

M1.(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]

M2. (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:

- 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]

- M3.** (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]