Science Home learning

We hope you are all doing well at home, well done for doing your science work :-). Below are the email addresses for all Science staff. Do not hesitate to contact any of us with any questions. We even have twitter!

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**L11 Using concentrations of solutions in mol/dm3 Year: 10 (Triple only)**

Topic: ChemistryUnit:Quantitative Chemistry

Date Set:

Information to read / watch:

<https://www.youtube.com/watch?v=XCX0PkZdUjM>

(Concentration calculations and formual | Chemical Calculations | Chemistry | FuseSchool)

<https://www.youtube.com/watch?v=xsma3KjKPx8>

(Free science lessons “Using concentrations of solutions 1”)

<https://www.youtube.com/watch?v=Z93_atEmxNI>

(Free science lessons “Using concentrations of solutions 2”)

Objectives:

Be able to explain how the concentration of a solution in mol/dm3 is related to the mass of the solute and the volume of the solution.

Explain the terms concentration and mol/dm3

Convert cm3 into dm3

Calculate the concentration of a solution.

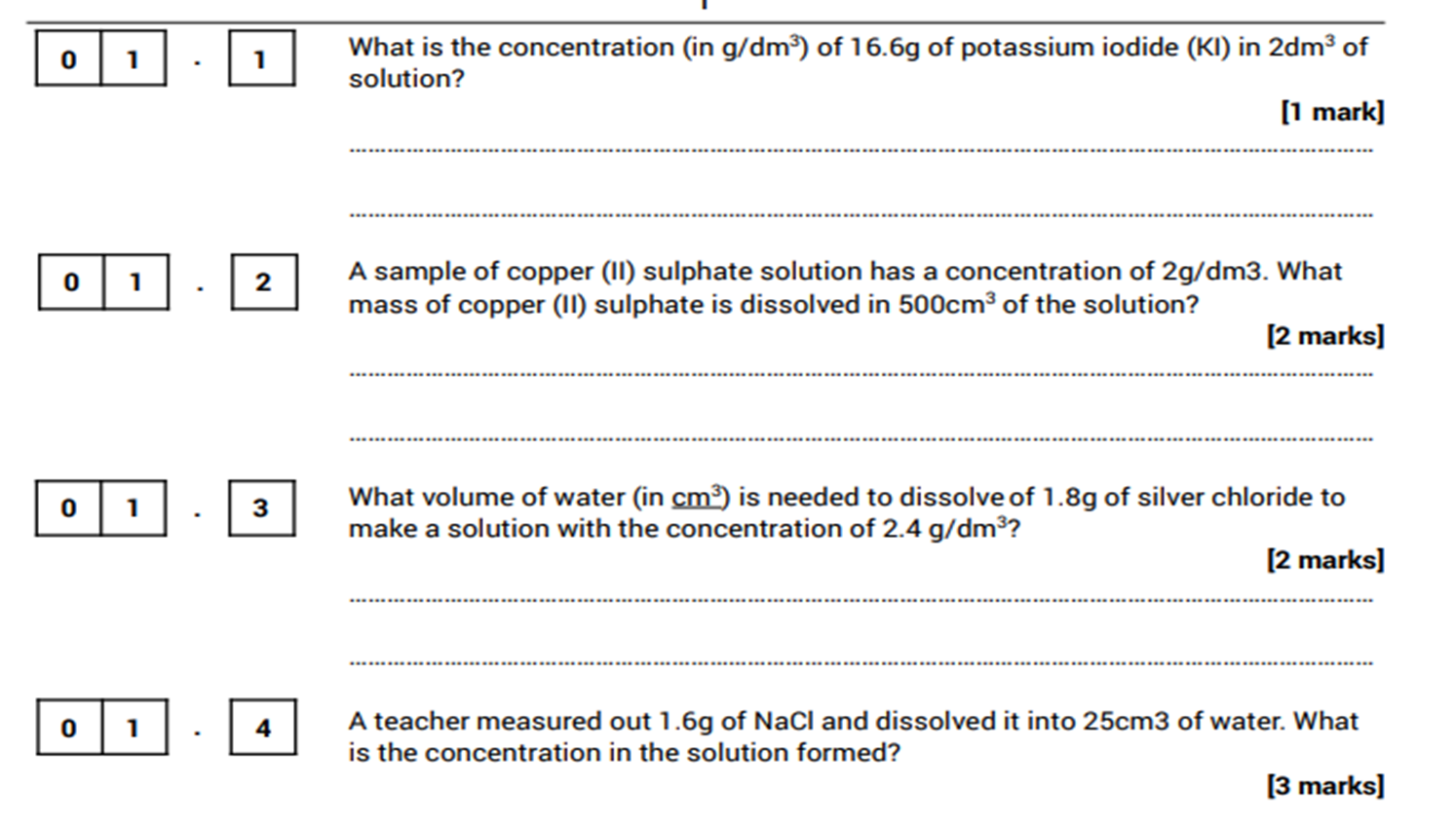
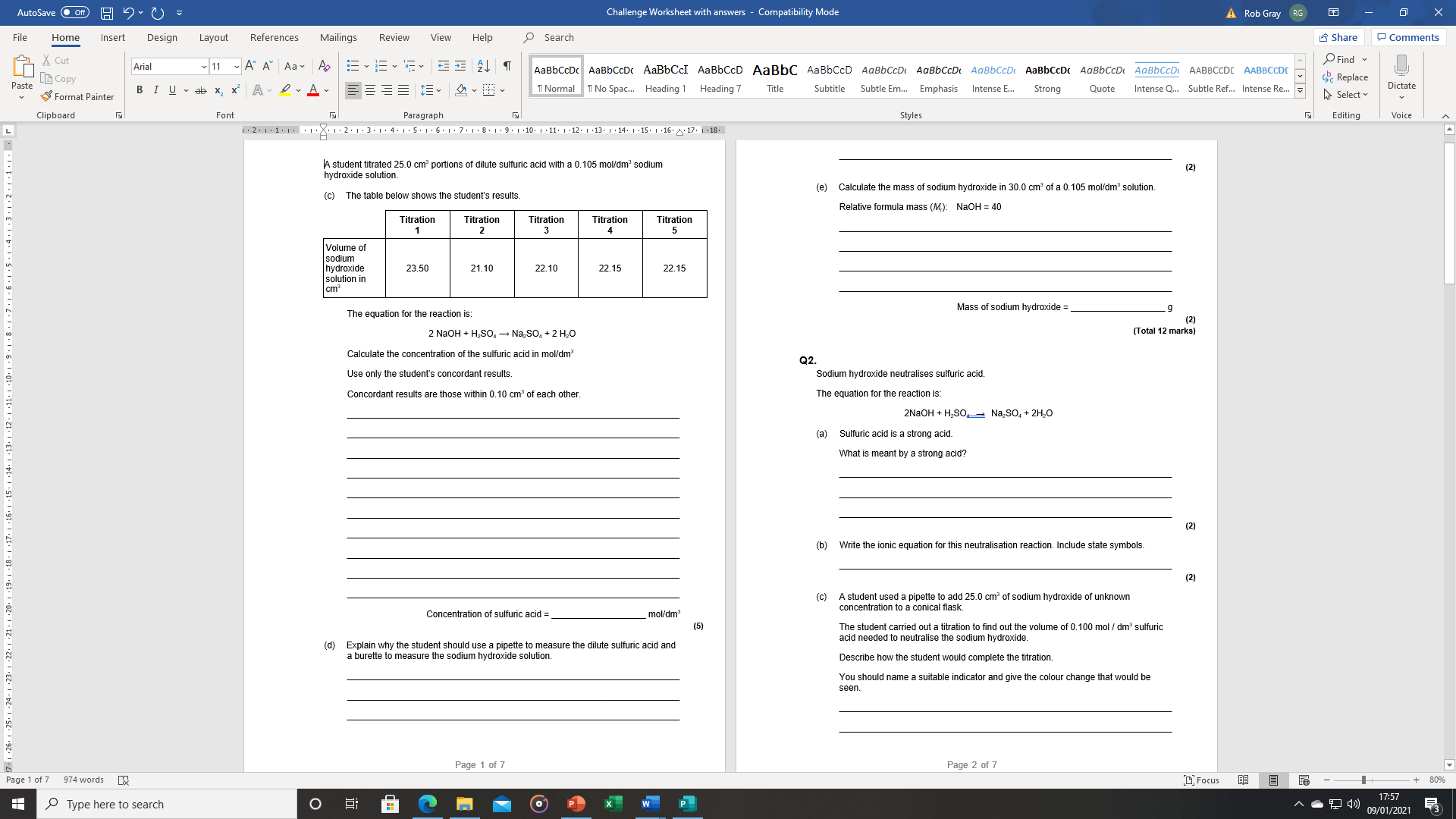
Additional Websites:

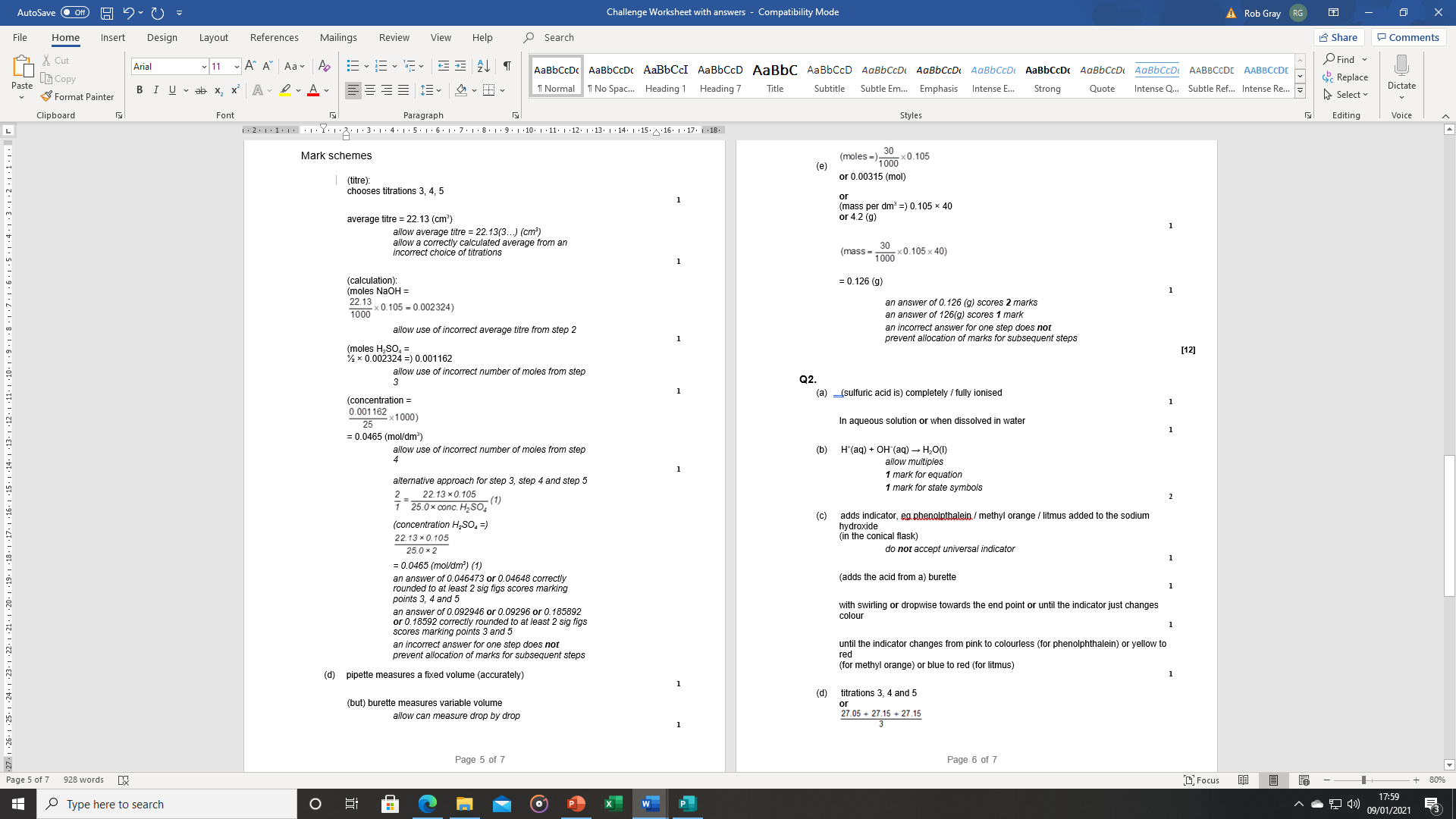
<https://www.bbc.co.uk/bitesize/guides/zgcyw6f/revision/4>

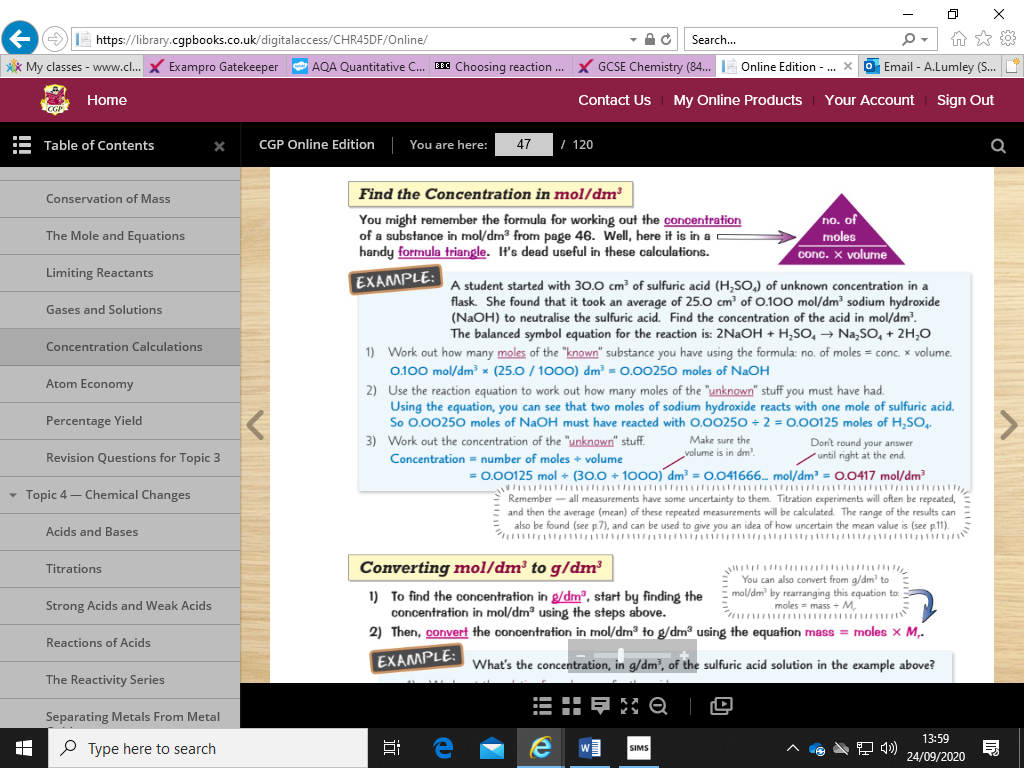
Read the information on page 1

<https://classroom.thenational.academy/units/quantitative-chemistry-4db7>

Lesson 9 – Titration calculations







**OR**

**Draw a table and fill in the gaps…**

**e.g.**

**A Student started with 30.0cm3 of sulphuric acid (H2SO4) of unknown concentration in a flask.**

**She found that it took on average 25cm3 of 0.100mol/dm3 sodium hydroxide (NaOH) to neutralise the sulphuric acid. Find the concentration of acid in mol/dm3.**

**The balanced symbol equation is:**

**2NaOH + H2SO4 → Na2SO4 + 2H2O**

**Step 1: fill in the information you have**

|  |  |  |
| --- | --- | --- |
|  | **NaOH** | **H2SO4** |
| **Mol** | **?** | **?** |
| **Concentration (mol/dm3)** | **0.100** | **?** |
| **Volume (dm3)** | **0.025** | **0.03** |

**Step 2: Calculate the moles of the solution where you have the concentration and the volume using mol = conc x vol.**

**0.1x0.025 = 0.0025 moles of NaOH (add this to your table)**

|  |  |  |
| --- | --- | --- |
|  | **NaOH** | **H2SO4** |
| **Mol** | **0.0025** | **?** |
| **Concentration (mol/dm3)** | **0.100** | **?** |
| **Volume (dm3)** | **0.025** | **0.03** |

**Step 3: The NaOH and H2SO4 are in a ratio of 2:1 (using the multiplier numbers from the equation). This means that the H2SO4 has half the number of moles that the NaOH does.**

**0.0025÷2=0.00125 moles of H2SO4 (add this to your table)**

|  |  |  |
| --- | --- | --- |
|  | **NaOH** | **H2SO4** |
| **Mol** | **0.0025** | **0.00125** |
| **Concentration (mol/dm3)** | **0.100** | **?** |
| **Volume (dm3)** | **0.025** | **0.03** |

**Step 4: Use your moles and volume of H2SO4 that you now have to calculate the concentration using the equation mol = conc x vol. (rearranged conc = mol ÷ vol)**

**0.00125 ÷ 0.03 = 0.0416 mol/dm3**

|  |  |  |
| --- | --- | --- |
|  | **NaOH** | **H2SO4** |
| **Mol** | **0.0025** | **0.00125** |
| **Concentration (mol/dm3)** | **0.100** | **0.0416** |
| **Volume (dm3)** | **0.025** | **0.03** |

**Q1.**

This question is about acids and alkalis.

(a)  Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

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**(2)**

(b)  A 1.0 × 10−3 mol/dm3 solution of hydrochloric acid has a pH of 3.0

What is the pH of a 1.0 × 10−5 mol/dm3 solution of hydrochloric acid?

pH = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

A student titrated 25.0 cm3 portions of dilute sulfuric acid with a 0.105 mol/dm3 sodium hydroxide solution.

(c)  The table below shows the student’s results.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Titration 1** | **Titration 2** | **Titration 3** | **Titration 4** | **Titration 5** |
| Volume of sodium hydroxide solution in cm3 | 23.50 | 21.10 | 22.10 | 22.15 | 22.15 |

The equation for the reaction is:

2 NaOH + H2SO4 ⟶ Na2SO4 + 2 H2O

Calculate the concentration of the sulfuric acid in mol/dm3

Use only the student’s concordant results.

Concordant results are those within 0.10 cm3 of each other.

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Concentration of sulfuric acid = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol/dm3

**(5)**

(d)  Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

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**(2)**

(e)  Calculate the mass of sodium hydroxide in 30.0 cm3 of a 0.105 mol/dm3 solution.

Relative formula mass (*M*r): NaOH = 40

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Mass of sodium hydroxide = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(2)**

**(Total 12 marks)**

**Q2.**

Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:

                 2NaOH + H2SO4  →  Na2SO4 + 2H2O

(a)     Sulfuric acid is a strong acid.

What is meant by a strong acid?

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**(2)**

(b)     Write the ionic equation for this neutralisation reaction. Include state symbols.

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**(2)**

(c)     A student used a pipette to add 25.0 cm3 of sodium hydroxide of unknown concentration to a conical flask.

The student carried out a titration to find out the volume of 0.100 mol / dm3 sulfuric acid needed to neutralise the sodium hydroxide.

Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

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**(4)**

(d)     The student carried out five titrations. Her results are shown in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Titration 1 | Titration 2 | Titration 3 | Titration 4 | Titration 5 |
| Volume of 0.100 mol / dm3 sulfuric acid in cm3 | 27.40 | 28.15 | 27.05 | 27.15 | 27.15 |

Concordant results are within 0.10 cm3 of each other.

Use the student’s concordant results to work out the mean volume of 0.100 mol / dm3 sulfuric acid added.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Mean volume = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm3

**(2)**

(e)     The equation for the reaction is:

                               2NaOH + H2SO4  →  Na2SO4 + 2H2O

Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Concentration = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol / dm3

**(4)**

(f)     The student did another experiment using 20 cm3 of sodium hydroxide solution with a concentration of 0.18 mol / dm3.

Relative formula mass (*M*r) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm3 of this solution.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(2)**

**(Total 16 marks)**

Mark schemes

**Q1.**

(a)  (strong because) completely ionised (in aqueous solution)

*ignore pH*

*allow dissociated for ionised*

*do* ***not*** *accept hydrogen is ionising*

*do* ***not*** *accept H+ are ionised*

**1**

(dilute because) small amount of acid per unit volume

*ignore low concentration*

**1**

(b)  5.0

*allow 5*

**1**

(c)  (titre):

chooses titrations 3, 4, 5

**1**

average titre = 22.13 (cm3)

*allow average titre = 22.13(3…) (cm3)*

*allow a correctly calculated average from an incorrect choice of titrations*

**1**

(calculation):

(moles NaOH =



*allow use of incorrect average titre from step 2*

**1**

(moles H2SO4 =

½ × 0.002324 =) 0.001162

*allow use of incorrect number of moles from step 3*

**1**

(concentration =



= 0.0465 (mol/dm3)

*allow use of incorrect number of moles from step 4*

**1**

*alternative approach for step 3, step 4 and step 5*

**

*(concentration H2SO4 =)*

**

*= 0.0465 (mol/dm3) (1)*

*an answer of 0.046473* ***or*** *0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*

*an answer of 0.092946* ***or*** *0.09296* ***or*** *0.185892* ***or*** *0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*

*an incorrect answer for one step does* ***not*** *prevent allocation of marks for subsequent steps*

(d)  pipette measures a fixed volume (accurately)

**1**

(but) burette measures variable volume

*allow can measure drop by drop*

**1**

(e)  

**or** 0.00315 (mol)

**or**

(mass per dm3 =) 0.105 × 40

**or** 4.2 (g)

**1**

****

= 0.126 (g)

**1**

*an answer of 0.126 (g) scores* ***2*** *marks*

*an answer of 126(g) scores* ***1*** *mark*

*an incorrect answer for one step does* ***not*** *prevent allocation of marks for subsequent steps*

**[12]**

**Q2.**

(a)     (sulfuric acid is) completely / fully ionised

**1**

In aqueous solution **or** when dissolved in water

**1**

(b)     H+(aq) + OH−(aq) → H2O(l)

*allow multiples*

***1*** *mark for equation*

***1*** *mark for state symbols*

**2**

(c)     adds indicator, eg phenolpthalein / methyl orange / litmus added to the sodium hydroxide  
(in the conical flask)

*do* ***not*** *accept universal indicator*

**1**

(adds the acid from a) burette

**1**

with swirling **or** dropwise towards the end point **or** until the indicator just changes colour

**1**

until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red  
(for methyl orange) or blue to red (for litmus)

**1**

(d)     titrations 3, 4 and 5

**or**

****

**1**

27.12 cm3

*accept 27.12 with no working shown for* ***2*** *marks*

**1**

*allow 27.1166 with no working shown for* ***2*** *marks*

(e)     Moles H2SO4 = conc × vol = 0.00271

*allow ecf from 8.4*

**1**

Ratio H2SO4:NaOH is 1:2

**or**

Moles NaOH = Moles H2SO4 × 2 = 0.00542

**1**

Concentration NaOH = mol / vol = 0.00542 / 0.025 = 0.2168

**1**

0.217 (mol / dm3)

*accept 0.217 with no working for* ***4*** *marks*

**1**

*accept 0.2168 with no working for* ***3*** *marks*

(f)           ×   0.18 = no of moles

**or**

0.15 × 40 g

**1**

0.144 (g)

**1**

*accept 0.144g with no working for* ***2*** *marks*

**[16]**