



## Mark schemes

1

- (a) (i) a continuous straight line missing anomalous point  
*allow a line which does not start at zero / origin*

1

- (ii) any **two** sensible errors eg

- timing errors and / or example(\*)
- measurement errors and / or example(\*)
- apparatus errors and / or example(\*)
- human / experimental / random error and / or example  
or 'did not do it right'(\*)  
*(\*)could be two from **same** category eg two timing errors – watch  
not started at the same time plus difficulty in deciding when the  
cross has disappeared.*
- temperature fluctuation
- anomalous point  
*accept outlier / wrong result*
- results not recorded correctly
- plotting error
- rate calculated incorrectly  
*ignore 'not repeated'*  
*ignore systematic / zero error / weighing error **or** error unqualified*

2

- (b) (i) straight line

**or**

as concentration increases the rate goes up **or** converse

*accept numerical example*

*accept positive correlation*

*accept same gradient*

*ignore 'most points near / on line of best fit'*

1

(ii) more collisions

*accept greater chance of collisions*

*accept collide more successfully*

*accept alternative versions of collide eg 'bump / hit'*

*ignore references to energy / speed of particles / surface area*

1

more particles (in each volume of solution)(i.e. an attempt at defining concentration)

*accept 'particles are closer together'*

*allow ions / atoms / molecules for particles ignore reactants*

*accept greater frequency of collisions **or** greater number of collisions per second for **2** marks*

1

[6]

2

(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]

**3**

(a) sensible line of best fit which goes through or close to all the points **except** the anomalous point

*allow wobbly / short double lines*

*± ½ square*

1

(b) loss of gas / loss of CO<sub>2</sub>

*idea of gas produced / formed*

1

(c) 7

1

(d) (i) steeper line from around the same starting point and left of the points

*allow crosses if they are fully correct for 1 mark*

1

levelling off at 99

*accept short level line at 99*

*± ½ square*

1

(ii) any **three** from:

- particles / molecules / atoms/ ions have more energy  
*allow given / gain / get energy*
- move faster  
*ignore move about more*  
*ignore vibrate more / faster*
- collide more often  
  
**or** more chance of collisions  
  
**or** bump into each other more  
*ignore collide quicker / faster*
- collide with more force / energy  
  
**or** more particles have the activation energy  
  
**or** more collisions result in reaction  
  
**or** more collisions are successful

3

**[8]****4**

(a) (i) (phosphoric) acid

*allow phosphoric acid*

1

(ii) hydrogen

1

(b) (i) faster / quicker / speeds it up (owtte)

*allow answers based on activation energy*

*ignore helps it to react*

1

(ii) most of the starting materials end up as useful products

1

(iii) H<sub>2</sub>O

*allow HOH **or** OH<sub>2</sub>*

1

**[5]**

**5**(a) any **two** from:

- increases  
*owtte allow 'goes up'*
- until reaches maximum / levels off  
*owtte*
- quickly at first  
*owtte*
- then more slowly / rate decreases  
*allow reaction finished*  
*ignore rate increases*

2

(b) use a more concentrated acid  
*list principle applies*

use zinc powder

2

**[4]****6**

(a) (i) sulfuric

*accept  $H_2SO_4$*   
*accept sulphuric*  
*allow phonetic spellings*

1

(ii)  $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$ 

*1 mark for reactants*  
*1 mark for products*  
*ignore state symbols*  
*max 1 mark for incorrect balancing*

2

(b) any **two** from:

- particles gain energy **or** particles have more energy  
*allow have more activation energy*
- particles move faster  
*allow they collide faster / quicker*  
*ignore move / vibrate more*
- collide more often  
*allow more collisions*
- collide more energetically
- more of the collisions are successful  
**or** more particles have the activation energy  
**NB** *more successful collisions alone = 1 mark*  
*if particles are identified as electrons = max 1 mark*

2

**[5]****7**

(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  $\Delta H$  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  
*allow converse*  
*do **not** accept energy needed to form new bonds greater than energy needed to break existing bonds*  
 1

[6]

8

- (a) (i) accurate plotting of points ( $\pm \frac{1}{2}$  square)  
*2 marks for all points*  
*1 mark for 3 or 4 points*  
 2
- sensible smooth curve  
*reasonable attempt*  
*do **not** accept double lines **or** dot to dot*  
 1
- (ii) accurately read from their graph to  $\pm \frac{1}{2}$  square  
 1
- (b) (i) (as temperature increases) rate increases  
*accept speeds up, gets faster, gets quicker*  
*accept higher speed*  
*do **not** accept gets bigger / higher unqualified*  
*do **not** accept answers about time on its own*  
 1



(ii) **Quality of Written Communication**

*The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*

*maximum 2 marks if ideas not expressed well*

any **three** from:

*for converse maximum 2 marks*

particles have more energy

*higher kinetic energy*

particles move faster

*do **not** accept move more or vibrate more*

3

more collisions

*accept greater rate of collisions*

more energetic / successful / harder collisions

*more particles have activation energy*

(c) concentration (of solutions) **or** volume (of solutions)

*accept 'how much of'*

*accept references to intensity of colour*

*accept same endpoint*

*accept rate of stirring / shaking*

*do **not** accept reference to solids **or** catalysts etc*

*ignore containers*

*do **not** accept pH*

1

**[9]**

9

- (i) measure volume / mass of gas produced

1

in a certain time period

*1 mark is for a sensible way of measuring the amount of product produced and 1 mark is for the idea of timing*

e.g. measure volume of gas produced at regular time intervals

**or** time taken to fill a test tube with the gas

or collect a certain volume of gas

*(measuring the rate at which bubbles are produced e.g. number of bubbles in 30 seconds gains only 1 mark unless an enclosed system is used)*

**or** measure decrease in mass of flask and contents at regular time intervals**or** time taken for the mass to decrease by certain amount

1

- (ii) increases rate (owtte)

1

- (ii) change the concentration
- or**
- add a catalyst
- or**
- change the surface area
- 
- or**
- lower
- the temperature

*accept 'expose to sunlight' (owtte) **or** change the amount of water / powder / solution used*

*ignore 'stirring'*

1

**[4]**

10

- (a) 6

*accept 5.8 – 6*

1

- (b) hydrochloric acid used up / reacted / combined /
- or**
- fewer particles
- 
- (of hydrochloric acid)
- or**
- fewer hydrogen ions owtte

*accept reactants used up*

*accept less calcium carbonate **or***

*smaller surface area of calcium carbonate*

*accept lower concentration / less crowded*

*do **not** accept atoms / molecules*

*ignore references to energy*

*do **not** accept references to atoms or molecules*

1

fewer collisions owtte

*independent mark*

1

(c) steeper curve initially

*independent marks*

1

levels out at same volume

- *must indicate levelling out*
- *if line goes higher than 66 do **not** award this mark*
- *diagonal line only = 0 marks*
- *if steeper initially and then crosses the line and finishes correctly, then loses one*

1

[5]

11

(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]

12

(a) (i) **must** be chemical symbol

Ca

1

C

 $\text{CaCO}_3 = 2$  marks

1

O not  $\text{O}_2$ 

1

(ii) carbon dioxide

**must** be name

1

(b) (i) *points all correct 2 marks*  
*one point incorrect 1 mark*  
*two points incorrect 0 marks*

2

suitable line -narrow neat single curve

**not** dot to dot

1

(ii) reaction with X forms less gas

**must** include X or Ydo **not** penalise for  $\text{H}_2/\text{O}_2$  if (a) (ii) already penaliseddo **not** accept is finished in less time **or** slower/faster reaction **or** lower on graph

1

(iii) any two from:

- concentration (of acid) decreases/less reacting particles/molecules  
**not** acid/ $\text{CaCO}_3$  runs out/is used up

- surface area of calcium carbonate decreases  
**not** strength of acid decreases

- less collisions between reacting particles  
**not** smaller (amount of)  $\text{CaCO}_3$

2

[10]

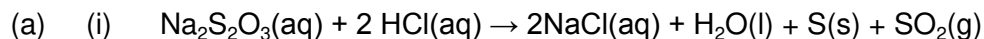
13

- (a) (i)  $\text{H}_2\text{O}_2$  reactant correct  
*ignore any state symbols* 1
- $\text{H}_2\text{O} + \text{O}_2$  products correct 1
- $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$  balanced  
*accept correct multiple* 1
- (ii) glowing splint 1
- relights  
*accept 'bursts into flame'*  
*do **not** accept a lighted splint burns brighter **or** faster* 1
- (b) unchanged  
*accept **not** used up **or** left (behind)* 1
- (c) (i) gas syringe **or** measuring cylinder **either** with scale drawn **or** labelled 1
- the apparatus as drawn would work 1
- (ii) correct plotting of points  
***one** mark to be deducted for each error* 2
- best fit graph line drawn (single line drawn) 1
- (iii) concentration of hydrogen peroxide decreases  
*accept less particles of hydrogen peroxide to collide*  
*do **not** accept hydrogen peroxide gets used up* 1
- rate of reaction decreases  
*accept reaction gets slower* 1

(iv) any two from:

- temperature
- pressure
- division of catalyst **or** manganese oxide  
*do not accept any other factors*

2

**[15]****14**

1

(ii) (formation of) sulphur

*accept precipitate **or** solid produced*  
*do not accept goes cloudy **or** milky*

1

(b) (i) heat  $\equiv$  temperature increased temperature increases (the rate of reaction)  
**or** decreased temperature decreases rate of reaction

*may be gained in part (ii) if stated and not implied*

1

(ii) (these ideas may be given in (i))

particles have more kinetic energy  
*accept particles move faster*

1

more collisions (so more reactions)

*more energetic collisions **two** marks*

1

**[5]****15**

(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]

16

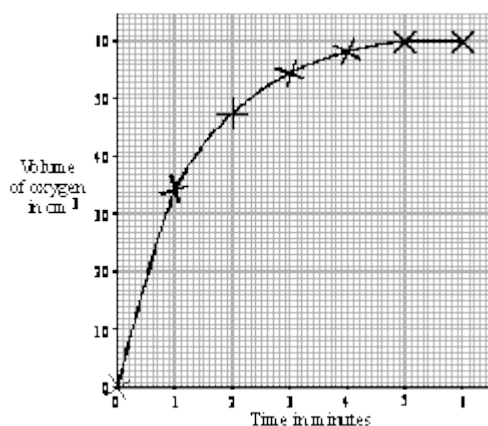
(a) (i) H<sub>2</sub>O must be formula

1

(ii) catalyst

1

(b) (i)



correct plotting

2

*1 mark deducted per error to a maximum of 2*

*do **not** accept a complete dot-to-dot line*

*do **not** accept a bar chart if the (0,0) point is missing and line to one minute missing then maximum mark is 2*

best fit single line

*if curve correct but no obvious points award 3marks*

1

(ii) 4.5 – 5

*no units required*

1

(iii) all hydrogen peroxide had reacted

*accept all hydrogen peroxide had decomposed **or** been used up*

*accept no hydrogen peroxide (particles) left*

1

(c) (i) remains lower than previous line

*do **not** accept bar chart*

1

line levels off lower than  $60\text{cm}^3$

*correct points but no line drawn then maximum 1 mark*

1

(ii) decrease of (hydrogen peroxide) concentration

*accept concentration is less*

*accept fewer collisions (of particles)*

*do **not** accept weaker solutions **or** dilute solutions*

1

[10]

17

(a) (i) 78-80%

1

(ii) proteins

*accept amino acids*

1

(b) (i) natural gas

*accept methane ( $\text{CH}_4$ )*

*accept water ( $\text{H}_2\text{O}$ )*

1

(ii) carbon dioxide

1

(c) (i)  $\text{N}_2 + \text{H}_2$

1

correct balancing  $1 + 3 \rightarrow 2$

*award only if reactants are correct*

1



- (ii) iron  
*accept Fe* 1
- (iii) at low temperatures rate of reaction is too slow  
*accept very few collisions at low temperatures*  
*accept converse*  
particles need enough (activation) energy to react  
*accept particles need enough energy for bonds to break*  
*accept converse* 1
- (d) all three covalent bonds displayed correctly as electron pairs 1  
two lone electrons displayed not necessarily as a pair 1
- [11]**

**18**

- (a) (i) (s) (aq) (1) (g)  
*2 or 3 correct 1 mark*  
*1 correct 0 marks* 2
- (ii) calcium chloride 1
- (b) (i) points  
*deduct 1 mark for each error to a maximum of 2 marks* 2  
line  
*accept a single line 'best fit' curve*  
*accept reasonable attempt at curve* 1
- (ii) increase temperature **or** heat  
*accept increase surface area or*  
*increase concentration or description* 1

- (iii) 75% or  $\frac{3}{4}$   
*not pure 1 mark*  
*only 60 cm<sup>3</sup> (instead of 80 cm<sup>3</sup> of gas)*

**or**  $\frac{60}{80} \times 100$  **1 mark**

3

[10]

19

- (a) (i) iron **must** be named  
*do not accept Fe*

1

- (ii) hydrogen

1

and oxygen mixtures

1

burn rapidly

1

- (b) (i) lowers concentration  
*accept dilutes the acid*  
*do not accept cooling*

1

less collisions (between particles)

1

- (ii) H<sup>+</sup> (aq)  
*accept H<sub>3</sub>O<sup>+</sup> only if 2 in front of H<sub>2</sub>O*

1

OH<sup>-</sup> (aq)

*if spectator ions correctly included on both sides, maximum = 1 mark*

1

- (iii) Ca(OH)<sub>2</sub> weak alkali  
*accept NaOH strong alkali*

1

Ca(OH)<sub>2</sub> causes no problems

*accept NaOH causes named problem*  
*(eg caustic or exothermic or burns or corrosive)*

1

[10]

- 20**
- (a) increase concentration of acid;  
increase surface area of solid  
**or** grind up the solid;  
add a catalyst  
*any two for 1 mark each* 2
- (b) 1;  
it is the one that makes the gas fastest (steeper curve etc)  
(second part is dependant on first)  
*for 1 mark each* 2
- (c) (i) faster after one minute, slower after 2 minutes  
*for 1 mark* 1
- (ii) the reactants get used up;  
so concentration decreases/less chance of collision  
*for 1 mark each* 2
- [7]

- 21**
- (a) (i)  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} / \text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2\text{H}_2\text{O}$   
*for 1 mark* 1
- (ii) 1 point from e.g.  
smaller bits  
bigger surface area  
faster reaction  
dissolve faster  
more particles open to attack by acid  
*any 1 for 1 mark* 1
- (iii)  $\text{MgCO}_3$  or  $\text{Mg}^{2+}\text{CO}_3^{2-}$  or  $\text{CO}_3\text{Mg}$   
*for 1 mark* 1
- (b) (i) 2 HCl  
*for 1 mark* 1
- (ii) aqueous/dissolved in water (not in solution)  
*for 1 mark* 1

- (iii) CO<sub>2</sub>/gas evolved/gas has mass  
*for 1 mark* 1
- (c) (i) plotting points  
scales  
curve  
labelling axes including units  
*for 1 mark each* 4
- (d) faster  
same final mass  
*for 1 mark each* 2
- [12]**

**22**Effect of pressure

- high pressure increases yield  
*for 1 mark*
- either because less product molecules (Le Chatelier)  
or but high pressure increases cost/safety  
*for 1 mark*

Effect of temperature

- low temperature increases yield  
*for 1 mark*
- either because exothermic reaction (Le Chatelier)  
*for 1 mark*
- or but at low temperature rate is slow/catalyst does not work

Compromise

- optimum conditions to balance rate and % yield  
*for 1 mark*
- or rate is slow (at higher temperature) so need a catalyst  
or low percentage conversion so recycle untreated gases

**[5]**

<b>23</b>	(a) (i) test tube / boiling tube <i>for 1 mark</i>	1
	(ii) Na <sub>2</sub> CO <sub>3</sub> NaCl <i>each for 1 mark</i>	2
	(b) (i) flask measuring cylinder <i>each for 1 mark</i>	2
	(ii) used smaller pieces <i>gains 1 mark</i>	
	<b>but</b> larger surface area for reaction <i>gains 2 marks</i>	2
	(c) (i) steeper line straight line <i>each for 1 mark</i>	2
	(ii) reaction occurs when particles collide higher temperature, higher speed of particles so harder collisions more frequent collisions <i>any three for 1 mark each</i>	3
		<b>[12]</b>

**24**Factor 1

heating the solution / heat / increasing temperature / candidates can gain one mark here for the idea of the water evaporating faster with increased heat (so heating the reactants faster).

particles (of fat and sodium hydroxide) move faster (not vibration / not just move more) / more kinetic energy

collide more often / more collisions

have more energy when they collide / more successful collisions

Factor 2

concentrated (solution of alkali)

more (sodium hydroxide) particles (in a given volume) particles closer/ more crowded etc.

more collisions / greater chance of successful collisions

*each for 1 mark*

Possible alternative answer

size of fat pieces / small pieces of fat

have larger surface area

more collisions / greater chance of collisions

[7]

25

(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)  $2354 - 2148 = 206 \text{ kJ}$  (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 it) / or  $\Delta H$  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]

26

- (a)  $\text{NO}_2$  /  $2\text{NO}_{2(g)}$  / Nitrogen dioxide

*for one mark*

1

- (b) particles of gas move / they move

*reject* spread out

particles move randomly / mix / go between air molecules / diffusion

*any two for 1 mark each*

2

- (c) faster reaction / more surface area (*not* smaller pieces)

*for one mark*

1

- (d) (i) **either** lower temperature / particles move slower  
 fewer collisions (owtte) / less energetic collisions / owtte  
**or** acid diluted (owtte)  
 fewer collisions (owtte)

*for 1 mark each*

2

- (ii) alkali neutralises the acid / stops the reaction  
**or** water will only slow the reaction not stop it  
*either for 1 mark*

1

**[7]****27**

- (a) oxygen

*Ignore any numbers  
 accept hydrogen oxide / steam*

1

water

1

- (b) catalyst

1

**[3]****28**

- (a) the concentration of the (nitric) acid is decreasing

*accept the number of acid particles is  
 decreasing **or** there are fewer collisions*

1

(the volume of carbon dioxide remains at 83 cm<sup>3</sup>)  
 when the concentration of the (nitric) acid is zero

*accept no acid remains **or** all the acid  
 is used up **or** no acid particles*

1

- (b) line starts at origin is steeper **and** remains to the left of the original line

1

graph line levels off at 83 cm<sup>3</sup> **and** before 12 minutes

*tolerance  $\pm$  square*

1

- (c) change the temperature

*accept increase **or** decrease the temperature  
 accept change (increase **or** decrease) the concentration (of the  
 nitric acid)  
 ignore amounts of reactants **or** changes in pressure **or** stirring **or**  
 use of catalyst*

1

**[5]**



- 29** (a) oxidising 1
- (b) (i) oxygen  
*ignore any numbers* 1
- (ii) (catalyst) speeds up a (chemical reaction)  
*accept changes the rate (of reaction)* 1
- [3]**

- 30** (a) **A** faster because: the graph line steeper / the reaction had stopped earlier  
*accept sample B slower because: the graph line was less steep / the reaction stopped later*
- A** because CO<sub>2</sub> given off faster / fizzes more for 1 mark  
**B** because CO<sub>2</sub> given off slower / fizzes less for 1 mark 2
- (b) increases the speed / energy of the (hydrochloric acid) particles 1
- collide more frequently 1
- collide more energetically / successfully  
*accept more successful collisions = 2 marks* 1
- [5]**

- 31** (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]****32**

(a) (i) catalyst / enzyme

1

(ii) any **two** from

*do not accept increase volume of peroxide*

- heat
- stir / shake
- increase concentration of peroxide / catalyst

2

(b) oxygen lost

*do not allow incorrect gas*

1

**[4]**

33

(a) (i) 2.25

*correct answer gains three marks**if incorrect allow 1 mark for 2 correct**readings (130 and 175) and further mark for  $45 \div 20$* *allow e.c.f.*

3

(ii) concentration of reactant(s) lower

1

fewer collisions per second / time unit

1

(b) labour costs lower / enzymes costs lower

***not** stop and start*

1

**[6]**

34

(a) ammonium nitrate

*accept  $NH_4NO_3$* *do **not** accept ammonia nitrate*

1

(b) different reactions need different catalysts

1

(c) they are used over and over again

*accept they are reused**accept they are not used up**accept they are not changed**recycling is neutral*

1

(d) any **two** from

they speed up reactions

they reduce energy requirements

*accept allow reactions to take place at a lower temperature*

they reduce costs

*accept make process more economic*

2

- (e) (high pressure) increases the frequency of collisions

*accept more collisions  
move faster is neutral*

1

this increases the rate of reaction

*accept 'more successful collisions' for 2 marks*

1

[7]

35

- (i) (Y)  
more gas / carbon dioxide given off

1

- (ii) (X)  
curve / slope steeper

*accept rises more rapidly / only took 30 seconds*

1

- (iii) (flat)  
since calcium carbonate /  
substrate all used up

*accept the reaction has stopped /  
no more gas is being produced* 1

1

[3]

36

- (a)  $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$

1

- (b) (i) 12.5

1

- (ii) steeper curve same volume of gas evolved  
*do not credit two intersects of straight lines  
accept a sharp bend*

2

(iii) any **two** from:

stir it

*accept mix it better*

heat it

*accept warm it*

use a more finely divided catalyst

*accept use a better catalyst or more finely divided zinc*

*do not credit use acid of a higher*

2

(c) (i) any **one** from

zinc is more reactive than copper

*accept zinc is above copper in the reactivity series*

zinc displaces copper

*accept it is higher than copper in the reactivity series*

1

(ii) zinc + copper sulphate → copper + zinc sulphate

*ignore the presence of acid **or** water*

*accept a balanced equation*

1

**[8]**

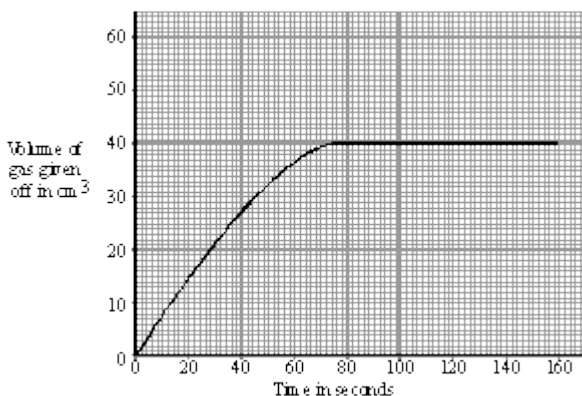
**37** graph steeper

1

becomes horizontal

1

reaches twice the height,  $40 \text{ cm}^3 \pm 1 \text{ cm}^3$



1

**[3]**

**38** (a)  $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$

*one mark for  $\text{CO}_2$  and  $\text{H}_2\text{O}$  or  $\text{H}_2\text{CO}_3$*

*one mark for balancing the equation*

2

(b) (i) linear suitable scale for y axis

*± one small square*

1

accurate plots

*deduct one mark for each error plot*

1

smooth curve through the points **or** a line of best fit

*this mark requires a neat smooth curve*

1

- (ii) curve becomes almost horizontal at **or** above 268.5  
*do not credit a straight line reaching 268.5 at 11 mins*  
*accept a plot at 268.6*

1

- (iii) steeper initial part to curve

1

becoming nearly horizontal between 268.6 and 268.4 g

1

**[8]****39**

- (a) gas

1

- (b) (i)

acid

*ignore any reference to a particular kind of acid*

1

- (ii) 7

1

- (c) 1

*credit potassium **or** K written into Group 1*

1

- (d) (i) reacts rapidly **or** quickly **or** fast

*credit melts **or** fizzes **or** dissolves **or** violently **or** less violently (than K)*

1

sodium hydroxide **or** hydrogen

*credit NaOH **or** H<sub>2</sub>*

1

- (ii) add universal indicator

*credit add indicator **or** litmus **or** use pH paper*

1

turns blue **or** purple

*credit 'it goes purple' providing something has been added to the water*

1

(e) any two from

heat **or** warm

cut it up **or** have smaller pieces or larger surface area

*do not accept more lithium **or** less water*

stir

2

[10]

40

(a) (i) corners

*accept an arrow to any corner*

1

(ii) more (surface) exposed

*accept can be attacked from more directions **or** more space around it*

1

(b) (i) 1 any **two** pairs from

more concentrated

*answers may be in either order*

*do not accept more acid*

*do not accept more powerful **or***

*stronger (but stronger is neutral)*

*a reference to sulphuric acid is neutral*

1

more particles to hit the solid

*accept more collisions per second*

*do not accept more collisions*

1

2 hotter solution **or** increasing temperature

(faster) particles hit more often

**or** harder

*accept particles have more energy*

***or** are more powerful **or***

*more successful collisions*

1

3 stirring

more surface area exposed **or**

particles available

*accept more collisions per second*

*do not accept more collisions*

1



- (ii) cut it up **or** increase the surface area  
*accept grind it up or powder it*  
**or** flatten it do not accept make it smaller  
**or** use a smaller piece

1

more particles are exposed **or** available **or** can react  
*accept heat it and there are more*  
*successful collisions for both marks*

1

**[8]****41**

- (a) both reactions slow down with time;  
 both reactions produce same volume of hydrogen  
*each for 1 mark*

2

- (b) *idea* rate is faster with powder  
**or** *idea* rate is slower with ribbon  
*(allow powder completed before ribbon) for 1 mark*

1

**[3]****42**

- (a) (i) *idea that it is*

a reaction in which the products can themselves react to reform the original substance or a reaction that can go in either direction  
*(allow explanation in terms of the specific reaction in the question)*  
*for 1 mark*

1

- (ii) nitrogen, hydrogen and ammonia  
*(allow formulae)*  
*for 1 mark*

1

- (b) (i) high pressure/400 atm  
 low temperature/100 °C  
*for 1 mark each*

2

- (ii) higher rate of reaction  
 good rate of production  
**or** idea that more economic (ally viable)  
 (allow catalyst more effective at higher temperature)  
*for 1 mark each* 2
- (c) (i) *ideas that it involves*  
 use of catalyst  
*gains 1 mark*  
 but use of platinum catalyst  
*gains 2 marks* 2  
 high temperature/900 °C  
*for 1 mark* 1
- (ii)  $\underline{2} \text{NO} + \text{O}_2 \rightarrow \underline{2}\text{NO}_2$   
*for 1 mark each* 1
- (iii)  $\underline{3} \text{NO}_2 + \text{H}_2\text{O} \rightarrow \underline{2}\text{HNO}_3 + \text{NO}$   
*for 1 mark each* 1
- (d) (i) references to
- transport reductions
  - economic savings
  - saves time
  - guaranteed consumer/supplier  
*for 1 mark each* 2

- (ii)
- selection of site
  - design of plant
  - safe disposal of waste
  - make gas emissions safe(r)
  - monitoring/safety checks
  - reduction of waste gas emissions
  - research into more efficient processes
  - research into energy savings/use of cooling water
  - training of staff re: emergency procedures
  - warning/evacuation procedures for the community

(or any two sensible suggestions)

*any two for 1 mark each*

2

[15]

43

(a) *ideas that*

- ref to read the balance / read the mass / weight
  - ref to read the stop clock / read the time
  - 'readings' taken at the beginning and end / at regular intervals
- for 1 mark each*

2

- (b) (i) • loss of carbon dioxide (from the flask) }
- (ii) • smaller chips give faster reaction / reaction } **mark as a whole**  
 finishes quicker /dissolved faster [*or reverse*]
- smaller chips have a larger surface area }
- any 2 for 1 mark each*  
*[Allow converse answers]*

2

(c) *ideas that*

- heating increases the speed / energy / vibration of the (acid) particles / marble particles
- (acid) particles collide (with marble chips / (particles)) more frequently / more likely to collide
- reacting particles collide with greater energy / collide faster
- so particles more likely to react [*do not accept* 'react faster' ]

[*Accept* 'atoms', 'molecules' or 'ions' instead of 'particles' *in this question*]  
*any three for 1 mark each*

3

[7]

44

(a) (must be possible for the gas to enter and displace the water) **or** other suitable apparatus

- apparatus to collect the gas correctly assembled  
*for 1 mark*
- **calibrated** collection vessel (award even if diagram is wrong)  
*for 1 mark*

2

(b) (i) at the start / in the first 1/2 minutes (or any time within this range)  
*for 1 mark*

1

- (ii) increase the temperature / use smaller pieces of metal /  
 use more metal / increase the surface area of the metal /  
 add a catalyst / shake the flask / increase the concentration /  
 strength of the acid  
*for 1 mark*

1

(c) (i) 48  
*for 1 mark*

1

- (ii) increase the amount of magnesium used  
*for 1 mark*  
*(do not allow increase the amount of acid used)*

1

[6]