Past-paper walk-through

Exothermic and endothermic reactions ▪ 5.1

eXercise

Questions in this set

- 0620/21 N25 Q14 ▪ 1 mark
- 0620/21 N25 Q15 ▪ 1 mark
- 0620/22 N25 Q14 ▪ 1 mark
- 0620/22 N25 Q15 ▪ 1 mark
- 0620/63 N25 Q2 ▪ 18 marks
- 0620/21 J25 Q13 ▪ 1 mark
- 0620/22 J25 Q14 ▪ 1 mark
- 0620/23 J25 Q13 ▪ 1 mark
- 0620/22 M25 Q17 ▪ 1 mark

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 14

0620/21 N25 ▪ Q14 ▪ 1 mark

14 Information about two reactions is given.

- The neutralisation reaction between citric acid and sodium hydrogencarbonate is endothermic.
- The displacement reaction between magnesium and carbon dioxide is exothermic.

Which statements about the two reactions are correct?

1 The energy of the products formed in the neutralisation reaction is greater than the energy of the reactants.

2 The energy of magnesium and carbon dioxide is greater than the energy of magnesium oxide and carbon.

Question 14

3 In an exothermic reaction, the energy required to break the bonds is greater than the energy released when the new bonds are formed.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Solution 14

Answer: **B**

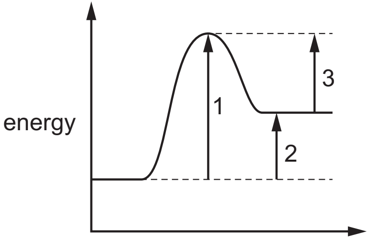
Why

- An endothermic reaction takes energy in, so the mixture gets colder.
- An exothermic reaction gives energy out, so the mixture gets hotter.
- So the neutralisation cools down and the displacement warms up.

Question 15

0620/21 N25 ▪ Q15 ▪ 1 mark

15 The reaction pathway diagram for a reaction is shown.



Question 15

progress of reaction

Which row identifies the activation energy, E_a, and the enthalpy change, ΔH, for this reaction?

	E_a	ΔH
A	1	2
B	1	3
C	2	3
D	3	1

Solution 15

Answer: **A**

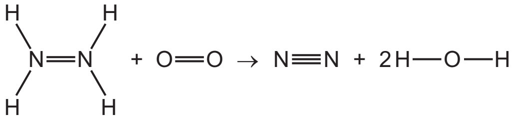
Why

- Activation energy is measured from the reactant level up to the peak.
- The enthalpy change is measured from the reactant level to the *product* level.
- So they start from the same place but end at different ones – do not confuse the two arrows.

Question 14

0620/22 N25 ▪ Q14 ▪ 1 mark

14 The equation for the combustion of hydrazine, N_2H_4, is shown.



bond	bond energy in kJ / mol
N–H	391
N=N	409
N≡N	944

Question 14

[illegible]	[illegible]
O–H	463
O=O	496

What is the overall enthalpy change for the combustion of one mole of hydrazine?

A –327 kJ / mol

B –111 kJ / mol

C +111 kJ / mol

D +327 kJ / mol

Solution 14

Answer: **A**

Why

- Bonds broken: the four N–H bonds and the N–N bond of the hydrazine, plus the O=O of the oxygen.
- Bonds formed: the N≡N triple bond of nitrogen and four O–H bonds in the two waters.
- $\Delta H =$ energy in $-$ energy out; the very strong N≡N is what makes this so exothermic.

Question 15

0620/22 N25 ▪ Q15 ▪ 1 mark

15 Dissolving ammonium chloride in water is an endothermic change.

Which row shows the energy change and temperature change of the mixture during the dissolving of ammonium chloride?

	energy change	temperature change
A	energy is absorbed	decrease
B	energy is absorbed	increase
C	energy is released	decrease
D	energy is released	increase

Solution 15

Answer: **A**

Why

- Endothermic means the change takes energy *in* from its surroundings.
- The surroundings here are the water and the beaker.
- So they lose energy and the temperature of the mixture falls.

Question 2

0620/63 N25 ▪ Q2 ▪ 18 marks

2 A student investigates the temperature change when a 5 cm length of coiled magnesium ribbon reacts with excess dilute sulfuric acid.

The student does five experiments.

Experiment 1

- Rinse a burette with distilled water and then with dilute sulfuric acid.
- Fill the burette with dilute sulfuric acid. Run some of the dilute sulfuric acid out of the burette so that the level of the dilute sulfuric acid is on the 0.0 cm^3 mark.
- Use the burette to add 30.0 cm^3 of dilute sulfuric acid to a boiling tube.
- Use a thermometer to measure the initial temperature of the acid.
- Record the initial temperature.
- Add a coil of magnesium ribbon to the boiling tube. At the same time start a stop-watch.
- Continually stir the contents of the boiling tube using the thermometer.
- After 1 minute, measure the temperature of the mixture in the boiling tube.
- Record this temperature.

Question 2

Experiment 2

- Refill the burette with dilute sulfuric acid. Run some of the dilute sulfuric acid out of the burette so that the level of the dilute sulfuric acid is on the 0.0 cm^3 mark.
- Use the burette to add 25.0 cm^3 of dilute sulfuric acid to a new boiling tube.
- Use the thermometer to measure the initial temperature of the acid.
- Record the initial temperature.
- Add a coil of magnesium ribbon to the boiling tube. At the same time start the stop-watch.
- Continually stir the contents of the boiling tube using the thermometer.
- After 1 minute, measure the temperature of the mixture in the boiling tube.
- Record this temperature.

Experiment 3

- Repeat Experiment 2, using 20.0 cm^3 of dilute sulfuric acid instead of 25.0 cm^3.

Experiment 4

- Repeat Experiment 2, using 15.0 cm^3 of dilute sulfuric acid instead of 25.0 cm^3.

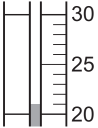
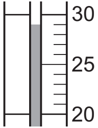
Question 2

Experiment 5

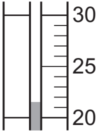
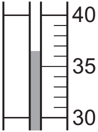
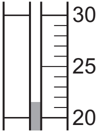
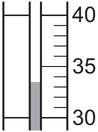
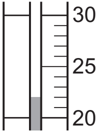
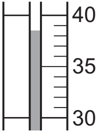
- Repeat Experiment 2, using 10.0 cm^3 of dilute sulfuric acid instead of 25.0 cm^3.

(a) Use the thermometer diagrams to complete Table 2.1.

Table 2.1

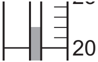
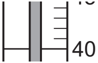
experiment	volume of dilute sulfuric acid / cm^3	thermometer diagram for initial temperature / °C	initial temperature / °C	thermometer diagram for temperature after 1 minute / °C	temperature after 1 minute / °C	temperature increase / °C
1	30.0					

Question 2

2	25.0					
3	20.0					
4	15.0					
						

Question 2

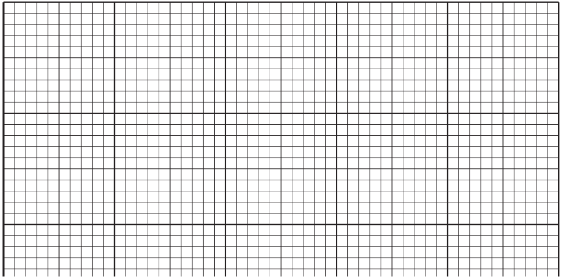
Question 2

[illegible]	[illegible]					

[4]

(b) On Fig. 2.1, complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5. Draw a line of best fit.

temperature



Question 2

increase / °C

Question 2

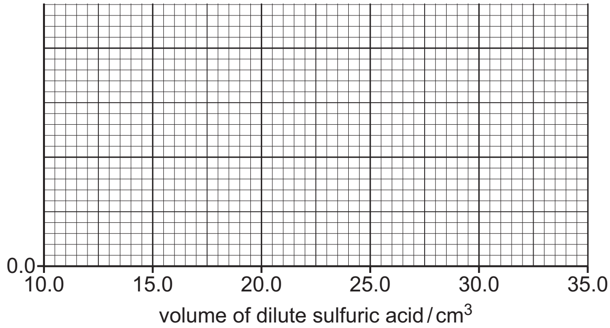


Fig. 2.1

[4]

(c) Explain why the temperature increase changes as the volume of dilute sulfuric acid changes.

Question 2

(c) Explain why the temperature increase changes as the volume of dilute sulfuric acid changes.

Question 2

(d) Extrapolate the line of best fit on your graph in Fig. 2.1 to deduce the temperature increase if 33.0 cm^3 of dilute sulfuric acid is used.

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

Question 2

(e) The investigation is repeated using 2.5 cm lengths of coiled magnesium ribbon instead of 5 cm lengths.

On Fig. 2.1, sketch a line to show the results you would expect. Label this line **E**. [1]

(f) **(i)** Give **one** reason why a burette, rather than a measuring cylinder, is used to measure the volume of the dilute sulfuric acid.

Question 2

(ii) Explain why the contents of the boiling tube are stirred during each experiment.

Question 2

(g) Describe **one** change to the apparatus that will give more accurate results.

Explain your answer.

Question 2

Question 2

Question 2

Question 2

[2]

[Total: 18]

Solution 2

(a) Mark scheme

- M1 all initial temperatures correct
- (21.0, 21.5, 21.5, 22.0, 22.0) M2
- all readings for temperature after one minute correct
- (29.0, 36.5, 33.5, 38.5, 46.0) M3
- temperature changes correct
- (8.0, 15.0, 12.0, 16.5, 24.0) M4
- all temperatures and temperature changes recorded to 1 decimal place
- 4

Solution 2

(b)

Mark scheme

- M1 y-axis scale is linear, and points extend above halfway up the scale **M2**
- and M3 all points plotted correctly **M4**
- best fit curve correctly drawn
- 4

Solution 2

(c)

Mark scheme

- M1 the larger the volume of acid, the lower the temperature (increase/change) **M2**
- same amount of heat energy given out (as same length of magnesium and acid is in excess)
- 2

Solution 2

(d)

Mark scheme

- M1 extrapolation shown on graph, this must be a smooth continuation of line M2
- correct reading from their working shown on graph M3
- oC
- 3

Solution 2

(e)

Mark scheme

- sketched line is below plotted line for all volumes of acid and does not drop to or below zero
- 1

Solution 2

(f)(i)

Mark scheme

- (burette is more) accurate (than a measuring cylinder)
- 1

(f)(ii)

Mark scheme

- to mix them / to evenly distribute acid/heat energy
- 1

Solution 2

(g)

Mark scheme

- M1 change: insulate the boiling tube M2
- explanation: reduce/no heat loss
- 2
- 0620/63
- October/November 2025

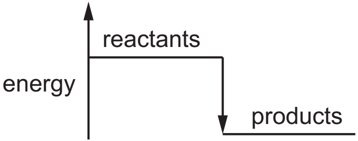
Question 13

0620/21 J25 ▪ Q13 ▪ 1 mark

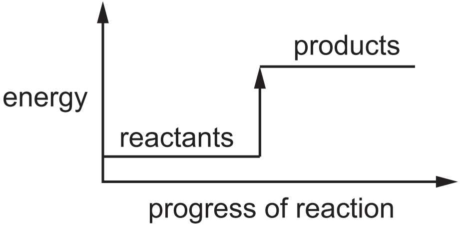
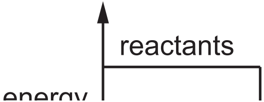
13 Water is added to anhydrous copper(II) sulfate in a test-tube.

The mixture becomes hot.

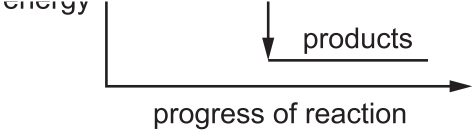
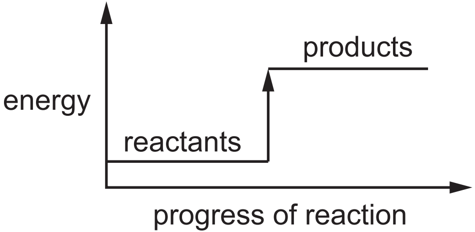
Which type of reaction and reaction pathway diagram apply to this reaction?

	type of reaction	reaction pathway diagram
A	endothermic	

Question 13

		
B	endothermic	
		

Question 13

C	exothermic	
D	exothermic	

Solution 13

Answer: **C**

Why

- The mixture gets hot, so energy is released – the reaction is exothermic.
- On a reaction pathway diagram the products must therefore sit *below* the reactants.
- ΔH is negative.

Question 14

0620/22 J25 ▪ Q14 ▪ 1 mark

14 The average bond energy for the C–H bond is 413 kJ / mol.

What is the enthalpy change when 1.0 mol of methane molecules is formed from carbon and hydrogen atoms?

A –1652 kJ **B** –413 kJ **C** +413 kJ **D** +1652 kJ

Solution 14

Answer: **A**

Why

- Forming a bond *releases* energy, so the enthalpy change must be negative.
- Methane contains four C–H bonds.
- $4 \times 413 = 1652$, so $\Delta H = -1652$ kJ.

Question 13

0620/23 J25 ▪ Q13 ▪ 1 mark

13 Which row describes an exothermic reaction?

	sign of enthalpy change, ΔH	temperature of the surroundings
A	positive	decreases
B	positive	increases

Question 13

C	negative	decreases
D	negative	increases

Solution 13

Answer: **D**

Why

- Exothermic means energy is given out to the surroundings.
- So the surroundings get warmer.
- Energy leaving the reacting system makes ΔH negative.

Question 17

0620/22 M25 ▪ Q17 ▪ 1 mark

17 The equation for the complete combustion of methane is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

The table shows some bond energies.

bond	bond energy in kJ / mol
C–H	410
C=O	805

Question 17

O=O	496
O–H	460

What is the enthalpy change for this reaction?

A –1458 kJ / mol

B –818 kJ / mol

C –359 kJ / mol

D +102 kJ / mol

Solution 17

Answer: **B**

Why

- Bonds broken: $4\times$ C–H $+2\times$ O=O $= 1640 + 992 = 2632$ kJ.
- Bonds formed: $2\times$ C=O $+4\times$ O–H $= 1610 + 1840 = 3450$ kJ.
- $\Delta H = 2632 - 3450 = -818$ kJ/mol – negative, because more is released than absorbed.