

# CALCULATE MOLES

**1 (a)** The elements in Group VII are known as the halogens. Some halogens react with aqueous solutions of halides.

(i) Complete the table by adding a ✓ to indicate when a reaction occurs and a ✗ to indicate when no reaction occurs.

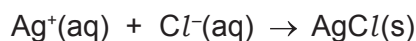
	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide
chlorine	✗	✓	
bromine		✗	
iodine			✗

[3]

(ii) Write a chemical equation for the reaction between chlorine and aqueous potassium bromide.

..... [1]

(b) A sample of vanadium chloride was weighed and dissolved in water. An excess of aqueous silver nitrate, acidified with dilute nitric acid, was added. A precipitate of silver chloride was formed. The ionic equation for this reaction is shown.



The mass of silver chloride formed was 2.87 g.

(i) State the colour of the precipitate of silver chloride.

..... [1]

(ii) The relative formula mass of silver chloride, AgCl, is 143.5.

Calculate the number of moles in 2.87 g of AgCl.

moles of AgCl = ..... mol [1]

(iii) Use your answer to (b)(ii) and the ionic equation to deduce the number of moles of chloride ions, Cl<sup>-</sup>, that produced 2.87 g of AgCl.

moles of Cl<sup>-</sup> = ..... mol [1]

(iv) The amount of vanadium chloride in the sample was 0.01 moles.

Use this and your answer to (b)(iii) to deduce the **whole number** ratio of moles of vanadium chloride : moles of chloride ions.  
Deduce the formula of vanadium chloride.

moles of vanadium chloride : moles of chloride ions ..... : .....

formula of vanadium chloride .....

[2]

**MARKING SCHEME:**

(a)(i)	<table border="1" data-bbox="191 174 922 352"> <thead> <tr> <th></th> <th>aqueous potassium chloride</th> <th>aqueous potassium bromide</th> <th>aqueous potassium iodide</th> </tr> </thead> <tbody> <tr> <td>chlorine</td> <td></td> <td></td> <td>✓</td> </tr> <tr> <td>bromine</td> <td>✗</td> <td></td> <td>✓</td> </tr> <tr> <td>iodine</td> <td>✗</td> <td>✗</td> <td></td> </tr> </tbody> </table> <p data-bbox="191 380 535 457">                     5 cells completed correctly = [3]                      3 or 4 cells completed correctly = [2]                      2 cells completed correctly = [1]                 </p>		aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide	chlorine			✓	bromine	✗		✓	iodine	✗	✗		<b>3</b>
	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide															
chlorine			✓															
bromine	✗		✓															
iodine	✗	✗																
(a)(ii)	$\text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2$ <p><b>OR</b></p> $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$	<b>1</b>																
(b)(i)	white	<b>1</b>																
(b)(ii)	0.02 (mol)	<b>1</b>																
(b)(iii)	0.02 (mol)	<b>1</b>																
(b)(iv)	1:2	<b>1</b>																
	$\text{VCl}_2$	<b>1</b>																

**2** Copper(II) sulfate crystals,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , are hydrated.

Copper(II) sulfate crystals are made by reacting copper(II) carbonate with dilute sulfuric acid.

The equation for the overall process is shown.



**step 1** Powdered solid copper(II) carbonate is added to  $50.0 \text{ cm}^3$  of  $0.05 \text{ mol/dm}^3$  sulfuric acid until the copper(II) carbonate is in excess.

**step 2** The excess of copper(II) carbonate is separated from the aqueous copper(II) sulfate.

**step 3** The aqueous copper(II) sulfate is heated until the solution is saturated.

**step 4** The solution is allowed to cool and crystallise.

**step 5** The crystals are removed and dried.

**(a)** Calculate the maximum mass of the copper(II) sulfate crystals,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , that can form using the following steps.

- Calculate the number of moles of  $\text{H}_2\text{SO}_4$  in  $50.0 \text{ cm}^3$  of  $0.05 \text{ mol/dm}^3 \text{ H}_2\text{SO}_4$ .

..... mol

- Determine the number of moles of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  that can form.

..... mol

- The  $M_r$  of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is 250.

Calculate the maximum mass of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  that can form.

..... g  
[3]

(b) **Steps 1–5** were done correctly but the mass of crystals obtained was less than the maximum mass.

Explain why.

..... [1]

(c) State **two** observations that would indicate that the copper(II) carbonate is in excess in **step 1**.

1 .....

2 .....

[2]

**MARKING SCHEME:**

(a)	<b>M1</b> $0.0025 / 2.5 \times 10^{-3}$ (moles of $\text{H}_2\text{SO}_4$ ) (1) <b>M2</b> $0.0025 / 2.5 \times 10^{-3}$ (moles of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ) (1) <b>M3</b> 0.625(g) (1)	<b>3</b>
(b)	some copper(II) sulfate remains in solution / some copper(II) sulfate does not form crystals <b>OR</b> some of the crystals decomposed <b>OR</b> some crystals lost in transfer	<b>1</b>
(c)	<b>M1</b> no more bubbling / fizzing / effervescence (1) <b>M2</b> solid or powder stops dissolving (1)	<b>2</b>