

Mark schemes

1

- (a) s 1
- l

*Answers **must** be in the correct order.*

1

- (b) A gas was lost from the flask 1

(c) **Level 3 (5–6 marks):**

A coherent method is described with relevant detail, and in correct sequence which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.

Level 2 (3–4 marks):

The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):

Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:

No relevant content.

Indicative content

- sulfuric acid in beaker (or similar)
- add copper carbonate one spatula at a time
- until copper carbonate is in excess or until no more effervescence occurs *
- filter using filter paper and funnel
- filter excess copper carbonate
- pour solution into evaporating basin / dish
- heat using Bunsen burner
- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper)
- wear safety spectacles / goggles

*Students. may choose to use a named indicator until it turns a neutral colour, record the number of spatulas of copper carbonate added then repeat without the indicator.

6

- (d) Total mass of reactants = 221.5 1

159.5

221.5

allow ecf from step 1

1

72.0 (%)

allow 72.0 with no working shown for 3 marks

1

(e) any **one** from:

- Important for sustainable development
- Economic reasons
- Waste products may be pollutants / greenhouse gases

1

[13]**2**

(a) add excess copper carbonate (to dilute hydrochloric acid)

accept alternatives to excess, such as 'until no more reacts'

1

filter (to remove excess copper carbonate)

reject heat until dry

1

heat filtrate to evaporate some water **or** heat to point of crystallisation*accept leave to evaporate or leave in evaporating basin*

1

leave to cool (so crystals form)

until crystals form

1

must be in correct order to gain 4 marks(b) $M_r \text{ CuCl}_2 = 134.5$ *correct answer scores 4 marks*

1

moles copper chloride = (mass / M_r = 11 / 134.5) = 0.0817843866

1

 $M_r \text{ CuCO}_3 = 123.5$

1

Mass CuCO_3 (=moles $\times M_2$ = 0.08178 \times 123.5) = 10.1(00)

1

accept 10.1 with no working shown for 4 marks

(c) $\frac{79.1}{100} \times 11.0$

or

11.0×0.791

1

8.70 (g)

1

accept 8.70(g) with no working shown for 2 marks

(d) Total mass of reactants = 152.5

1

134.5

152.5

allow ecf from step 1

1

88.20 (%)

1

allow 88.20 with no working shown for 3 marks

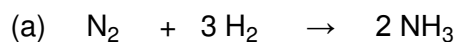
(e) atom economy using carbonate lower because an additional product is made or carbon dioxide is made as well

allow ecf

1

[14]

3



1

(b) catalyst

1

(c) as pressure increases percentage yield increases

1

(d) 32-23

both readings correct

1

= 9 (%)

1

[5]

4

(a) (i) lit splint or ignite the gas

1

(squeaky) pop / explosion

1

(ii) because it provides energy (for the reaction)

1

to break bonds (in the reactants) **or** so the particles collide successfully

ignore reference to frequency or rate of collisions

because it provides the activation energy gains 2 marks

1

(b) (i) 1.67(g)

allow 1.66-1.68

correct answer (to 3 significant figures) with or without working gains 3 marks

if answer incorrect allow up to 2 marks for the following steps:

24 → 40

1.00 → 40 / 24

or

*moles magnesium = 1 / 24 **or** 0.04(17)*

multiply by 40

*allow ecf from incorrect ratio **or** incorrect number of moles*

3

(ii) **if correct answer from part (b)(i) used**

allow ecf from part (b)(i)

89.8 or 90

if 1.82 g used

82.4 or 82

correct answer with or without working gains 2 marks

if answer incorrect, allow the following for 1 mark:

1.50 / 1.67 (or their answer from part (b)(i))

if 1.82 g used: 1.50 / 1.82

2

(iii) any **one** from:

ignore measurement errors

- not all the magnesium reacted
allow the reaction may be reversible
- some of the magnesium oxide / product may have been left in the tube **or**
may have been lost
ignore magnesium lost
- different / unexpected reaction
- magnesium not pure

1

[10]

5

- (a) (i) so ions can move (and carry charge)
accept so current can flow
allow so it can conduct (electricity)
allow so charged particles can move
*do **not** accept so electrons can move* 1
- (ii) because zinc ions gain electrons
accept because zinc ions are reduced 1
- 2 (electrons) 1
- zinc is formed
*accept correct half equation for **3** marks*
if no mark gained allow
*positive ions go to negative electrode **or***
*opposites attract **or***
*reduction (of zinc) **or***
*(zinc) gains electrons for **1** mark* 1
- (iii) $2 \text{Cl}^- \longrightarrow \text{Cl}_2 + 2 \text{e}^-$
must be completely correct 1
- (b) (i) because the magnesium is a gas
allow magnesium goes from solid to gas 1
- (ii) (a reaction which) takes in energy (from the surroundings)
accept more energy needed to break bonds than released by forming bonds
accept correct reference to energy level diagram
allow (a reaction which) takes in heat (from the surroundings) 1
- (iii) ($M_r \text{MgO} =$) 40
accept ($2 M_r \text{MgO} =$) 80 1
- 1.2 / 24 (x40) **or** 0.05 (x40)
or
 40 / 24 (x1.2) **or** 1.67 (x1.2)
allow ecf from step 1 1
- 2(.0)

allow ecf carried through from step 1
correct answer with or without working gains **3** marks

- (iv) 75(%) 1
- (v) any **one** from: 1
- the reaction is reversible
accept incomplete reaction
ignore equilibrium not reached
 - *some lost / escaped / released (when separated)*
 - some of the reactant may react in different ways from the expected reaction
 - *impure reactant(s)*
ignore measurement and calculation errors

1
[12]

6

- (a) any **two** from:
- heat water / make steam / boil water **or** heat / steam used in stage 1 or from stage 3
 - carbon dioxide from stage 3 used in stage 7 /to make urea
 - nitrogen and / or hydrogen recycled
 - ammonia and / or carbon dioxide recycled
allow unreacted material / gas recycled from stage 5 (to 4)
allow unreacted material / gas recycled from stage 8 (to 7)
NB: if neither of the last two points are awarded unreacted material recycled = 1 mark

2

- (b) (i) increase yield
- because (forward) reaction is exothermic
ignore references to rate 1
- allow because (forward) reaction gives out heat* 1
- (ii) increase yield
- ignore references to rate* 1
- because more (gaseous) reactant molecules than (gaseous) product molecules
accept because greater volume on the left than the right 1

1

(c) 76.9 - 77

correct answer gains 2 marks with or without working
allow 77 **or** 76.923...

allow 76 **or** 0.77 **or** 0.76923 for 1 mark

if answer incorrect allow 1 mark for **either**

$$\frac{60}{\text{attempt at total } M_r \text{ of all reactants}} \times 100$$

or

$$\frac{\text{attempt at total } M_r \text{ of area}}{78} \times 100$$

2

[10]

7

(a) gives out energy **or** heat

1

(b) (i) *accept qualified answers in terms of volume of gas related to time*

fast initially

1

slows down

1

reaction stops

accept reaction is now very slow

1

(b) (ii) 21

1

(iii) 84

correct answer with or without working = 2 marks

allow ecf from (b)(ii) correctly calculated for 2 marks

allow evidence of 21/25 **or** (b)(ii)/25 for 1 mark

2

(c) because they / particles have more energy / move faster

ignore particles move more / vibrate

1

(and so) particles collide more often / more frequently **or** particles more likely to collide*ignore collide faster**ignore more collisions*

1

(and) more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy*accept more successful collisions*

1

8

(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** *$(180/138) \times 2$ gains 1 mark***or** *$1 \text{ g} \rightarrow 180/138 = (1.304 \text{ g})$ 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 $(1.1 / \text{their answer from (a)}) \times 100$ correctly calculated gains 2 marks**if answer incorrect percentage yield = $1.1 / 2.61 \times 100$ gains 1 mark*

if they do not have an answer to part (a)

or

they choose not to use their answer then:

- $\text{yield} = (1.1 / 2.5) \times 100$ (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
- 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]

9

(a) 1213.8 to 1214.3

gains 3 marks without working

correct answer not given then check working

$$1) \text{ moles of N}_2 = \frac{1000}{28} = 35.7 \text{ mol}$$

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

$$2) \text{ moles of NH}_3 = 2 \times (\text{answer from (1)}) = 71.4 \text{ mol}$$

$$3) \text{ mass of NH}_3 = (\text{answer from 2}) \times 17 = 71.4 \times 17 = 1214 \text{ g}$$

3

or

- $28\text{g of N}_2 \rightarrow 34\text{g of NH}_3$

1 mark for each correct step

- $1\text{g of N}_2 \rightarrow \frac{34}{28} = 1.214\text{g NH}_3$

do not penalise rounding errors in this part

- $1000 \text{ g of N}_2 \rightarrow 1000 \times 1.214$
 $= 1214\text{g}$

*allow error carried forward eg***or**

- $1000 \times \frac{34}{28}$

gains 2 marks if correct answer not given

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

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

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 $304 / (\text{their answer from (a)}) \times 100$ 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 then $304 / 1100 \times 100$ gains 1 mark

2

(c) (i) increase yield

1

reaction is exothermic

or

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

- 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
- CO₂ is produced by burning fuels / heating
- CO₂ causes global warming / any effect of global warming
- eye sore
- any other sensible environmental factor

1

[12]

10

- (a) (i) (phosphoric) acid
allow phosphoric acid
- (ii) hydrogen
- (b) (i) faster / quicker / speeds it up (owtte)
allow answers based on activation energy
ignore helps it to react
- (ii) most of the starting materials end up as useful products
- (iii) H₂O
*allow HOH **or** OH₂*

1

1

1

1

1

[5]

11

- (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) $3 \times (1 \times 2)$ of hydrogen
 $\rightarrow 2 \times (14 + 1 \times 3)$ of ammonia
*accept 6 parts of hydrogen \rightarrow 34 parts of ammonia **or** similar*
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]