EDEXCEL INTERNATIONAL GCSE CHEMISTRY
EDEXCEL CERTIFICATE IN CHEMISTRY
ANSWERS

SECTION E

(To save endless repetition, wherever they are included, comments are intended for home-schooling parents who may well lack confidence in this area.)

Chapter 22

1. If you had 100 typical atoms, the total mass would be (60.2 x 69) + (39.8 x 71) = 6980 (3 sig figs)
   RAM is therefore 6980/100 = 69.8

2. If you had 100 atoms of Si-28 and the others in the correct proportion, the total number of atoms would be 100+5.10+3.36 = 108.46
   The total mass would be (100 x 28) + (5.10 x 29) + (3.36 x 30) = 3048.7
   RAM = 3048.7/108.46 = 28.1

3. a) The relative atomic mass of an element is the weighted average mass of the isotopes of the element. It is measured on a scale on which a carbon-12 atom has a mass of exactly 12 units.

   b) Repeat the sum in Q1 twice to give Cu = 63.6 and S = 32.1. Add these together to give CuS = 95.7

4. a) 44
   b) 132
   c) 286
   d) 392
   e) 392
   (The common mistakes in c) and e) would be not to multiply the whole water molecule by 10 or 6. So for example in c) the mass of the $10H_2O$ is 180. Students will commonly and wrongly come up with 36 for this by multiplying the H_2 by 10 but not the O as well. Work out the mass of the whole H_2O first and then multiply it by the number in front. That way you won't make this mistake.)

5. a) 81.8%
   b) 51.2%
   (In each case, work out the M_r and the mass of the element you are interested in and find the percentage.)

6. a) 46.7%
   b) 13.9%
   c) 35%
   d) 21.2%
   (Be careful of the cases where there are two nitrogen atoms in the fertiliser (all except KNO_3). The masses of the nitrogen in those cases will be 28 and not 14.)

7. In each case, work out the M_r by adding up the RAMs, and then attach the unit "g" to give the mass of 1 mole. Then scale it by multiplying by the number of moles you want.
   a) 331 g
   b) 68.8 g
   c) 68.64 g
   (In c), the M_r should be 286. Care with the water! See above. Strictly, this number shouldn't be quoted to more than 2 significant figures, because the number of moles is only quoted to that accuracy.)

8. In each case, work out the mass of 1 mole as above, and then work out how many moles you've got in the stated mass.
   a) 0.2
   b) 17900 (or 17857 although this is accurate to more significant figures than the RAM). You have to divide 1,000,000 grams by 56 g (the mass of 1 mole of Fe)
   c) 5×10^{-4} (0.0005)

9. These are a random mixture of the sort of conversions that have been explored in earlier examples. The only working is shown for a slight variant.
   a) 234 g
   b) 0.5 mol
   c) 25 mol
   d) 10 g
   e) 40 g
   f) 250 (If 0.004 mol weighs 1 g, then 1 mol weighs 1/0.004 g = 250 g. The relative formula mass is the mass of 1 mole, but without the unit "g".)

10.a)

	K	N	O
combining mass	5.85 g	2.10 g	4.80 g
No of moles of atoms	5.85/39 = 0.15	2.10/14 = 0.15	4.80/16 = 0.3
Ratio of moles	1	1	2

Empirical formula = KNO_2

b)

	Na	S	O
combining mass	3.22 g	4.48 g	3.36 g
No of moles of atoms	3.22/23 = 0.14	4.48/32 = 0.14	3.36/16 = 0.21
Ratio of moles (divide by smallest number)	1 simplifies to 2	1 2	1.5 3

Empirical formula = $Na_2S_2O_3$

c)

	carbon	hydrogen	bromine
given %	22.0	4.6	73.4
combining mass in 100g	22.0 g	4.6 g	73.4 g
No of moles of atoms	22.0/12 = 1.833	4.6/1 = 4.6	73.4/80 = 0.9175
Ratio of moles (divide by smallest number)	2	5	1

Empirical formula = C_2H_5Br

11.a) Calculate the mass of oxygen in the compound (2.84 - 1.24 g), and then a straightforward empirical formula sum as before will lead to P_2O_5

(b) P_2O_5 has a M_r of 142. To get a M_r of 284 needs twice as many atoms - so P_4O_{10}

12.a)

	carbon	hydrogen	oxygen
given %	66.7	11.1	22.2
combining mass in 100g	66.7 g	11.1 g	22.2 g
No of moles of atoms	66.7/12 = 5.558	11.1/1 = 11.1	22.2/16 = 1.3875
Ratio of moles (divide by smallest number)	4	8	1

Empirical formula = C_4H_8O

b) If you add up C_4H_8O, you get 72. The molecular formula is the same as the empirical formula.

13. You know the mass of anhydrous sodium sulphate (1.42 g)
You can work out the mass of water of crystallisation (3.22 - 1.42 g = 1.8 g)

You can work out the mass of 1 mole of sodium sulphate, Na_2SO_4 = 142 g
and the mass of 1 mole of water = 18 g

Number of moles of sodium sulphate = 1.42/142 = 0.01 mol
Number of moles of water = 1.8/18 = 0.1 mol

So for every 1 mole of sodium sulphate, there are 10 moles of water.

14. Work out the mass of $CaSO_4$ = 44.14 - 37.34 = 6.8 g
Work out the mass of water = 45.94 - 44.14 = 1.8 g
Work out how many moles you've got of each and then compare them.
You should find that n = 2.

15. 1 mol of water (18 g) contains 6 x 10^{23} molecules.

Therefore, 18 cm^3 of water contains 6 x 10^{23} molecules. (Density is 1 g cm^{-3})
1 cm^3 of water contains 6 x 10^{23} /18 = 3.333 x 10^{22} molecules.
0.05 cm^3 of water contains 0.05 x 3.333 x 10^{22} = 1.67 x 10^{21} molecules.

Chapter 23

1. From the equation, 4 mol Na gives 1 mol Ti.
Substituting masses: 4 x 23 g Na give 48 g Ti
i.e. 92 g Na give 48 g Ti
Because the ratio is bound to be the same 92 tonnes Na give 48 tonnes Ti.
Therefore, 92/48 tonnes Na give 1 tonne Ti.

Mass of Na needed = 1.92 tonnes

2. The equation shows that 1 mol $AlCl_3$ gives 3 mol AgCl
Substituting masses: (27 + (3x35.5)) g $AlCl_3$ gives 3 x (108 + 35.5) g AgCl
i.e. 133.5 g $AlCl_3$ gives 3 x 143.5 g AgCl = 430.5 g AgCl
So, 2.67 g $AlCl_3$ gives 2.67/133.5 x 430.5 g AgCl = 8.61 g

(For students whose maths isn't very good, insert another step by working out what 1 g of $AlCl_3$ would give (divide by 133.5) and then multiplying that by 2.67. The same sort of technique can be used in all examples of this type.)

3. a) From the first equation: 1 mol $CaCO_3$ gives 1 mol CaO
Substituting masses: 100 g $CaCO_3$ gives 56 g CaO
This ratio will be the same for tonnes as for grams:
100 tonnes $CaCO_3$ gives 56 tonnes CaO
So, 1 tonne $CaCO_3$ gives 0.56 tonnes CaO

b) In the second equation 1 mol CaO needs 1 mol H_2O
56 g CaO needs 18 g H_2O
Or, 56 tonnes CaO needs 18 tonnes H_2O
So, 0.56 tonnes CaO needs 0.18 tonnes H_2O

c) Again from the second equation, 1 mol CaO produces 1 mol $Ca(OH)_2$
56 g CaO gives (40 + 2 x (16 + 1)) g $Ca(OH)_2$ = 74 g $Ca(OH)_2$
56 tonnes CaO gives 74 tonnes $Ca(OH)_2$
0.56 tonnes CaO gives 0.74 tonnes $Ca(OH)_2$

4. a) Tracing the equations through, 1 mol CuO will eventually produce 1 mol $CuSO_4.5H_2O$
80 g CuO will give 64 + 32 + (4x16) + (5 x 18) g $CuSO_4.5H_2O$ = 250 g
4 g CuO will give 4/80 x 250 g $CuSO_4.5H_2O$ = 12.5 g

b) Percentage yield = 11.25 / 12.5 x 100% = 90%

5. a) From the equation: 1 mol Cr_2O_3 reacts with 2 mol Al
(2 x 52) + (3 x 16) g Cr_2O_3 reacts with 2 x 27 g Al
152 g Cr_2O_3 reacts with 54 g Al
Or, 152 tonnes Cr_2O_3 reacts with 54 tonnes Al
So, 1 tonne Cr_2O_3 reacts with 54/152 tonnes Al = 0.355 tonnes Al

(b) 1 mol Cr_2O_3 produces 2 mol Cr
152 g Cr_2O_3 produces 104 g Cr
152 tonnes Cr_2O_3 produces 104 tonnes Cr
1 tonne Cr_2O_3 produces 104/152 tonnes Cr = 0.684 tonnes Cr

6. 4 mol FeS_2 produces 2 mol Fe_2O_3 and 8 mol SO_2
(4 x 120) g FeS_2 produces (2 x 160) g Fe_2O_3 and (8 x 64) g SO_2
480 g FeS_2 produces 320 g Fe_2O_3 and 512 g SO_2
Or, 480 tonnes FeS_2 produces 320 tonnes Fe_2O_3 and 512 tonnes SO_2
1 tonne of ore contains 0.5 tonnes FeS_2
So, 0.5 tonnes FeS_2 produces 0.5/480 x 320 tonnes Fe_2O_3 and 0.5/480 x 512 tonnes SO_2
Therefore (a) mass of Fe_2O_3 = 0.333 tonnes, and (b) mass of SO_2 = 0.533 tonnes

7. a) 1 mol Cl_2 weighs 71 g
If 24000 cm^3 (at rtp) weighs 71 g
200 cm^3 weighs 200/24000 x 71 g = 0.592 g

b) 1 mol O_2 weighs 32 g
So 32 g O_2 occupies 24000 cm^3 at rtp
and 0.16 g O_2 occupies 0.16/32 x 24000 cm^3 at rtp = 120 cm^3
(or you could have worked in dm^3 - giving 0.12 dm^3)

c) The mass of 1 mole is what would occupy 24 dm^3 at rtp
If 1 dm^3 weighs 1.42 g, 24 dm^3 weighs 24 x 1.42 g = 34.1 g

8. The equation says that 1 mol Mg gives 1 mol H_2
So, 24 g Mg gives 24000 cm^3 H_2 at rtp
Therefore, 0.240 g Mg gives 0.240/24 x 24000 cm^3 H_2 = 240 cm^3 H_2

9. The equation says that 2 mol KNO_3 gives 1 mol O_2
So, (2 x 101) g KNO_3 gives 24 dm^3 O_2
Or, 202 g KNO_3 gives 24 dm^3 O_2
Therefore, to get 1 dm^3, you would need 202/24 g KNO_3 = 8.42 g

10. The equation says that 1 mol MnO_2 gives 1 mol Cl_2
So, 87 g MnO_2 gives 24000 cm^3 Cl_2
Therefore, 2.00 g MnO_2 gives 2.00/87 x 24000 cm^3 Cl_2 = 552 cm^3

11. a) 1 mol $BaSO_4$ weighs 233 g
So, 0.328 g $BaSO_4$ is 0.328 / 233 mol = 1.41×10^{-3} mol (0.00141 mol)

b) The second equation shows that 1 mol $BaSO_4$ comes from 1 mol Na_2SO_4
Therefore the mixture contained 1.41×10^{-3} mol Na_2SO_4

c) 1 mol Na_2SO_4 weighs 142 g
Therefore 1.41×10^{-3} mol weighs 1.41×10^{-3} x 142 g = 0.200 g

d) The total mixture of sodium sulfate and sodium sulfite weighed 1.000 g.
Remaining sodium sulfite weighs 1.000 - 0.200 g = 0.800 g
Percentage remaining = 0.800/1.000 x 100 = 80.0%

Chapter 24

1. A current of 0.50 amps for 1 hour = 0.50 x 60 x 60 coulombs
= 1800 coulombs

1 mol of copper deposited needs 2 mol of electrons = 2 x 96000 coulombs
= 192000 coulombs

If 192000 coulombs causes 1 mol Cu to be deposited
then 1800 coulombs causes 1800/192000 mol Cu to be deposited

1 mol Cu weighs 64 g

1800/192000 mol Cu weighs 1800/192000 x 64 g = 0.60 g

2. a) No of coulombs = 0.350 x 1000
= 350

1 mol Pb (207 g) is deposited by 2 mol electrons = 2 x 96000 coulombs
= 192000 coulombs

350 coulombs deposit 350/192000 x 207 g Pb = 0.377 g

b) 1 mol O_2 (24000 cm^3 at rtp) is given off by 4 mol electrons = 4 x 96000 coulombs
= 384000 coulombs

350 coulombs will release 350/384000 x 24000 cm^3 at rtp = 21.9 cm^3

3. a) No of coulombs = 0.40 x 75 x 60
= 1800

1 mol Cu (64 g) is deposited by 2 mol electrons = 2 x 96000 coulombs
= 192000 coulombs

1800 coulombs will deposit 1800/192000 x 64 g Cu = 0.60 g

(b) The equations show that, for a given number of electrons flowing, the mass of copper gained by the cathode is exactly the same as the mass of copper lost from the anode.

Therefore, of the 0.80 g actually lost, 0.60 g is pure copper.

Percentage purity = 0.60/0.80 x 100 % = 75%

4. The equation shows that 1 mol Al (27 g) is produced from 3 mol e^- = 3 x 96000 coulombs
= 288000 coulombs

1 tonne (1000000 g) would be produced by 1000000 / 27 x 288000 coulombs
= 1.067 x 10^{10} coulombs

The current has flowed for 24 hours = 24 x 60 x 60 secs = 86400 secs

Coulombs = amps x secs,
and so amps = coulombs/secs
Current needed = 1.067 x 10^{10} / 86400 amps
= 123000 amps

(Yes, that's pretty big - but it's the sort of currents they actually use!)

5. a) Working from the cobalt figure to start with:

   1 mol Co (59 g) is deposited by 2 mol electrons = 2 x 96000 coulombs
   = 192000 coulombs

   0.295 g Co is deposited by 0.295/59 x 192000 coulombs = 960 coulombs

   b) For chromium, 1 mol Cr (52 g) is deposited by 3 mol electrons = 3 x 96000 coulombs
   = 288000 coulombs

   The same quantity of electricity (960 coulombs) flows through both beakers.

   960 coulombs will deposit 960/288000 x 52 g Cr = 0.173 g

6. There are two ways of doing this calculation. You could do it exactly as in Q6, but notice that the question doesn't give a value for the faraday. The solution below shows a short cut method, but there is no reason why you can't do it by the longer method in Q6 if you want to. You should get the same answer either way.

   Notice that 2 mol of electrons are needed to deposit 1 mol of either lead or copper.
   That means that you will always get the same number of moles of both.

   Moles of copper = 0.64/64 = 0.01

   Therefore, moles of lead also = 0.01

   mass of lead = 0.01 x 207 g = 2.07 g

Chapter 25

1. a)

Bonds broken:	4 x C-H	= 4 x (+413)	= +1652
	1 x Br-Br		= + 193
	total		= +1845
Bonds made:	3 x C-H	= 3 x (-413)	= -1239
	1 x C-Br		= - 290
	1 x H-Br		= - 366
	total		= -1895
Overall change	= +1845 - 1895	= -50 kJ (exothermic)	

b)

Bonds broken:	1 x H-H		= +436
	1 x Cl-Cl		= +243
	total		= +679
Bonds made:	2 x H-Cl	= 2 x (-432)	= -864
Overall change	= +679 - 864	= -185 kJ (exothermic)	

c)

Bonds broken:	2 x H-H	= 2 x (+436)	= +872
	1 x O=O		= +498
	total		= +1370
Bonds made:	4 x O-H	= 4 x (-464)	= -1856
Overall change	= +1370 - 1856	= -486 kJ (exothermic)	

2. a) Her first two results weren't reliable - there was too much difference between them.

b) Two of: Danger of fire from burning hexane if spilt. Danger of scalding from hot water. Danger of cuts if fragile thermometer or flask are broken. (Plus anything else relevant to your school's risk assessment policies.)

c) Heat evolved = mass x specific heat x temperature rise.

Mass is taken as the mass of water = 100 g
Specific heat = 4.18 J g^{-1} $°C^{-1}$
Temperature rise = 55.0 - 19.0 = 36.0°C

Heat evolved = 100 x 4.18 x 36.0 J = 15048 J (or 15.048 kJ or 15.0 kJ to 3 sf)

d) Mass of hexane burnt = 35.62 - 35.23 g = 0.39 g

Heat evolved per gram = 15.0 / 0.39 kJ = 38.5 kJ

e) 1 mol hexane weighs 86 g

Heat evolved per mole = 38.5 x 86 kJ = 3310 kJ

(It is important to notice that we have introduced rounding errors here. Every time you feed a rounded answer into the next part of the calculation, you introduce a small extra error. If you simply used the number on your calculator for the next step rather than the rounded one, you would get a final answer of 3320 kJ (to 3 sf). On the other hand, there is no simple way of showing that you have done that in an exam, and so you could end up with an answer inconsistent with your working.)

f) There must be some precision here, and the reason given must have produced a higher value for the heat evolved. For example:

- ·Misreading one of the weighings of the spirit burner so that it looked as if less hexane had been burnt that was really the case.
- ·Misreading the thermometer to give a final temperature higher than it should have been.
- ·Adding less than 100 cm^3 of water to the flask, so that the temperature went up more than it should because the heat was going into a smaller volume of water.

g) Massive heat losses. Not all of the heat from the burner goes into the water in the flask; much will go straight into the air. No account is taken of the heat being used to warm up the flask or the thermometer. Heat is lost from the water to the surrounding air as the water warms up, and the higher its temperature, the faster it loses heat.

Chapter 26

1. 1 mol H_2SO_4 weighs 98 g
   4.90 g is 4.9/98 mol = 0.0500 mol
   Concentration = 0.0500 mol dm^{-3} (0.0500 to show that the answer is accurate to 3 sig figs)

2. KOH is 0.200 mol dm^{-3}
   1 mol KOH weighs 56 g
   0.200 mol weighs 0.200 x 56 g = 11.2 g
   Concentration = 11.2 g dm^{-3}

3. Relative formula mass Na_2CO_3 = 106
   So 1 mol Na_2CO_3 weighs 106 g
   0.100 mol weighs 10.6 g
   To get a 0.100 mol dm^{-3} solution you would have to dissolve 10.6 g in 1 dm^3 (1000 cm^3)
   If you only wanted 100 cm^3 of solution you would only need 1.06 g Na_2CO_3

4. No of moles of copper(II) sulphate = 20/1000 x 0.100
   = 0.00200 mol

   Equation shows that 1 mol $CuSO_4$ produces 1 mol $BaSO_4$
   No of moles $BaSO_4$ formed = 0.00200 mol

   1 mol $BaSO_4$ weighs 233 g
   0.00200 mol $BaSO_4$ weighs 0.00200 x 233 g = 0.466 g

5. 25.0 cm^3 of 2.00 mol dm^{-3} HCl contains 25.0/1000 x 2.00 mol = 0.0500 mol

   The equation shows that you only need half the number of moles of calcium carbonate as of hydrochloric acid.

   No of moles of $CaCO_3$ = 1/2 x 0.0500 mol
   = 0.0250 mol

   I mole of $CaCO_3$ weighs 100 g.
   0.0250 mol $CaCO_3$ weighs 0.0250 x 100 g = 2.50 g

6. No of moles of H_2SO_4 = 25/1000 x 1.0 = 0.025 mol
   The equations show that 1 mol CuO will produce 1 mol of $CuSO_4.5H_2O$
   1 mol of $CuSO_4.5H_2O$ weighs 250 g.
   Mass produced = 0.025 x 250 g = 6.25 g

7. a) No of moles of NaOH solution = 25.0/1000 x 0.400 mol = 0.0100 mol
   The equation shows that you need half as many moles of sulfuric acid = 0.00500 mol
   The acid has a concentration of 0.200 mol dm^{-3} . . .
   . . . which means that 0.200 mol is contained in 1000 cm^3
   Therefore 0.00500 mol is contained in 0.00500/0.200 x 1000 cm^3 = 25.0 cm^3

   b) 1 mol of $CaCO_3$ weighs 100 g.
   Therefore 10.0 g is 0.100 mol
   From the equation, you need twice as many moles of HCl = 0.200 mol
   The acid has a concentration of 2.00 mol dm^{-3} . . .
   . . . which means that 1000 cm^3 contains 2.00 mol
   Therefore 0.200 mol is contained in 100 cm^3.

8. (For home-schooling parents: In each of these examples, start from what you know most about and work from there. If a student needs to put extra steps in, encourage them to do so. For example, if there are 0.2 mol in 1000 cm^3, there are 0.2/1000 mol in 1 cm^3 and 25 x 0.2/1000 mol in 25 cm^3.

Or, if there are 0.05 mol in 24 cm^3, there are 0.05/24 mol in 1 cm^3 and 1000 x 0.05/24 mol in 1000 cm^3.

There is no embarrassment in doing this. All that matters is getting the answer right!)

a) No of moles of NaOH = 25/1000 x 0.100 = 0.00250 mol

The equation shows a 1:1 reaction.

No of moles of HNO_3 = 0.00250 mol
That's in 20.0 cm^3.

Concentration of HNO_3 = 1000/20.0 x 0.00250 mol dm^{-3} = 0.125 mol dm^{-3}

b) No of moles of HNO_3 = 30.0/1000 x 0.100 = 0.00300 mol

The equation shows that you need half as many moles of sodium carbonate as of nitric acid.

No of moles of Na_2CO_3 = 1/2 x 0.00300 mol
= 0.00150 mol
That's in 25.0 cm^3.

Concentration of Na_2CO_3 = 1000/25.0 x 0.00150 mol dm^{-3} = 0.0600 mol dm^{-3}

c) No of moles of K_2CO_3 = 25.0/1000 x 0.250 = 0.00625 mol

The equation shows that you need twice as many moles of ethanoic acid as of potassium carbonate.

No of moles of CH_3COOH = 2 x 0.00625 mol
= 0.0125 mol

That's in 12.5 cm^3.

Concentration of CH_3COOH = 1000/12.5 x 0.0125 = 1.00 mol dm^{-3}

9. a) No of moles of HCl = 18.8/1000 x 0.04 mol = 7.52 x 10^{-4} mol (0.000752 mol)
The equation shows that this reacts with half that number of moles of calcium hydroxide.
No of moles of $Ca(OH)_2$ = 3.76 x 10^{-4} mol (0.000376 mol)
That's in 25 cm^3.
Concentration of $Ca(OH)_2$ = 1000/25 x 3.76 x 10^{-4} mol dm^{-3} = 0.0150 mol dm^{-3}

b) 1 mol $Ca(OH)_2$ weighs 74 g.
Concentration = 0.0150 x 74 g dm^{-3} = 1.11 g dm^{-3}

End of Section E Questions

1. a) The relative atomic mass of an element is the weighted average mass of the isotopes of the element.(1) It is measured on a scale on which a carbon-12 atom has a mass of exactly 12 units. (1).

   b) The total mass of 100 atoms = (75 x 35) + (25 x 37) = 3550 (1)
   The average mass of 1 atom = 3550/100 = 35.5 (1)

   c) 1 mole of KI weighs 39 + 127 g = 166 g (1)
   4.15 g of KI = 4.15/166 mol = 0.025 mol (1)
   From the equation, 2 mol KI gives 1 mol I_2
   Number of moles of I_2 = 0.025/2 mol = 0.0125 mol (1)
   Mass of I_2 = 0.0125 x 254 g = 3.175 g (1)

   d) 1 mole of chlorine, Cl_2, weighs 71 g
   24.0 dm^3 weighs 71 g (1)
   1 dm^3 weighs 71/24 g = 2.96 g
   Density = 2.96 g dm^{-3} (1)

2. a) Mass of lead = 24.16 - 17.95 = 6.21 g (1)

   b) Mass of oxygen = 24.80 - 24.16 g = 0.64 g (1)

   c)

	Pb		O	
Combining masses	6.21 g		0.64 g	
No of moles of atoms	6.21/207		0.64/16 (1)	
	= 0.03		= 0.04	
Ratio of moles	3	:	4	(1)
Empirical formula:		Pb_3O_4	(1)	

   d) RFM of PbO_2 = 239 (1)
   % Pb = 207/239 x 100 = 86.6 % (1)

3. a) RFM CO_2 = 44 (or mass of 1 mole = 44g) (1)
   No of moles = 0.55/44 = 0.0125 (1)

   b) 0.0125 mol (1) (Equation shows 1:1 relationship between calcium carbonate and CO_2)

   c) RFM $CaCO_3$ = 100 (or mass of 1 mole = 100g) (1)
   No of moles = 0.0125 x 100 = 1.25 g (1)

   d) % of $CaCO_3$ in sand = 1.25/1.86 x 100 = 67.2 % (1)

4. a) (i) RFM $CuFeS_2$ = 184 (1)
   % of copper = 64/184 x 100 = 34.8 % (1)

   (ii) % of copper in total ore would be 0.5 x 34.8 % = 17.4% (1)
   Therefore 1 tonne contains 0.174 tonnes of Cu (1) (or any other valid method)

   b) (i) 1 mol Cu gives 1 mol $Cu(NO_3)_2$ (1)
   64 g Cu gives 188 g $Cu(NO_3)_2$ (1)
   8.00 g Cu gives 8.00/64 x 188 g $Cu(NO_3)_2$ = 23.5 g (1)

   (ii) 1 mol Cu gives 2 mol NO_2
   64 g Cu gives 2 x 24.0 dm^3 NO_2 = 48.0 dm^3 (1)
   8.00 g Cu gives 8.00/64 x 48.0 dm^3 = 6.00 dm^3 (1)

5. a) 4 mol FeS_2 gives 2 mol Fe_2O_3
4 x 120 g = 480 g FeS_2 gives 2 x 160 g = 320 g Fe_2O_3 (1)
480 kg FeS_2 gives 320 kg Fe_2O_3 (1)

b) 480 g FeS_2 would give 4 mol Fe = 4 x 56 g = 224 g Fe (1)
480 kg FeS_2 gives 224 kg Fe (1)

c) 480 g pyrite gives 8 x 24.0 dm^3 SO_2 (1) = 192 dm^3 (1)
480 kg gives 1000 x 192 dm^3 = 192000 dm^3 (1)

d) 96000 dm^3 (1) (half the answer to part (c) - using Avogadro's Law)

6. a) Moles of HCl = 32.8/1000 x 0.100 = 3.28 x 10^{-3} mol (1)

b) 3.28 x 10^{-3}/2 mol = 1.64 x 10^{-3} mol (1)

c) 1000/25.0 x 1.64 x 10^{-3} (1) = 0.0656 mol dm^{-3} (1)

d) RFM $Sr(OH)_2$ = 122 (1) (or mass of 1 mol = 122 g)
Concentration = 0.0656 x 122 g dm^{-3} = 8.00 g dm^{-3}

7. a) 1000 cm^{-3} needs 40 x 0.100 g = 4.00 g (1)
250 cm^3 needs 1.00 g (1)

b) Moles of NaOH = 25.0/1000 x 0.100 = 2.5 x 10^{-3} mol (1)
Need half the number of moles of H_2SO_4 (1)
Moles of H_2SO_4 = 0.5 x 2.5 x 10^{-3} = 1.25 x 10^{-3} mol (1)
Concentration of acid = 1000/20.0 x 1.25 x 10^{-3} = 0.0625 mol dm^{-3} (1)

c) (i) 0.0625 mol H_2SO_4 reacts with 0.0625 mol Mg
Mass Mg = 0.0625 x 24 g (1) = 1.50 g (1)

(ii) 0.0625 mol H_2SO_4 gives 0.0625 mol H_2
Vol of H_2 = 0.0625 x 24.0 dm^3 (1) = 1.50 dm^3 (1)

8. a) 0.64 g Cu is 0.64/64 mol = 0.01 mol (1)
Same number of moles of Cl_2 formed.
Vol Cl_2 = 0.01 x 24.0 dm^3 = 0.24 dm^3 (1)

b) (i) 1 mol Mg (24 g) produced by 2 mol e^- (1)
1.20 tonne Mg produced by 1,200,000/24 x 2 mol e^- =100,000 mol e- (1)
(ii) No of coulombs = 100,000 x 96000 = 9.6 x 10^9 (1)

(iii) coulombs = amps x time in secs
Time in secs = 9.6 x 10^9 / 250,000 = 38400 secs (1)
Time in hours = 38400 /3600 = 10.7 hours (1)