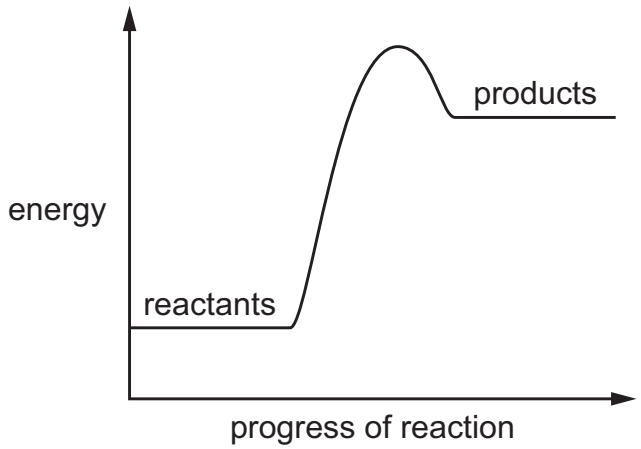
13 A reaction pathway diagram is shown.



Which row identifies the type of reaction and how the temperature of the surroundings changes during the reaction?

	type of reaction	temperature of the surroundings
A	endothermic	decreases
B	endothermic	increases
C	exothermic	decreases
D	exothermic	increases

11 Two statements about hydrogen are listed.

1 Hydrogen is used as a fuel.

2 When hydrogen burns in the air to form water, thermal energy is produced.

Which conclusion about these statements is correct?

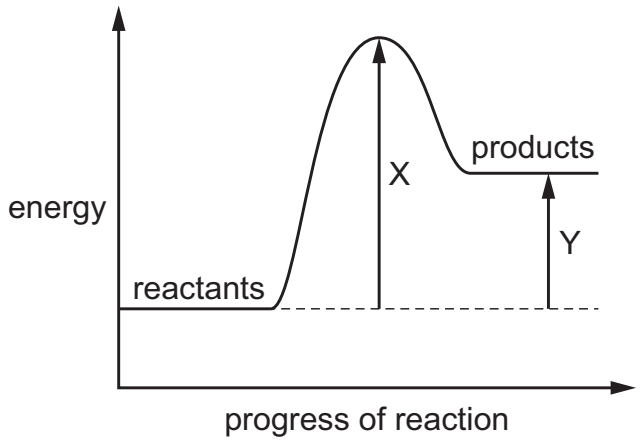
A Both statements are correct, and statement 2 explains statement 1.

B Both statements are correct, but statement 2 does **not** explain statement 1.

C Statement 1 is correct, but statement 2 is **not** correct.

D Statement 2 is correct, but statement 1 is **not** correct.

14 A reaction pathway diagram is shown.



Which row shows the correct labels for X and Y and the type of reaction taking place?

	X	Y	type of reaction
A	enthalpy change	activation energy	exothermic
B	activation energy	enthalpy change	endothermic
C	activation energy	enthalpy change	exothermic
D	enthalpy change	activation energy	endothermic

6 This question is about the Periodic Table.

(a) State the name given to Group VII elements.

..... [1]

(b) State which Group VII element is most reactive.

..... [1]

(c) Give the physical state and colour of iodine at room temperature and pressure.

state .....

colour .....

[2]

(d) When bromine is added to aqueous potassium iodide a displacement reaction occurs.

The equation for the reaction is shown.

$$Br_2 + 2KI \rightarrow 2KBr + I_2$$

(i) Write an ionic equation for the reaction.

..... [2]

(ii) Iodine and bromine react at high temperatures to form iodine monobromide, IBr.

The equation is shown.

$$I_2(g) + Br_2(g) \rightarrow 2IBr(g)$$

The structures of the molecules involved in the reaction are I–I, Br–Br and I–Br.

Table 6.1

bond	bond energy in kJ / mol
I–I	150
Br–Br	193
I–Br	175

Calculate the enthalpy change, ΔH, for the reaction using the bond energies in Table 6.1.

Use the following steps.

- Calculate the **total** amount of energy required to break the bonds in 1 mol of $I_2(g)$ and 1 mol of $Br_2(g)$.

..... kJ

- Calculate the total amount of energy released when the bonds in 2 mol of IBr(g) are formed.

..... kJ

- Calculate the enthalpy change, ΔH, for the reaction.
  Your answer should include a sign.

..... kJ / mol
[3]

(e) Sodium is in Group I of the Periodic Table.

When sodium is added to water a chemical reaction occurs.

(i) Give **two** observations when sodium is added to water.

1 .....

2 .....

[2]

(ii) Thymolphthalein is added to the solution when the reaction has finished.

State the final colour of the thymolphthalein in the solution.

..... [1]

[Total: 12]

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Name:

2 A student investigates the temperature change when anhydrous lithium chloride dissolves in water.

The student does five experiments.

Experiment 1

- Use a 50 cm^3 measuring cylinder to pour 40 cm^3 of distilled water into a 100 cm^3 beaker.
- Use a thermometer to measure the initial temperature of the water.
- Add a 2.0 g sample of anhydrous lithium chloride to the water in the beaker.
- Continually stir the mixture in the beaker using the thermometer.
- Measure the highest temperature reached by the mixture in the beaker.
- Empty the beaker and rinse the beaker with distilled water.

Experiment 2

- Repeat Experiment 1 using 30 cm^3 of distilled water instead of 40 cm^3.

Experiment 3

- Repeat Experiment 1 using 25 cm^3 of distilled water instead of 40 cm^3.

Experiment 4

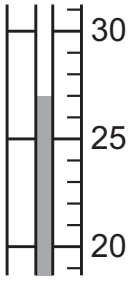
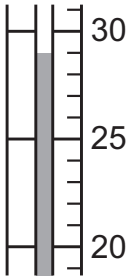
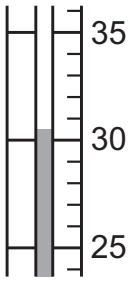
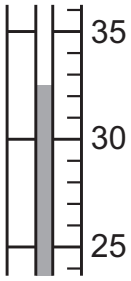
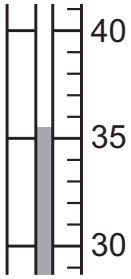
- Repeat Experiment 1 using 20 cm^3 of distilled water instead of 40 cm^3.

Experiment 5

- Repeat Experiment 1 using 15 cm^3 of distilled water instead of 40 cm^3.

(a) Use the information in the description of the experiments and the thermometer diagrams to complete Table 2.1.

Table 2.1

experiment	mass of anhydrous lithium chloride / g	volume of distilled water / cm^3	initial temperature / °C	thermometer diagram for highest temperature reached / °C	highest temperature reached / °C	temperature change / °C
1	2.0	40	22.5			
2		30	22.5			
3		25	22.5			
4		20	22.0			
5		15	22.0			

[4]

(b) Complete a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on Fig. 2.1.

Draw a line of best fit.

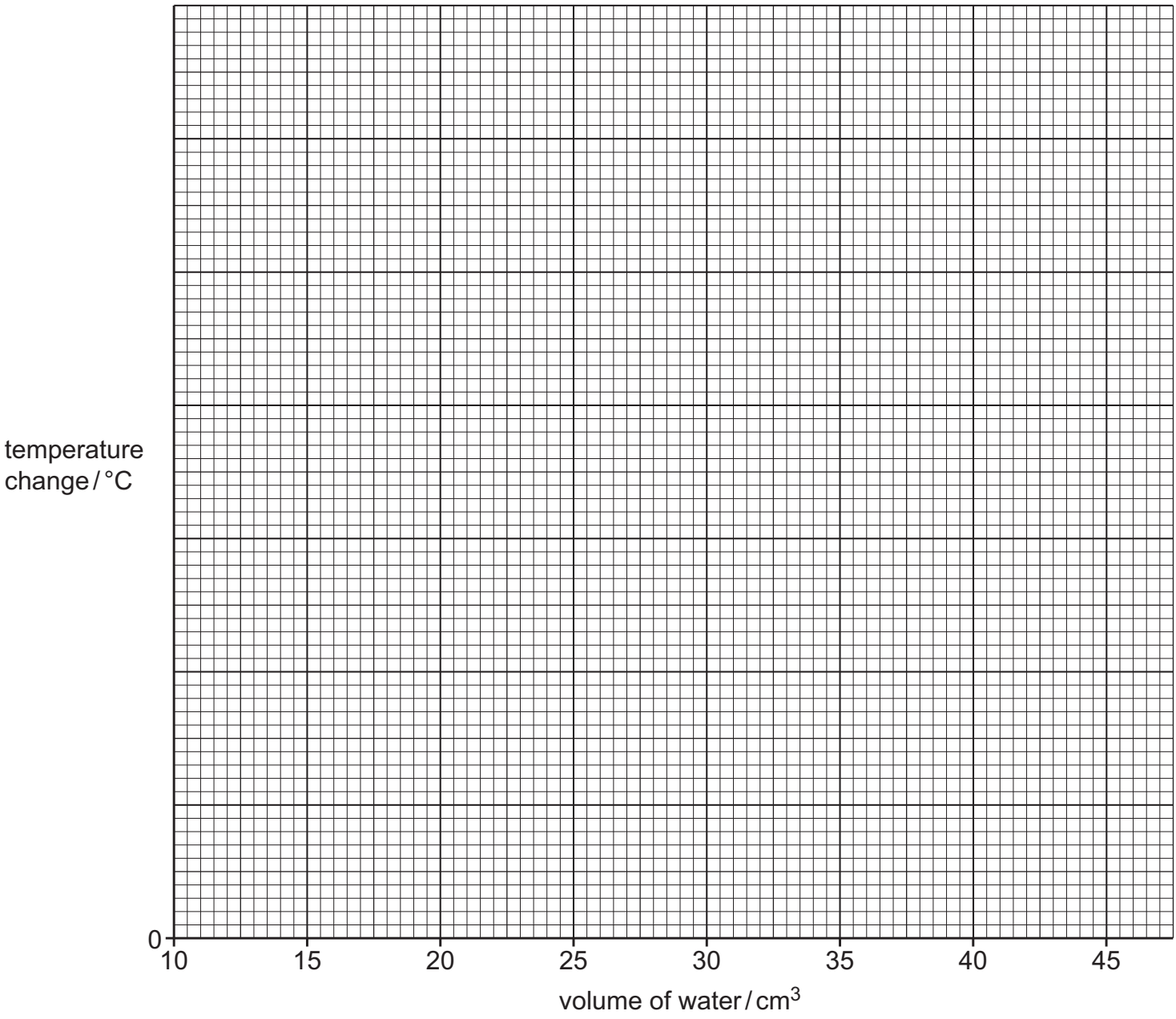


Fig. 2.1

[4]

(c) Extrapolate the line on your graph in Fig. 2.1 to deduce the temperature change when Experiment 1 is repeated with 45 cm^3 of water instead of 40 cm^3 of water.

Show clearly on Fig. 2.1 how you worked out your answer.

temperature change = ... [3]

(d) The energy, in J, given out when 2.0 g of anhydrous lithium chloride dissolves is calculated using the equation shown.

energy given out = temperature change × 4.2 × volume of water

Calculate the energy given out when 2.0 g of anhydrous lithium chloride dissolves in Experiment 5.

energy given out = ... J [1]

(e) Estimate the temperature change when Experiment 1 is repeated using 4.0 g of anhydrous lithium chloride instead of 2.0 g.

Give a reason for your answer.

temperature change .....

reason .....

.....

[2]

(f) Explain why the results obtained would be more accurate if the beaker used in each experiment was replaced by a polystyrene cup.

.....

.....

..... [2]

(g) **(i)** Explain why using a burette instead of a measuring cylinder is an improvement.

.....

..... [1]

(ii) Explain why standing the beaker in a water-bath is **not** an improvement.

.....

..... [1]

[Total: 18]