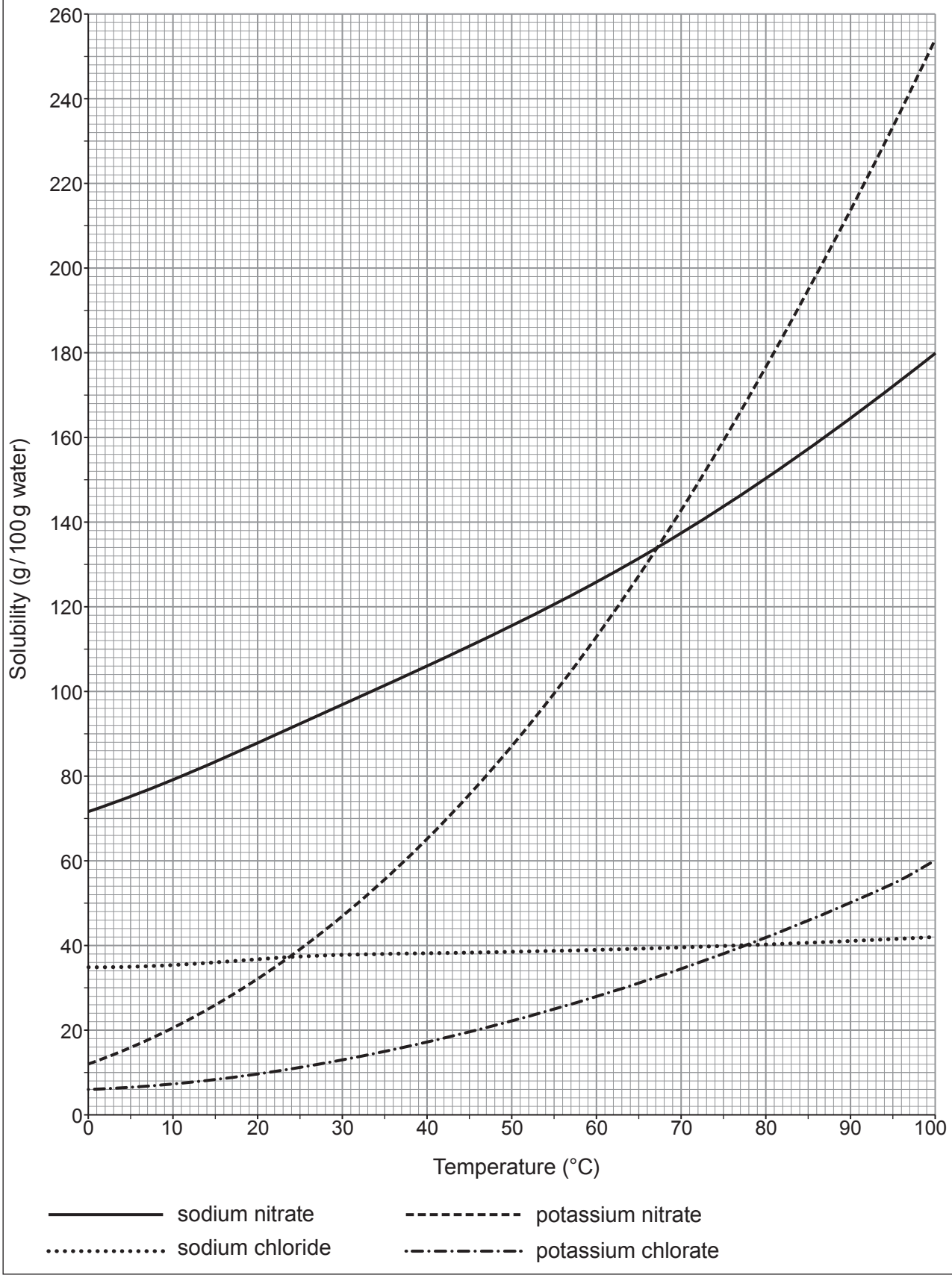
6. The graph below shows the solubility curves of two potassium salts and two sodium salts.



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(a) Describe a practical method of obtaining data to produce a solubility curve. [6 QER]

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(b) Use the information in the graphs to answer the following questions.

(i) Compare the solubilities of sodium nitrate and potassium nitrate between the temperatures of 30 °C and 90 °C. [3]

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(ii) A student adds 100 g of potassium chlorate to 200 g of water at 60 °C and stirs. Calculate the mass of solid that remains undissolved. [3]

mass = ... g

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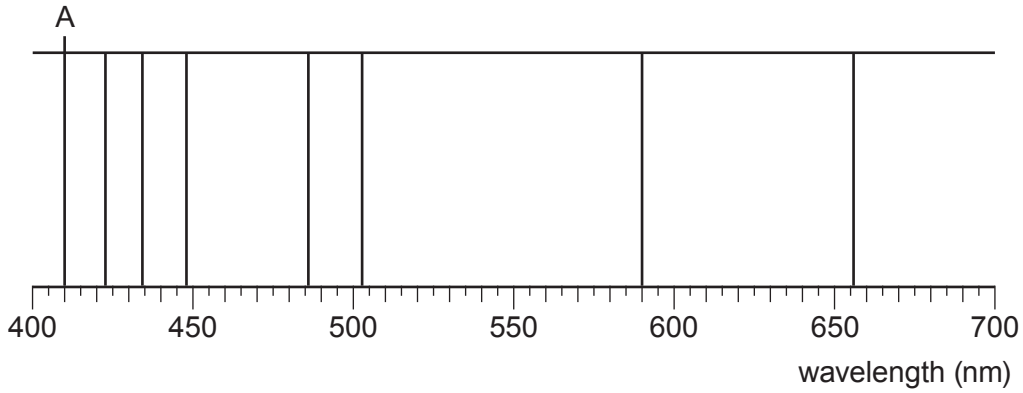
7. The diagram shows the absorption lines in the spectrum of a star.



(a) Identify the elements present in the atmosphere of the star by putting yes (Y) or no (N) in the last column of each row of the table. [3]

Element	Wavelengths (nm)	Present in star's atmosphere?
sodium	590	.....
hydrogen	410, 434, 486, 656	.....
oxygen	558, 630	.....
helium	447, 502	.....

(b) Use the equation

wave speed = frequency × wavelength

to calculate the frequency of the dark line labelled A. [3]

(wave speed of light = 3×10^8 m/s; 1 nm = 1×10^{-9} m = $\frac{1}{1\,000\,000\,000}$)

frequency = ... Hz

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(c) Explain how absorption spectra provide evidence for the origin of the Universe. [3]

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END OF PAPER

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

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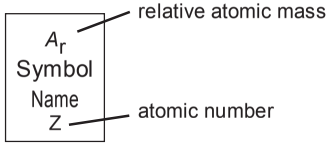
THE PERIODIC TABLE

Group 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
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



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