

Mark schemes

1	(a) gives out heat / energy		
	<i>allow more energy given out in making bonds than is used in breaking bonds</i>		
	or		
	energy / heat transferred to surroundings		
	<i>ignore light</i>		1
	(b) activation		
	<i>allow phonetic spelling</i>		1
	(c) (i) 2 crosses on inner circle and		
	8 crosses on outer circle		
	<i>accepts dots / e / – for electrons</i>		1
	(ii) opposite charges (attract)		
	<i>allow electrostatic forces (attract)</i>		
	<i>do not accept intermolecular attraction / shared electrons</i>		1
			[4]
2	(a) goes up		1
	(b) (i) B		1
	(ii) A		1
	(iii) a catalyst		1
	activation energy		1

- (c) (i) eg (ensures) complete reaction
allow spread heat / energy

or even heating

allow mixes properly or mix them together or to get correct temperature

ignore dissolves

1

- (ii) lid (on beaker)
accept cover beaker

or

insulate (beaker) / use a plastic cup

1

[7]

3

- (a) energy released from making (new) bonds is greater than the energy needed to break (existing) bonds

accept the energy needed to break (existing) bonds is less than the energy released in making (new) bonds

*do **not** accept energy needed to make bonds*

1

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

accept products are lower than reactants

or reactants higher than products

accept more energy / heat given out than taken in

or less energy / heat taken in than given out

accept energy / heat is given out / lost (to the surroundings)

allow produce heat

ignore produce energy

accept ΔH is negative

or energy change / **A** is negative

or B is less than C

1

- (ii) **B** is (very) high / large

*it = **B***

*ignore energy change **C** is high*

1

(iii) $it = MnO_2$

(MnO_2) catalyst (is added)

accept it is a catalyst

or reaction catalysed (by MnO_2)

*do **not** accept MgO / magnesium oxide*

1

which lowers activation energy

accept provides alternative / lower energy pathway

or which lowers (energy change) **B**

if hydrogen peroxide is given as a catalyst instead of MnO_2 penalise once only in question

1

(c) any **two** from:

- (chemicals) not mixed / stirred
- heat / energy lost (from apparatus)
- (apparatus) not insulated **or** no lid
- low amount / mass / not enough MnO_2 **or** low concentration H_2O_2
- thermometer read incorrectly
ignore other experimental error

2

[7]

4

(a) (i) 48

1

(ii) 3

1

(b) heat / energy

1

given out / transfers to surroundings

the mark for given out / transfers to cannot be awarded without heat / energy

allow given off

1

(c) it has a low boiling point

1

it is made of small molecules

1

[6]**5**

- (a) electricity / (high) temperatures
allow lightning / heat
ignore energy

1

- (b) nitrogen + oxygen → nitrogen oxide/ monoxide
allow any oxide of nitrogen

1

- (c) more than

1

- (d) (i) A

1

- (ii) C

1

[5]**6**

- (a) energy of product greater than energy of reactants
allow converse
allow energy = heat
*do **not** accept temperature for energy*
allow product / nitrogen oxide is higher than reactants
allow less energy / heat given out than taken in
allow energy / heat is taken in / gained
allow ΔH is positive

1

- (b) (minimum) energy needed to start the reaction / overcome energy barrier
accept (minimum) energy needed for a collision to be successful

1

- (c) (i) *correct answer with or without working= 3 marks*

$$\text{bonds broken} = 945 + 498 = 1443 \text{ (kJ)}$$

1

$$\text{bonds made} = 2 \times 630 = 1260 \text{ (kJ)}$$

1

energy change = 1443 - 1260 = (+) 183

ignore sign

allow ecf

1

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

allow converse

accept energy change (ΔH) is + / positive

*do **not** accept energy needed to form new bonds is less than energy needed to break existing bonds*

1

[6]

7

- (a) (i) (different) properties

allow ideas of different property / behaviour / element

1

- (ii) any **one** from:

they = Crawford + Cruikshank

- they had high status

or

they were lecturers / doctors / professors / famous scientists

- other scientists repeated experiments

allow experiment could be repeated

allow other scientists showed they had different properties

- they had proof

or

lots of / strong / conclusive / enough / clear evidence

ignore evidence unqualified

1

- (iii) other scientists obtained similar results / proved it

or

experiments were repeated

1

- (b) (i) any **one** from:
- mass of solid / strontium (chloride) / barium (chloride)
allow amount / volume
 - volume of water
allow amount / mass
 - type of container
allow initial / starting temperature (of water)
ignore room temperature / time / concentration
ignore reference to hydrochloric acid
- 1
- (ii) 2 **and** takes in heat / energy
- or**
- 2 **and** temperature goes down (owtte)
- 1
- (iii) temperature increased for one experiment and decreased for the other (owtte)
- or**
- one was exothermic and one was endothermic (owtte)
accept experiment 1 was exothermic
- 1
- (c) any **one** from
- positive / + (charge)
do not accept incorrect further qualification eg electrons / atoms / electrodes
 - opposite (charges) attract
- 1

[7]**8**

- (a) (i) increase
- 1
- (ii) high melting point
- 1
- (b) (i) decreases
- 1
- increases
- 1

(ii) it gives the particles more energy

1

it makes the particles move faster

1

[6]

9

(a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed

any sensible modification to reduce heat loss

ignore prevent draughts

ignore references to gas loss

1

(b) all the substances react **or** all (the substances) react fully / completely **or** heat evolved quickly **or** distribute heat

accept to mix them

'so they react' is insufficient for the mark

accept increase chances of (successful) collisions / collision rate

increase

*do **not** accept rate of reaction increase / make reaction faster*

1

(c) experiment 2 **and** different / higher / initial / starting temperature

*accept experiment 2 **and** the room is hotter / at higher temperature*

*do **not** accept temperature change / results higher*

1

(d) temperature change does not fit pattern

*accept anomalous / odd **or** it is the lowest **or** it is lower than the others **or** it is different to the others*

'results are different' is insufficient

1

(e) 7 / 7.0

1

(f) $(100 \times 4.2 \times 7) = 2940$

ecf from (e)

1

(g) diagram A **and** reaction exothermic / heat evolved / ΔH is negative / temperature rises

accept energy is lost (to the surroundings)

1

[7]

- 10** (a) carbon dioxide
must be name
*do **not** accept carbon oxide* 1
- (b) (i) the temperature of the solution will decrease
(list principle) 1
- (ii) energy is taken in from the surroundings
(list principle) 1
- [3]**
- 11** (a) hydrogen + oxygen → water
accept $2H_2 + O_2 \rightarrow 2H_2O$ or balanced multiples or fractions
allow 1 or 2 correct formulae substituted for words
*allow hydrogen oxide **or** steam for water* 1
- (b) supplied
 released
both needed, must be in this order 1
- (c) (i) B 1
- (ii) A 1
- (iii) to overcome activation energy to react **or** (activation) energy needed to start reaction
allow to provide energy 1
- [5]**
- 12** (a) (bonds broken) = 1370 (kJ) 1
- (bonds made) = 1856 (kJ) 1
- change in energy = (-) 486
ecf
ignore sign
*correct answer with **or** without working = 3 marks* 1

- (b) energy released from forming new bonds is greater than the energy needed to break existing bonds

allow the energy needed to break bonds is less than the energy released in forming bonds

*do **not** accept energy needed to form bonds*

1

- (c) (i) energy barrier needs to be overcome

or

activation energy supplied / needed

*allow energy needed to start reaction **or** energy needed to break bonds*

accept high activation energy

1

- (ii) lowers activation energy(*)

or

provides lower energy pathway / route(*)

()2 mark answers*

*allow provides alternative pathway **or** platinum / it is a catalyst for 1 mark*

2

[7]

13

- (a) gives out (heat)

1

- (b) D

1

- (c) L

1

- (d) magnesium chloride

1

[4]

14

- (a) either:
calculations: all correct (ethanol = 6, methanol = 3,
peanut oil = 10, vegetable oil = 15)

ignore repetition of data from table unqualified

or

implication of correct calculation

(vegetable oil) gives largest temperature / heat increase per gram (owtte)

allow 'produced most heat in proportion to the fuel used' owtte for 1 mark

2

- (b) any **one** from:

owtte

- smoke
ignore references to crops/food
- soot
- carbon
- carbon monoxide
- carbon dioxide
- global warming / climate change / greenhouse gases
- (air) pollution
- harmful/poisonous

1

scrub / wash the gases owtte

filter / remove (gases / fumes / appropriate named substance) owtte

(add extra oxygen) can burn more efficiently owtte

use a cleaner fuel owtte

plant more trees or similar linked to CO₂

any sensible answer

'don't burn so much fuel' insufficient alone

ignore extractor fans / air conditioning

1

(c) (i) A

1

(ii) B

1

[6]**15**

(a) the bag gets cold because heat energy is taken in from the surroundings

1

(b) endothermic

1

(c) any **two** from:

- mix / spread (the ammonium nitrate and water)
- dissolve faster(*)
- get cold faster **or** so the whole bag gets cold(*)
(*allow increase rate **or** quicker reaction)
- particles collide more **or** more collisions

2

[4]**16**

(a) (i) floated / (moved on) surface

*accept does not sink**ignore it melted*

1

(ii) melted / molten

ignore heat is given off

1

(iii) hydrogen

allow H₂

1

(b) (i) potassium / rubidium / caesium / francium

accept: K / Rb / Cs / Fr

1

(ii) they are metals

1

they form ions with a 1+ charge

1

- (c) (i) atomic weight 1
- (ii) similar 1
- (iii) groups 1
- (d) left gaps owtte 1

[10]

17

- (a) (i) energy / heat of products less than energy of reactants
 owtte
 allow products are lower than reactants
 allow more energy / heat given out than taken in
 allow methanol is lower
 allow converse
 allow energy / heat is given out / lost allow ΔH is negative 1
- (ii) lowers / less activation energy
 owtte
 allow lowers energy needed for reaction
 or it lowers the peak/ maximum
 do **not** allow just 'lowers the energy' 1
- (b) (i) bonds broken: $(2 \times 435) + 498 = 1368$
 allow: $(8 \times 435) + 498 = 3978$ 1
- bonds made: $(2 \times 805) + (2 \times 464) = 2538$
 allow: $(6 \times 435) + (2 \times 805) + (2 \times 464) = 5148$ 1
- energy change: $1368 - 2538 = (-)1170$
 allow: $3978 - 5148 = (-)1170$
 ignore sign
 allow ecf
 correct answer (1170) = **3 marks** 1

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

allow converse

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

1

[6]

18

- (a) endothermic **and** because it takes in heat / energy

***both** for one mark*

1

- (b) (i) reversible reaction (or explanation)

1

- (ii) add water

*do **not** accept cooling **or** reverse the reaction*

1

[3]

19

- (a) (i) high temperature

accept temperature given if ≥ 400 °C

ignore value if "high" stated, unless silly value

1

endothermic or reaction takes in energy

or ΔH is +ve

independent marks

1

- (ii) low pressure

or up to and including 10 atmospheres

1

(low pressure) favours a reaction in which more molecules are formed

2 moles \rightarrow 4 moles

(2 molecules \rightarrow 4 molecules)

independent marks

1

- (iii) nickel **and** it is a transition / transitional element / metal (owtte) **or** nickel **and** variable oxidation state / number or it is similar to other named transition elements e.g. iron

1

- (b) (i) (bonds broken =) 2005 (kJ) 1
- (bonds formed =) 2046 (kJ) 1
- energy change = 2005 – 2046 = (-)41
for correct subtraction ignore sign 1
- (ii) (exothermic)
- if in part (b)(i) answer is not 41
 answer is consequential on endothermic or exothermic shown
 accept correct reasoning for **incorrect** answer from (b)(i)*
- energy given out forming new bonds
*do **not** accept energy needed to form new bonds* 1
- greater than energy put in to break old bonds
*accept exothermic **and** more energy given out than taken in for 1
 mark
 accept negative value for energy change **or** energy in products less
 than energy in reactants for 1 mark* 1
- [10]**

20

- (a) (i) high **and** low
both needed for mark 1
- (ii) reversible 1
- (iii) to prevent ammonium chloride / solid / particles escaping
*idea of a filter
 do **not** accept 'to prevent gases escaping'* 1
- (b) endothermic 1
- [4]**

21

(a) $M_r(\text{SiO}_2) = 60$

if M_r incorrect ecf for max 2

1

$60 \text{ g SiO}_2 \rightarrow 28 \text{ g Si}$

correct answer for 3 marks

1

$2.14 \text{ g SiO}_2 \rightarrow 1 \text{ g Si}$

*allow 2, 2.1, 2.14 (or anything rounding to 2.14), 2.16 or 2.2**a unit is not required but an incorrect unit loses the third mark*

OR $M_r(\text{SiO}_2) = 60$ (1)

moles if silicon needed = $\frac{1}{28} = 0.0357$

mass of SiO_2 needed = 0.0357×60 (1)

= 2.14 g (1)

allow 2, 2.1, 2.14 (or anything rounding to 2.14), 2.16 or 2.2

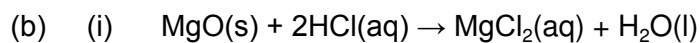
OR $M_r(\text{SiO}_2) = 60$ (1)

mass $\text{SiO}_2 = 1 \times \left(\frac{60}{28}\right)$ (1)

= 2.14 g (1)

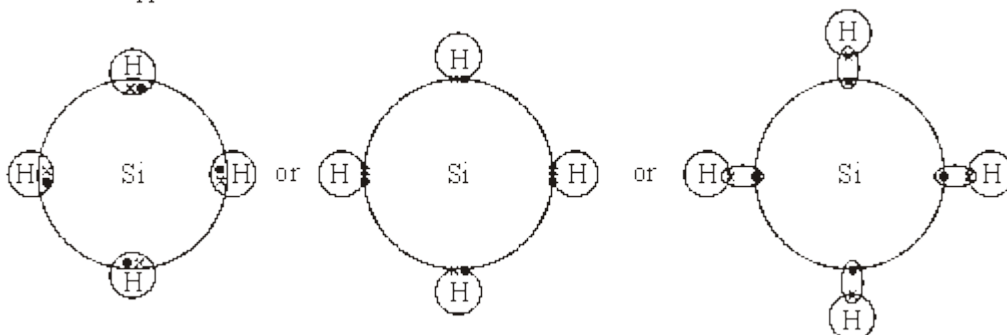
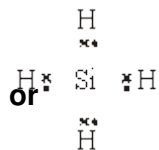
allow 2, 2.1, 2.4 (or anything rounding to 2.14), 2.16 or 2.2

3

*penalise incorrect symbols correctly balanced equation for 1 mark**state symbols for 1 mark**allow correct multiples / fractions*

2

(ii)



*ignore inner shell electrons of silicon
allow correct drawings without symbols
must clearly indicate four shared pairs of electrons with one
electron from each atom*

(iii)

Si**H**

$$\frac{1.4}{28}$$

$$\frac{0.15}{1}$$

1

$$= 0.05$$

$$= 0.15$$

1

1

3

for whole number ratio can be implied

1

Si H₃

accept H₃ Si or any correct formula with 1:3 ratio

*if in step 1 they get either of ratios incorrect they lose first 2 marks
but can be ecf for 3rd and 4th mark*

evidence of mass / A_r 1 mark

proportions of each 1 mark

whole number ratio 1 mark

correct formula 1 mark

1

(iv) **C***accept c***1**(c) any **four** from:

- giant structure / macromolecule / lattice / giant molecule
allow giant molecular / giant atomic structure
- each silicon atom joined to four other atoms
(or diagram)
- covalent bonds
- bonds are strong **or** large amount of energy needed to break bonds
accept hard to break bonds
- large number of bonds to be broken
*mention of giant **ionic** structure **or** intermolecular forces **or** intermolecular bonds max 1 mark*
*diamond **or** carbon discussion max 3 marks unless clearly linked to silicon*

4**[15]****22**(a) sodium
hydrogen
phosphorus
oxygen

2 marks for all 4
1 mark for 2 or 3
0 marks for 0 or 1
not symbols / formulae

2

- (b) (i) gives out
gets hot(ter) / temperature rises (1) 1
- heat / energy
independent mark 1
- (ii) **Quality of written communication**
for clearly expressed ideas 1
- take temperature of water at start
owtte 1
- take temperature after adding soup powder 1
- plus any **one** from:
- using a thermometer
 - mix / stir / shake etc
 - in beaker / conical flask / test tube / plastic cup
 - temperature will rise (indicates an exothermic reaction) 1
- [8]**

23

- (a) (i) yield increases
two marks are linked 1
- because more (gaseous) reactant molecules / particles than (gaseous)
product molecules / particles
accept 7 → 4 moles or volumes
ignore more reactants
accept fewer particles on the right 1
- (ii) increased (rate) / faster / speeds up etc
two marks are linked 1
- more collisions **or** increased concentration **or** particles closer together
greater chance of more successful collisions 1

- (b) heat / high temperatures
do **not** accept burn it ignore cracking / catalyst

1

[5]

24

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

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

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^+ (and Cl^-)

1

hydrogen ions **or** H^+ causes a solution to be acidic

1

[8]

25

- (a) exothermic (reaction)

1

- (b) smaller lumps react faster
or larger lumps react slower

*accept smaller lumps cause a more rapid rise in temperature **or**
vice versa*

*do **not** accept higher temperature
or more heat unless linked to time*

1

smaller lumps have a larger surface (area) or larger lumps have a smaller surface (area)

*more water can react at the same time
or so less water can react at the same time*

1

(c) heats up (too) rapidly

accept temperature (too) high

1

burning the food **or** the hands

*accept danger of container exploding **or** splitting **or** food overheating*

do not accept reference to handling of powder

*do **not** accept a lot of powder needed **or** powder getting into food **or** too hot to eat **or** food would not cook properly **or** heat through properly*

1

[5]

26

rises as energy needed for bond breaking (of reactants)

1

called activation energy **or** correctly labelled on diagram

1

bond making (to form products) releases energy

1

called exothermic reaction **or** more energy given out than taken in **or** releases heat to the surroundings

1

[4]

27

(i) the energy needed by reactants before reaction can occur

accept energy required for particles to collide successfully

accept energy required to break bonds

accept energy needed to start reaction

1

(ii) reference to reactants 'energy' higher than products 'energy'

accept exothermic reaction

accept heat (energy) released

1

melting point of iron is exceeded

accept temperature is above melting point of iron

1

[3]

28	(a) (i) fertilisers <i>for 1 mark</i>	1
	(ii) 7 <i>for 1 mark</i>	1
	(iii) 5 for 1 mark <i>(ignore other units)</i>	1
	(b) (i) both nitrogen and hydrogen <i>for 1 mark</i>	1
	(ii) two of: nitrogen; hydrogen/methane/natural gas; oxygen/air; water; any fuel (allow symbols, do not allow nitrogen oxides) <i>any two for 1 mark each</i>	2
	(c) (i) alkali/alkaline/base/basic <i>for 1 mark</i>	1
	(ii) must be nitrate <i>for 1 mark</i>	1
	(iii) thermometer or any other temperature measuring device <i>for 1 mark</i>	1
		[9]

29	(a) gives out heat <i>each for 1 mark</i>	2
	(b) chromium and aluminium oxide	1

- (c) (i) chromium oxide 1
- (ii) oxygen removed/gains electrons 1
- [5]**

- 30** (a) oxygen/O₂
for 1 mark 1
- (b) water/H₂O
for 1 mark 1
- (c) carbon dioxide/CO₂
(if symbols are used they must be correct)
for 1 mark 1
- (d) gives out
for 1 mark 1
- heat or energy (2 independent marks)
for 1 mark 1
- [5]**

- 31** (a) (i) $4 E (\text{H-O}) = 4 \times 464 = 1856$
 $2 E (\text{O-O}) = 2 \times 146 = 292$
gains 1 mark each
- but** Total = 2148 kJ
Deduct one mark for each mistake.
Answer of 1074 kJ gains 1 mark. (Candidate has ignored the 2 in front of the brackets.)
gains 2 marks 2

- (ii) $4 E(\text{H-O}) = 4 \times 464 = 1856$
 $E(\text{O=O}) = 498$

gains 1 mark each

but Total = 2354 kJ

Deduct one mark for each mistake.

Answer of 1426 kJ gains 1 mark. (Candidate has ignored the 2 in front of the brackets.)

gains 2 marks

2

- (iii) $2354 - 2148 = 206$ kJ (Ignore any signs)
 Answer is consequential on their answers to (i) and (ii).

for 1 mark

1

- (iv) exothermic because (more) heat is given out (than put in) / or ΔH is negative / answer to (iii) is negative.
 (If the candidate gives the answer 'endothermic because heat / energy is taken in' then look back to their answers to (i) and (ii).
 If (i) is greater than (ii) then accept this answer.

for 1 mark

1

- (b) (i) eg minimum energy for reaction
 energy needed to start a reaction
 energy needed to break bonds
 energy needed to make two substances react
 (Energy linked to starting a reaction.)

for 1 mark

1

- (ii) B

for 1 mark

1

- (iii) lowers activation energy / needs less energy to start reaction /
 less energetic route

for 1 mark

1

[9]

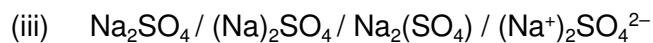
32

- (i) sulphuric acid / H_2SO_4
accept sulfuric *1 for one mark*

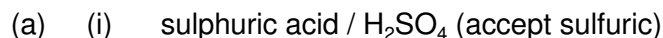
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- (ii) exothermic
for one mark

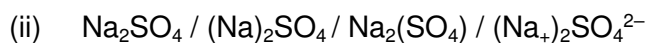
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*for one mark**lower case O(Na₂SO₄) not accepted / tops of subscripted letters should be in line or lower than lower case letters of symbols*

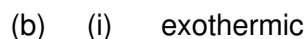
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[3]**33***for one mark*

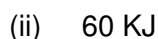
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*for one mark**lower case O (Na₂SO₄) not accepted/tops of subscripted numbers should be in line with or lower than lower case letters of symbols / upper case 'a' not accepted*

1

*for one mark*

1

*for one mark*

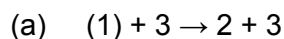
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(iii) energy given out when bonds form
energy taken in when bonds break
energy given out is greater than energy taken in (owtte)*for 1 mark each*

3

(iv) activation energy is low / many molecules have enough energy to react
for one mark

1

[8]**34***accept correct multiples*

1

- (b) any **three** from
- to react particles must collide
 - with sufficient energy
 - reference to activation energy
 - (to cause) bond breaking
- 3
- (c) (i) $(436 \times 2) + 498$
- 1
- $= 1370$ (kJ)
- accept $(436 \times 2) + 498$ **or** 934 kJ for one mark*
- allow 2 marks for 1370 if no working*
- or** correct working is shown
- 1
- (ii) calculation of bond energy or product
- 1
- $464 + 464 = 928 \times 2 = 1856$
- incorrect calculation = 0 marks*
- correct deduction
- allow deduction on ecf exothermic / endothermic on own without calculation are neutral*
- 1
- [8]**

35

- exothermic does **not** gain any credit
- 1
- reactants: bond breaking $(436 + 242 =)$ 678 (kJ)
- 1
- products: bond making $(2 \times 431 =)$ 862(kJ)
- so overall 184 (kJ) released / -184 (kJ)
- 1

[3]**36**

- (a) increases % / amount of ammonia
- 1
- favours the forward reaction
- 1
- (b) reaction(s) would be too slow
- 1

(c) any **three** from:

- rate increased
- decreases % / amount of ammonia
- the forward reaction is exothermic
- the backward reaction is endothermic
- backward reaction favoured / forward reaction not favoured
- yield / amount of nitrogen and hydrogen increased
- the relative amount (yield) of ammonia decreases as the equilibrium is changed
- the relative amount (yield) of nitrogen and hydrogen increases as the equilibrium is changed

explanations in terms of particles are neutral

3

[6]**37**

(a) Bunsen (burner)

accept spirit burner do not credit candle

1

(b) blue

1

white

credit (1) if both colours correct but answers are reversed

1

to cool the tube (B)

*accept answers which anticipate part (d) e.g. 'to condense the water vapour' or gases **or** vapours*

1

(d) (i) water

do not credit 'condensation'

1

(ii) (Water) vapour from the crystals (from tube A)

*accept steam **or** steam from tube A*

1

condenses **or** cools

accept turns to (liquid) water

1

(e) add water

gets hot **or** hotter **or** warm **or** warmer turns into solution
dissolves

*or the temperature rises or there is an exothermic reaction
accept steams **or** hisses ignore any reference to colour(s)*

2

(f) sulphuric acid

*accept H_2SO_4 only if correct in every
detail*

1

[10]

38

(a) bonds broken bonds made

C - C	2 (4)	
<hr/>		
C - H	12 (10)	
<hr/>		
O = O	7	
<hr/>		
C = O		8
<hr/>		
H - O		12

1 mark for all bond breaking correct

1 mark for all bond making correct

2

(b) 1 mark for the three energy levels drawn

1

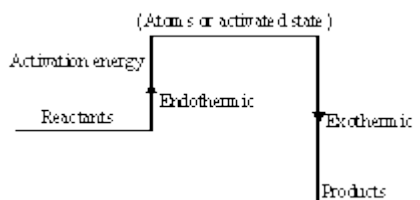
1 mark is for products and reactants labelled, with products shown lower than reactants

1

1 mark for activation energy in the correct position

1

(c) 1 mark (for arrows) and endothermic exothermic labels



arrows not required

1

lowers activation energy

1

more particles have the energy to react

particles do not need as much energy to react

1

[8]

39

NOTE

In this question and throughout the Paper, if the name of a chemical is asked for, then the formula is acceptable only if it is correct in every detail. If the name is correct and the candidate has tried to be 'helpful' by giving, in addition, an incorrect version of the formula, then this is acceptable provided it does not lead to ambiguity.

(i) nitric (acid)

accept HNO_3

1

(ii) sulphuric (acid)

accept H_2SO_4

1

(iii) heat given out

or temperature rise

or energy given out

or steam

do not credit just 'use a thermometer'

do not credit just 'change in temperature'

1

(iv) neutralisation

accept neutralise

accept neutral

accept formation of salt or water

do not credit exothermic

1

[4]

- 40** (a) heat/light 1
- (b) any reference to the products being (colourless) gases/smoke 1
- [2]**

- 41** (a) breaking of C-H bonds
breaking of O-O bonds
making of C-O bonds
for 1 mark each
- making of H-O bonds 4
- (b) X energy needed to break bonds
has to be **supplied**/activation energy
- Y energy released when bonds form
- Z = Y-X
overall, energy is released/reaction is exothermic
each for 1 mark
- 5
- [9]**

- 42** (i) Bonds broken
4 × (C – H)
2 × (O = O)
each for 1 mark
- Bonds formed
2 × (C = O)
4 × (O – H)
each for 1 mark
- 4
- (ii) Total energy change in breaking bonds
(4 × 413) + (2 × 498)
each gains 1 mark
- Total energy change in forming bonds
(2 × 805) + (4 × 464)
but
to break bonds = 2648
to form bonds = 3466
each gains 2 marks
- 4

- (iii) nett energy transfer = 818 (kj)
 this energy is released in the reaction/is an exothermic reaction
 (*credit answers consistent with (ii) or derived from the initial information*)
each for 1 mark

2

[10]**43**

- | <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 Total energy change in forming bonds
 $3 \times 498 = 1494$ $4 \times 464 = 1856$
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]**44**

- (a) fuels
 heat – allow light
for 1 mark each

2

- (b) gases
for 1 mark

1

[3]

45

- (a) (i) oxygen (not air)
(ii) oxides/monoxides/dioxides
for 1 mark each

Do not allow specific examples

2

- (b) (i) water
(ii) sulphur
(iii) carbon
for 1 mark each

3

- (c) gives out/releases heat/energy
for 1 mark

1

- (d) (i) carbon dioxide
(ii) carbon
for 1 mark each

(allow correct symbols/formulae)

2

[8]**46**

- (a) nitrogen / N₂
[Do not allow N or N²] for 1 mark

- (b) heat
for 1 mark

- (c) carbon dioxide / CO₂
for 1 mark

[3]

47

ideas that

- x = the energy required / taken in / used* to break the bonds of water / reactant [*not used up / formed]
gains 1 mark
 - **but** = the energy required taken in / used to break the bonds in water **or** activation energy
gains 2 marks
 - y = the energy released given out when bonds form
gains 1 mark
 - **but** = the energy released / given out when hydrogen / oxygen form
gains 2 marks
 - $z = 1856 - 1370$ or $(+)486$ kJ
for 1 mark
- or** difference between x and y **or** net energy transferred
- overall, energy is taken in / absorbed in the reaction
or the reaction is endothermic **or** energy required to break existing bonds is $>$ energy released when new bonds form
for 1 mark

[6]

48

- (a) heat
light
an exothermic

in any order for 1 mark each

3

- (b) oxygen / O_2

for 1 mark

1

[4]

49

- (a) *idea that*
existing bonds must first be broken

for 1 mark

(*credit* molecules / atoms more likely to react when they collide)
energy is released when new bonds form

gains 1 mark

but more energy is released when new bonds form

gains 2 marks

or overall reaction exothermic
this breaks more bonds so the reaction continues

for 1 mark

max 4

- (b)
- reactant level higher than product level (names of reactants and products not required)
 - indication that activation energy required (i.e. the “hump”)
 - any correct indication of nett energy change

(i.e. between product and reactant levels even if other marks not gained)

for 1 mark each

3

[7]