BTEC Assignment Brief

Qualification	Pearson BTEC Level 3 National Certificate in Applied Science Pearson BTEC Level 3 National Extended Certificate in Applied Science Pearson BTEC Level 3 National Foundation Diploma in Applied Science Pearson BTEC Level 3 National Diploma in Applied Science Pearson BTEC Level 3 National Extended Diploma in Applied Science
Unit number and title	**Unit 2: Practical Scientific Procedures and Techniques**
Learning aim(s) (For NQF only)	**A:** Undertake titration and colorimetry to determine the concentration of solutions.
Assignment title	**Concentrate on keeping up your standards**
Assessor	
Issue date	
Hand in deadline	

Vocational Scenario or Context	You are a newly appointed technical assistant at a large chemical plant, *Chemcalequip*. As part of your induction period and to progress in your role, you have to demonstrate skills in a range of practical procedures and techniques. Part of your role is to ensure equipment is calibrated and equipment and chemicals are safety checked. A key part of your job will be making and testing standard solutions using **titration** and **colorimetry** procedures. You must demonstrate your ability to carry out these techniques skilfully and accurately. Evidence of your practical skills, along with your results, calculations, evaluation of the techniques and possible improvements will need to be submitted in a report(s).

Task 1	**Evaluate the accuracy and safety of the following quantitative procedures and techniques in relation to their outcomes.** Your practical work must be undertaken correctly and safely at all times. Your techniques will need to be performed to a high degree of accuracy and precision in order to obtain reliable and valid outcomes. You will be observed performing your preparation of

	solutions, calibration of equipment and application of titration and colorimetry techniques. **Titration:** • You will perform different titrations to accurately and skilfully determine the concentration of a solution of sodium hydroxide. • You will first need to calibrate the equipment that you will use for these titrations which will include: the pipette, the weighing balance and the pH meter (using buffer solutions). • Your practical work will involve **three** stages: ○ Preparation of a primary standard solution of Na_2CO_3 by weighing the solid, using the calibrated weighing balance, mixing and dissolving in water, and making up the solution to an accurate volume ○ Accurate standardisation of a given concentration of hydrochloric acid (HCl) by titration with your primary standard solution of Na_2CO_3 and using the calibrated pipette ○ Titration of the sodium hydroxide (NaOH) solution of unknown concentration with the standardised HCl • You must use **two** different titration techniques in your determination of the concentration of sodium hydroxide (NaOH): ○ by use of an appropriate indicator to determine the end point ○ by use of the calibrated pH meter to monitor the pH change before, during and after the end point • You must produce accurate, precise and reliable results from both techniques • You must calculate the concentration of NaOH solution: ○ directly from your recorded results, in the titration technique using the indicator ○ by plotting and using a graph of pH against volume of HCl, in the titration technique using the pH meter **Colorimetry:** • You will use a colorimeter (or visible spectrometer) to accurately and skilfully determine the concentrations of Sample A and B, which are two different concentrations of copper(II) sulfate ($CuSO_4$) solution that you will be provided with. • Your practical work will involve: ○ Preparing your own known concentration of $CuSO_4$ solution by weighing hydrated copper(II) sulfate solid ($CuSO_4.5H_2O$), dissolving in water and making up to an accurate volume ○ Accurately dilute your stock $CuSO_4$ solution to produce a series of $CuSO_4$ standard solutions of different concentrations ○ Select an appropriate filter / wavelength for the

	colorimeter or visible spectrometer that you will use to measure the absorbance (or transmission) of the $CuSO_4$ solutions ○ Calibrate the colorimeter / visible spectrometer according to the manufacturer's instructions or practical instructions provided ○ Measure and record the absorbance (or transmission) for each of your $CuSO_4$ solutions ○ Plot a calibration curve of absorbance (or transmission) against concentration of $CuSO_4$ ○ Measure and record the absorbance (or transmission) for Sample A and B (unknown concentrations of $CuSO_4$ solution) that you are provided with ○ Use the calibration curve to determine the concentrations of Sample A and B • You must produce accurate, precise and reliable results from your colorimetry technique **Report:** Produce a report of your practical work, which will: • Provide an account of the experiments, including all observations, measurements, tables of results, calculations and graphs • Evaluate the accuracy of your results, providing sound justification and reasoning, and comparing the concentrations you have determined with actual (or published) concentrations and with those of other learners • Explain how accuracy, precision and reliability were ensured during your experiments, and discuss any problems or issues that occurred during performance of the experiments • Propose improvements or alternatives to the procedures and techniques, providing a strong rationale why they will improve accuracy, precision, reliability or validity • Discuss the hazards and risks associated with the procedures and techniques you have used, justifying the way in which certain procedures were carried out in a particular way on grounds of safety
Checklist of evidence required	• A report on the use of Na_2CO_3 to standardise HCl and how HCl is then used to determine the concentration of NaOH solution by titration, including results (and graph) from indicator and pH meter methods • A report on the determination of the concentration of copper(II) sulfate solutions by use of colorimetry, to include results, calculations and calibration graph • The reports must also include your results from checking the calibration of the pipette, balance(s) and pH meter for titration and for the equipment used for colorimetry

	• Evaluation of the accuracy of the procedures and techniques, suggested improvements and discussion of safety aspects • Observation records (or other media) showing how you worked skilfully, accurately and safely whilst: ○ preparing standard solutions ○ calibrating equipment ○ titrating sodium hydroxide with hydrochloric acid ○ determining concentrations of copper(II) sulfate using colorimetry
Criteria covered by this task:	
Unit/Criteria reference	To achieve the criteria you must show that you are able to:
A.D1	Evaluate the accuracy of procedures and techniques used in titration and colorimetry in relation to outcomes and suggest improvements.
A.M1	Demonstrate skilful application of procedures and techniques in titration and colorimetry to accurately determine the concentration of solutions.
A.P1	Correctly prepare and standardise solutions for titration and colorimetry.
A.P2	Investigate the concentration of unknown solutions, using procedures and techniques in titration and colorimetry.
Sources of information to support you with this Assignment	https://www.creative-chemistry.org.uk/alevel/practical.htm http://www.titrations.info/acid-base-titration http://www2.hkedcity.net/sch_files/a/scg/scg-chem/visitor_cabinet/5324/N6lab_1.pdf http://mccscience.yolasite.com/resources/EXP%204.2.pdf http://www.rsc.org/learn-chemistry/resource/res00000697/titrating-sodium-hydroxide-with-hydrochloric-acid http://www.sparknotes.com/chemistry/acidsbases/titrations/section1.rhtml http://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html https://chem.libretexts.org/Textbook_Maps/Analytical_Chemistry_Textbook_Maps/Map%3A_Analytical_Chemistry_2.0_(Harvey)/02_Basic_Tools_of_Analytical_Chemistry/2.5%3A_Preparing_Solutions https://www.sciencecompany.com/Preparing-Chemical-Solutions.aspx http://www.virtlab.com/main.aspx

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Other assessment materials attached to this Assignment Brief	*Optional practical worksheets:* *Part 1 - Preparation of a Standard Solution* *Part 2 - Standardisation of an acid* *Part 3a - Titration of sodium hydroxide with hydrochloric acid (using an indicator)* *Part 3b - Titration of sodium hydroxide with hydrochloric acid (using a pH meter)* *Part 4 - Determining the concentration of copper(II) sulfate solution by colorimetry* *Practical worksheets can be substituted or adapted according to resourcing and local requirements.* *All practical worksheets must be risk assessed by the centre before use.*
Notes to assessor and technician	The practical activities suggested for this assignment are required to be safety checked by the centre before use. Pearson Education can take no responsibility for the safety of any practical activities. Before doing a practical activity you should always carry out your own risk assessment and refer to the necessary regulations. In particular, any local rules issued by your employer must be obeyed, regardless of what is suggested here. *Learners should be provided with anhydrous sodium carbonate which has been dried in an oven for 1 hour at 270-300^{o} C immediately before use for Part 1.* *Learners should be provided with hydrated copper(II) sulfate rather than anhydrous copper(II) sulfate to make up copper(II) sulfate solution in Part 4. The hydrated copper(II) sulfate should be powdered or ground before use, and a small quantity of hot distilled water to assist dissolving.* *Learners should be provided with two different but unknown concentrations of copper(II) sulfate labelled Sample A and Sample B that are between 0.0 and 0.1M for Part 4.*

	The centre assessor must keep a record of concentrations and results for comparison with the learners. *Alternative practicals can be used and Pearson BTEC encourage that the activities in this assignment brief are changed periodically to prevent malpractice and collusion.* *Suggested substitutes include:* • *Preparation of a standard solution of potassium hydrogenphthalate* • *Standardisation of sodium hydroxide using potassium hydrogenphthalate* • *Titration of unknown concentration of hydrochloric acid with sodium hydroxide* • *Determining the concentration of iron(III) ions by colorimetry*

Practical Worksheets

Part 1 - Preparation of a Standard Solution

- Calibrate the weighing balance that you will be using.
- Weigh approximately between 1.25 and 1.45g of **anhydrous** sodium carbonate.
- Carefully transfer the sodium carbonate to a large beaker, accurately and precisely recording measurements to determine the exact mass transferred.
- Add 150cm^3 of distilled water to the beaker, stir and completely dissolve the sodium carbonate.
- Carefully and accurately transfer all of the solution to a 250cm^3 volumetric flask, and make up the solution to 250cm^3 with more distilled water.

You must risk assess your experiment and have it checked by your supervisor before starting.

You will need to demonstrate and evidence your skills and techniques in calibrating equipment, transferring solids and liquids, mixing of substances and taking and recording accurate measurements.

You will need to accurately calculate the concentration of the solution you have made.

Part 2 - Standardisation of an acid

- Calibrate the pipette that you will be using.
- Carefully and accurately transfer 25cm^3 of your sodium carbonate solution into a 250cm^3 conical flask and add a few drops of methyl orange indicator.
- Clean and fill a burette with a given solution of hydrochloric acid, which will have a concentration of approximately 0.1M.
- Titrate the sodium carbonate solution with the hydrochloric acid, until the indicator changes colour at the end point.
- Accurately and precisely record all measurements to determine the exact titre of hydrochloric acid required to reach the end point of the titration.
- You will need to decide whether the titration needs repeating and how many times.

You must risk assess your experiment and have it checked by your supervisor before starting.

You will need to demonstrate and evidence your skills and techniques in calibrating equipment, using volumetric glassware, transferring and mixing liquids, and taking and recording accurate measurements.

You will need to use your results to accurately calculate the precise concentration of the hydrochloric acid.

Part 3 - Titrations of sodium hydroxide with hydrochloric acid

You must risk assess your experiment and have it checked by your supervisor before starting.

You will need to demonstrate and evidence your skills and techniques in calibrating equipment, using volumetric glassware, transferring and mixing liquids, and taking and recording accurate measurements.

Part 3a - Titration of sodium hydroxide with hydrochloric acid (using an indicator)

- Calibrate the pipette that you will be using.
- Carefully and accurately transfer 25cm^3 of sodium hydroxide solution (unknown concentration) into a 250cm^3 conical flask and add a few drops of methyl orange indicator.
- Clean and fill a burette with the standardised solution of hydrochloric acid.
- Titrate the sodium hydroxide solution with the hydrochloric acid, until the indicator changes colour at the end point.
- Accurately and precisely record all measurements to determine the exact titre of hydrochloric acid required to reach the end point of the titration.
- You will need to decide whether the titration needs repeating and how many times.

You will need to use your results to accurately calculate the precise concentration of the sodium hydroxide.

Part 3b - Titration of sodium hydroxide with hydrochloric acid (using a pH meter)

- Calibrate the pipette that you will be using.
- Carefully and accurately transfer 25cm^3 of sodium hydroxide solution (unknown concentration) into a small beaker (size 100cm^3 or 150cm^3).
- Calibrate the pH meter that you will be using with the buffer solutions provided.
- Place the pH meter into the beaker of sodium hydroxide.
- Clean and fill a burette with the standardised solution of hydrochloric acid.
- Add hydrochloric acid from the burette to the sodium hydroxide solution in 1cm^3 portions until all of the acid has been added. Measure the pH reading on the pH meter every 1cm^3 of hydrochloric acid added.
- Accurately and precisely record all burette and pH measurements in a table.
- Plot a graph of pH against volume of acid added (burette reading) / cm^3.
- You will need to decide whether the titration needs repeating and if the precision needs to be improved.

You will need to use your graph to accurately calculate the precise concentration of the sodium hydroxide.

Part 4 – Determining the concentration of copper(II) sulfate solution by colorimetry

- Calibrate the weighing balance that you will be using.
- Weigh between 2.50 and 2.70g of **hydrated** copper(II) sulfate ($CuSO_4.5H_2O$).
- Carefully transfer the hydrated copper(II) sulfate to a beaker, accurately and precisely recording measurements to determine the exact mass transferred.
- Add 25cm^3 of hot distilled water to the beaker, stir and completely dissolve the hydrated copper(II) sulfate.
- Carefully and accurately transfer all of the solution to a 100cm^3 volumetric flask, and make up the solution to 100cm^3 with more distilled water.
- You have made a stock copper(II) sulfate solution of approximately 0.1M. Calculate the precise concentration and label the volumetric flask.
- Using some of the stock copper(II) sulfate solution you have made, dilute so that you have four other solutions of approximately 0.08M, 0.06M, 0.04M and 0.02M. Calculate the precise concentration of each solution that you make.
- Select an appropriate colour filter and calibrate the colorimeter (or visible spectrometer) that you will be using with the stock solution and distilled water, according to the manufacturer's instructions.
- Measure and record the absorbance (or transmission) of each copper(II) sulfate solution (approximately 0.1M, 0.08M, 0.06M, 0.04M, 0.02M) and for distilled water (0.00M) using the calibrated colorimeter (or visible spectrometer).
- Plot a calibration curve of absorbance (or transmission) against the concentration of copper(II) sulfate.
- Measure and record the absorbance (or transmission) of Sample A and Sample B (the unknown concentrations of copper(II) sulfate solution) supplied by your supervisor.
- Using the calibration curve, determine the concentrations of Sample A and B.

You must risk assess your experiment and have it checked by your supervisor before starting.

You will need to demonstrate and evidence your skills and techniques in calibrating equipment, transferring solids and liquids, mixing of substances, use of the colorimeter / visible spectrometer, and taking and recording accurate measurements.

You will need to accurately calculate the concentration of all of the copper(II) sulfate solutions you have made.

You will need to use your calibration curve to accurately calculate the precise concentration of copper(II) sulfate in Samples A and B.