

# MARK SCHEME

# GCSE

## CHEMISTRY

## AQA - COMBINED SCIENCE

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C5 - TEST 6

ENERGY CHANGES

Advanced

## Mark schemes

1.

- (a) (i) energy / heat of products less than energy of reactants

*allow converse*

*allow products are lower than reactants*

*allow more energy / heat given out than taken in*

*allow methanol is lower*

*allow energy / heat is given out / lost*

*allow  $\Delta H$  is negative*

1

- (ii) lowers / less activation energy

*allow lowers energy needed for reaction*

*or it lowers the peak/ maximum*

*do **not** allow just 'lowers the energy'*

1

- (b) (i)  $(8 \times 435) + 497 = 3977$

*accept: bonds broken:  $(2 \times 435) + 497 = 1367$*

1

$$(6 \times 435) + (2 \times 336) + (2 \times 464) = 4210$$

*bonds made:  $(2 \times 336) + (2 \times 464) = 1600$*

1

$$3977 - 4210 = (-) 233$$

*energy change:*

$$1367 - 1600 = (-) 233$$

*ignore sign*

*allow ecf*

*correct answer (233) = 3 marks with or without working*

1

- (ii) energy released forming (new) bonds is greater than energy needed to break (existing) bonds

*allow converse*

*do **not** accept energy needed to form (new) bonds greater than energy needed to break (existing) bonds*

1

[6]

2.

- (i)  $436 + 242 = 678$  (kJ) [1]

$$2 \times 431 = 862$$
 (kJ) [1]

answer = 184

*first **two** marks can be awarded if answer is incorrect  
ignore sign*

3

- (ii) exothermic 1
- more energy released by, bond formation than needed for bond breaking  
*both parts to be marked depending on answers given in (b)(i)* 1
- (iii) hydrogen chloride is (a) covalent (compound) 1
- when added to water it forms ions **or** H<sup>+</sup> (and Cl<sup>-</sup>) 1
- hydrogen ions **or** H<sup>+</sup> causes a solution to be acidic 1

**[8]**

**3.**

- (a) products are at a lower energy level than reactants  
*if candidate has drawn a profile for an endothermic reaction  
 penalise first marking point only* 1
- activation energy correctly drawn and labelled 1
- ΔH correctly labelled 1
- (b) (i) -93 (kJ per mole) 3
- correct answer with or without working gains 3 marks  
 allow 2 marks for +93 kJ per mole  
 if any other answer is seen award up to 2 marks for any two of the  
 steps below:  
 bonds broken (614 + 193) = 807 (kJ) or (614 + 193 + (4 × 413)) =  
 2459(kJ)  
 bonds formed (348 + 276 + 276) = 900(kJ) or 348 + (2 × 276) + (4 ×  
 413) = 2552(kJ)  
 bonds broken – bonds formed  
 allow ecf for arithmetical errors*
- (ii) more energy is released when the bonds (in the products) are formed 1
- than is needed to break the bonds (in the reactants)  
*if no other marks gained, allow 1 mark for energy released for bond  
 making **and** energy used for bond breaking* 1

**[8]**

**4.**

- (a) CH<sub>4</sub> + 2O<sub>2</sub> → CO<sub>2</sub> + 2H<sub>2</sub>O 1
- allow multiples*

(b) 3444 J

*if answer incorrect:*

*one mark for temperature increase = 16.4 °C*

*one mark for mass of water = 50 g*

*ecf for one incorrect value gains two marks for correct calculation*

*no ecf for two incorrect values*

3

(c) (i) 1276 (kJ per mole)

*ignore + or -*

*if answer incorrect:*

$[(5 \times 413) + 347 + 358 + 467] + [(3 \times 495)] = 4722$  (1 mark)

$[(4 \times 799) + (6 \times 467)] = 5998$  (1 mark)

*correct subtraction of calculated energy values (1 mark)*

3

(ii) because energy released when bonds form is greater than energy used when bonds broken

*allow converse*

*if no mark awarded allow one mark for energy is used to break bonds*

*or*

*one mark for energy is released when bonds form*

2

(iii) products line lower than reactants

1

activation energy labelled

1

overall energy change labelled

1

[12]

5.

(a) (i) any **one** from:

- incorrect measurement of temperature or volume
- incorrect recording of temperature
- failure to stir
- heat loss

*ignore faulty equipment*

1

(ii) 32 - 33

1

(iii) 55

1

(iv) 20

1

(v) 4620

allow 4.62 kJ for **2 marks**

1

J / joules

allow kJ if evidence of dividing by 1000

mark independently, but if a numerical answer has been divided by 1000 must be kJ.

allow ecf from their answers to (iii) and (iv)

1

(b) twice as much energy released

1

but twice as much water to heat

allow more energy released but more water to heat for **2 marks**

if no other mark awarded, allow twice the amount of hydrochloric acid used for **1 mark**

1

[8]

6.

exothermic does **not** gain any credit

1

reactants: bond breaking (436 + 242 =) 678 (kJ)

1

products: bond making (2 × 431 =) 862(kJ)

so overall 184 (kJ) released / -184(kJ)

1

[3]

7.

<u>Bonds broken</u>		<u>Bonds formed</u>	
number	type	number	type
3	[O=O]	4	[O-H]

each for 1 mark

2

(b) Total energy change in breaking bonds  
3 × 498 = 1494

Total energy change in forming bonds  
4 × 464 = 1856

each for 1 mark

Total = 3758

Total = 5076

each for 1 mark

4

- (c) net energy transfer = 1318  
this energy is released in the reaction/it is an exothermic reaction  
*each for 1 mark*

[N.B. credit e.c.f. (a) → (b) and (b) → (c)]

2

[8]

8.

- (a) (i) endothermic  
*could be answered by indicating the correct word in the box*

1

- (ii) final temperatures got lower **or** temperature went down  
*ignore comments on energy*

1

- (b) polystyrene / plastic cup **or** description of insulation / lagging container  
*ignore references to a lid*

1

because (polystyrene) is an insulator **or** prevents heat / energy gain (and so temperature is more accurate)

*allow references to heat loss **or** glass conducts / absorbs heat*

1

- (c) **variable:** volume **or** mass **or** amount of water  
*1 mark for variable and 1 mark for reason linked to that variable  
maximum of 4 marks for two variables and two explanations*

**reason:** the greater the volume / mass of water, the more heat energy it contains **or** the smaller the temperature change will be

*do **not** allow 'time taken to heat'*

**variable:** start temperature **or** temperature of water

**reason:** the higher the start temperature, the more heat energy it contains **or** the higher the final temperature will be

*do **not** allow higher temperature change*

**variable:** the time at which the temperature is measured

**reason:** if left longer may gain heat energy from surroundings **or** warm up **or** if measured too soon not all ammonium chloride will have dissolved so less temperature change

**variable:** rate of dissolution **or** speed of dissolving **or** amount of stirring

**reason:** if it dissolves faster **or** is stirred faster then it will cool more quickly **or** small particles dissolve faster

max. 4

- (d) (i) all 7 points correct  
*at least 4 points plotted correctly scores 1 mark* 2
- (ii) straight line through first 3 or 4 points  
*lines must be drawn with a ruler* 1
- straight line through last three points  
*if no other marks awarded allow curve joining lines for 1 mark* 1
- (iii) valid extrapolation of line back to mass of 0 g 1
- correct value read from graph  
*award 1 mark for 20 – 21 if no extrapolation shown* 1
- (e) not all of the ammonium chloride would dissolve  
*allow water limiting factor or all water used* 1
- so no more heat would be absorbed
- or**
- the solution is saturated (1)  
*allow water limiting factor or all water used*
- so some ammonium chloride remains solid **or** not all will dissolve (1) 1
- (f) greater volume of water was used **or** volume was twice as large  
*allow different volume of water* 1
- so temperature decrease was less than the first student's result  
*allow so final temperature was higher*
- or**
- starting temperature / room temperature was higher (1)
- so final temperature was greater than the first student's result (1)  
*accept by 6 °C or was any value in range 26 – 27°C* 1

[18]