

1. Which of the compounds shown are in the same homologous series?

- 1 ✓ CH<sub>3</sub>OH
- 2 ✓ CH<sub>3</sub>CH<sub>2</sub>OH
- 3 CH<sub>3</sub>COOH
- 4 ✓ CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH

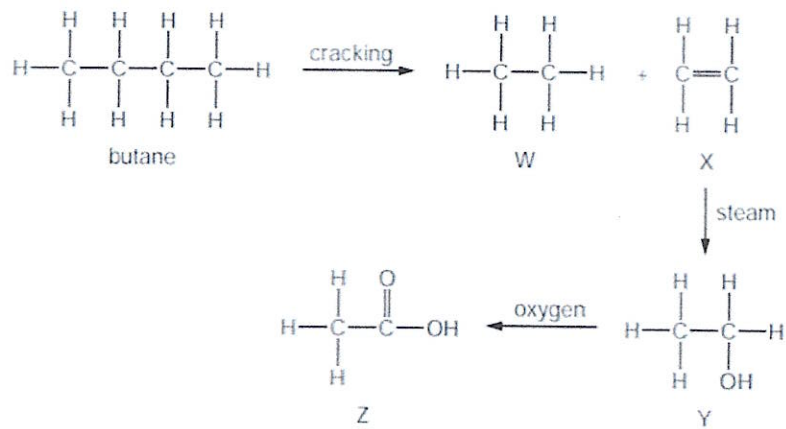
A. 1, 2 and 3

**B. 1, 2 and 4**

C. 1, 3 and 4

D. 2, 3 and 4

2. What are the names of the compounds shown in the reaction scheme below?

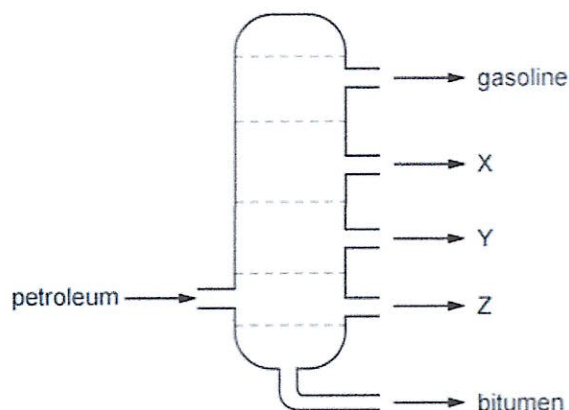


	W	X	Y	Z
<b>A</b>	ethane ✓	ethene ✓	ethanol ✓	ethanoic acid ✓
<b>B</b>	ethane ✓	ethene ✓	ethanoic acid	ethanol
<b>C</b>	ethene	ethane	ethanol	ethanoic acid
<b>D</b>	ethene	ethane	ethanoic acid	ethanol

3. Which statement about alkane molecules is correct?

- A. They burn in oxygen.**
- B. They contain carbon, hydrogen and oxygen atoms.
- C. They contain double bonds.
- D. They contain ionic bonds.

4. The diagram shows the separation of petroleum into fractions.



What could X, Y and Z represent?

	X	Y	Z
A	diesel oil	lubricating fraction	paraffin
B	lubricating fraction	diesel oil	paraffin
C	paraffin	lubricating fraction	diesel oil
D	paraffin ✓	diesel oil ✓	lubricating fraction ✓

5. Which reaction is used as a test for alkenes?

A. Alkenes burn in air to give carbon dioxide and water.

**B.** Alkenes decolourise aqueous bromine.

C. Alkenes form polymers when heated in the presence of a catalyst.

D. Alkenes react with steam to form alcohols.

6. Which term describes the formation of ethanol from glucose?

A. cracking

B. distillation

**C.** fermentation

D. polymerisation

11. Some chemical properties of three metals W, X and Y and their oxides are shown.

metal	reaction with steam	reaction with dilute hydrochloric acid	reaction of metal oxide with carbon
W	reacts	reacts	reacts
X	no reaction	no reaction	reacts
Y	reacts	reacts	no reaction

What is the order of reactivity of these metals, most reactive first?

A.  $W \rightarrow Y \rightarrow X$

B.  $X \rightarrow Y \rightarrow W$

C.  $Y \rightarrow W \rightarrow X$

D.  $Y \rightarrow X \rightarrow W$

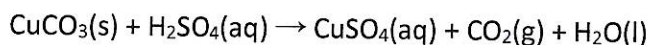
12. Which statements are properties of an acid?

1 reacts with ammonium sulfate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	x
C	x	✓
D	x	x

13. Copper carbonate reacts with dilute sulfuric acid to make copper sulfate.



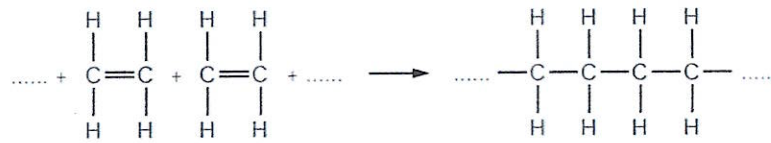
Which row gives the correct order of steps for making copper sulfate crystals?

	step 1	step 2	step 3	step 4
A	add excess acid to the copper carbonate	filter	evaporate filtrate to point of crystallisation	leave to cool
B	add excess acid to the copper carbonate	filter	evaporate to dryness	leave to cool
C	add excess copper carbonate to the acid	evaporate to point of crystallisation	leave to cool	filter
D	add excess copper carbonate to the acid	filter	evaporate filtrate to point of crystallisation	leave to cool

7. Which row correctly describes the production of ethanol and its properties?

	can be made from glucose	can be made from ethene	is used as a fuel	is used as a solvent
<b>A</b>	✓	✓	✓	✓
<b>B</b>	✓	x	✓	✓
<b>C</b>	x	✓	✓	x
<b>D</b>	x	✓	x	✓

8. Ethene forms an addition polymer as shown.



Which terms describe this polymer?

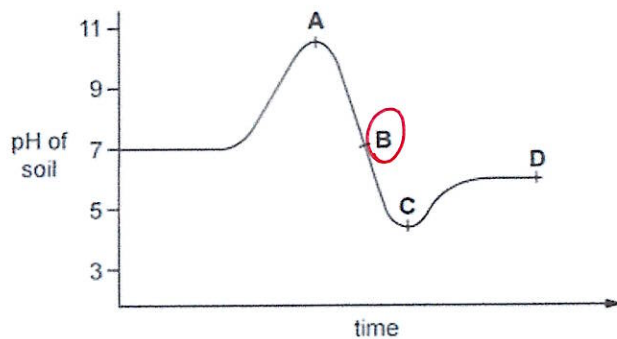
- A. a saturated compound called poly(ethane)
  - B. a saturated compound called poly(ethene)**
  - C. an unsaturated compound called poly(ethane)
  - D. an unsaturated compound called poly(ethene)
9. Iron is extracted from its ore (hematite) in the blast furnace.

Which gas is produced as a waste product?

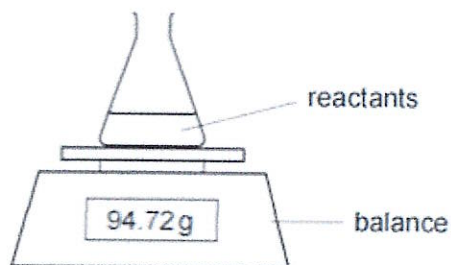
- A. carbon dioxide**
- B. hydrogen
- C. nitrogen
- D. oxygen

10. The graph shows how the pH of soil in a field changes over time.

At which point was the soil neutral?



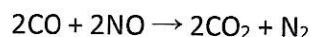
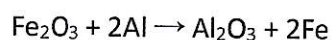
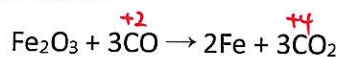
16. The rates of some chemical reactions can be measured by using the apparatus shown.



For which reaction is this apparatus suitable?

- A.  $\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$
- B.  $\text{Mg} + \text{ZnCl}_2 \rightarrow \text{MgCl}_2 + \text{Zn}$
- C.  $\text{MgCl}_2 + 2\text{NaOH} \rightarrow \text{Mg(OH)}_2 + 2\text{NaCl}$
- D.  $\text{MgO} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O}$

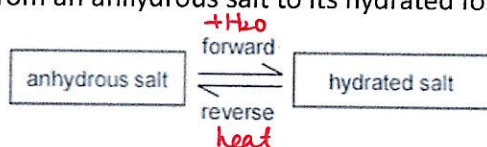
17. The equations below all show redox reactions.



Which oxide is oxidised in these reactions?

- A.  $\text{Fe}_2\text{O}_3$
- B.  $\text{CO}$
- C.  $\text{ZnO}$
- D.  $\text{NO}$

18. The diagram shows the change from an anhydrous salt to its hydrated form.



Which statement is correct?

- A. forward reaction requires heat and water
- B. forward reaction requires water only
- C. reverse reaction requires heat and water
- D. reverse reaction requires water only

14. An aqueous solution of copper(II) sulfate was made by adding excess copper(II) oxide to dilute sulfuric acid. The mixture was heated, stirred and then filtered.

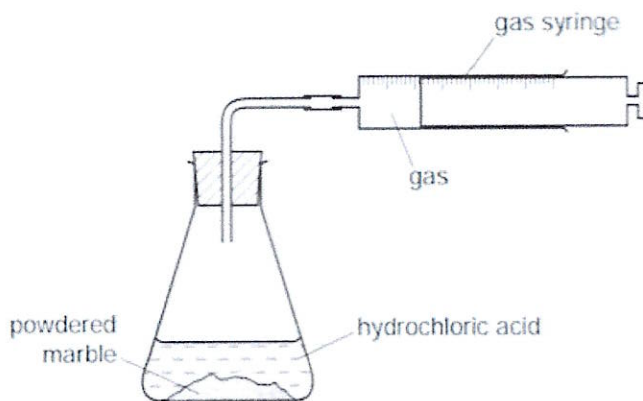


What was the pH of the acid before adding the copper(II) oxide and of the solution after filtration?

	pH of acid before adding copper(II) oxide	pH of solution after filtration
A	greater than 7	<u>7</u>
B	greater than 7	less than 7
<b>C</b>	less than 7	<u>7</u>
D	less than 7	greater than 7

15. Powdered marble reacts with hydrochloric acid using the apparatus shown.

The gas syringe fills in 36 seconds.

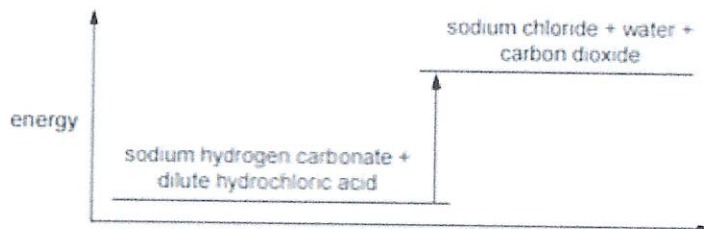


The experiment is repeated using marble chips in place of powdered marble.

How long does it take to fill the gas syringe in this experiment?

- A. 9 seconds
- B. 18 seconds
- C. 36 seconds
- D. 72 seconds**

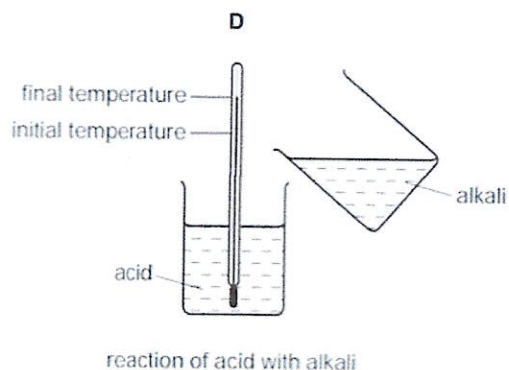
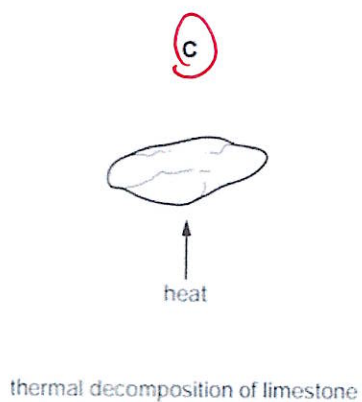
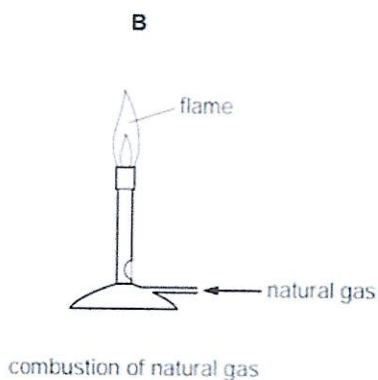
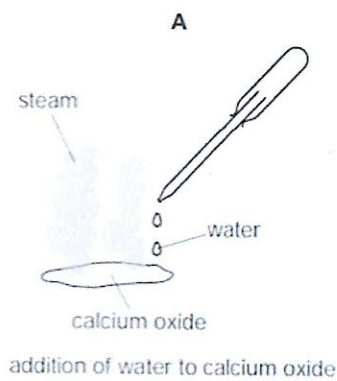
19. The energy level diagram for the reaction between sodium hydrogen carbonate and dilute hydrochloric acid is shown.



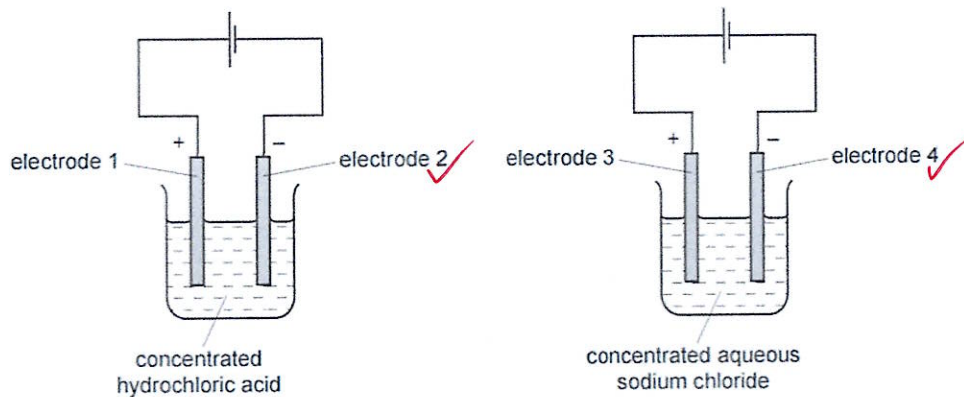
Which row correctly describes the type of reaction and the energy of the reactants and products?

	type of reaction	energy of the reactants and products
<b>A</b>	endothermic ✓	the products have more energy than the reactants ✓
<b>B</b>	endothermic ✓	the reactants have more energy than the products
<b>C</b>	exothermic	the products have more energy than the reactants
<b>D</b>	exothermic	the reactants have more energy than the products

20. The diagrams show four chemical reactions. Which reaction is endothermic?



21. The diagram shows the electrolysis of concentrated hydrochloric acid and concentrated aqueous sodium chloride using carbon electrodes.



At which electrode(s) is hydrogen produced?

- A. electrode 1 only
- B. electrodes 1 and 3
- C. electrode 2 only
- D. electrodes 2 and 4



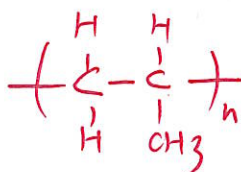
22. A South Korean chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

(a) (i) Give the structural formula of the monomer.



[1]

(ii) Draw the structural formula of the polymer.



[2]

(iii) Suggest which one, monomer or polymer, will react with aqueous bromine and why?

monomer  
it contains "C=C".

[2]

(b) The unpleasant smell is caused by carboxylic acids. Bacteria cause the fats on the skin to be hydrolysed to these acids. Silver kills the bacteria and prevents the hydrolysis of the fats.

(i) Fats are esters. Give the name and structural formula of an ester.

name ..... methyl ethanoate .....

[1]

structural formula



[1]

(ii) Complete the word equation.

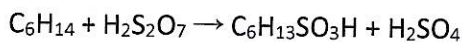
Ester + water → carboxylic acid + alcohol .....

[1]



24. Sulfuric acid is a strong acid. Hexanesulfonic acid is also a strong acid. It has similar properties to sulfuric acid.

(a) Sulfonic acids are made from alkanes and oleum,  $H_2S_2O_7$ .



(i) Describe how oleum is made from sulfur by the Contact process. Give equations and reaction conditions.



Catalyst:  $V_2O_5$

temp:  $\sim 450^\circ C$

High pressure:  $\sim 2 \text{ atm}$

dissolve  $SO_3$  in  $H_2SO_4 \rightarrow H_2S_2O_7$

(ii) How is concentrated sulfuric acid made from oleum? [6]



(b) The formula of the hexanesulfonate ion is  $C_6H_{13}SO_3^-$ . [1]

The formula of the barium ion is  $Ba^{2+}$ . What is the formula of barium hexanesulfonate?



(c) Complete the following equations. [1]

(i) magnesium + hexanesulfonic acid  $\rightarrow$  magnesium hexanesulfonate + hydrogen gas [1]

(ii) calcium oxide + hexanesulfonic acid  $\rightarrow$  calcium hexanesulfonate + water [1]

(iii)  $2C_6H_{13}SO_3H + Na_2CO_3 \rightarrow 2NaC_6H_{13}SO_3 + H_2O + CO_2$  [2]

(d) Sulfuric acid is a strong acid.

(i) You are given aqueous sulfuric acid, concentration  $0.1 \text{ mol/dm}^3$ , and aqueous hexanesulfonic acid, concentration  $0.2 \text{ mol/dm}^3$ . Describe how you could show that hexanesulfonic acid is also a strong acid.

an extremely low pH value  
universal indicator is red.  
same pH value as  $\text{H}_2\text{SO}_4$

[2]

(ii) Deduce why, for a fair comparison, the two acid solutions must have different concentrations.

$\text{H}_2\text{SO}_4$  can produce two  $\text{H}^+$

hexanesulfonic acid can produce one  $\text{H}^+$  only.

[1]

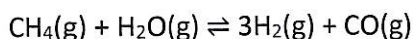
(iii) Explain the terms strong acid and weak acid.

completely dissociate      partially dissociate

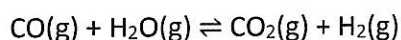
[2]

25. At present the most important method of manufacturing hydrogen is steam reforming of methane.

In the first stage of the process, methane reacts with steam at  $800^\circ\text{C}$ .



In the second stage of the process, carbon monoxide reacts with steam at  $200^\circ\text{C}$ .



(a) Explain why the position of equilibrium in the first reaction is affected by pressure but the position of equilibrium in the second reaction is not.

first reaction: different moles of reactants & products  
second reaction: moles of reactants & products are same.

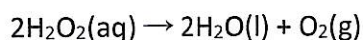
[2]

(b) Suggest why a high temperature is needed in the first reaction to get a high yield of products but in the second reaction a high yield is obtained at a low temperature.

first: endothermic  $\rightarrow$  forward reaction.  
second: exothermic  $\rightarrow$  forward reaction.

[2]

26. The decomposition of hydrogen peroxide is catalysed by manganese(IV) oxide.



To 50 cm<sup>3</sup> of aqueous hydrogen peroxide, 0.50 g of manganese(IV) oxide was added. The volume of oxygen formed was measured every 20 seconds. The average reaction rate was calculated for each 20 second interval.

time / s	0	20	40	60	80	100
volume of oxygen / cm <sup>3</sup>	0	48	70	82	88	88
average reaction rate in cm <sup>3</sup> /s	2.4	1.1	...0.6...	0.3	0.0	0.0

$\frac{82-70}{20} = 0.6$

(a) Explain how the average reaction rate, 2.4 cm<sup>3</sup>/s, was calculated for the first 20 seconds.

$$\frac{48-0}{20-0} = 2.4 \text{ cm}^3/\text{s}$$

(b) Complete the table.

[2]

(c) Explain why the average reaction rate decreases with time.

[1]

concentration of H<sub>2</sub>O<sub>2</sub> ↓  
less collision frequency in unit time.

[2]

(d) The experiment was repeated but 1.0 g of manganese(IV) oxide was added.

What effect, if any, would this have on the reaction rate and on the final volume of oxygen? Give a reason for each answer.

effect on rate increase

[1]

reason more catalyst increases surface area for collision.

[2]

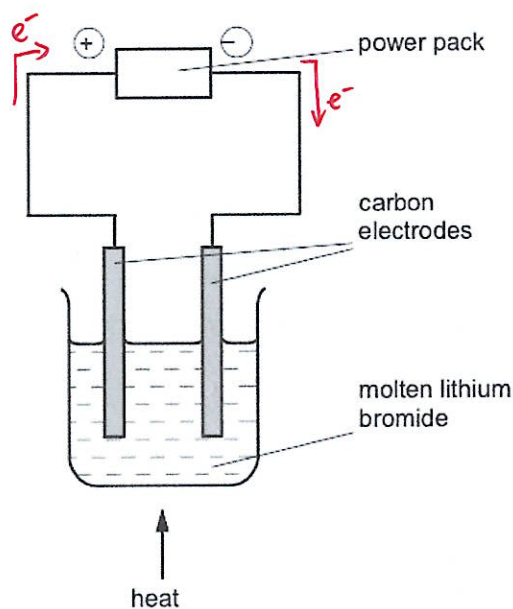
effect on final volume of oxygen no effect

[1]

reason catalyst just speed up reaction, and do not participate in the reaction finally.  
it is not reactant.

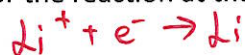
[2]

27. The diagram shows the electrolysis of molten lithium bromide.



(a) Mark on the diagram the direction of the electron flow. [1]

(b) Write an ionic equation for the reaction at the negative electrode (cathode). [1]



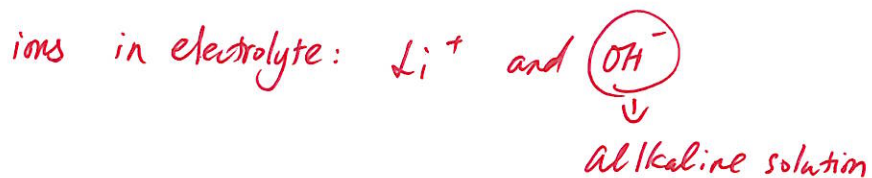
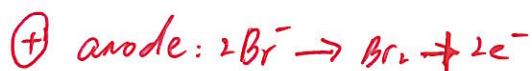
(c) Write an ionic equation for the reaction at the positive electrode (anode). [1]



(d) Which ion is oxidised? Explain your answer. [2]



(e) When aqueous lithium bromide is electrolysed, a colourless gas is formed at the negative electrode and the solution becomes alkaline. Explain these observations and include an equation in your explanation. [3]



28. The alkenes are a series of unsaturated hydrocarbons. They have the general molecular formula  $C_nH_{2n}$ .

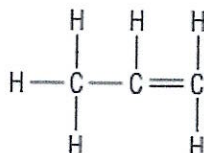
(a) Deduce the molecular formula of an alkene which has a relative molecular mass of 126. Show your working.

method 1:  $CH_2 \Rightarrow 14$   
 $126/14 = 9$   
 $C_9H_{18}$

method 2:  $C_nH_{2n}$   
 $12n + 2n = 126$   
 $n = 9$   
 $C_9H_{18}$

[2]

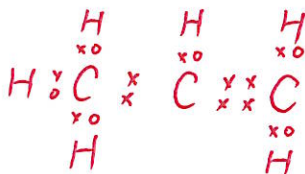
(b) The structural formula of propene is drawn below.



(i) Draw a diagram showing the arrangement of the valency electrons in one molecule of this covalent compound.

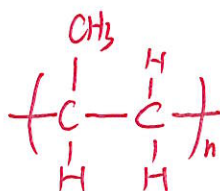
Use x to represent an electron from an atom of carbon.

Use o to represent an electron from an atom of hydrogen.



[3]

(ii) Draw the structure of the polymer formed from propene.

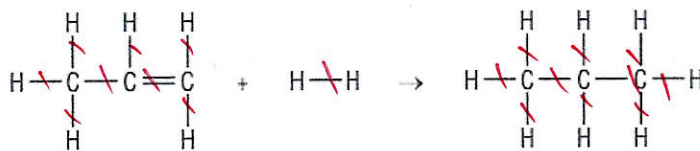


[2]

(iii) Bond energy is the amount of energy, in kJ, which must be supplied to break one mole of the bond.

bond	bond energy in kJ/mol
H—H	+436
C=C	+610
C—C	+346
C—H	+415

Use the data in the table to show that the following reaction is exothermic.



$$\text{Bond energy (Reactants)} = 6 \times (\text{C-H}) + (\text{C-C}) + (\text{C=C}) + (\text{H-H}) \\ = 6 \times 415 + 346 + 610 + 436 = 3882$$

$$\text{Bond energy (Products)} = 8 \times (\text{C-H}) + 2 \times (\text{C-C}) \\ = 8 \times 415 + 2 \times 346 = 4012$$

$$\Delta H = 3882 - 4012 = -130 \text{ kJ mol}^{-1}$$

[3]

29. A student investigated the temperature change when zinc reacted with two different aqueous solutions of copper(II) sulfate, solution Q and solution R.

(a) Experiment 1

- A polystyrene cup was placed in a 250 cm<sup>3</sup> beaker for support.
- Using a measuring cylinder, 25 cm<sup>3</sup> of solution Q was poured into the polystyrene cup.
- Using a thermometer, the initial temperature of solution Q was measured.
- 3 g of zinc powder was added to the polystyrene cup. At the same time a stop-clock was started.
- Using the thermometer, the mixture in the polystyrene cup was continually stirred and the temperature measured every 30 seconds.

initial temperature in Experiment 1	23 °C
-------------------------------------	-------

Use the thermometer diagrams and the initial temperature to complete the table.  
Calculate the temperature changes using the equation:

$$\text{temperature change} = \text{temperature} - \text{initial temperature}$$

time / s	30	60	90	120	150	180	210	240
thermometer diagram								
temperature / °C	43.0	49.0	51.0	52.0	51.0	49.5	48.0	46.5
temperature change / °C	10.0	26.0	28.0	29.0	28.0	26.5	25.0	23.5

[3]



(b) Experiment 2

- The polystyrene cup was washed out with distilled water.
- Experiment 1 was repeated using solution R instead of solution Q.

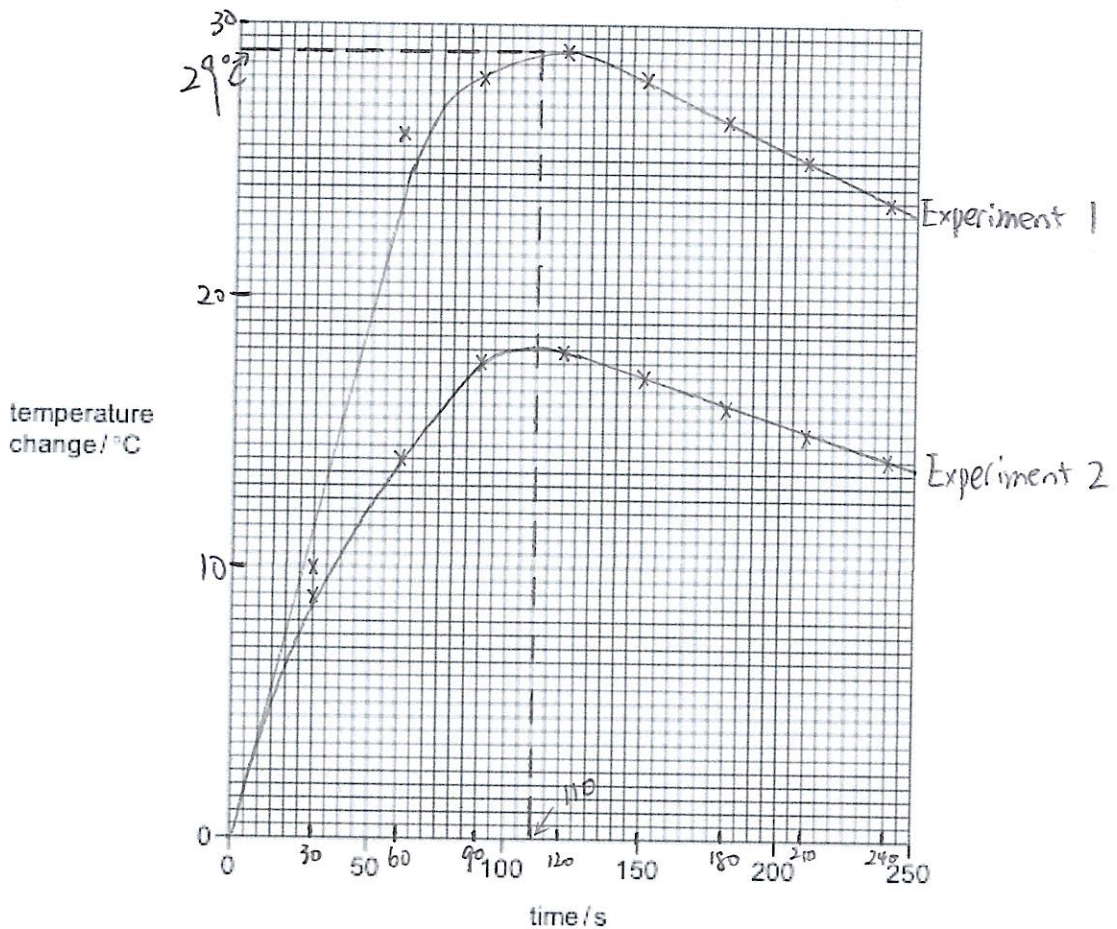
initial temperature in Experiment 2	24 °C
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Use the thermometer diagrams and the initial temperature to complete the table.

time / s	30	60	90	120	150	180	210	240
thermometer diagram								
temperature / °C	33.0	38.0	41.5	42.0	41.0	40.0	39.0	38.0
temperature change / °C	9.0	14.0	17.5	18.0	17.0	16.0	15.0	14.0

[3]

- (c) Complete a suitable scale on the y-axis and plot the results from Experiment 1 and Experiment 2 on the grid. Draw two curves of best fit. Both curves must start at (0,0). Label your curves.



[5]

(d) From your graph, deduce the temperature change at 110 seconds in Experiment 1. Show clearly on the grid how you worked out your answer.

.....29.0..... °C [2]

(e) Predict the temperature of the solution in Experiment 2 after 5 hours. Explain your answer.

24°C      reaction is complete, and no more heat will be released. The temp will drop to room temp [2]

(f) (i) Suggest why the experiments were done in a polystyrene cup rather than a glass beaker.

insulator  
to prevent the heat loss to the surroundings. [1]

(ii) Describe how the results would be different if a glass beaker is used in place of the polystyrene cup.

temp change will be lower. [1]

(g) Suggest one change that could be made to the apparatus that would improve the accuracy of the results. Explain why this change would improve the accuracy of the results.

Change use pipette.

explanation more accurate than a measuring cylinder | use a lid to reduce the heat loss

[2]