# Higher Chemisty
# Unit 3
# Activity Sheets

# REACTING MASSES – ACTIVITY SHEET

1. $2Mg + O_2 \rightarrow 2MgO$

   What mass of MgO would be formed from 4·86g of Mg?

2. $2AgNO_3 + Zn \rightarrow 2Ag + Zn(NO_3)_2$

   What mass of silver will be deposited if 1·962g Zn reacts completely?

3. $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

   Calculate the mass of carbon dioxide produced when 5g of calcium carbonate reacts completely with acid?

4. $MgCO_3 \rightarrow MgO + CO_2$

   Calculate the mass of magnesium oxide formed when 100g magnesium carbonate decomposes on heating.

5. A dragster can accelerate from 0 to 270mph in 5secs. The fuel is nitromethane which burns as follows:

   $4CH_3NO_2 + 3O_2 \rightarrow 4CO_2 + 6H_2O + 2N_2$

   During a race, 45kg of fuel is used. Calculate the mass of oxygen needed to burn this fuel.

6. A Perth company buys in ammonia and phosphoric acid to make the fertiliser ammonium phosphate.

   $3NH_3 + H_3PO_4 \rightarrow (NH_4)_3PO_4$

   What mass of fertiliser would be made from 500g of $NH_3$?

7. At Grangemouth, BP make large quantities of ethanol by a process called catalytic hydration of ethene:

   $C_2H_4 + H_2O \rightarrow C_2H_5OH$

   What mass of ethanol would be produced from 560kg of ethene

8. During WW2 US Pilots carried lithium hydride tablets. If their plane crashed, the tablets reacted with sea water to produce hydrogen to fill the lifeboats.
   What mass of hydrogen would be produced from 1kg of lithium hydride?

   $LiH + H_2O \rightarrow LiOH + H_2$

**Gas Calculations - Molar volume**

**1.** The volume of 0.22g of propene is 118$cm^3$. Calculate the volume of 2 moles of propene

**2.** The volume of 1 g of hydrogen is 11.6 Litres. Calculate the volume of 4 mol of hydrogen.

**3.** A flask, capacity 600$cm^3$, was used to calculate the molar volume of sulphur dioxide. The following data was obtained.

Mass of evacuated flask = 512.97g
Mass of flask+ sulphur dioxide = 514.57g

Calculate the molar volume of sulphur dioxide.

**4.** From the data calculate the approximate formula mass of gas X.

Mass of plastic bottle empty = 112.80g
Mass of plastic bottle + gas X = 113.52g
Capacity of plastic bottle = 1 Litre
Molar gas volume of gas = 23.6 litres $mol^{-1}$

**In questions 5 and 6 take the molar gas volume of the gases to be 23.0 litres $mol^{-1}$.**

**5.** Calculate the volume of
a) 10g of neon b) 3.2g of oxygen

**6.** Calculate the mass of
a) 2.3 Litres of ammonia b) 1 Litre of hydrogen

**7.** $2NH_3$ (g) + $H_2SO_4$ (aq) → $(NH_4)_2SO_4$(aq)

Calculate the volume of ammonia gas that would react with excess sulphuric acid to produce 33g of ammonium sulphate. Take the molar gas volume to be 24 litres $mol^{-1}$.

**8.** Zn (s) + 2HCl(aq) → $ZnCl_2$ (aq) + $H_2$ (g)

Use the equation above to calculate the volume of hydrogen gas produced when the following reactions go to completion. Vmol = 24 litres $mol^{-1}$.

a) 13.1g of zinc are added to excess dilute hydrochloric acid.
b) Excess zinc is added to 100$cm^3$ of 2 $moll^{-1}$ hydrochloric acid.

**9.** 12.25g potassium chlorate ($KlO_3$) on heating decomposed to potassium chloride and oxygen. Calculate the volume of oxygen produced. (When the molar gas volume is 22.4L)

**10.** 2C + $O_2$ → 2CO

Under a set of experimental conditions, the volume of 1 mole of gas was found to be 22.4L. What mass of carbon will be required to form 2.24 litres of carbon monoxide under the same conditions?

# EXCESS CALCULATIONS – ACTIVITY SHEET

1. $2Mg + O_2 \rightarrow 2MgO$

0·24g is burned in 0·24 mol of oxygen. Calculate which reactant is in excess

2. $AgNO_3 + HCl \rightarrow AgCl + HNO_3$

A pupil mixed 20cm$^3$ of silver nitrate solution, concentration of 0·5 mol l$^{-1}$ with 15cm$^3$ of hydrochloric acid, concentration 1·0 mol l$^{-1}$
Show by calculation which reactant was in excess.

3. $2AgNO_3 + Zn \rightarrow 2Ag + Zn(NO_3)_2$

0·5g of zinc was added to 20cm$^3$ of silver nitrate concentration 0·25 mol l$^{-1}$
Show by calculation which reactant is in excess

**4.** $NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$

A common method of preparing ammonia is to heat an ammonium salt with soda lime. A student heated 5g of each chemical together.
Which one was in excess?

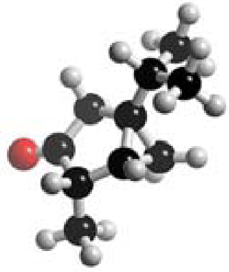
**5.** (a) In a small scale smelter, 5kg CuO is reduced using 0·25kg carbon (charcoal).
Which reactant is in excess?

$2CuO + C \rightarrow 2Cu + CO_2$

Copper oxide casts £50 per kilogram
Charcoal costs £3 per kilogram

(b) Suggest a modification to the process that would make it more cost effective.

# PERCENTAGE YIELD



## PERCENTAGE YIELD

1) Sulfur dioxide reacts with oxygen to make sulfur trioxide. $2SO_2 + O_2 \rightarrow 2SO_3$
   a) Calculate the maximum theoretical mass of sulfur trioxide that can be made g of sulfur dioxide with an excess of oxygen.

   b) In the reaction, only 90 g of sulfur trioxide was made. Calculate the percentage yield.

2) Iron is extracted from iron oxide in the Blast Furnace as shown:

   $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

   a) Calculate the maximum theoretical mass of iron that can be made from 1 tonne of iron oxide.

   b) In the reaction, only 650000 g of iron was made. Calculate the percentage yield.

3) Nitrogen reacts with hydrogen to make ammonia:

   $N_2 + 3H_2 \rightarrow 2NH_3$

   a) Calculate the maximum theoretical mass of ammonia that can be made by reacting 90g of hydrogen with an excess of nitrogen.

   b) In the reaction, only 153 g of ammonia was produced. Calculate the percentage yield.

4) Titanium can be extracted from titanium chloride by the following reaction:

   $TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

   a) Calculate the maximum theoretical mass of titanium that can be extracted from 100 g oft titanium chloride.

   b) In the reaction, only 20 g of titanium was made. Calculate the percentage yield.

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5) Aluminium is extracted from aluminium oxide in the following reaction. $2Al_2O_3 \rightarrow 4Al + 3O_2$
   a) Calculate the maximum theoretical mass of aluminium that can be made from 1 kg of aluminium oxide.

   b) In the reaction, only 500 g of aluminium was made. Calculate the percentage yield.

6) The fertiliser ammonium sulpfate is made as follows:

   $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

   a) Calculate the maximum theoretical mass of ammonium sulfate that can be made by reacting 85 g of ammonia with an excess of sulfuric acid.

   b) What mass was produced if the yield was 60%?

## ATOM ECONOMY

1) Calculate the atom economy to make sodium from sodium chloride. $2NaCl \rightarrow 2Na + Cl_2$
2) Calculate the atom economy to make hydrogen from the reaction of zinc with hydrochloric acid $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
3) Calculate the atom economy to make iron from iron oxide in the Blast Furnace. $Fe_2O_3 + 3CO \rightarrow 2\,Fe + 3CO_2$
4) Calculate the atom economy to make calcium oxide from calcium carbonate. $CaCO_3 \rightarrow CaO + CO_2$
5) Calculate the atom economy to make sulfur trioxide from sulfur dioxide. $2SO_2 + O_2 \rightarrow 2SO_3$
6) Calculate the atom economy to make oxygen from hydrogen peroxide. $2H_2O_2 \rightarrow 2H_2O + O_2$

## GENERAL QUESTIONS

1) Hydrazine ($N_2H_4$) was used as the rocket fuel for the Apollo missions to the moon. It is by reaction of ammonia ($NH_3$) with sodium chlorate (NaOCl):

ammonia + sodium chlorate → hydrazine + sodium chloride + water

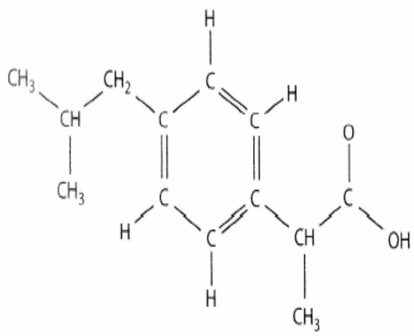
$$2NH_3 + NaOCl \rightarrow N_2H_4 + NaCl + H_2O$$

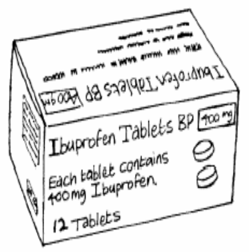
a) Calculate the maximum theoretical mass of hydrazine that can be made by reacting 340 g of ammonia with an excess of sodium chlorate.

b) In the reaction, only 280 g of hydrazine was produced. Calculate the percentage yield.

c) Calculate the atom economy for this way of making hydrazine.

2) **Ibuprofen is a common pain killer used for symptoms such as head aches, tooth ache and period pains. It was invented in the 1960's by Boots and became available without a prescription in the 1980's. In the original method for making ibuprofen the atom economy was 40%. However, a new way of making ibuprofen was invented in the 1980's that had an atom economy of 77%. This means there is less waste to dispose of and so is a "greener" way of making ibuprofen. The method is also cheaper**






Sustainable development is where we do what we need to meet peoples' needs and improve their lives today in a way that does not stop people from meeting the needs of people in the future. Often, the higher the atom economy the better a process for sustainable development because there is less waste.

a) The newer method has a much better atom economy of 77%. Explain why a higher atom economy is better.

b) About 3000 tonnes of ibuprofen tablets are taken in the UK each year. Calculate the mass of waste created making 3000 tonnes of ibuprofen tablets at an atom economy of 40%.

c) Calculate the mass of waste created making 3000 tonnes of ibuprofen tablets at an atom economy of 77%.

d) Calculate how much less waste is produced making 3000 tonnes of ibuprofen tablets by the new method compared to the old method.

# ENTHALPY CALCULATIONS ACTIVITY SHEET

**1.** Write the definition of:

(a) enthalpy of combustion
(b) enthalpy of solution

**2.** Write an equation to represent:

(a) enthalpy of combustion of ethanol
(b) enthalpy of solution NaOH

**3.** (i) A pupil discovered that 2·3g ethanol released 14kJ on combustion. Calculate ΔH of combustion of ethanol.

(ii) 1·6g of sodium hydroxide was dissolved in 25cm$^3$ water. The temperature rose from 20°C to 29°C. Calculate ΔH solution of NaOH

**4.** 100cm$^3$ boiling water is needed to rehydrate a "dried meal". A climber has 5g methanol left. Is this sufficient to provide the energy to heat 100cm$^3$ to 100°C from air temp, 10°C?

(a) Calculate energy required to heat the water
(b) Calculate energy released by 5g methanol
(c) Is it worth lighting the primus stove?

**5.** A rudimentary hand warmer is made by breaking a seal and allowing hydroxythymol to mix with solvent. ΔH for the reaction is –73kJmol$^{-1}$.

(a) How much hydroxythymol (mass of 1mol = 276g) should be used to raise the temp by 10°C? Assume solvent is water and the volume of water present is 250cm$^3$.
(b) Why is your calculated mass unlikely to be correct in practice?

**6.** A pupil was investigating the enthalpy of combustion of an alcohol. Water was heated in a copper calorimeter using an alcohol burner.

(a) Write down 5 measurements he would need to take during the experiment.
(b) The answer that was obtained was very different to the value given in data booklet. Give 3 reasons why this may be so.
(c) Look at the values given for the enthalpy of combustion of alcohols in the data booklet on page 9.
   (i) What is the trend in size of the molecule compared with the enthalpy of combustion?

   (ii) Predict a value for the enthalpy of combustion of butan-1-ol

# HESS'S LAW

**1.** Using enthalpies of combustion figures from the Data Book, calculate the enthalpy of formation of:-

(a) methane (b) butane (c) ethene

(d) ethyne (e) methanol (f) propanol

**2.** $2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s)$ $\Delta H = -822kJmol^{-1}$

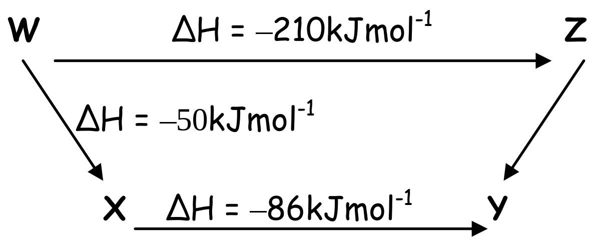
$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -394kJmol^{-1}$

Which of the following is the standard enthalpy change, in $kJmol^{-1}$, for the reaction shown below?

$Fe_2O_3(s) + \frac{3}{2}C(s) \rightarrow 2Fe(s) + \frac{3}{2}CO_2(g)$

**A** +231
**B** +428
**C** +1216
**D** +1413

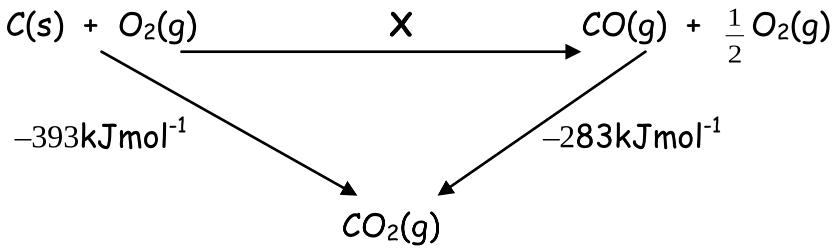
**3.** Consider the reaction pathway shown.




According to Hess's Law, the $\Delta H$ value, in $kJmol^{-1}$, for reaction **Z** to **Y** is

**A** +74
**B** -74
**C** +346
**D** -346

**4.** Consider the reaction pathway shown.




According to Hess's Law, what is the enthalpy change for reaction **X**?

**A** $+110kJmol^{-1}$
**B** $-110kJmol^{-1}$
**C** $-676kJmol^{-1}$
**D** $+676kJmol^{-1}$

**5.** The enthalpy of formation of $Al_2O_3$ is $-1596kJmol^{-1}$ and that for $Cr_2O_3$ is $-1134kJmol^{-1}$.

Calculate the enthalpy of reaction for $2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2C_r$

**6.**

$H_{2(g)} \rightarrow 2H_{(g)}$ $\Delta H = 435kJmol^{-1}$

$Br_{2(g)} \rightarrow 2Br_{(g)}$ $\Delta H = 192kJmol^{-1}$

$2HBr_{(g)} \rightarrow 2H_{(g)} + 2Br$ $\Delta H = 728kJmol^{-1}$

Calculate the enthalpy of formation of hydrogen bromide.

7 The equation for the enthalpy of formation of $C_2H_6$ is shown below.

$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

Determine the heat of reaction for this reaction

Use the following reactions:

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$ $\Delta H = -1401$ kJ

$C_2H_6(g) + 7/2O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ $\Delta H = -1550$ kJ

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286$ kJ

# BOND ENTHALPY ACTIVITY SHEET

## Selected Bond and Mean Bond Enthalpies

### Bond Enthalpies

| Bond | Enthalpy/kJ mol$^{-1}$ |
|---|---|
| H – H | 436 |
| O = O | 498 |
| N ≡ N | 945 |
| F – F | 159 |
| Cl – Cl | 243 |
| Br – Br | 194 |
| I – I | 151 |
| H – F | 570 |
| H – Cl | 432 |
| H – Br | 366 |
| H – I | 298 |

### Mean Bond Enthalpies

| Bond | Mean Enthalpy/ kJ mol$^{-1}$ |
|---|---|
| Si – Si | 226 |
| C – C | 348 |
| C = C | 612 |
| C ≡ C | 838 |
| C ⋯ C (aromatic) | 518 |
| H – O | 463 |
| H – N | 388 |
| C – H | 412 |
| C – O | 360 |
| C = O | 743 |
| C – F | 484 |
| C – Cl | 338 |
| C – Br | 276 |
| C – I | 238 |

1. Use bond enthalpy data to calculate the enthalpy of formation of

   (a) ethane (b) ammonia
   (c) propane (d) carbon dioxide

2. Calculate enthalpy of combustion of methane using bond enthalpy data.

   $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

3. In which of these is ΔH equal to the CH bond enthalpy?

   (a) $C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)}$

   (b) $CH_{4(g)} \rightarrow C_{(s)} + 4H_{(g)}$

   (c) $CH_{4(g)} \rightarrow CH_{3(g)} + H_{(g)}$

   (d) $CH_{4(g)} \rightarrow CH_{2(g)} + H_{2(g)}$

4. From bond enthalpy data calculate ΔH for

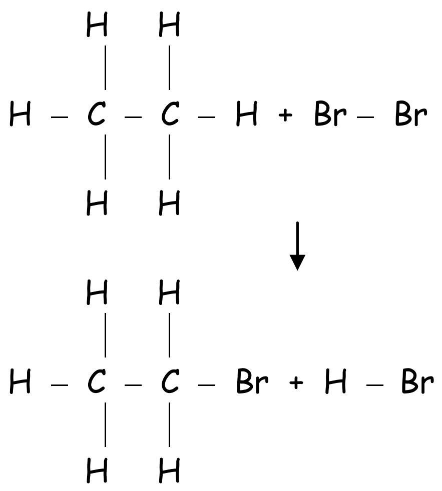
   (a) $N_2 + 2H_2 \rightarrow N_2H_4$ (N – N) = 159kJmol$^{-1}$

   (b) $C_2H_2 + 2H_2 \rightarrow C_2H_6$

5. Consider the following bond enthalpies.

| Bond | Enthalpy/$kJmol^{-1}$ |
|---|---|
| Br - Br | 194 |
| H - Br | 362 |
| C - H | 414 |
| C - Br | 285 |

What is the enthalpy change, in $kJmol^{-1}$, for the following reaction?



A. -1255

B. -39

C. +39

D. +1255

6. The bond enthalpy of a gaseous diatomic molecule is the energy required to break one mole of the covalent bonds. It is also the energy released in the formation of one mole of the bonds from the atoms involved.

| Bond | Bond Enthalpy/$kJmol^{-1}$ |
|---|---|
| H - H | 432 |
| I - I | 149 |
| H - I | 295 |

$$H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$$

What is the enthalpy change, in $kJmol^{-1}$, for the above reaction?

A. +9

B. -9

C. +286

D. -286

# REDOX TITRATIONS – ACTIVITY SHEET

**1(a)** The overall equation for the reaction of $I_2$ with $SO_3^{2-}$ ions is:

$$I_2 + SO_3^{2-} + H_2O \rightarrow 2I^- + SO_4^{2-} + 2H^+$$

**(b)** Calculate the volume of iodine solution (concentration 0·5mol $l^{-1}$) needed to completely react with 50cm$^3$ of sodium sulphite solution of concentration 0·2mol $l^{-1}$.

**2(a)** The overall equation for the reaction of $Fe^{3+}$ ions with $I^-$ ions is:

$$2Fe^{3+} + 2I^- \rightarrow I_2 + 2Fe^{2+}$$

**(b)** Calculate the volume of iodide solution (concentration 0·2mol $l^{-1}$) needed to completely react with 25cm$^3$ of iron (iii) nitrate solution of concentration 0·1mol $l^{-1}$.

**3(a)** The overall equation for the reaction of sodium sulphite solution with iron(lll) ions is:

$$2Fe^{3+} + 2SO_3^{2--} + H_2O \rightarrow 2Fe^{2+}\ 2SO_4^{2-} + 2H^+$$

**(b)** Calculate the concentration of the sodium sulphite solution if 25cm$^3$ of it is needed to completely react with 50cm$^3$ of iron(lll) nitrate solution of concentration 0·5mol $l^{-1}$.

**4.** 25cm$^3$ of acidified potassium dichromate solution reacted completely with 25cm$^3$ of potassium iodide solution (concentration 0·5mol $l^{-1}$). Calculate the concentration of the potassium dichromate solution. The overall equation for the reaction is:

$$Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 7\,H_2O + 3I_2$$

5. Hydrogen peroxide is a colourless liquid with the formula $H_2O_2$. Its solution can be used as an antiseptic. A hospital technician was checking the concentration of a hydrogen peroxide solution. She titrated 25·0cm$^3$ portions of the solution against an acidified potassium permanganate solution. The reaction taking place during the titrations is:

$2MnO_4^-$(aq) + $6H^+$(aq) + $5H_2O_2$(aq) → $2Mn^{2+}$(aq) + $8H_2O$(*l*) + $5O_2$(g)
(purple) (colourless)

The technician's results are shown in the table below.

| Titration | 1 | 2 | 3 |
|---|---|---|---|
| Titre volume/cm$^3$ | 16·5 | 15·8 | 15·8 |

(i) How would the technician know that the end-point of titration had been reached?

(ii) Why would the technician ignore the result of the first titration when calculating the mean titre volume?

(iii) The concentration of the potassium permanganate solution was 0·101mol l$^{-1}$. Use the technician's results to calculate the concentration of the hydrogen peroxide solution.

**5.** Sugars, such as glucose, are often used as sweeteners in soft drinks.


The glucose content of a soft drink can be estimated by titration against a standardised solution of Benedict's solution.
The copper(II) ions in Benedict's solution react with glucose as shown

$C_6H_{12}O_2$(aq) + $2Cu^{2+}$(aq) + $2H_2O$(*l*) → $Cu_2O$(s) + $4H^+$(aq) + $C_6H_{12}O_7$(aq)

(a) In one experiment, 25·0cm$^3$ volumes of a soft drink were titrated with Benedict's solution in which the concentration of copper(II) ions was 0·500mol l$^{-1}$. The following results were obtained:

| Titration | Volume of Benedict's solution/cm$^3$ |
|---|---|
| 1 | 18·0 |
| 2 | 17·1 |
| 3 | 17·3 |

Average volume of benedict's solution used = 17·2cm$^3$
Calculate the concentration of glucose in the soft drink, in mol l$^{-1}$.

(b) In some soft drinks, sucrose is used instead of glucose. Why can the sucrose concentration of a soft drink **not** be estimated by this method?

**6.** Cigarette lighter flints are composed principally of an alloy of iron and "misch" metal. One flint has a mass of 0·20g. Its percentage composition by mass is shown in Table 1. Table 2 shows the percentage composition by mass of "misch" metal.

| Table 1 | |
|---|---|
| Misch metal | 75·00 |
| Iron | 19·70 |
| Others | 5·30 |

| Table 2 | |
|---|---|
| Cerium | 44·00 |
| Lanthanum | 35·00 |
| Neodymium | 12·50 |
| Praseodymium | 4·75 |
| Others | 3·75 |

(a) Calculate the mass of cerium metal in the flint.

(b) A second flint, also with a mass of 0·20g, was dissolved in 30cm$^3$ of dilute sulphuric acid, and heated with a catalyst to produce a solution containing $Ce^{4+}$(aq) ions. The mass of cerium in this second flint was found by titrating 10cm$^3$ of the $Ce^{4+}$(aq) solution with iron(II) sulphate solution, using a suitable indicator.

Equations

$$Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e$$

$$Ce^{4+}(aq) + e \rightarrow Ce^{3+}(aq)$$

(i) 0·76g of solid $FeSO_4$ was required to make 100cm$^3$ of 0·05mol $l^{-1}$ iron(II) sulphate solution. Describe fully how you would prepare 100cm$^3$ of 0·05 mol $l^{-1}$ iron(II) sulphate solution.

(ii) It was found that 4·85cm$^3$ of 0·05mol $l^{-1}$ iron(II) sulphate solution was required to reduce 10cm$^3$ of the $Ce^{4+}$(aq) solution.

Calculate the mass of cerium in the flint.

(Take the relative atomic mass of cerium to be 140)

# Names, Symbols, Relative Atomic Masses and Densities

(Relative atomic masses, also known as average atomic masses, have been rounded to the nearest 0·1)

| Element | Symbol | Relative atomic mass | Density ($g\ cm^{-3}$) |
|---|---|---|---|
| Actinium | Ac | 227·0 | 10·1 |
| Aluminium | Al | 27·0 | 2·70 |
| Americium | Am | 243·1 | 13·7 |
| Antimony | Sb | 121·8 | 6·68 |
| Argon | Ar | 39·9 | 0·0018 |
| Arsenic | As | 74·9 | 5·78 |
| Astatine | At | 210·0 | unknown |
| Barium | Ba | 137·3 | 3·62 |
| Berkelium | Bk | 247·1 | 14·8 |
| Beryllium | Be | 9·0 | 1·85 |
| Bismuth | Bi | 209·0 | 9·79 |
| Boron | B | 10·8 | 2·47 |
| Bromine | Br | 79·9 | 3·12 |
| Cadmium | Cd | 112·4 | 8·69 |
| Calcium | Ca | 40·1 | 1·54 |
| Californium | Cf | 251·1 | unknown |
| Carbon | C | 12·0 | * |
| Cerium | Ce | 140·1 | 6·77 |
| Caesium | Cs | 132·9 | 1·93 |
| Chlorine | Cl | 35·5 | 0·0032 |
| Chromium | Cr | 52·0 | 7·15 |
| Cobalt | Co | 58·9 | 8·86 |
| Copper | Cu | 63·5 | 8·96 |
| Curium | Cm | 247·1 | 13·3 |
| Dysprosium | Dy | 162·5 | 8·55 |
| Einsteinium | Es | 252·1 | unknown |
| Erbium | Er | 167·3 | 9·07 |
| Europium | Eu | 152·0 | 5·24 |
| Fluorine | F | 19·0 | 0·0017 |
| Francium | Fr | 223·0 | unknown |
| Gadolinium | Gd | 157·3 | 7·90 |
| Gallium | Ga | 69·7 | 5·91 |
| Germanium | Ge | 72·6 | 5·32 |
| Gold | Au | 197·0 | 19·3 |
| Hafnium | Hf | 178·5 | 13·3 |
| Helium | He | 4·0 | 0·0002 |
| Holmium | Ho | 164·9 | 8·80 |
| Hydrogen | H | 1·0 | 0·00009 |
| Indium | In | 114·8 | 7·31 |
| Iodine | I | 126·9 | 4·95 |
| Iridium | Ir | 192·2 | 22·5 |
| Iron | Fe | 55·8 | 7·87 |
| Krypton | Kr | 83·8 | 0·0037 |
| Lanthanum | La | 138·9 | 6·15 |
| Lead | Pb | 207·2 | 11·3 |
| Lithium | Li | 6·9 | 0·53 |
| Lutetium | Lu | 175·0 | 9·84 |
| Magnesium | Mg | 24·3 | 1·74 |

*The density of carbon as graphite is 2·27 $g\ cm^{-3}$
The density of carbon as diamond is 3·51 $g\ cm^{-3}$

| Element | Symbol | Relative atomic mass | Density ($g\ cm^{-3}$) |
|---|---|---|---|
| Manganese | Mn | 54·9 | 7·47 |
| Mercury | Hg | 200·6 | 13·5 |
| Molybdenum | Mo | 96·0 | 10·2 |
| Neodymium | Nd | 144·2 | 7·01 |
| Neon | Ne | 20·2 | 0·0009 |
| Neptunium | Np | 237·0 | 20·2 |
| Nickel | Ni | 58·7 | 8·90 |
| Niobium | Nb | 92·9 | 8·57 |
| Nitrogen | N | 14·0 | 0.0013 |
| Osmium | Os | 190·2 | 22·6 |
| Oxygen | O | 16·0 | 0·0014 |
| Palladium | Pd | 106·4 | 12·0 |
| Phosphorus | P | 31·0 | 1·82 |
| Platinum | Pt | 195·1 | 21·5 |
| Plutonium | Pu | 244·1 | 19·7 |
| Polonium | Po | 209·0 | 9·20 |
| Potassium | K | 39·1 | 0·89 |
| Praseodymium | Pr | 140·9 | 6·77 |
| Promethium | Pm | 144·9 | 7·26 |
| Protactinium | Pa | 231·0 | 15·4 |
| Radium | Ra | 226·0 | 5·00 |
| Radon | Rn | 222·0 | 0·0097 |
| Rhenium | Re | 186·2 | 20·8 |
| Rhodium | Rh | 102·9 | 12·4 |
| Rubidium | Rb | 85·5 | 1·53 |
| Ruthenium | Ru | 101·1 | 12·1 |
| Samarium | Sm | 150·4 | 7·52 |
| Scandium | Sc | 45·0 | 2·99 |
| Selenium | Se | 79·0 | 4·81 |
| Silicon | Si | 28·1 | 2·33 |
| Silver | Ag | 107·9 | 10·5 |
| Sodium | Na | 23·0 | 0·97 |
| Strontium | Sr | 87·6 | 2·64 |
| Sulfur | S | 32·1 | 2·09 |
| Tantalum | Ta | 180·9 | 16·4 |
| Technetium | Tc | 97·9 | 11 |
| Tellurium | Te | 127·6 | 6·25 |
| Terbium | Tb | 158·9 | 8·23 |
| Thallium | Tl | 204·4 | 11·8 |
| Thorium | Th | 232·0 | 11·7 |
| Thulium | Tm | 168·9 | 9·32 |
| Tin | Sn | 118·7 | 7·26 |
| Titanium | Ti | 47·9 | 4·51 |
| Tungsten | W | 183·8 | 19·3 |
| Uranium | U | 238·0 | 19·1 |
| Vanadium | V | 50·9 | 6·00 |
| Xenon | Xe | 131·3 | 0·0059 |
| Ytterbium | Yb | 173·0 | 6·90 |
| Yttrium | Y | 88·9 | 4·47 |
| Zinc | Zn | 65·4 | 7·14 |
| Zirconium | Zr | 91·2 | 6·52 |