**M1.**(a)     1

*must be in this order*

**1**

very small

*accept negligible, 1 / 2000*

*allow zero*

**1**

(b)     The mass number

**1**

(c)     C

**1**

(d)     (i)      2

**1**

(ii)     3

**1**

(e)     (i)      28

**1**

(ii)     42.9

*accept ecf from (e)(i)*

*accept 42 - 43*

**1**

(f)    (i)      0.9

**1**

(ii)     any **one** from:

•        accurate

•        sensitive

•        rapid

•        small sample.

**1**

**[10]**

**M2.**         36.8 / 37

*correct answer, no workings = 3 if incorrect, allow 1 mark for rfm FeSO4 = 152****or*** *if incorrect rfm, allow 1 mark for 56/Y × 100 where Y is incorrect formula mass*

*allow 2 marks for  × 100*

**[3]**

**M3.**(a)     (i)      an alloy

**1**

(ii)     harder

**1**

(b)     (i)      162.5

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

*if no answer or incorrect answer then evidence of correct working [56 + (3x35.5)] gains* ***1*** *mark*

**2**

(ii)     34.46

*accept rounding from 34 - 34.5*

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

*accept ecf from (b)(i) correctly calculated for* ***2*** *marks*

*if no answer or incorrect answer then evidence of 56 / 162.5* ***or*** *56 / answer to (b)(i) gains****1*** *mark*

**2**

**[6]**

**M4.**(a)     (i)      central block

**1**

(ii)     conducts electricity

**1**

(b)     any **two** from:

•        visual pollution

•        noise pollution

•        dust pollution

•        habitat destruction.

**2**

(c)     (i)      to concentrate the ore / copper carbonate

**or**

to remove / separate the rock

**1**

(ii)     12 (tonnes)

*If answer is incorrect allow one mark for (127 + 132) − 247 or*

*259 - 247*

**2**

(iii)    any **one** from:

•        so no reactant is wasted / left unreacted

•        so they know how much product they will make

•        need to record / compensate for the carbon dioxide produced

*allow so they can work out their carbon footprint.*

**1**

**[8]**

**M5.**         (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]**

**M6.**         160

*ignore units if answer incorrect then (2 × 56) + (3 × 16)****or****112   +   48 for* ***one*** *mark*

**[2]**

**M7.**         (a)     hydrogen / H+ /2H+ / H3O+

*allow H / 2H*

*do* ***not*** *accept H2*

*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**

(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]**

**M8.**         (a)      (i)     40

*correct answer with or without working* ***or*** *incorrect working*

*if the answer is incorrect then evidence of 24 + 16 gains* ***1*** *mark*

*ignore units*

**2**

(ii)     60

*correct answer with* ***or*** *without working or incorrect working*

*if the answer is incorrect then evidence of 24/40* ***or*** *24/(i) gains* ***1*** *mark*

*ecf allowed from part(i)*

*ie 24/(i) ×100*

*ignore units*

**2**

(iii)    15

*ecf allowed from parts(i) and (ii)*

*24/(i) × 25 or (ii)/100 × 25*

*ignore units*

**1**

(b)     (i)      any **two** from:

*ignore gas is lost*

•        error in weighing magnesium / magnesium oxide

*allow some magnesium oxide left in crucible*

•        loss of magnesium oxide / magnesium

*allow they lifted the lid too much*

*allow loss of reactants / products*

•        not all of the magnesium has reacted

*allow not heated enough*

*allow not enough oxygen / air*

**2**

(ii)     any **two** from:

*ignore fair test*

•        check that the result is not anomalous

•        to calculate a mean / average

*allow improve the accuracy of the mean / average*

•        improve the reliability

*allow make it reliable*

•        reduce the effect of errors

**2**

**[9]**

﻿

**M9.**         (a)      (i)     65

*correct answer with or without working =* ***2*** *marks*

*if answer incorrect*

*evidence of (81 - 16) for* ***1*** *mark*

*ignore units*

**2**

(ii)     zinc

*accept error carried forward from (a)(i)*

*allow correct symbol*

*answer given should be element / metal closest to their answer*

*do* ***not*** *allow compounds*

**1**

(b)     (i)      •    it loses electrons

*sharing / covalency = max* ***1*** *mark*

**1**

•    three electrons

**1**

(ii)     8 electrons shown in second shell.

*accept dots / crosses / mixture of dots and crosses / e*

*electrons do not need to be paired*

*do* ***not*** *allow extra electrons in first shell*

**1**

**[6]**

**M10.**         (a)     (smell) warns of a leak / gas escape

*accept leak / gas escape by implication*

*ignore smell alone*

**1**

(b)     eg (mass spectrometry gives)  
different molecular ions / *M*r / formula mass **or**shows that one has mass 44 and the other 58

*‘mass of butane is more than mass of propane’ is insufficient*

*accept different fragmentation / pattern*

*do* ***not*** *accept Ar / RAM*

*accept references to butane deflects less or converse*

**1**

(c)     CO2                      2 H2O  
1.1                        0.9  
–––                      –––

44                         18

**1**

= 0.025                 = 0.05

**1**

1 (mole) CO2         2 (moles) H2O

**1**

1                           4

**or**

CH4

**1**

**or alternative method**

Mass of C = (1)

Mass of H =(1)

C : H



proportions 0.025 : 0.1 (1)

whole number 1 : 4 (1)

**or**

CH4

*correct formula with no working is only 1 mark*

*M3 can be awarded from the formula if steps one and two are clear*

*correct formula from their incorrect ratio gets 1 mark*

*if fraction is wrong way around e.g. Mr / mass, then lose M1 and M2 but accept ecf for M3 and M4 max 4*

**[6]**

**M11.**          (a)     40 + 12 + (3 × 16) = 100

*each for 1 mark*

**2**

(b)     Mr of CaO = 56

*for 1 mark*

mass required = 60 × 100/56

*for 2 marks*

= 107.1

*for 1 mark*

**4**

(c)     (i)      calcium hydroxide

**1**

(ii)     solid

**1**

**[8]**

**M12.**          (a)     calcium atom loses two electrons

*accept diagrams with correct labelling*

**1**

(each) fluorine atom gains one electron

*accept two electrons transfer from a calcium atom to the two fluorine atoms for these first* ***two*** *marks*

**1**

forming full (outer) shells of electrons

*accept forming full (outer) energy levels* ***or*** *noble gas electronic structures*

*do* ***not*** *accept stable unless qualified*

**1**

giving the ions Ca2+ and F

**1**

          attraction between ions of opposite charges

*accept electrostatic attraction between ions*

*if candidate mentions sharing* ***or*** *pairing of electrons then no credit*

*if explanation is entirely correct but they state this is called covalent bonding, the maximum mark is* ***four***

**1**

(b)     atoms of the same element

**1**

          atomic number is same

*accept each contains 92 or same number of protons*

**1**

          mass numbers differ **or** each has a different number of neutrons

**1**

          one has 146 neutrons the other has 143 neutrons

*accept one has three more* ***or*** *less neutrons than the other*

**1**

          (c)     (i)      349

**1**

(ii)     349g UF2 produces 235g U [1]

*first mark can be awarded if answer is incorrect*

answer = 117.5

**1**

**[12]**

**M13.**         144

*accept TiCl4 = 190 for 1 mark*

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

**[3]**

**M14.**          (a)     Mg    S    O424 + 32 + 16 (×4) or 64 / evidence of all Ar’s

*gains 1 mark*

**but** (Mr) = 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]**

**M15.**          (a)     because calcium is +2 and hydroxide is –1

*accept to balance the charges*

**or**to make the compound neutral (in terms of charges)

*allow calcium needs to lose 2 electrons and hydroxide needs to gain one electron*

**1**

(b)     particles of size 1-100 nm

*allow clear comparison to ‘normal’ size particles*

**or** particles with a few hundred atoms / ions

**or** particles with a high surface area (to volume ratio)

**or** as different properties to ‘normal’ size particles of the same substance

**1**

(c)     **M**r CaO = 56  
**and**

**M**r Ca(OH)2= 74

**1**

2/56 (x74) **or** 0.036 (x74)  
**or**

*allow ecf from step 1*

74/56 (x2) **or** 1.3(214…) (x2)

**1**

2.6(428…) in range 2.6 to 2.96

*correct answer with or without working gains* ***3*** *marks*

*allow ecf carried through from step 1*

*ignore final rounding to 3*

**1**

**[5]**

**M16.**          (a)     130.4

*accept 130 to 130.43478………*

*correct answer gains two marks with or without working*

*an answer of 131 would gain* ***one*** *mark.*

*if answer is not correct then:  
moles of salicylic acid = 0.7 .......... (1 mark)****or****mass of aspirin = moles of salicylic acid x 180 (1 mark)****or****100 x (180/138) (1 mark)*

**2**

(b)     (i)      62.5%

*accept 63%*

*correct answer gains two marks with or without working*

*if answer is not correct then:*

*250/400 x 100 (1 mark)*

**2**

(ii)     any **one** from:

•        reversible reaction

*accept not all of the reactant converted to product*

•        some of product lost

**1**

(c)     use lower temperatures  
**or**less energy needed

*allow product made faster or more product made in a given time*

**1**

**[6]**

**M17.**          70/56      30/16

*division by atomic mass*

**1**

= 1.25       = 1.875

*proportion*

**1**

2       3

*ratio (accept 1:1.5 / 4:6 / etc)*

*allow e.c.f from proportion if sensible attempt at step 1*

**1**

Fe2O3

*formula allow e.c.f from ratio if sensible attempt at step 1*

*allow correct formula with no working =* ***1*** *mark*

***1***

***[4]***

***M18.****(a)      (i)     84 / 84.5 / 83.98*

*correct answer with or without working gains* ***3*** *marks*

*(moles of NaN3 =) 130/65 (1)*

*moles of nitrogen = 3 (1)*

*mass of nitrogen = 3 x 28 = 84 (1)*

***or***

*2 x (23 + (3 x 14)) (1)*

*3 x (2 x14) (1)*

***or***

*2NaN3 = 130 (1)*

*3N2 = 84 (1)*

*if answer is incorrect then look for evidence of correct working.*

*allow ecf from previous stage*

***1*** *mark lost for each mistake in the working if they do not have the correct answer.*

***3***

*(ii)     72 / 72.24 / 72.2*

*allow ecf from part (i) × 0.86*

***or***

*ignore working*

*69* ***or*** *68.8*

***1***

*(b)     (i)      2* ***and*** *5*

***1***

*(ii)     any* ***one*** *from:*

*•        corrosive / burns*

*•        alkaline / basic*

*do* ***not*** *accept acidic*

*•        attacks / destroys / damages living tissue / cells*

*allow irritant*

*ignore reference to reactivity*

*ignore reference to silicates*

*ignore harmful / toxic*

***1***

***[6]***

***M19.****(a)     (i)      10.8 / 24        31.8 / 35.5        57.4 / 16*

*division by atomic mass*

***1***

*0.45        0.90        3.59*

*proportion*

***1***

*1        :        2        :        8*

*ratio*

***1***

*MgCl2O8*

*formula*

*if the candidate has just written down the correct answer with no working allow* ***3*** *marks. If working is shown award* ***4*** *marks.*

*allow* ***2*** *marks if the candidate has the initial fractions upside down and gets the answer Mg8Cl4O as long as working has been shown*

*allow symbols in any order but do* ***not*** *allow incorrect capitals or subscript and superscript numbers, eg mGCl2O8 (final mark)*

*allow ecf after step 2 provided a sensible attempt has been made in step 1*

***1***

*(ii)     because it has electrostatic forces of attraction* ***or*** *attraction between oppositely charged ions*

*any mention of covalent bonds* ***or*** *molecules* ***or*** *intermolecular forces max.* ***2*** *marks*

***1***

*giant structure / lattice* ***or*** *many bonds*

*accept attraction between positive and negative ions  
do* ***not*** *accept atoms*

***1***

*that need lots of energy to overcome / break*

***1***

*(b)     any* ***three*** *from:*

*•        more can be stored in a given volume* ***or*** *takes up less space*

*could be answered in terms of comparing liquid with gas, but not simply the disadvantages of storing a gaseous fuel*

*•        (liquid has) greater energy density*

*•        (liquid) does not require high pressure containers*

*•        (liquid is) less likely to leak*

*allow easier to detect a leak*

***3***

***[10]***

***M20.****(a)     magnesium loses electrons*

*there are four ideas here that need to be linked in two pairs.*

***1***

*two electrons*

***1***

*chlorine gains electrons*

*magnesium loses electrons and chlorine gains electrons scores* ***2*** *marks.*

***1***

*two atoms of chlorine*

*magnesium loses two electrons and two chlorines each gain one electron will score full marks.*

***1***

*(b)     95*

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

*if answer incorrect, allow 24 + 35.5 + 35.5 for* ***1*** *mark*

***2***

***[6]***

***M21.****(a)     *

***or***

*426 × (67.6 / 100) = 288  
288 / 12 = 24*

***1***

*(b)     5.65 / 12        2.2 / 14        0.629 / 1*

*correct answer of C3NH4 with no working scores* ***2*** *marks*

***1***

*0.471            0.157            0.629*

*allow ecf from mp2 onwards*

***1***

*3                     1                4*

*if the ratios are not shown but the correct working is shown for mp1 and mp2 , the ratio mark can be scored from C3NH4*

***1***

*C3NH4*

*if the initial fractions are inverted and the candidate gets an answer of C4N12H3 award* ***2*** *marks*

***1***

***[5]***

***M22.****(a)     (i)      calcium (carbonate)*

*allow CaCO3*

***or***

*magnesium (carbonate)*

*allow MgCO3*

***1***

*(ii)     carbon dioxide*

*allow CO2*

***1***

*(b)     – COOH group correctly displayed*

***1***

*(c)     (i)      because hydrochloric acid is a strong(er) acid*

*allow converse throughout*

*‘it’ refers to hydrochloric acid*

*allow because hydrochloric acid has lower pH*

***1***

*which ionises more*

*accept produces / has more hydrogen ions / H+ ions*

***1***

*(ii)     corrosive*

*allow reacts with heating element / kettle*

*ignore dissolves*

***1***

*(d)     0.2288*

*correct answer gains* ***3*** *marks with or without working accept 0.229* ***or*** *0.23*

*if answer is incorrect*

*28.6 × 0.2 ÷ 1000 (=0.00572) gains* ***1*** *mark*

*0.00572 × 1000 ÷ 25 or ecf gains* ***1*** *mark*

***or***

*28.6 × 0.2 ÷ 25 gains* ***2*** *marks*

***3***

***[9]***

***M23.****(a)     any* ***two*** *from:*

*•        temperature (of the HCl)*

*•        mass or length of the magnesium*

*•        surface area of the magnesium*

*•        volume of HCl*

***2***

*(b)     (i)      (a greater concentration has) more particles per unit volume*

*allow particles are closer together*

***1***

*therefore more collisions per unit time* ***or*** *more frequent collisions.*

***1***

*(ii)     particles move faster*

*allow particles have more (kinetic) energy*

***1***

*therefore more collisions per unit time* ***or*** *more frequent collisions*

***1***

*collisions more energetic (therefore more collisions have energy greater than the activation energy)* ***or*** *more productive collisions*

***1***

*(c)     (i)       add (a few drops) of indicator to the acid in the conical flask*

*allow any named indicator*

***1***

*add NaOH (from the burette) until the indicator changes colour* ***or*** *add the NaOH dropwise*

*candidate does not have to state a colour change but penalise an incorrect colour change.*

***1***

*repeat the titration*

***1***

*calculate the* ***average*** *volume of NaOH* ***or*** *repeat until concordant results are obtained*

***1***

*(ii)****moles of NaOH***

*0.10 × 0.0272 = 0.00272 moles*

*correct answer with or without working gains* ***3*** *marks*

***1***

***Concentration of HCl***

*0.00272 / 0.005 = 0.544*

*allow ecf from mp1 to mp2*

***1***

*correct number of significant figures*

***1***

***[14]***

***M24.****(a)      (i)               incorrect test or no test =* ***0*** *mark*

*testing the solution* ***or*** *using blue litmus =* ***0*** *mark*

*(test ammonia / gas with red) litmus*

*accept any acid-base indicator with correct result*

***1***

*(goes) blue*

***OR***

*(conc.) HCl (1)*

*white fumes / smoke / solid (1)*

*allow white gas / vapour*

***OR***

*(test ammonia / gas with) Universal Indicator (1)*

*blue / purple (1)*

***1***

*(ii)               incorrect test or no test =* ***0*** *marks*

*add barium chloride / BaCl2 (solution)*

*do* ***not*** *accept H2SO4 added*

***or*** *add barium nitrate / Ba(NO3)2 (solution)*

*allow Ba2+ solution / aqueous added*

***1***

*white precipitate / solid (formed)*

*allow white barium sulfate / BaSO4*

*ignore barium sulfate / BaSO4 alone*

***1***

*(b)     (i)      fully / completely ionised / dissociated****or*** *hydrogen ions fully dissociated*

*accept has more ions than weaker acid / alkali of same concentration*

*ignore strongly ionised*

*do* ***not*** *accept ions are fully ionised*

*ignore concentrated* ***or*** *reference to concentrations of ions*

***1***

*(ii)     methyl orange*

*accept correct spelling only*

*accept any strong acid-weak base indicator*

*do* ***not*** *allow phenolphthalein / litmus / universal indicator*

***1***

*(iii)    32 × 0.05/1000* ***or*** *0.0016 (mole H2SO4 )*

*accept (0.05 x 32) = (V x 25)* ***or*** *0.05 x 32 / 25*

***1***

*(reacts with) 2 × 0.0016* ***or*** *0.0032 (mole NH3 in 25 cm3)*

*accept dividing rhs by 2* ***or*** *multiplying lhs by 2*

***1***

*(0.0032 × 1000/25 =) 0.128*

*allow ecf from previous stage*

*correct answer 0.128* ***or*** *0.13 with or without working gains all* ***3*** *marks*

***1***

*(iv)     2.176* ***or*** *2.18*

*correct answer with or without working*

***or*** *ecf from candidate’s answer to (b)(iii)*

***or*** *2.55 if 0.15 moles used*

*if answer incorrect or no answer*

*0.128 × 17* ***or*** *0.13 x 17*

***or*** *their (b)(iii) × 17*

***or*** *0.15 × 17 gains* ***1*** *mark*

***2***

***[11]***

***M25.****(a)     Hydrogen / H+*

*ignore state symbols*

*ignore proton / H*

***1***

*(b)                        it = weak acid*

*pH of weak acid is higher than the pH of a strong acid*

*allow converse for strong acids*

*allow correct numerical comparison*

***1***

*any* ***one*** *from:*

*allow converse for strong acids*

*•        only partially dissociated (to form ions)*

*allow ionises less*

*•        not as many hydrogen ions (in the solution)*

*allow fewer H+ released*

***1***

*(c)     (i)      (titration of) weak acid and strong base*

***1***

*(ii)     0.61*

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

*if the answer is incorrect:*

*moles of sodium hydroxide = (30.5 × 0.5)/1000 = 0.01525 moles*

***or***

*(0.5 × 30.5/25) gains* ***1*** *mark*

***2***

*(d)     12*

*correct answer with or without working gains* ***2*** *marks or even with incorrect working.*

*if the answer is incorrect:*

*0.8 × 60 = 48g*

***or***

*evidence of dividing 48g (or ecf) by 4*

***or***

****** *0.8 × 0.25 = 0.2 mol*

***or***

*evidence of multiplying 0.2mol (or ecf) by 60*

*would gain* ***1*** *mark*

***2***

***[8]***