AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.6.1 RATE OF REACTION (PACK 3)

SCORE	PERCENTAGE
/210	%

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Q1.

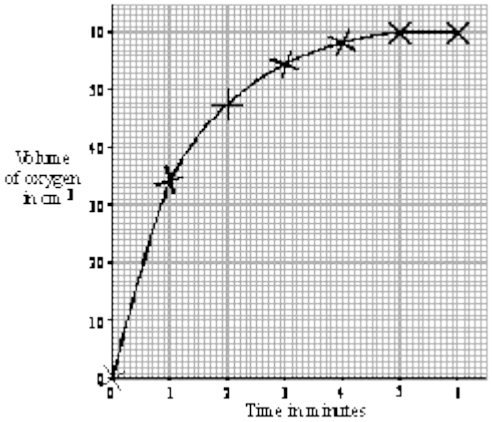
(a) (i) H_2O must be formula

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 ***3****marks*

1

(ii) 4.5 – 5

no units required

1

(iii) all <u>hydrogen peroxide</u> had reacted

accept all <u>hydrogen peroxide</u> had decomposed ***or*** *been used up*

accept no <u>hydrogen peroxide</u> (particles) left

1

(c) (i) remains lower than previous line

do ***not*** *accept bar chart*

1

line levels off lower than $60cm^3$

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

1

(ii) decrease of (hydrogen peroxide) <u>concentration</u>

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accept <u>concentration</u> is less
accept fewer collisions (of particles)
*do **not** accept weaker solutions **or** dilute solutions*

1

[10]

Q2.

(a) (i) 78-80%

1

(ii) proteins
accept amino acids

1

(b) (i) natural gas
accept methane (CH_4)
accept water (H_2O)

1

(ii) carbon dioxide

1

(c) (i) $N_2 + H_2$

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]

Q3.

(a) (i) (s) (aq) (1) (g)
*2 **or** 3 correct **1** mark*
*1 correct **0** marks*

2

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(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 ¾

not pure 1 mark

only 60 cm^3 (instead of 80 cm^3 of gas)

$\frac{60}{80}$ *× 100 **1** mark*

3

[10]

Q4.

(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^+ (aq)

accept H_3O^+ only if 2 in front of H_2O

1

OH^- (aq)

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

1

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(iii) $Ca(OH_2)$ weak alkali

accept NaOH strong alkali

1

$Ca(OH)_2$ causes no problems

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

1

[10]

Q5.

(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]

Q6.

(a) (i) $H^+ + OH^- \rightarrow H_2O / H_3O^+ + OH^- \rightarrow 2H_2O$

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) $MgCO_3$ or $MG^{2+}CO_3^{2-}$ or CO_3Mg

for 1 mark

1

(b) (i) 2 HCl

for 1 mark

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1

(ii) aqueous/<u>dissolved</u> in water (not in solution)

for 1 mark

1

(iii) CO_2/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]

Q7.

<u>Effect of pressure</u>

- high pressure increases yield

  for 1 mark

- <u>either</u> because less product molecules (Le Chatelier)
  <u>or</u> but high pressure increases cost/safety

  for 1 mark

<u>Effect of temperature</u>

- low temperature increases yield

  for 1 mark

- <u>either</u> because exothermic reaction (Le Chatelier)

  for 1 mark

- <u>or</u> but at low temperature rate is slow/catalyst does not work

<u>Compromise</u>

- optimum conditions to balance rate and % yield

  for 1 mark

- <u>or</u> rate is slow (at higher temperature) so need a catalyst
  <u>or</u> low percentage conversion so recycle untreated gases

[5]

Q8.

(a) (i) test tube / boiling tube

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for 1 mark

1

(ii) Na_2CO_3
NaCl
each for 1 mark

2

(b) (i) flask
measuring cylinder
each for 1 mark

2

(ii) used smaller pieces
gains 1 mark

but larger surface area for reaction
gains 2 marks

2

(c) (i) steeper line
straight line
each for 1 mark

2

(ii) reaction occurs when particles collide
higher temperature, higher speed of particles
so harder collisions
more frequent collisions
any three for 1 mark each

3

[12]

Q9.

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

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Possible alternative answer

size of fat pieces / small pieces of fat

have larger surface area

more collisions / greater chance of collisions

[7]

Q10.

(a) (i) 4 E (H-O) = 4 × 464 = 1856
2 E (O-O) = 2 × l46 = 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 (H-O) = 4 × 464 = 1856
E (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 it) / 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

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1

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

for 1 mark

1

[9]

Q11.

(a) NO_2 / $2NO_{2(g)}$ / 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 <u>neutralises</u> the acid / stops the reaction
or water will only slow the reaction not stop it

either for 1 mark

1

[7]

Q12.

(a) oxygen

Ignore any numbers
accept hydrogen oxide / steam

1

water

1

(b) catalyst

1

[3]

Q13.

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

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

1

(the volume of carbon dioxide remains at 83 cm^3)
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^3 **and** before 12 minutes

tolerance ± 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]

Q14.

(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]

Q15.

(a) **A** faster because: the graph line steeper / the reaction had stopped earlier

*accept sample **B** slower because: the graph line was <u>less steep</u> / the reaction stopped later*

A because CO_2 given off faster / fizzes more for 1 mark

***B** because CO_2 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

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accept more successful collisions = 2 marks

1

[5]

Q16.

(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]

Q17.

(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]

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Q18.

(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 ÷ 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]

Q19.

(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

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[7]

Q20.

(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]

Q21.

(a) $Zn + 2HC1 \rightarrow ZnC1_2 + H_2$

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

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

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

accept a balanced equation

1

[8]

Q22.

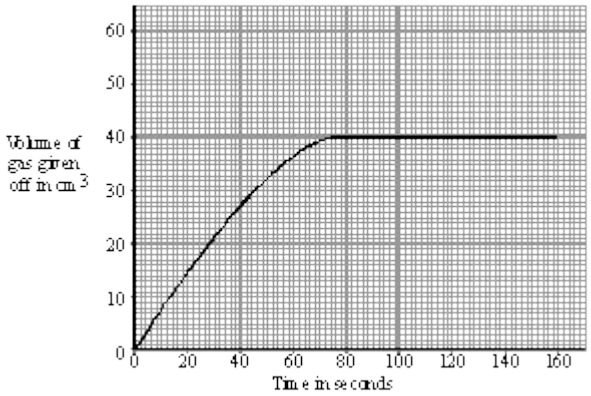
graph steeper

1

becomes horizontal

1

reaches twice the height, 40 cm^3 ± 1 cm^3



1

[3]

Q23.

(a) $CaCO_3$ + **2**HC1 → $CaC1_2$ + **CO_2 + H_2O**

*one mark for CO_2 and H_2O **or** H_2CO_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

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1

becoming nearly horizontal between 268.6 and 268.4 g

1

[8]

Q24.

(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** H2*

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]

Q25.

(a) (i) corners

accept an arrow to any corner

1

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(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]

Q26.

(a) both reactions slow down with time;
both reactions produce same volume of hydrogen

each for 1 mark

2

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

1

[3]

-

Q27.

(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) $\underline{2}\ NO + O_2 \rightarrow \underline{2}NO_2$
for 1 mark each

1

(iii) $\underline{3}\ NO_2 + H_2O \rightarrow \underline{2H}NO_3 + NO$
for 1 mark each

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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]

Q28.

(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 }

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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]

Q29.

(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]

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