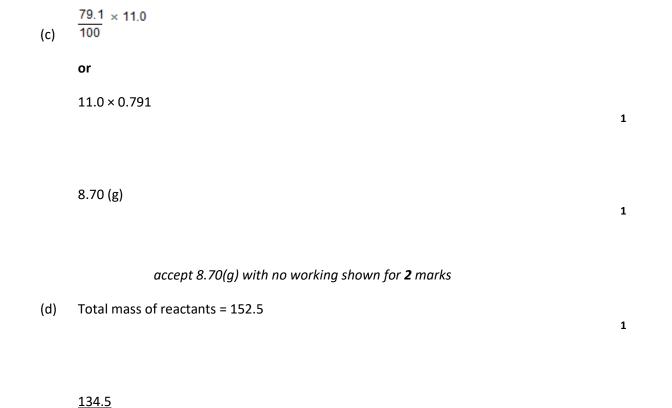
M1 .(a)	add exc	ress copper carbonate (to dilute hydrochloric acid) accept alternatives to excess, such as 'until no more reacts'	1
		filter (to remove excess copper carbonate) reject heat until dry	1
		heat filtrate to evaporate some water or heat to point of crystallisation accept leave to evaporate or leave in evaporating basin	1
		leave to cool (so crystals form) until crystals form	1
	(b)	must be in correct order to gain 4 marks $M_{r} \operatorname{CuCl}_{2} = 134.5$ $correct \ answer \ scores \ \textbf{4} \ marks$	1
		moles copper chloride = (mass / M_r = 11 / 134.5) = 0.0817843866	1
		<i>M</i> _r CuCO ₃ = 123.5	1
		Mass CuCO ₃ (=moles × M_2 = 0.08178 × 123.5) = 10.1(00)	1



accept 10.1 with no working shown for 4 marks

152.5

allow ecf from step 1

1

88.20 (%)

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 wellallow ecf

[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) × 2 gains **1** mark

or

 $1 g \rightarrow 180/138 = (1.304 g) gains 1 mark$

(**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)) \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) × 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 →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 either (iv) 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]