

**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  $\text{CuCO}_3$  (=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

$11.0 \times 0.791$

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]