AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.3.1 CHEMICAL MEASUREMENTS, CONSERVATION OF MASS AND QUANTITATIVE INTERPRETATION OF EQUATIONS (PACK 2)

SCORE	PERCENTAGE
/202	%

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Q1.

(a) 2.61 / range 2.5 to 2.7

*correct answer with **or** without **or** with wrong working gains **2** marks*

(accept answers between 2.5 and 2.7)

if answer incorrect moles of salicylic acid = 2/138 = 0.0145 moles
*ie 2/138 **or** 0.0145 gains **1** mark*
or
*(180/138) × 2 gains **1** mark*
or
*1 g → 180/138 = (1.304 g) gains **1** mark*
*(**not** 1.304g alone)*

2

(b) 42.1 range 40.7 to 42.3

*accept correct answer with **or** without **or** with wrong working for **2** marks*

*ecf ie (1.1 / their answer from (a)) × 100 correctly calculated gains **2** marks*

*if answer incorrect percentage yield = 1.1 / 2.61 × 100 gains **1** mark*

if they do not have an answer to part (a)
or
they choose not to use their answer then:

- yield = (1.1 / 2.5) × 100 (1)
- = 44

*accept 44 for **2** marks with no working*

2

(c) any **one** from:

- errors in weighing
- some (of the aspirin) lost

  *do **not** allow 'lost as a gas'*
- not all of the reactant may have been converted to product

  eg reaction didn't go to completion

  allow loss of some reactants
- the reaction is reversible

  accept other products / chemicals
- side reactions

  ignore waste products
- reactants impure

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- not heated for long enough
- not hot enough for reaction to take place

1

(d) any **one** from:

- use lower temperature
- use less fuel / energy
  ignore references to use of catalyst
- produce product faster **or** speed up reaction
- more product produced in a given time (owtte)
- increased productivity
- lowers activation energy

1

[6]

Q2.

(a) hydrogen / H^+ /$2H^+$ / H_3O^+

allow H / 2H
*do **not** accept H_2*
apply list principle

1

(b) (i) 143

*correct answer with or without working = **2** marks*
ignore units
if answer is not correct
*40 + (2 × 35.5) + (2 × 16) gains **1** mark*

2

(ii) 49.7% (49.6 to 50)

*correct answer with or without working = **2** marks*
*answer 49 gains **1** mark*
if answer is not correct:
*(71 ÷ 143) × 100 gains **1** mark*
allow error carried forward from part (b)(i)
*ie. (71 or their (2 × 35.5) ÷ answer to (b)(i)) × 100 gains **2** marks if calculated correctly and **1** mark if not calculated correctly.*
***Special case** 35.5 ÷ 143 × 100 = 24.8*
*to 25% **or** 35.5 ÷ answer to (b)(i) × 100 correctly calculated for **1** mark*

2

(iii) 9.9 to 10g

allow ecf from (b)(i) or (b)(ii)

1

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(c) (i) an alkali

apply list principle
accept named alkali
accept hydroxide
accept soluble base
ignore base

1

(ii) a solid / insoluble substance (owtte)

1

(iii) filter / filtration

allow decant / centrifuge
*accept filtration followed by evaporation **or** filtration and evaporation*
*do **not** accept filtration or evaporation*
*do **not** accept evaporation and filtration*

1

[9]

Q3.

(a) N_2O

1

(b) 13.8 to 14

gains full marks without working
if answer incorrect
*13 gains **1** mark*
or
*14/101 × 100 gains **1** mark*

2

[3]

Q4.

(a) 1213.8 to 1214.3

*gains **3** marks without working*

correct answer not given then check working

1) moles of N_2 $= \frac{1000}{28} = 35.7$ mol

***1** mark for each correct step*
*do **not** penalise rounding errors in this part*

2) moles of NH_3 = 2 × (answer from (1)) = 71.4 mol

3) mass of NH_3 = (answer from 2) × 17 = 71.4 × 17 = 1214 g

3

or

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- 28g of N_2 → 34g of NH_3

  1 *mark for each correct step*

- 1g of N_2 → $\frac{34}{28}$ = 1.214g NH_3

  *do **not** penalise rounding errors in this part*

- 1000 g of N_2 → 1000 × 1.214
  = 1214g

  allow error carried forward eg

or

- 1000 × $\frac{34}{28}$

  *gains **2** marks if correct answer not given*

  *1000 × $\frac{28}{34}$ gains **1** mark, **2** marks if correctly calculated*

  *(823.5g) 1000 × $\frac{28}{17}$ gains **1** mark if calculated correctly (1647.05g)*

or

other correct methods

look for the key ideas in the methods above

(b) 25 / 25.035 **or** ecf from (a)

*gains **2** marks even when there is no working*

*incorrect answer then 304/(their answer from (a)) × 100 gains **1** mark*

or using figures from part (b)

27.6 / 28

*gains **2** marks even when there is no working*

*accept 27 for **1** mark*

*if answers incorrect then304/1100 × 100 gains **1** mark*

2

(c) (i) increase yield

1

reaction is exothermic

or

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allow decreased yield because rate of reaction is slower / fewer collisions for **2** marks

***must** get both points for **2** marks*

1

(ii) increase yield

1

plus **one** from:

- more (gaseous) reactant molecules than (gaseous) product molecules (owtte)
  accept greater volume on the left than the right owtte
- increased rate of reaction / more collisions

1

(d) any **one** from:

economic

- large town provides workforce
- workers do not have to travel far to the factory. (owtte)
- transport infrastructure already in place for large town. (owtte)
- factory brings prosperity to town (owtte)
- factory provides employment
- reduced tourism
- reduction in local house prices
- any other sensible economic factor linked to town

1

any **one** from:

safety

- escape of dangerous / harmful chemicals / gases (owtte)
  *do **not** allow polluting gases unqualified*
- danger of increased traffic
- risk of explosion.(owtte) /danger of high pressure
- consequences of an accident could be severe if the town is close
- any other sensible safety idea

1

any **one** from:

environmental

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- factory might be unsightly (owtte)
- screening of factory (owtte)
- loss of habitats (owtte)
- plant trees/ hedges etc on and around plant site
- pollution of water / air / soil could harm plants / animals **or** noise pollution
  must be explained
- CO_2 is produced by burning fuels / heating
- CO_2 causes global warming / any effect of global warming
- eye sore
- any other sensible environmental factor

1

[12]

Q5.

(a) 157

*correct answer with **or** without working*
*(2 × 19 + 119) for **1** mark only*
*allow (119 + 19 =) 138 for **1** mark only*
ignore units

2

(b) 24.2

accept answers in the range 24 to 24.2038.....
ignore incorrect rounding after correct answer
*25 only without working gains **1** mark **or***
*38/157 × 100 gains **1** mark **or***
*(19/157 × 100 =) 12 to 12.1 gains **1** mark*
allow error carried forward from part(a)
*38/(a) × 100 gains **2** marks if calculated correctly*
*(19/138 × 100 =) 13.8 gains **1** mark*

2

(c) 0.29

accept answers in the range 0.28 to 0.3
allow error carried forward from part (b)
(b)/100 × 1.2 correctly calculated
ignore units

1

(d) an electron

allow electrons
*allow electron shared / lost for **1** mark*
apply list principle for additional particles

1

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is gained owtte

must be linked to electron

accept can hold / take in if in correct context

*eg it can hold another electron (in its outer shell) = **2** marks*

*it can take an electron (from another atom) = **2** marks*

ignore reference to fluoride ions

*incorrect number of electrons gained does **not** gain the second mark*

1

[7]

Q6.

(i) 160 ignore units

(2 × 56) + (3 × 16) for **1** mark

2

(ii) 70

$\frac{2 \times 56}{160} (\times 100)$ *for **1** mark*

allow ecf from part (i)

2

(iii) 700

allow ecf from part (ii)

1

[5]

Q7.

168g → 44g

1

1g → $\frac{44}{168}$

1

11g → 2.88g (2.9g)

care with rounding

1

or

Mr values 84 and 44

(1)

moles hydrogen carb = $\frac{11}{84} = 0.13$

(1)

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mass of CO_2 = $\frac{0.13}{2} \times 44$ = <u>2.9g</u>

*answer 2.88 to 2.9 gets **3** marks*
*answer of 3 gets **2** marks*

(1)

[3]

Q8.

(a) 100

ignore units
*40 + 12 + (3 × 16) for **1** mark*

1

(b) 40

*(**ecf** from part (a) can get **2** marks)*

$\frac{40}{\text{their (a)}} \times 100$ *for **1** mark*

1

(c) 0.5

*(**ecf** from part (b) can get **2** marks)*

$1.25 \times \left(\frac{\text{their (b)}}{100}\right)$ ***or** other correct working for **1** mark*

2

(d) gas produced **or** carbon dioxide / CO_2 produced

1

[7]

Q9.

(a) M_r (SiO_2) = 60

if M_r incorrect ecf for max 2

1

60 g SiO_2 → 28 g Si

*correct answer for **3** marks*

1

2.14 g SiO_2 → 1 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 (SiO_2) = 60 (1)

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

mass of SiO_2 needed = 0.0357 × 60 (1)

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= 2.14 g (1)

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

OR M_r (SiO_2) = 60 (1)

mass SiO_2 = 1 × $\left(\frac{60}{28}\right)$ (1)

= 2.14 g (1)

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

3

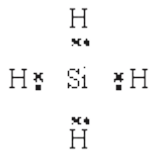
(b) (i) $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$

*penalise incorrect symbols correctly balanced equation for **1** mark state symbols for **1** mark*

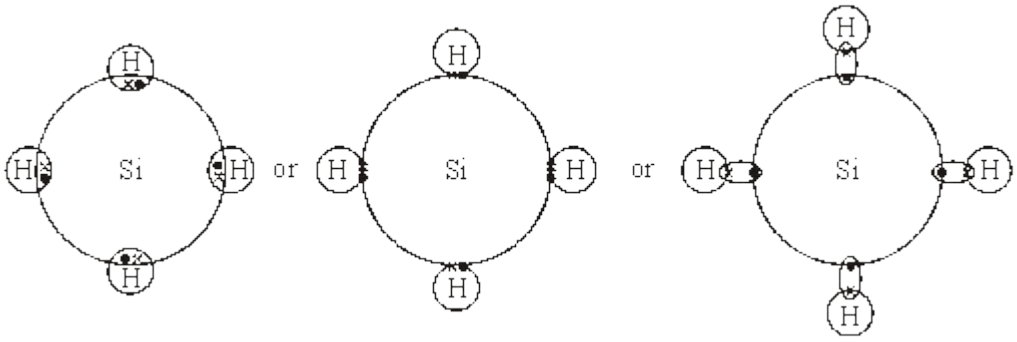
allow correct multiples / fractions

2

(ii)



or



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

SiH_3

*accept H_3Si **or** any correct formula with 1:3 ratio*

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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]

Q10.

352 g gains **3** marks

(moles C_8H_{18} = 114 / 114 = 1 mole)
moles CO_2 = 8 (1)
mass CO_2 = 8 × 44 (1) = 352 g (1)

1 *mark for each point*
(ecf allowed between parts)

or

114 → 8 (1) × 44

(1)

114 → 352 g

(1)

ecf allowed between parts

[3]

Q11.

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(a) put on soil **or** for plants

*accept land **or** field **or** garden **or** crops **or** plants*

accept alternative answer to provide more food for increased population

for growth

*accept to improve plant yield **or** help them grow*

*accept to replace **or** add nutrients (**not** nitrates) **or** minerals **or** to make plants grow better **or** for healthy plants*

*do **not** accept to make soil fertile **or** to feed plants*

2

(b) (i) 2

1

(ii) 80

1

[4]

Q12.

(i) a reaction in which the products can be changed back to reactants

*accept a reaction that can go forwards **or** backwards*

1

under certain conditions

1

(ii) M_r $CaCO_3$ = 100

1

M_r CaO = 56

1

mass of CaO = 140 (tonnes)

1

mark consequentially

[5]

Q13.

(i) 160

ignore units

1

(ii) 112

ignore units

1

(iii) 70

*do **not** carry forward errors*

1

[3]

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Q14.

144

accept TiCl4 = 190 for 1 mark

accept another correct step in calculation
*eg 570/190 = 3 for **1** mark*

[3]

Q15.

(a) (i) 45%

for 1 mark

1

(ii) 126 000 (consequential on (i))

for 1 mark

1

(b) (i) $Cl_2 = 71$
1 × 71/24 or correct mathematical attempt

for 1 mark

(If Cl_2 wrong take figure given)

for 1 mark

= 2.96 kg

gains 3 marks

(or alternative methods)
(if units not given - 3 marks. If units wrong - 2 marks)

3

(ii) any sensible eg. bleach/disinfectant/antiseptics/kill bacteria/
sterilise water/solvents/refrigerents/CFCs/PVC
(not water treatment or warfare)

for 1 mark

1

[6]

Q16.

(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

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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_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]

Q17.

(a) 56g

for 1 mark

1

(b) 44 tonnes

for 1 mark

1

[2]

Q18.

56
74

each for 1 mark

[2]

Q19.

(a) plot correct (2 segments)

for 1 mark

1

(b) nitrogen + hydrogen $\rightleftharpoons$ ammonia
or N_2 H_2 NH_3

all correct for 1 mark

1

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(c) largest area labelled nitrogen or shaded

for 1 mark

1

(d) (i) nitrogen

1

oxygen

hydrogen

1

three correct for 2 marks
two correct for 1 mark

(ii) potassium chloride

for 1 mark

1

(e) (i) $NH_4NO_3 = 14 + (4 \times 1) + 14 + (3 \times 16) = 80$

for one mark

1

(ii) ecf (error carried forward from part (i))
look for 28 / 80 for first mark

gains 1 mark

but 35% (% sign not needed)

special case of (14 / 80 × 100 = 17.5%) gains 1 mark

gains 2 marks

2

[9]

Q20.

(a) (i) both scales (must be sensible) (use at least half the paper)
plots for 350°C (to accuracy of +/- 1/2 square)
plots for 500°C (to accuracy of +/- 1/2 square)
lines of best fit (sensible smooth curves) (ignore below 50 atm.)
(must not join the dots and each curve must be a single line)

for 1 mark each

4

(ii) read accurately from their graph (must be 350 °C and pressure read to +/– half square from their graph)

for one mark

1

(iii) smooth curve drawn between 350°C and 500 °C - must be of similar shape to the other curves - a dashed line would be accepted here but would not be accepted for part (i)

for one mark

1

(b) (i) reversible reaction (owtte) / equilibrium / equilibria /
reaction goes in both directions etc.

for one mark

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1

(ii) maximum of 2 marks from each section up to a maximum total of 5

<u>effect of temperature (max. 2 marks)</u>
best yield at low temperature / poor yield at high temperature
reaction too slow at low temperature / fast at high temperature

<u>effect of pressure (max. 2 marks)</u>
high yield at high pressure (owtte) / low yield at low pressure
ideas to do with cost / safety factor of using higher pressures

<u>evaluation (max. 2 marks)</u>
formation of ammonia favoured at low temperature **because** reaction is exothermic formation of ammonia favoured at high pressure **because** more reactant molecules than product molecules
actual temperature and / or pressure used are a compromise between good yield and reasonable rate ammonia removed / unreacted nitrogen and hydrogen recycled so rate more important than yield catalyst used (not a wrongly named catalyst)

for 1 mark each

5

(c) (i) NH_4NO_3 = 14 + (4 × 1) + 14 + (3 × 16) = 80 (ignore units)

for one mark

1

(ii) ecf (error carried forward from part (i))
look for (28/80) for first mark

gains 1 mark

but 35% (% sign not needed)

special case of (14/80 × 100 = 17.5%) gains one mark

gains 2 marks

2

[15]

Q21.

1000 × 1000 / 0.065

gains 1 mark

but
15384615g (accept answer rounded to minimum of 2 sig. figures)

(accept answer with no units or correct units but incorrect unit loses one mark)
(answer correctly worked out in kg is acceptable)

gains 2 marks

[2]

Q22.

(a)

*the answer yes **or** no does not gain a mark*

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Yes – plants will grow faster

*do **not** accept grow better*

1

more food available, greater yield

1

OR

No – plants still grow without adding nitrates

*accept the idea that **small** amounts of nitrate could be used*

1

(nitrates) can 'kill' babies / causes brain damage

do not accept can stop respiration in babies

1

(b) (i) 2

accept two

1

(ii) 2 × 14 + 4 × 1 + 3 × 16

1

= 80

1

$\frac{28}{80} \times 100 = 35$ %

1

allow 1 mark for correct working for percentage 28/Y × 100, where Y is an incorrect formula mass
allow 2 marks for formula mass of 80 where no working ***or*** *correct working is shown*
allow 3 marks for 35 where no working ***or*** *correct working is shown*

[6]

Q23.

(a) 1400

1

(b) 980

correct answer gains full credit

160 tonnes Fe_2O_3 produces 112 tonnes Fe

if incorrect allow one mark for relative formula mass iron oxide = 160
allow e.c.f.

1400 tonnes Fe_2O_3 will produce 1400 / 160 × 112 tonnes Fe

use of 2000 tonnes Fe_2O_3 – deduct one mark only if working out is correct

4

[5]

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Q24.

36.8 / 37

correct answer, no workings = 3 if incorrect, allow 1 mark for rfm $FeSO_4$ = 152
***or** if incorrect rfm, allow 1 mark for 56/Y × 100 where Y is incorrect formula mass*

allow 2 marks for $\frac{56}{152} \times 100$

[3]

Q25.

(a) 10.86

accept answers between 10.64 to 10.9
if answer is incorrect allow 1 mark for
rfm $FeSO_4$ = 152
2 marks for 152 × 4/56

3

(b) $2\ Fe + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2$

accept other correct multiples for balancing

1

[4]

Q26.

(i) 4 **and** 1

both answers must be correct

1

(ii) 53.5

if incorrect relative formula mass
allow 1 mark for correct working
accept e.c.f. from c(i) for 2 marks

2

[3]

Q27.

73 (seventy three)

if answer is incorrect allow 1 mark for the correct proportion that H_2:HCl is 1:2
and 1 mark for 36.5

[3]

Q28.

(a) $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$

* reactants correct in every detail
* products correct in every detail

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if the spectator ions are sown then (1) mark should be credited but only if they are shown correctly on both sides
e.g.
$Mg + 2H^+ + 2Cl^- \rightarrow Mg^{2+} + 2Cl^- + H_2$

2

(b) 24 (parts) of magnesium → 2 (parts)

1

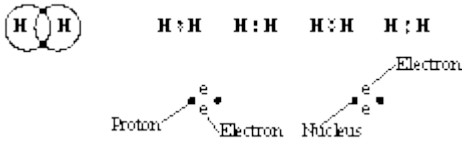
of hydrogen **or** equally clear working (so) 6 grams/g (are needed)

1

unit required

(c) (i) two (and no more) atoms shown to be sharing their single electrons examples

do not credit if anything which contradicts the impression that these are hydrogen atoms



1

(ii) (single) covalent (bond)

1

(d) $\frac{2}{34}$ (×100) = 6 (just 6 is worth (1) mark)

1

$\frac{2}{32} \times 100 = 6$ *or similar is (0)*

do not credit 5.8823529 and the like

1

[8]

Q29.

(a) (i) atmosphere

or (fractional distillation of liquid) air

1

(ii) **either**
more (chance) of them colliding/

not just 'faster'

coming into contact
or
the volume of the product / the ammonia is less than /
only half the volume of the reactants / the nitrogen and hydrogen

1

(iii) 3 × (1 ×2) of hydrogen
→ 2 × (14 +1 ×3) of ammonia

*accept 6 parts of hydrogen →34 parts of ammonia **or** similar*

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i.e. candidate uses the atomic masses and works correctly from the equation

1

= 225 (tonnes/t)

unit not required

1

(b) (i) megapascal(s)

accept million pascal(s)

1

(ii) 28 (%)

accept any answer in the range 28.0 to 28.5 inclusive

1

(iii) reduce the temperature and increase the pressure

both required

1

(iv) **either**

use a catalyst

accept use iron as a catalyst

accept use iron which has been more finely divided

accept use iron / catalyst with a bigger (surface) area

accept use a better catalyst

1

or

remove the ammonia (as it is produced)

*accept react the ammonia with **or** dissolve the ammonia in water (as it is produced)*

1

(c) ammonia
nitric acid
phosphoric acid

all three on the left correct

ammonia potassium chloride

all three on the right correct

water **or** water vapour

accept 'steam'

1

[10]

Q30.

(a) any **one** from

(as a) catalyst

***or** to mix with promoters*

to speed up the reaction (process)

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or *process is quicker do not credit just it is quicker*

to save energy
to reduce costs

or *process is cheaper*
do not credit just it is cheaper

larger surface area
(than lumps of iron)

or *larger surface area for the*
(catalysed) reaction (to take place)

1

(b) (i) water **or** steam
and methane
or natural gas
or North Sea gas

both required either order

1

(ii) **EITHER**
more (chance) of them colliding / coming into contact

do not credit just faster

OR volume of the product / ammonia less than / only half the volume of the reactants / the nitrogen and hydrogen

1

(iii) **EITHER**
680 (tonnes)

OR 28 (of nitrogen) → 34 (of ammonia)

accept any correct 14 : 17 ratio

1

560 (of nitrogen) → 34 × 20 (of ammonia)

3

[6]

Q31.

(a) *reference to*
hydrogen (atoms))
nitrogen (atoms)) but **not** molecules

each for 1 mark

ratio of 1N to 3H **atoms**

for 1 further mark

or 1 nitrogen atom and 3 hydrogen atoms
(ignore any incorrect statements about nature of bonding)

3

(b) *evidence of*
H = 1
N = 14
O = 16

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gains 1 mark

but
H = 1
N = 14
O = 16 × 3 or 48

gains 2 marks

but 63

gains 3 marks

3

[6]

Q32.

(a) Fe_2 [56 × 2] **or** 112
O_3 [16 × 3] **or** 48

each gain 1 mark

but M_r = 160

gains 3 marks

3

(b) [$Fe_2O_3 + 2A1 \rightarrow 2Fe + A1_2O_3$]

160 → 112 (NB Credit if unworked
(or value from (a)) (or value but should be totalled) from (a))

gains 1 mark

but
32 g. of Fe_2O_3 → 32/160 × 112

gains 2 marks

but = 22.4

gains 3 marks

3

[6]

Q33.

Ca = 40

$(OH)_2$ = (16 + 1)2 **or** 34

gain 1 mark each

but
M_r = 74

gains 3 marks

[3]

Q34.

Mg S O_4

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24 + 32 + 16 (×4) or 64 / evidence of <u>all</u> A_r's correct [so 24 + 32 + 16 1 mark]

gains 1 mark

but (M_r) = 120 No ECF

gains 2 marks

[2]

Q35.

(a) Mg S O_4

24 + 32 + 16 (×4) or 64 / evidence of <u>all</u> A_r's

gains 1 mark

but (M_r) = 120

gains 2 marks

2

(b) evidence that 24(g) magnesium would produce 120(g) mapesiurn sulphate

gains 1 mark

or correct scaling by 1/6

but 20(g) magnesium sulphate

gains 2 marks

[credit error carried forward from (a) with full marks in (b)]

2

[4]

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