A-level Chemistry
CPAC – best practice

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Overview of this session

- Common Practical Assessment Criteria (CPAC).
- Apparatus and techniques.
- Practical work in action – Chemistry.
  - Planning, assessing and tracking.
Common Practical Assessment Criteria (CPAC)

1. Follows written procedures.
2. Applies investigative approaches and methods when using instruments and equipment.
3. Safely uses a range of practical equipment and materials.
4. Makes and records observations.
5. Researches, references and reports.

**CPAC Pen portraits**

A series of pen portraits have been written to clarify what is meant by 'not achieved', 'achieved' and 'achieved at a level of competence exceeding the CPAC standard'.

These exemplars have been developed in collaboration between the four Awarding Bodies: AQA, Eduqas, OCR and Pearson. They are intended for guidance and training purposes, and to give an indication of the standard necessary for each CPAC statement.

Note that, although these pen portraits show (in the most part) CPAC skills in isolation, many practical exercises are likely to involve CPAC strands being assessed in combination.
## Apparatus and techniques – AT a to AT l

<table>
<thead>
<tr>
<th>AT a</th>
<th>Use appropriate apparatus to record a range of measurements (to include: mass, time, volume of liquids and gases, temperature).</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT b</td>
<td>Use water bath or electric heater or sand bath for heating.</td>
</tr>
<tr>
<td>AT c</td>
<td>Measure pH using pH charts, or pH meter, or pH probe on a data logger.</td>
</tr>
<tr>
<td>AT d</td>
<td>Use laboratory apparatus for a variety of experimental techniques including:</td>
</tr>
<tr>
<td></td>
<td>• titration, using burette and pipette,</td>
</tr>
<tr>
<td></td>
<td>• distillation and heating under reflux, including setting up glassware using retort stand and clamps,</td>
</tr>
<tr>
<td></td>
<td>• qualitative tests for ions and organic functional groups,</td>
</tr>
<tr>
<td></td>
<td>• filtration, including use of fluted filter paper, or filtration under reduced pressure.</td>
</tr>
<tr>
<td>AT l</td>
<td>Measure rates of reaction by at least two different methods, for example:</td>
</tr>
<tr>
<td></td>
<td>• an initial rate method such as a clock reaction,</td>
</tr>
<tr>
<td></td>
<td>• a continuous monitoring method.</td>
</tr>
</tbody>
</table>
## 12 core practical activities

<table>
<thead>
<tr>
<th>Required activity</th>
<th>Apparatus and technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Make up a volumetric solution and carry out a simple acid-base titration.</td>
<td>a, d, e, f, k</td>
</tr>
<tr>
<td>2. Measurement of an enthalpy change.</td>
<td>a, d, k</td>
</tr>
<tr>
<td>3. Investigation of how the rate of a reaction changes with temperature.</td>
<td>a, b, k</td>
</tr>
<tr>
<td>4. Carry out simple test-tube reactions to identify:</td>
<td>d, k</td>
</tr>
<tr>
<td>• Cations – Group 2, NH4+,</td>
<td></td>
</tr>
<tr>
<td>• anions – Group 7 (halide ions), OH–, CO32–, SO42–.</td>
<td></td>
</tr>
<tr>
<td>5. Distillation of a product from a reaction.</td>
<td>b, d, k</td>
</tr>
<tr>
<td>6. Tests for alcohol, aldehyde, alkene and carboxylic acid.</td>
<td>b, d, k</td>
</tr>
</tbody>
</table>
AQA practical endorsement online training

http://www.aqa.org.uk/resources/science/as-and-a-level/teach/practicals

<table>
<thead>
<tr>
<th>Common Practical Assessment Criteria (CPAC)</th>
<th>I am looking for my students to be able to …</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Follows written instructions</td>
<td>• follow a set of written instructions that are appropriate to the level of familiarity to equipment or techniques</td>
</tr>
<tr>
<td></td>
<td>• carry out steps in the correct order</td>
</tr>
<tr>
<td></td>
<td>• generate a set of data that is expected. This might be close to my own value or that expected from a data trend seen in a secondary source</td>
</tr>
<tr>
<td></td>
<td>• work independently, in pairs or small groups but they must carry out practical steps</td>
</tr>
<tr>
<td></td>
<td>• feel confident to seek clarification when carrying out method steps, when either using an unfamiliar set of apparatus or carrying out a new technique</td>
</tr>
</tbody>
</table>
Feedback

Prompt feedback to:

• show where there is evidence towards the pass standard

• show if the pass standard has been reached

• give constructive comments to support progress towards (and beyond) the pass standard.
Feedback strategies

Feedback can be:

• written by the teacher

• written by the student following oral feedback from the teacher

• via peer assessment

• by other creative means which help support progress towards the pass standard (and beyond).
CPAC 1

Follows written procedures.
CPAC 1: assessing in a manageable way

<table>
<thead>
<tr>
<th>AS band 1</th>
<th>Date 25 Sept</th>
<th>Wet</th>
<th>Crushed</th>
<th>Rip A out</th>
<th>Rip B out</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Megan</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dylan</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matthew</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millie</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaitlin</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethan</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jonathon</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isaac</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orla</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joe</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sam</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ben</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>William</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretash</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nathan</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Written instructions can be used directly from the handbook content.

Suggested method

The task is to prepare 250 cm$^3$ of a solution of sodium hydrogen sulfate with a known concentration in the range 0.0800 to 0.110 mol dm$^{-3}$.

a) Calculate the mass of sodium hydrogen sulfate solid needed to produce 250 cm$^3$ of a 0.100 mol dm$^{-3}$ solution. There are two forms of sodium hydrogen sulfate solid available (and, your teacher will tell you which form you have). Show your working. If you are using the anhydrous solid (NaHSO$_4$), the mass to weigh out will be between 2.7 and 3.3 g, and if you are using the monohydrate (NaHSO$_4$·H$_2$O), 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 an ordinary top-pan digital balance and, using a spatula, place into the bottle approximately the mass of sodium hydrogen sulfate that you have calculated to be necessary.

d) Weigh the weighing bottle and its contents accurately (on the high-resolution balance) 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 hydrogen sulfate).

f) Calculate the mass of sodium hydrogen sulfate that you have transferred. Remember to record all weighings to the resolution of the balance that you have used.

g) Add approximately 100 cm$^3$ of deionised (or distilled) water to the beaker containing the solid and use a glass rod to stir the contents of the beaker until all of the sodium hydrogen sulfate 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 deionised 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.

Additional Questions:

a) Explain the reason(s) for the operations in procedure step (h).
Suggested method

The aim of this experiment is to prepare a sample of aspirin

Introduction

Aspirin is prepared by the acylation of salicylic acid (2-hydroxybenzenecarboxylic acid) using ethanoic anhydride as the acylating agent. The reaction can be represented as follows.

\[
\text{HOOC}_2\text{H}_2\text{OH} + (\text{CH}_3\text{CO})_2\text{O} \rightarrow \text{HOOC}_2\text{H}_2\text{OCOCH}_3 + \text{CH}_3\text{COOH}
\]

salicylic acid  ethanoic anhydride  aspirin  ethanoic acid

Aspirin (2-ethanoylhydroxybenzenecarboxylic acid) is an antipyretic drug (reduces fever by lowering body temperature) and an analgesic (relieves pain).

Aspirin does not react in the acidic conditions in the stomach, but is hydrolysed in the alkaline conditions found in the intestines to produce ethanoate ions and salicylate (2-hydroxybenzenecarboxylate) ions. Salicylates lower the body temperature of feverish patients and have a mild analgesic effect relieving headaches and other pain. The toxic dose is relatively high, but symptoms of poisoning can occur with quite small quantities.

Part 1 Preparation

a) Weigh out approximately 6.00 g of salicylic acid directly into a 100 cm\(^3\) conical flask.
b) Record the mass of salicylic acid used. 6.0 g.
c) Using a 10 cm\(^3\) measuring cylinder, add 10 cm\(^3\) of ethanoic anhydride to the flask and swirl the contents.
d) Add 5 drops of concentrated sulfuric acid to the flask and swirl the mixture in the flask for a few minutes to ensure thorough mixing.
e) Warm the flask for twenty minutes in a 400 cm\(^3\) beaker of hot water at approximately 60 °C. The temperature in the flask should not be allowed to rise above 65 °C.
f) Allow the flask to cool and pour its contents into 75 cm\(^3\) of water in a beaker, stirring well to precipitate the solid.
g) Filter off the aspirin under reduced pressure, avoiding skin contact.
h) Collect the crude aspirin on a double thickness of filter paper and allow it to dry.

\[
\text{Mass of watchglass } + 2 \times \text{filter paper} = 25.18 + 0.42 = 25.60 \text{ g}
\]
CPAC 1 – what would you look for?
Determination of the Relative Molecular Mass of a Volatile liquid 06/10/15

Mass of syringe = 2.52g 2.64g
Mass of syringe with volatile liquid = 2.41g 2.79g
Volume of volatile liquid = 0.4cm$^3$ = 0.2ml
Volume of gas = 72ml
Mass of liquid = 0.15g = 2.79g - 2.64g = 0.15g
Pressure = 99600Pa
Temperature of the water bath = 84.5°C = 357.5K
Molar gas constant = 8.31 J K$^{-1}$ mol$^{-1}$

Number of moles = \( \frac{pV}{RT} = \frac{9600Pa \times 7.2 \times 10^{-3}}{8.31 \times 357.5} \)

\[ = 0.00241 \]

\[ = 2.41 \times 10^{-3} \text{ mol} \]

Mr = \( \frac{\text{mass}}{\text{moles}} \)

Mr of liquid = 62.3-

\[ \text{good!} \]

Propene \[ \text{Mr} = 28 \]

C$_2$H$_6$O \[ \text{was used.} \]
CPAC 2

Applies investigative approaches and methods when using instruments and equipment.
## Planning for CPAC 2 assessment

<table>
<thead>
<tr>
<th>What AQA is looking for.</th>
<th>Use the equipment properly, without much prompting. Work methodically and show ability to multi-task.</th>
<th>Have adapted method/equipment during the practical and have justified reasons for this.</th>
<th>Have listed the main variables and have explained how control variables will be kept the same.</th>
<th>Have selected the most appropriate equipment and explained reasons for choosing each piece in order to gather accurate results.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPAC 2: make choices about appropriate element Examples.</td>
<td>Use equipment to measure volumes and time.</td>
<td>At least two adaptations to the method provided, with justifications.</td>
<td>Independent and dependent identified and state how to control two variables.</td>
<td>Chosen equipment with lowest levels of uncertainty and justify.</td>
</tr>
</tbody>
</table>
3. Fill a beaker with tap water and put it on the gas ring. Heat it under a bunsen burner till it is approximately 50°C - 60°C. Use a thermometer.

- Don’t put your fingers in to test the heat as you could burn them.

4. Put the test tube of Tollens’ reagent in here.

5. Add 10 drops of the ethyl alcohol formed before to this.

6. Wait 3 minutes.

7. A silver mirror should have formed proving that it is ethyl alcohol.

Line anything which had Tollens’ reagent first with dilute sulphuric acid and then water once dry.

   Accessed on 14/05/18 at 1:52 AM
2. http://www.electromagnetics.co.uk/Science/2013/1-3-1892.pdf
   Accessed on 04/05/18 at 11:43 AM
3. A Level Year 1 and GCSE Chemistry Core Revision Guide
PAG 11.1 – Acids and Bases – Identifying unknowns

Introduction/Aims
To use your deductive skills to identify five unknown solutions.

Chemicals

V, W, X, Y, Z
HCl(aq) 0.5M, HCl(aq) 1.0M, NaOH(aq) 0.5M, phenolphthalein, deionised water – not in that order

Procedure
Make a plan in your notebook for how you are going to identify the five solutions above, using only them and the equipment provided, then implement that plan. Record your results.

To Submit
For this piece of work to count towards Practical Activity Group 11 of the GCE Chemistry Practical Endorsement, you should have evidence of all of the tests you carried out, your recordings and conclusions from this experiment. You should ensure your records are recorded in an appropriate format.

CPAC: 2a, 2b, 2d
In order to determine which is the more concentrated acid, we will mix 3 drops of £7 with 3 drops of $2$ with first 3 drops of $2$ with 3 drops of $2$.

To prepare the titration as a range of titration:

- 3 drops:
  - $W$ is 0.5M HCl
  - $V$ is 0.5M HCl

To differentiate between the NaOH and the phenolphthalein:
- 2 drops of $W$ (HCl) + 3 drops $X$ + 1 drop $Y$ → strong purple
- 2 drops $W$ (HCl) + 5 drops $X$ + 1 drop $Z$ → decolorises

The acid neutralised the NaOH sufficiently in the second mixture but not the first, so therefore:

- $Z$ is NaOH
- $X$ is phenolphthalein
Health & Safety
- Wear safety spectacles.

Procedure
1. Fill a 250 cm$^3$ beaker with chopped cabbage. Place the cabbage in a large beaker and add boiling water to cover the cabbage and boil and stir for 5 mins so the indicator leaches out of the cabbage.
2. Filter or decant to separate the plant material to obtain a red-purple-bluish coloured liquid.
3. This liquid is at about pH 7. (The exact colour you get depends on the pH of the water.)
4. Set up a test tube rack + tubes with a sample of your indicator soln. in each tube.
5. Using your knowledge of acids and bases adjust the pH to get the full colour range for pH 1 – 13, making notes on how you achieved the target pH.

<table>
<thead>
<tr>
<th>[H$^+$]</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Red</td>
</tr>
<tr>
<td>High</td>
<td>Red-blue</td>
</tr>
<tr>
<td>Moderate</td>
<td>Blue</td>
</tr>
<tr>
<td>Low</td>
<td>Green-Yellow</td>
</tr>
<tr>
<td>Very Low</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

Questions
Anthocyanins are weak organic acids, with the conjugate base structures like the following:
CPAC 3

Safely uses a range of practical equipment and materials.
CPAC 3: safe use of a range of practical equipment and materials

• It is not robust enough to say that students are reaching the pass standard because ‘nothing went wrong’.

• Clear statements outline that students must:
  • identify main hazards and associated risks
  • use appropriate safety equipment and approaches with minimal prompting
  • make adjustments when issues are identified.
HEALTH HAZARD

It is forbidden to eat or drink in this laboratory
CPAC 3
### CPAC 3a – assessing risks: what is expected?

#### King Edward VII Upper School Chemistry Department – Risk Assessment Form

<table>
<thead>
<tr>
<th>Title of experiment(s):</th>
<th>Hydrolysis of Halogenoalkanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outline of procedures</td>
<td>Placing ethanol and silver nitrate into 3 test tubes. Place test tubes in a hot water bath for 5 minutes and allow it to reach equilibrium. Keep in water bath and quickly add 3 drops of different halogenoalkanes into each test tube. Shake briefly. Let it sit and watch it until it forms.</td>
</tr>
<tr>
<td>Hazardous substances / procedure</td>
<td>Nature of the hazards</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Ethanol</td>
<td>Highly Flammable, Vapor may be explosive, Irritant</td>
</tr>
<tr>
<td>1-Chlorobutane</td>
<td>Highly Flammable, Vapor may be explosive, Irritant</td>
</tr>
<tr>
<td>1-Bromo-butane</td>
<td>Flammable, Irritant</td>
</tr>
<tr>
<td>1-Iodobutane</td>
<td>Flammable, Harmful, Irritant</td>
</tr>
</tbody>
</table>

#### Disposal of residues

Wash all residues down the sink carefully and rinse out test tubes.

Carried out by: [Name]

Checked by: [Name]

Date: 5/4/16
CPAC 3a – written risk assessment

Example with sources, showing some evidence of CPAC 5b too.

5. https://en.wikipedia.org/wiki/Acid_strength#Weak_acids_in_water

\[ \text{Hazards Assessment} \]

Acetic acid is intended to be handled. Be careful when handling containers.

- Acetic acid is slightly toxic if ingested.
- Acetic acid is slightly toxic.
- Acetic acid is slightly toxic.

**CPAC 5b**

* Sodium hydroxide and ammonia are corrosive.
* Be careful when handling containers with these substances.
* Wear a lab coat.
* Wear safety glasses.

1. Acetic acid is intended to be handled. Be careful when handling containers.
2. Acetic acid is slightly toxic if ingested.
3. Acetic acid is slightly toxic.
4. Acetic acid is slightly toxic.

(continued)
CPAC 4

Makes and records observations.
CPAC 4: makes records and observations

Data can be **qualitative** or **quantitative**.

Note that students must make **accurate**, **relevant** observations.

They are also required to obtain **accurate**, **precise** and **sufficient** data before recording it, **methodically using appropriate units and conventions**.
• Give prompt, constructive feedback.

• Indicate whether the pass standard has been reached or if there is some evidence of the pass standard.
CPAC 4 – observations: what would one expect to see in a results table?
CPAC 4 – is this a pass?

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-</td>
<td>- Pale yellow / green precipitate band formed on top of solution.</td>
<td>- A very small milky / cream precipitate formed</td>
<td>- A milky white emulsion formed</td>
</tr>
<tr>
<td></td>
<td>Silver nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dilute ( \text{NH}_3 ) ((aq))</td>
<td>- Pale yellow precipitate solution</td>
<td>- Precipitate remain</td>
</tr>
<tr>
<td></td>
<td>Conc. ( \text{NH}_3 ) ((aq))</td>
<td>- Pale yellow precipitate solution</td>
<td>- Precipitate dissolves</td>
</tr>
</tbody>
</table>
CPAC 4 – issues?
CPAC 4 – is this a pass?

<table>
<thead>
<tr>
<th></th>
<th>trial</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final burette reading / cm³</td>
<td>30.75</td>
<td>30.30</td>
<td>30.40</td>
<td>30.50</td>
<td>30.30</td>
</tr>
<tr>
<td>Initial burette reading / cm³</td>
<td>0.70</td>
<td>1.05</td>
<td>0.45</td>
<td>1.25</td>
<td>0.50</td>
</tr>
<tr>
<td>Titre / cm³</td>
<td>30.05</td>
<td>29.25</td>
<td>29.95</td>
<td>29.25</td>
<td>30.00</td>
</tr>
<tr>
<td>Used to calculate average (tick or cross)</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

Mean titre to two decimal places / cm³: 29.25 cm³
### CPAC 4 – feedback

<table>
<thead>
<tr>
<th>Rough</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial vol</td>
<td>6.10</td>
<td>7.50</td>
</tr>
<tr>
<td>Final vol</td>
<td>32.40</td>
<td>33.20</td>
</tr>
<tr>
<td>Tiene</td>
<td>26.30</td>
<td>25.7</td>
</tr>
</tbody>
</table>

Precision! (2 d.p. please)

Moles = Concentration × Volume

Moles = 

Moles = 0.1 × 0.2565

Moles = 0.02565

Mass = 2.9224
CPAC 4 – feedback

2H₂O₂ (aq) → 2H₂O(l) + O₂ (g)

mass of MnO₂ = 0.04 g

<table>
<thead>
<tr>
<th>Assessed practical PAG 9</th>
<th>CPAC</th>
<th>Below standard</th>
<th>Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rates of reaction – continuous monitoring method</td>
<td>2a Correctly uses appropriate instrumentation, apparatus and materials (including ICT) to carry out investigative activities, experimental techniques and procedures with minimal assistance or prompting.</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>5.1 Decomposition of hydrogen peroxide</td>
<td>4b Obtains accurate, precise and sufficient data for experimental and investigative procedures and records this methodically using appropriate units and conventions</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Volume of Gas (cm³)</th>
<th>V&lt;sub&gt;final&lt;/sub&gt; - V&lt;sub&gt;t&lt;/sub&gt; (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slide 36  Copyright © AQA and its licensors. All rights reserved.
CPAC 5

Researches, references and reports.
CPAC 5 is being evidenced as soon as students begin to **process their raw data**.

**Research** must be used to **inform further practical work** or to support a **conclusion** being made.

It may also be used well to **evaluate a practical** method; to inform adjustments for next time.
CPAC 5 – plotting a graph ‘old skool’ and calculating a gradient

\[ \text{Rate} = \frac{90}{110} = 0.82 \]
CPAC 5 – Arrhenius: using excel to plot ln(rate) vs 1/T

<table>
<thead>
<tr>
<th>°C</th>
<th>T/K</th>
<th>T⁻¹/K⁻¹</th>
<th>T/K</th>
<th>ln(rate/s⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.0</td>
<td>303</td>
<td>3.33</td>
<td>6.87</td>
<td></td>
</tr>
<tr>
<td>29.0</td>
<td>307</td>
<td>3.29</td>
<td>4.69</td>
<td></td>
</tr>
<tr>
<td>28.0</td>
<td>313</td>
<td>3.14</td>
<td>6.29</td>
<td></td>
</tr>
<tr>
<td>27.0</td>
<td>317</td>
<td>3.08</td>
<td>13.24</td>
<td></td>
</tr>
<tr>
<td>26.0</td>
<td>323</td>
<td>3.02</td>
<td>28.94</td>
<td></td>
</tr>
</tbody>
</table>
CPAC 5 – Arrhenius: using excel to plot $\ln(\text{rate})$ vs $1/T$

<table>
<thead>
<tr>
<th>$T/\degree$</th>
<th>$T/\text{K}$</th>
<th>$1/T/\text{K}^{-1}$</th>
<th>t/s</th>
<th>rate/$\text{s}^{-1}$</th>
<th>$\ln(\text{rate}/\text{s}^{-1})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>333</td>
<td>0.003003</td>
<td>6.29</td>
<td>0.158983</td>
<td>-1.83896107</td>
</tr>
<tr>
<td>45</td>
<td>325</td>
<td>0.003106</td>
<td>5.45</td>
<td>0.084556</td>
<td>-2.51245207</td>
</tr>
<tr>
<td>50</td>
<td>317</td>
<td>0.003155</td>
<td>13.24</td>
<td>0.075529</td>
<td>-2.58324255</td>
</tr>
<tr>
<td>55</td>
<td>310</td>
<td>0.003203</td>
<td>21.94</td>
<td>0.034554</td>
<td>-3.36522472</td>
</tr>
<tr>
<td>60</td>
<td>303</td>
<td>0.003333</td>
<td>28.94</td>
<td>0.034554</td>
<td>-3.36522472</td>
</tr>
<tr>
<td>70</td>
<td>343</td>
<td>0.002915</td>
<td>4.69</td>
<td>0.21322</td>
<td>-1.54543258</td>
</tr>
</tbody>
</table>

The equation of the line is $y = -4788.4x + 12.479$.
CPAC 5 – gradient calculated by excel, used to get $E_a$

$$\frac{d\ln k}{dT} = -\frac{E_a}{R}$$

$-E_a = 39.8 \text{kJmol}^{-1}$

CLEAPSS value is $\approx 47 \text{kJmol}^{-1}$
## CPAC 5 – feedback

<table>
<thead>
<tr>
<th>Assessed practical PAG 10</th>
<th>CPAC</th>
</tr>
</thead>
</table>
| Rates of reaction - initial rates method | 5a Uses appropriate software and/or tools to process data, carry out research and report findings.  
5b Cites sources of information, demonstrating that research has taken place, supporting planning and conclusions. |
| Below standard | Achieved |

*NB 15.11.16*
CPAC 5a – student records details of oral feedback

Verbal feedback given:
Mr. Matthew said that I had done well because plotted points and labels were good.
To improve I need to:
- The scale should be some bigger to get more detail. High error when extrapolating. Can not could be say for sure what line it will follow.
CPAC 5 – student mobiles: bluetooth colorimeters
CPAC 5 – gradient calculated on screen: rate, hence order and rate equation

\[ y = mx + c \]

Initial rate
CPAC 5 – using a mobile phone to conduct Rf analysis

**Rf values:**

Impure: \[ \frac{7.3}{9.3} = 0.785 \]

Pure: \[ \frac{8.1}{9.3} = 0.871 \]

Teaching sample: \[ \frac{8.2}{9.3} = 0.882 \]

**TLC conclusion**

Our sample of benzoic acid must be quite pure as it has only one spot on the TLC plate, and it's along the same length as the teachers sample. You can also tell the difference between the Impure sample.
Control measures (precautions) | Information Source.  
| --- | --- |
| Wear safety goggles, and avoid skin contact and inhalation. Wash hands after use. | https://www.sciencelab.com/msds.php?msdsId=9927606
21/11/16 |
| Wear safety goggles. Should not be harmful at this concentration. Wash hands if skin contact occurs. | www.avantormaterials.com/Document
MSDS/USA/SAP/00036277.pdf
21/11/16 |
2012/20/20/10 095c.pdf
https://isolab.ess.washington.edu/sol3ab/image?documents/30466سلط_د_أكسيد hiệu |
CPAC 5 – referencing: is this good enough?

See 4 pages after for more text of purity.

Purifying crude aspirin - Recrystallisation

1. Shake the sample with a solvent and heat it to dissolve
the aspirin.
2. Wash the residue with cold solvent.
3. Allow the solution to gradually cool.
4. Filter the solution by using a Buchner funnel and pump.
5. Throw away the residue.
6. Filter the solution cold using a Buchner funnel and pump.
7. Keep the residue.
8. Dry to constant weight.

To measure purity, test the melting point. If it is sharp then the product is pure, if it is over a range of temperatures it and also lower than the expected boiling point, it is impure.

Method for measuring melting point: - Place enough dry sample to reach a depth of about 0.5cm in a sealed melting point tube.

- Melting points:
  - 2-Aminobenzoic Acid = 138-146°C
  - Aspirin = 158-160°C

- Sources:
  - Measuring melting points
    2. http://www.rsc.org/learn-chemistry/content/figureposing/CMP/RSC00C045/Aspirin.pdf
  - CPAC 56
    2. 14/11/16
CPAC 5 – referencing: is this good enough?

24/11/16 Measuring purity: True melting point of aspirin = 138-140°C
Melting point 1 = 124-128°C
Melting point 2 = 126-128°C

Student ©

From my results, I can see that the melting point ranges that I recorded were significantly lower than the true melting point range.

An impure product would have a larger range over which it melts and would have a lower melting point compared with the true melting point range. Therefore, I can conclude that my product must contain some impurities and so if I were to do this experiment again, I would carry out recrystallisation thoroughly and carefully to purify my crude aspirin to a higher level of purity which would give me a more accurate melting point range.
Examples of good practice

1. Assessment grid per student.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Technique used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Use water bath or electric heater or sand bath for heating</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Use laboratory apparatus for a variety of experimental techniques</td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>Purify a liquid product, including use of a separating funnel</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Evidenced by</th>
<th>Standard achieved:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Correctly follows instructions to carry out experimental techniques or procedures.</td>
<td>observation</td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>Identifies hazards and assesses risks associated with these hazards, making safety adjustments as necessary, when carrying out experimental techniques and procedures in the lab or field.</td>
<td>uses hazards to identify risks</td>
<td></td>
</tr>
<tr>
<td>3b</td>
<td>Uses appropriate safety equipment and approaches to minimise risks with minimal prompting.</td>
<td>teacher observation and questioning</td>
<td></td>
</tr>
</tbody>
</table>

Targets from practical
Examples of good practice

2. Apparatus drawing.
Examples of good practice

Apparatus drawing (continued).

No need for straight lines in apparatus diagrams. They simply need to show correct apparatus set-up that would work.
Electrochemical cell

What CPAC assessment opportunities here?
Monitoring visits

The visits are:

1. To quality assure for provision of CPAC practical skills (via the 12 Core Practicals as a minimum).
2. To quality assure the judgement of the pass standard by teachers in each centre.
3. To offer coaching and advice to develop the capacity of every centre to do (even) better.

All exam boards share the provision of the monitoring visits to centres offering A-levels in Chemistry, Physics and/or Biology.
Monitoring visit

- Teacher records – online training, planning, tracking of CPAC assessments.

- Conversations with staff and students.

- Lab books.

- Observed lesson to ‘moderate’ CPAC judgments.

- Mixture of CPD for centre and quality assurance to ensure robust reporting of practical endorsement.
A-level practical sciences

Timeline for the new practicals

The monitoring of the practical endorsement for science A-levels for first teaching September 2015 is changing. We’ve summarised the main dates for you to keep in mind.

- **Sep 15**
  - Catherine Witter, Lead Practical Adviser joins AQA’s team
  - Updated Practical handbooks available
  - JCQ wrote to schools with practical registration information

- **Oct 15**
  - Free online practical endorsement training live on the AQA website aqa.org.uk/science-practical-training

- **Nov 15**
  - 1 Nov: deadline for returning JCQ practical registration information

- **Jan 16 to Apr 16**
  - First wave of practical advisory visits to schools take place

- **May 16 to Jul 16**
  - Repeat advisory visits to schools take place (if needed)

- **Sep 16 to Jan 17**
  - Second wave of practical advisory visits to schools take place

- **Feb 17 to Jul 17**
  - Repeat advisory visits to schools take place (if needed)

- **May 17**
  - Schools report students’ Pass/non-classified in the endorsement to exam boards
A-level practical sciences

Currently, centres are predicting practical endorsement grades
Your turn to ask the questions ...
Thank you

For qualification information, resources and support, please visit

aqa.org.uk/science