

Surname	Centre Number	Candidate Number
Other Names		0



GCSE – NEW

3440UA0-1



APPLIED SCIENCE (Single Award)
Unit 1: Science in the Modern World
HIGHER TIER

WEDNESDAY, 14 JUNE 2017 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	19	
2.	9	
3.	15	
4.	14	
5.	12	
6.	6	
Total	75	

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.

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.

INFORMATION FOR CANDIDATES

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

Question 4(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.

Answer **all** the questions in the spaces provided.

1. The table gives some information about the first four alkali metals in Group 1 of the periodic table. Use this information to answer the questions that follow.

Element	Number of particles in nucleus	Number of electrons	Melting point (°C)	Boiling point (°C)	Density (g/cm ³)
lithium	7	3	181	1 347	0.54
sodium	23	11	98	881	0.98
potassium	39	19	63	766	0.86
rubidium	85	37	39	688	1.50

- (a) (i) Write down the symbol for potassium in the form ${}^A_Z X$. [1]

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- (ii) Calculate the number of neutrons in a rubidium nucleus. [1]

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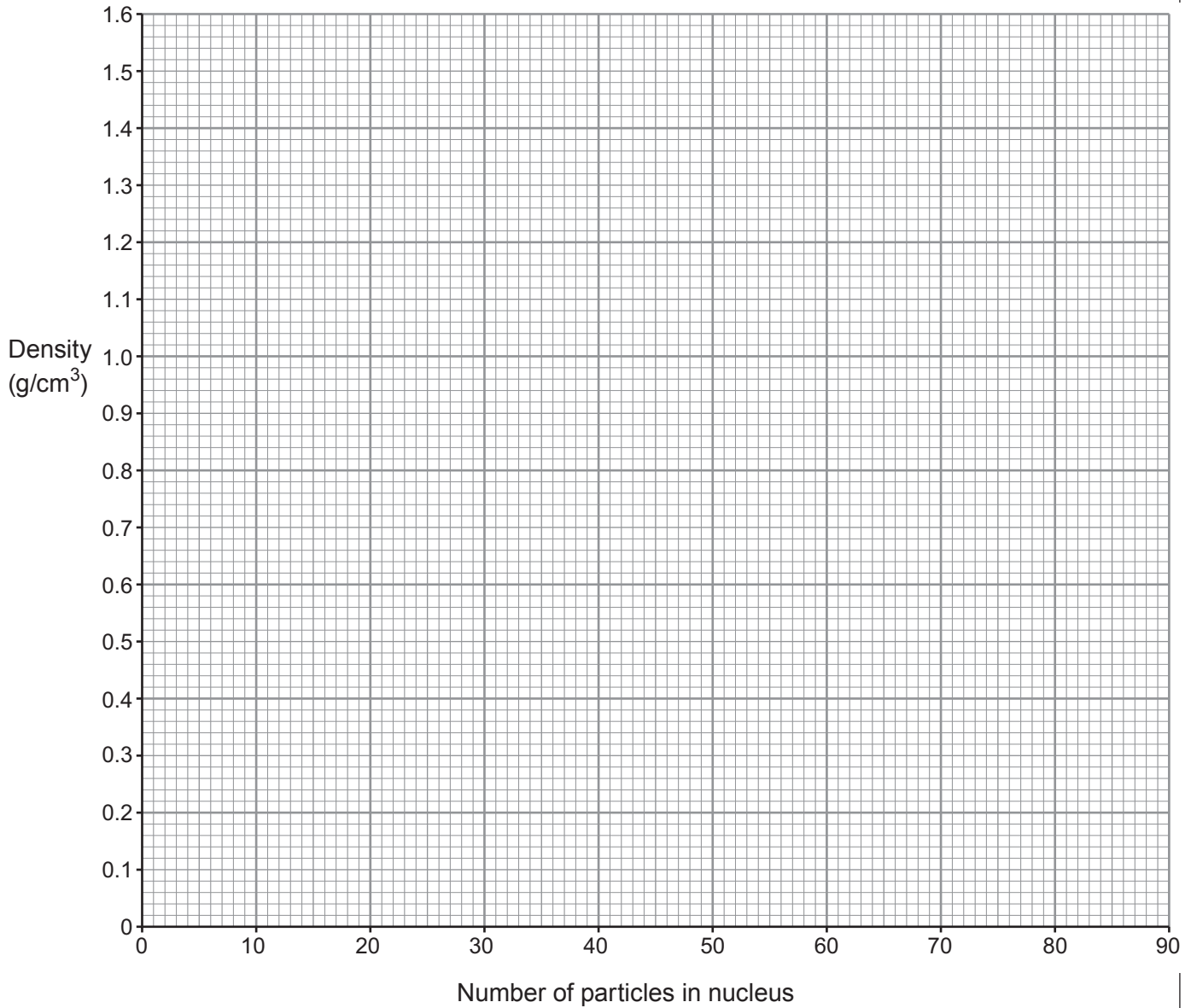
- (iii) State which alkali metal is solid at 100°C. [1]

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- (iv) Caesium is the next alkali metal in the series. Estimate its melting point. [1]

melting point = °C

- (b) (i) On the grid below, plot a graph to show how the density of the element depends on the number of particles in the nucleus. Draw a suitable line. [3]



- (ii) Explain whether or not the data agrees with the prediction that density increases with the number of particles in the nucleus. [2]

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- (iii) State what further information would help to reach a more definite conclusion. [1]

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- (c) (i) The electronic structure of potassium is 2,8,8,1. Write down the electronic structure of sodium. [1]

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- (ii) State **one** reason why all the alkali metals have the same chemical properties. [1]

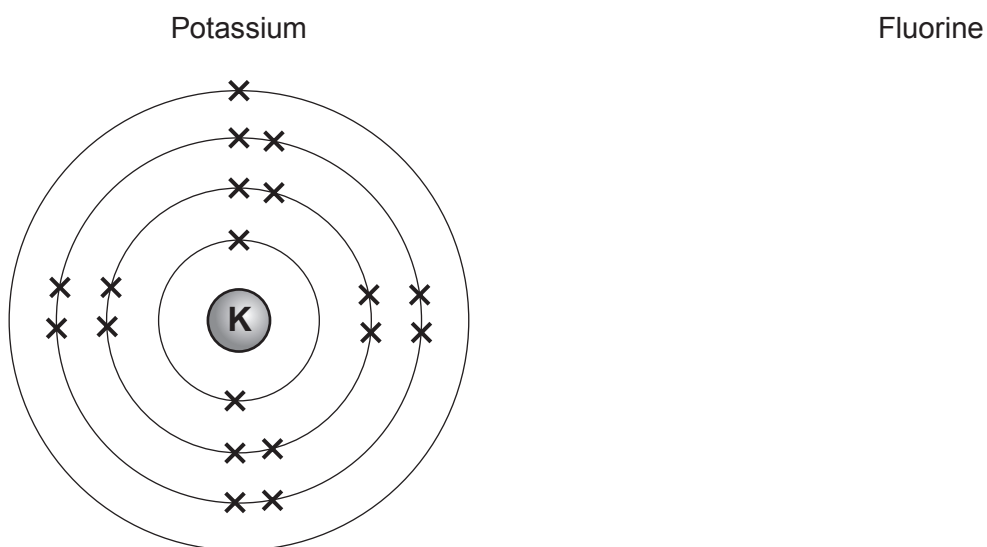
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- (iii) Name the most reactive alkali metal in the table. [1]

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- (d) Potassium reacts with fluorine to produce potassium fluoride.

- (i) The electronic structure of a potassium atom is shown below. Draw a similar diagram to show the electronic structure of a fluorine atom. [1]



- (ii) Describe how the electronic structure of the potassium and fluorine atoms change during the reaction between potassium and fluorine. [2]

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(e) Potassium is extracted from potassium fluoride by electrolysis.

(i) Complete the balanced symbol equation for the reaction shown below. [2]

potassium fluoride \longrightarrow potassium + fluorine



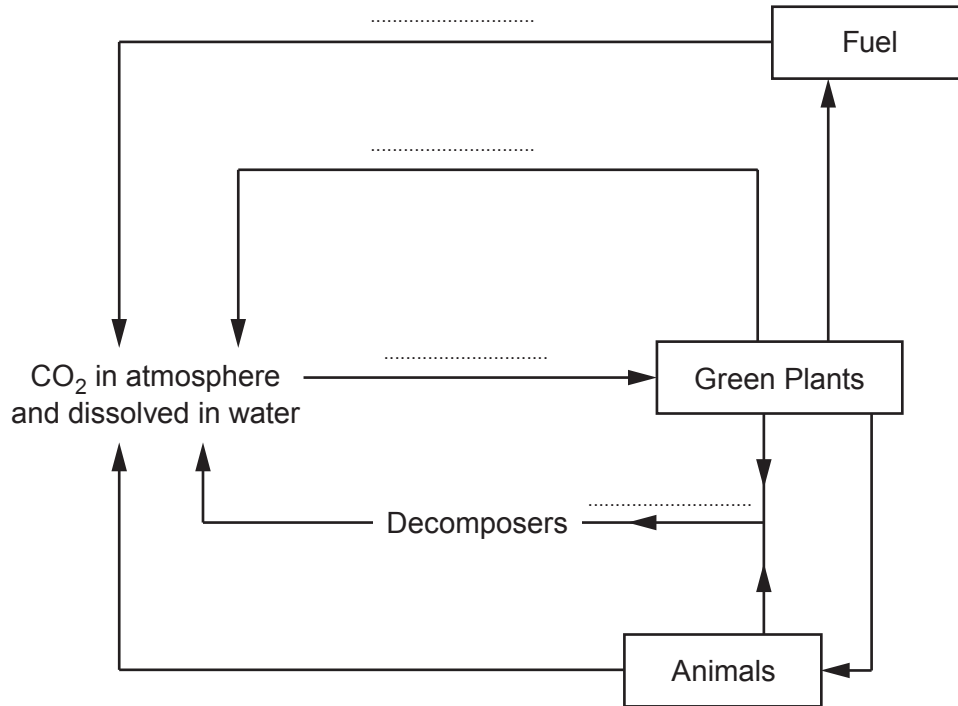
(ii) Potassium has been reduced in the reaction above. State what is meant by the term **reduction**. [1]

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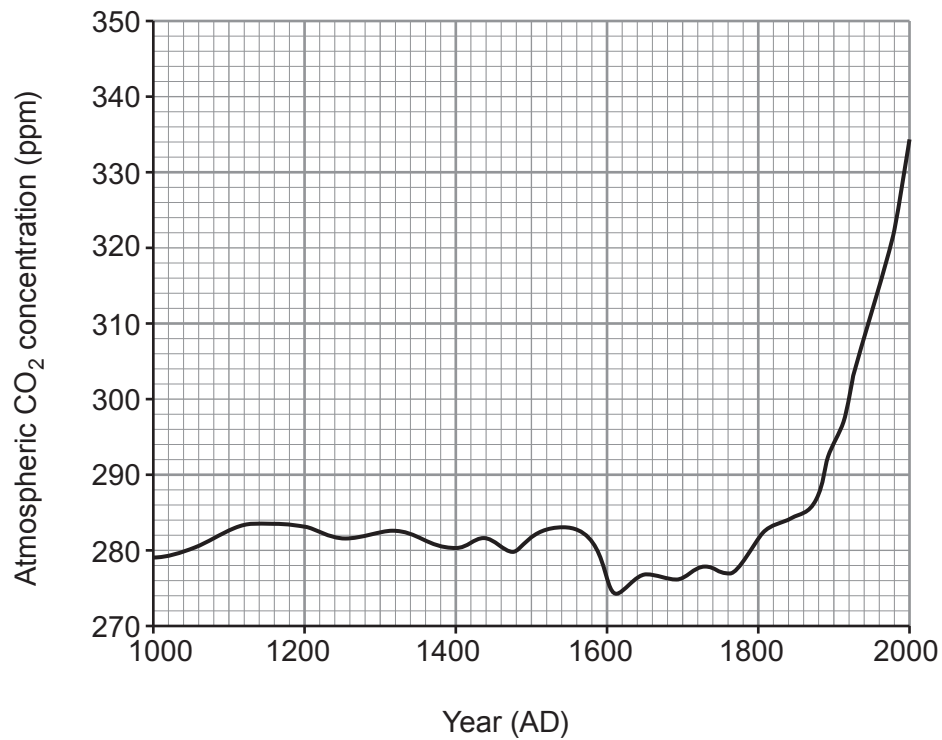
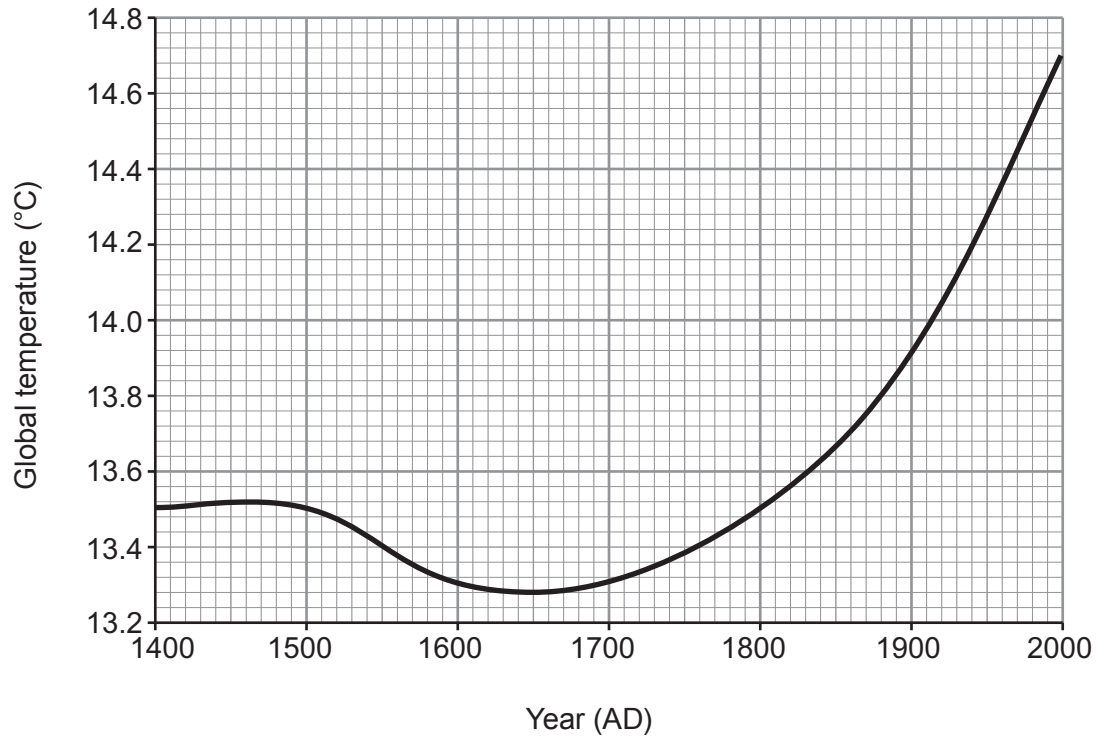
2. (a) The diagram below shows the carbon cycle. Complete the diagram.

[4]



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- (b) (i) The following graphs show how global temperature and atmospheric carbon dioxide concentrations have changed over time.



Explain whether the evidence shown in the graphs supports the view that global warming is linked to carbon dioxide concentration. [2]

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(ii) Describe how the greenhouse effect occurs. [3]

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3. Solar water heating systems use energy from the Sun to heat domestic hot water. An immersion heater can be used to make the water hotter, or to provide hot water when solar energy is unavailable.

The benefits of solar water heating;

- hot water throughout the year
- reduced energy bills
- lower carbon footprint

Solar water heating systems can achieve savings on energy bills.

Householders are able to receive payments for the heat generated from a solar water heating system through the government's Renewable Heat Incentive (RHI). Payments are shown in the table below.

Number of people per household	Solar panel area (m ²)	RHI payment (£/year)
2	2	195
3	3	265
4	4	335
5	6	435

- (a) During the summer 500 W/m² of sunlight arrives on the solar panel on the roof of a 5 person household. The panel is 40% efficient. Use the equation:

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{power input}} \times 100$$

to calculate the useful power output.

[4]

useful power output = W

(b) Before the solar panel was fitted to the roof, a 2500 W immersion heater provided hot water for the house. The immersion heater was switched on for 20 hours a week.

(i) Use the equations:

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

$$\text{total cost} = \text{energy used (kWh)} \times \text{cost per unit (p)}$$

to calculate the cost of using the immersion heater for 20 hours.
One unit of electricity costs 18p.

[4]

total cost =

(ii) After the solar panel was installed, the immersion heater was used on average for only 15 hours a week. Calculate how much the homeowner saved in a week. [2]

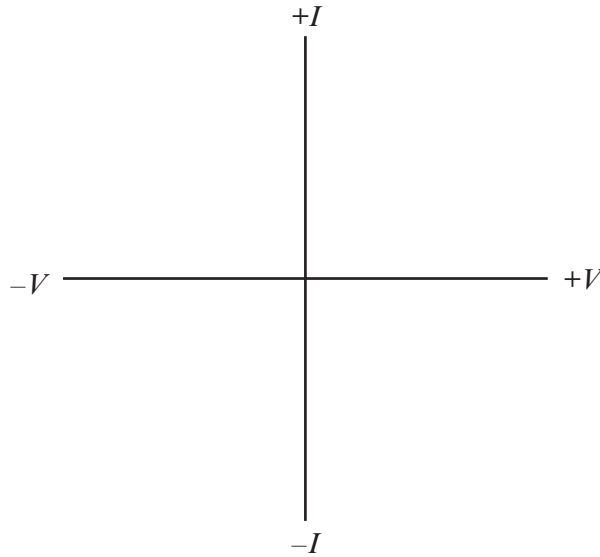
savings =

(c) The cost of installing a system for a 5 person household is £6000. The installer claims that the payback time for the system will be less than 10 years. Using the information above and the table, determine whether this claim is true. [5]

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- (b) Sketch the graph of the results you would expect for a filament lamp on the diagram below. [2]



- (c) Compare the behaviour of a filament lamp when positive or negative voltages are applied across it. [1]

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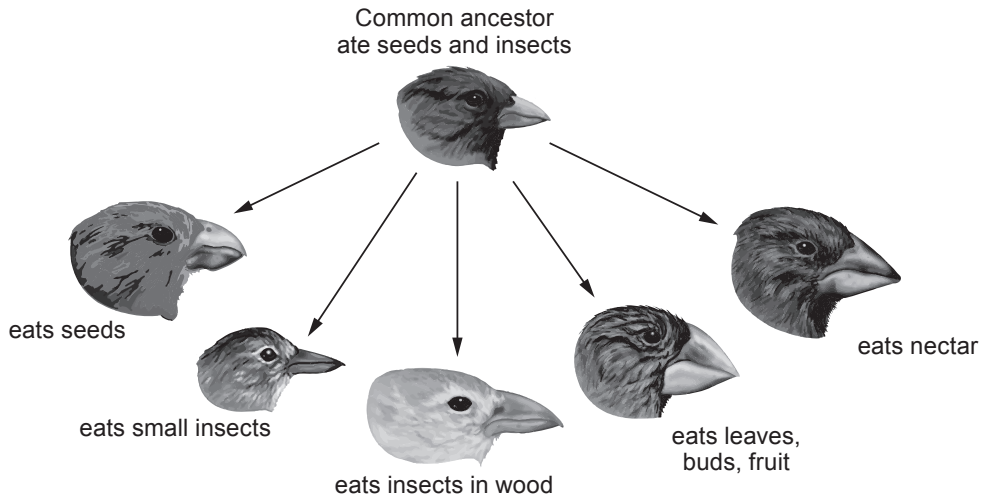
- (d) Explain whether the resistance of the lamp remains constant at all voltages. [2]

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- (e) Compare how the current from the power supply changes if another lamp is connected in series then in parallel with the original lamp. [3]

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5. (a) Biologists found different species of finch living in the Galapagos Islands. They are shown in the diagram below.



Describe the evolution of the different species of finch in terms of natural selection. [4]

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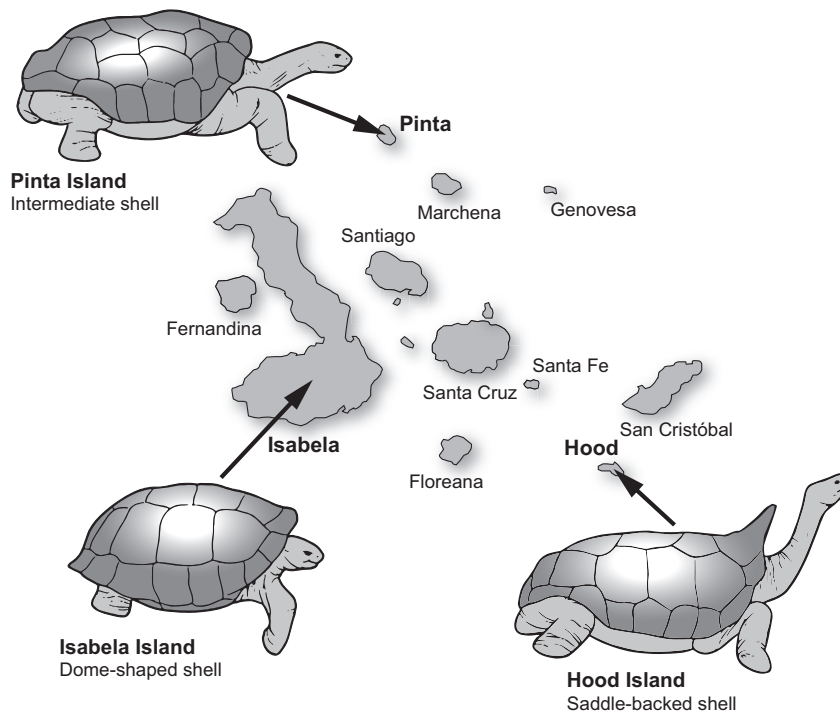
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- (b) The Biologists also found different species of tortoise as shown below:



Some parts of the Galapagos Islands have drier climates with little ground vegetation. Other parts have wetter climates with more ground vegetation.

The original ancestor of the tortoises was probably small in size and evolved into the present-day giants after its arrival in Galapagos. This is because there was no longer any need to hide from predators or competition for food. Once the tortoises spread, they evolved on their isolated islands into the different species we see today. More recently the human population on these islands has increased and animals such as goats have been introduced.

- (i) Use the diagram opposite and information above to explain how you can decide what the climate is like on Isabela and Hood islands. [4]

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- (ii) Explain how the increasing human population and the introduction of goats will affect the tortoise population. [4]

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6. One test for detecting metals in water is to add sodium hydroxide solution.

Positive ion	Symbol	Test	Observation
aluminium	Al^{3+}	add dilute sodium hydroxide solution	white precipitate that dissolves as more sodium hydroxide solution is added
copper	Cu^{2+}	add dilute sodium hydroxide solution	pale blue precipitate that does not dissolve as more sodium hydroxide solution is added
iron(II)	Fe^{2+}	add dilute sodium hydroxide solution	pale green precipitate formed
iron(III)	Fe^{3+}	add dilute sodium hydroxide solution	red-brown precipitate formed
lead	Pb^{2+}	add dilute sodium hydroxide solution	white precipitate that dissolves as more sodium hydroxide solution is added
magnesium	Mg^{2+}	add dilute sodium hydroxide solution	white precipitate that does not dissolve as more sodium hydroxide solution is added

Tests for some negative ions are shown below.

Negative ion	Symbol	Test	Observation
carbonate	CO_3^{2-}	add dilute hydrochloric acid	bubbles of gas are given off
chloride	Cl^-	add dilute nitric acid then silver nitrate	white precipitate
nitrate	NO_3^-	add iron(II) sulfate solution followed by concentrated sulfuric acid	brown ring forms
sulfate	SO_4^{2-}	add solution of barium chloride	white precipitate
iodide	I^-	add dilute nitric acid then silver nitrate	yellow precipitate
bromide	Br^-	add dilute nitric acid then silver nitrate	cream precipitate

- (a) Name **one** other test for identifying metals in solution.

[1]

- (b) A sample of a solution from leaking drums undergoes some chemical tests. The observations are shown below.

Test	Observation
barium chloride solution added	white precipitate
dilute nitric acid then silver nitrate solution added	cream precipitate
hydrochloric acid added	no change
sodium hydroxide solution added	green precipitate

- (i) Use the tables to determine the composition of the solution. [4]

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- (ii) Use the chemical symbols to write down the formula of a compound present in the solution. [1]

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THE PERIODIC TABLE

Group **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 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10																										
23 Na Sodium 11	24 Mg Magnesium 12	27 Co Cobalt 27	28 Si Silicon 14	29 K Potassium 19	30 Ca Calcium 20	31 Sc Scandium 21	32 Ti Titanium 22	33 V Vanadium 23	34 Cr Chromium 24	35 Mn Manganese 25	36 Fe Iron 26	37 Ni Nickel 28	38 Cu Copper 29	39 Zn Zinc 30	40 Ga Gallium 31	41 Ge Germanium 32	42 As Arsenic 33	43 Se Selenium 34	44 Br Bromine 35	45 Kr Krypton 36														
86 Rb Rubidium 37	87 Sr Strontium 38	89 Y Yttrium 39	90 Zr Zirconium 40	91 Nb Niobium 41	92 Mo Molybdenum 42	93 Tc Technetium 43	94 Ru Ruthenium 44	95 Rh Rhodium 45	96 Pd Palladium 46	97 Ag Silver 47	98 Cd Cadmium 48	101 Ru Ruthenium 44	102 Rh Rhodium 45	103 Pd Palladium 46	104 Ag Silver 47	105 Cd Cadmium 48	106 Pt Platinum 78	107 Au Gold 79	108 Hg Mercury 80	109 Tl Thallium 81	110 Pb Lead 82	111 Bi Bismuth 83	112 Po Polonium 84	113 At Astatine 85	114 Rn Radon 86									
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	140 Hf Hafnium 72	141 Ta Tantalum 73	142 W Tungsten 74	143 Re Rhenium 75	144 Os Osmium 76	145 Ir Iridium 77	146 Pt Platinum 78	147 Au Gold 79	148 Hg Mercury 80	150 Er Erbium 68	151 Tm Thulium 69	152 Yb Ytterbium 70	153 Lu Lutetium 71	154 Hf Hafnium 72	155 Ta Tantalum 73	156 W Tungsten 74	157 Re Rhenium 75	158 Os Osmium 76	159 Ir Iridium 77	160 Pt Platinum 78	161 Au Gold 79	162 Hg Mercury 80	163 Tl Thallium 81	164 Pb Lead 82	165 Bi Bismuth 83	166 Po Polonium 84	167 At Astatine 85	168 Rn Radon 86				
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89	228 Th Thorium 90	229 Pa Protactinium 91	230 U Uranium 92	231 Np Neptunium 93	232 Pu Plutonium 94	233 Am Americium 95	234 Cm Curium 96	235 Bk Berkelium 97	236 Cf Californium 98	237 Es Einsteinium 99	238 Fm Fermium 100	239 Md Mendelevium 101	240 Nd Nobelium 102	241 Lr Lawrencium 103	242 Rf Rutherfordium 104	243 Db Dubnium 105	244 Sg Seaborgium 106	245 Bh Bohrium 107	246 Hs Hassium 108	247 Mt Meitnerium 109	248 Ds Darmstadtium 110	249 Rg Roentgenium 111	250 Cn Copernicium 112	251 Nh Nihonium 113	252 Fl Flerovium 114	253 Uu Ununpentium 115	254 Uub Ununhexium 116	255 Uut Ununseptium 117	256 Uuq Ununquadium 118	257 Uuq Ununquadium 118	258 Uuo Ununoctium 118	259 Uuo Ununoctium 118

1 H Hydrogen 1

Key

Ar	relative atomic mass
Symbol	
Name	
Z	atomic number