AQA qualification support

AS/A-level Chemistry: Preparing to Teach

Resources B

BOOKLET 3

Published date: Spring 2015 version 1

Contents

Page

AQA

Practical handbook for A-level Chemistry

Contents

Key

There have been a number of changes to how practical work will be assessed in the new A-levels. Some of these have been AQA specific, but many are by common agreement between all the exam boards and Ofqual.

The symbol All signifies that **all boards** have agreed to this.

The symbol AQA is used where the information relates to **AQA only**.

A. Introduction

Practical work brings science to life, helping students make sense of the universe around them. That's why we've put practical work at the heart of our Biology, Chemistry and Physics A-levels. Practical science allows scientific theory to transform into deep knowledge and understanding – scientific thinking. Through investigation, students uncover the important links between their personal observations and scientific ideas.

> "In the best schools visited, teachers ensured that pupils understood the 'big ideas' of science. They made sure that pupils mastered the investigative and practical skills that underpin the development of scientific knowledge and could discover for themselves the relevance and usefulness of those ideas."
>
> Ofsted report
> Maintaining curiosity in science
> November 2013, No. 130135

The purpose of this Practical handbook

This handbook has been developed to support you in advancing your students to fluency in science.

Over the years, there have been many rules developed for practical work in Biology, Chemistry and Physics. Some have been prescriptive, some have been intended as guidance. Although we have always attempted to be consistent within subjects, differences have emerged over time. Worse, a student taking Biology may also be taking Physics and find themselves confronted with contradictory rules and guidance.

This practical handbook is an attempt to harmonise the rules and guidance for Biology, Chemistry and Physics. There are occasions where these will necessarily be different, but we will try to explain why where that happens.

The new A-level specifications accredited for first teaching in September 2015 bring with them a complete change in the way practical work is assessed. No longer will teachers have to force their students to jump through hoops set up by exam boards or worry about how much help they are giving students and whether it's allowed or not.

We have worked with teachers and examiners to produce this handbook. In this draft version, it's an evolving document, but one that we hope you will be able to use with your students, whether they're doing A-level Biology, Chemistry or Physics, or a combination of subjects, to improve their practical skills: in the classroom, in the laboratory, in exams, for the endorsement and on to university or the workplace.

Unless specified, all guidance is common to Biology, Chemistry and Physics at both AS and A-level and subject specific examples are for illustration only. However, the extent to which a particular aspect is assessed will differ. Teachers should refer to the specifications and specimen materials on our website for more information.

Chemistry example ladder and practical method

PRACTICAL 1

Required practical	**Make up a volumetric solution and carry out a simple acid-base titration**
Apparatus and techniques covered (Relevant apparatus only, not full statements)	a Use appropriate apparatus to record a range of measurements d Use laboratory apparatus for a variety of experimental techniques e Use volumetric flask, including accurate technique for making up a standard solution k Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances
Indicative apparatus	Basic laboratory glassware, volumetric flask, burette, volumetric pipette and filler, and protective equipment such as goggles.

	Amount of choice **Increasing independence** →			
	Least choice	Some choice	Many choices	Full investigation
	Teacher gives students a full method with clear instructions for how to produce a standard solution. Teacher gives students a full method for how to carry out a simple titration.	Teacher gives students an outline for the procedure but allows choices at different steps. Teacher gives students an outline for the procedure to carry out a simple titration, but with some choices in technique, equipment or indicators.	Teacher specifies the compound and concentration of solution. Students research the method to carry out for the preparation of the standard solution. Students research methods to carry out a simple titration using the equipment provided.	Students research methods for making a standard solution and choose the chemical and concentration to be made. Students research methods for carrying out a simple titration and choose the method, chemicals and equipment to use.
Opportunities for observation and assessment of competencies				
Follow written procedures	✓✓✓ Students follow written method.	✓✓✓ Students follow written method, making individual choices in technique or equipment.	✓✓✓ Students follow a method they have researched.	✓✓✓ Students follow a method they have researched.
Applies investigative approaches and methods when using instruments and equipment	✓ Students must correctly use the appropriate equipment. Procedure should be followed methodically and	✓Students must correctly use the appropriate equipment. Procedure should be followed	✓✓ Students must correctly select and use the appropriate equipment. Procedural steps should be well	✓✓✓ Student must choose an appropriate methodical approach, equipment and techniques. Procedural steps

	appropriate variables measured or controlled.	methodically and suitable variables identified, measured and controlled.	sequenced and adjusted where necessary. Suitable variables identified, measured and controlled.	should be well sequenced and adjusted where necessary. Suitable variables should be identified for measurement and control. Where variables cannot be readily controlled, approaches should be planned to take account of this.
Safely uses a range of practical equipment and materials	✓ Students must safely use the equipment.	✓ Students must safely use the equipment.	✓✓ Students minimise risks with minimal prompting.	✓✓✓ Students must carry out a full risk assessment and minimise risks.
Makes and records observations	✓ Students record data in specified ways	✓ Students record accurate data in specified ways	✓✓ Students record precise and accurate data, methodically using appropriate units, in specified ways	✓✓✓ Students must choose the most effective way of recording precise and accurate data methodically using appropriate units.
Researches, references and reports	✓ Data is reported and conclusions drawn.	✓ Data is reported and conclusions drawn. Students compare results and identify reasons for differences.	✓✓✓ Students must research methods available. They compare results and report on differences. Appropriate software is used to process data and report findings.	✓✓✓ Students must research alternatives in order to plan their work. Reporting covers the planning, carrying out and an analysis of their results. Appropriate software and/or tools are used to process data and report findings.

✓✓✓: Very good opportunity ✓✓: Good opportunity ✓: Slight opportunity ×: No opportunity

WORK SHEET 1a

To prepare a solution of sodium hydrogensulfate that has a known concentration.

Whenever possible, students should work individually.
If it is essential to work in a pair or in a small group, because of the availability of apparatus, supervisors must be satisfied that they are able to assess the contribution from each student to the practical activity.

Requirements

- weighing bottle or boat
- one 250 cm^3 volumetric (graduated) flask
- sodium hydrogensulfate solid (see below)
- filter funnel
- spatula
- de-ionised or distilled water in a wash bottle
- one 250 cm^3 beaker
- glass rod
- digital mass balance (reading to 2 or 3 decimal places)

The composition of the sodium hydrogensulfate should be known; either anhydrous (and the purest available) or the monohydrate. Students need to be advised which they are using. Suppliers can also call this reagent sodium bisulfate.

Suggested Method

The task is to prepare 250 cm^3 of a solution of sodium hydrogensulfate with a known concentration in the range 0.0900 to 0.110 mol dm^{-3}

The procedure is as follows

a) Calculate the mass of sodium hydrogensulfate solid needed to produce 250 cm^3 of a 0.100 mol dm^{-3} solution. Show your working. If you are using the anhydrous solid, the mass to weigh out will be between 2.7 and 3.3 g, and if you are using the monohydrate, the mass to weigh out should be between 3.1 and 3.8 g
b) Weigh a clean dry weighing bottle (or weighing boat).
c) Place the weighing bottle on the pan of a digital balance and, using a spatula, place into the bottle **approximately** the mass of sodium hydrogensulfate that you have calculated to be necessary.
d) Weigh the weighing bottle and its contents accurately and record the **precise** mass.
e) Pour the contents of the weighing bottle into a beaker and re- weigh the weighing bottle (which may still contain traces of sodium hydrogensulfate).
f) Calculate the mass of sodium hydrogensulfate that you have transferred. Remember to record all weighings to the precision of the balance that you have used.

g) Add approximately 100 cm^3 of de-ionised (or distilled) water to the beaker containing the solid and using a glass rod, stir the contents of the beaker until all of the sodium hydrogensulfate dissolves.
h) Using a funnel, pour the contents of the beaker into a 250 cm^3 volumetric (graduated) flask and then using the wash bottle rinse the beaker and funnel into the same volumetric flask. Rinse the glass rod into these washings.
i) Make the volumetric flask up to the graduated mark by carefully adding de-ionised water from the wash bottle. You will need to be careful so that you do not over-shoot the mark.
j) Stopper the volumetric flask and shake it thoroughly to mix the contents of the flask.
k) Calculate the exact concentration in mol dm^{-3} of your solution quoting the value to the appropriate precision. Show all of your working.

AQA

WORK SHEET 1b

To determine the concentration of a solution of sodium hydroxide by titration using a sodium hydrogensulfate solution that has a known concentration.

Whenever possible, students should work individually.
If it is essential to work in a pair or in a small group, because of the availability of apparatus, supervisors must be satisfied that they are able to assess the contribution from each student to the practical activity.

Requirements

- burette
- stand and clamp
- 25 cm^3 pipette
- pipette filler
- Two 250 cm^3 conical flasks
- Two 250 cm^3 beakers
- funnel
- wash bottle
- phenolphthalein indicator
- standard sodium hydrogensulfate solution (150 cm^3)
- sodium hydroxide solution (150 cm^3)

The sodium hydrogensulfate solution needs to be a solution with an accurately known concentration between 0.0900 and 0.100 mol dm^{-3} or could be the solution which the student prepared as part of Work Sheet 1a.

Students should use a sodium hydroxide solution with an accurately known concentration between 0.0900 and 0.100 mol dm^{-3} but labelled as "Sodium hydroxide solution of unknown concentration".

Suggested Method

a) Pour approximately 100 cm^3 of the sodium hydrogensulfate solution into a clean, dry beaker that is labelled 'sodium hydrogensulfate'. Use a small volume of this solution to rinse the burette before filling it with the sodium hydrogensulfate solution.
b) Pour approximately 100 cm^3 of the sodium hydroxide solution into a second clean, dry beaker labelled 'sodium hydroxide'.
c) Rinse a 25 cm^3 pipette with the sodium hydroxide solution provided and then, using a pipette filler, pipette exactly 25.0 cm^3 of sodium hydroxide solution into a 250 cm^3 conical flask (which has been rinsed with de-ionised water).
d) Add **two to three drops** of phenolphthalein indicator to the solution in the conical flask and note the colour of the indicator in alkali.
e) **Before you start** to titrate, construct a Table ready to record your results.
f) Record the initial burette reading. Make sure that all your burette readings are to the appropriate precision.
g) Titrate the contents of the conical flask by adding sodium hydrogensulfate solution to it

from the burette. Add the sodium hydrogensulfate solution slowly, swirling the flask gently to mix the solution. Add the sodium hydrogensulfate solution dropwise near the end-point until the indicator undergoes a definite colour change; this is the end-point of the titration. Record the colour change in your results. Record the final burette reading in your Table of results.

h) Calculate and record in your Table of results the volume of sodium hydrogensulfate solution used.

i) Repeat the titration until you obtain **two** results, which are **concordant.** You should normally carry out **at least three** titrations. **Record all of the results** that you obtain.

j) Calculate and record the mean volume of sodium hydrogensulfate solution used in the titration. Show your working.

AQA

Student name

	Practical 1	Practical 2	Practical 3	Practical 4	Practical 5	Practical 6	Practical 7	Practical 8	Practical 9
Apparatus and techniques covered									
Follow written procedures									
Applies investigative approaches and methods when using instruments and equipment									
Safely uses a range of practical equipment and materials									
Makes and records observations									
Researches, references and reports									
Date									

Ways this sheet could be used:

- Teacher and marks each student against each competency for each practical.
- Teacher ticks when a student has demonstrated a competency only.
- Teacher makes notes where a student has (or has not) demonstrated particular competencies.
- Students peer- or self-assess and either make notes or "grade" each competency.

Although the endorsement (and therefore each of the CPAC criteria) is pass/fail, many teachers will wish to judge competencies in individual practical lessons on a finer scale. For example they could use 1-5 or a red/amber/green rating.

This sheet could be glued into the front of lab books or files, or kept centrally by the teacher.

Students must cover all apparatus and techniques and should have experienced each of the 12 required practical activities. However, their competence can be assessed in any practical activity.