Pearson Edexcel

Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 9CH0

Resource Set 2 – Topic Group 6

Questions based on practical work taken from any topic

(Public release version)

Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

3 This question is about a titration experiment carried out by a group of students to determine the concentration of a solution of ethanoic acid using sodium hydroxide.

(a) A student weighed about 4.00 g of sodium hydroxide pellets and added them to a beaker containing 50 cm^3 of deionised water.

The mixture was stirred with a glass rod to dissolve the pellets and to give a homogenous solution.

The solution was poured through a funnel into a 250.0 cm^3 volumetric flask and deionised water was added up to the mark and then the flask was shaken.

(i) Describe how you would ensure that all the sodium hydroxide was transferred to the volumetric flask.

(2)

Washing the container where the sodium hydroxide was dissolved, as well as the glass rod and the funnel and filter. This should be done with deionised water and the washings added to the volumetric flask.

(ii) A student adds deionised water above the mark and shakes the flask.

State why the procedure has to be restarted rather than using a teat pipette to remove the excess water.

(1)

The excess water already contains some dissolved sodium hydroxide, so removing this will mean that the amount of sodium hydroxide in the remaining solution will be incorrect.

(b) Two students each cleaned a burette, then poured sodium hydroxide solution into their burettes.

(i) Student 1 used a funnel to pour sodium hydroxide solution into the burette.

Give **two** steps needed before the student takes the initial burette reading.

(2)

Open the tap to allow the bottom of the burette to be filled with solution, and to ensure the level in the burette is not above the scale. The tip of the burette should then be tapped gently to remove any gas trapped in the tip.

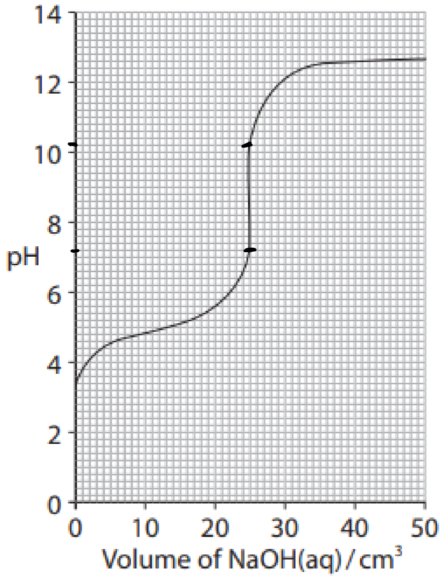
(ii) Student 2 cleaned the burette by rinsing it with deionised water immediately before filling it with the sodium hydroxide solution.

Give the effect, if any, on the value of the first titre. Justify your answer.

(1)

The titre will be larger than the true value, as the solution in the burette will be diluted by the water left in the burette from the washing

(c) The sketch shows the pH changes during a titration of 25.0 cm^3 of ethanoic acid with sodium hydroxide of the same concentration.



The ideal indicator for this titration will change colour on the addition of a very small volume of sodium hydroxide solution at a titre value very close to the equivalence point of the reaction.

(i) Assess the suitability of methyl red as an indicator for this titration. Make use of the Data Booklet in answering this question.

(4)

Methyl red changes in the range 4.4 - 6.3. This is not suitable for this titration as the pH range during the end-point of the reaction is approximately 7.2 - 10.2. This means that the indicator will change colour before the titration is actually finished. Chosen indicator should change colour at equivalence point (inflection, vertical region) which should show a rapid colour change when added dropwise as neutralisation.

(ii) Complete the table, with a tick (✓) or a cross (✗), to show whether or not the indicator would be suitable for use in this titration.

(1)

Indicator	pH range	Tick or Cross
Bromocresol purple	5.2 – 6.8	✗
Thymol blue	8.0 – 9.6	✓
Thymolphthalein	8.3 – 10.6	✓
Alizarin yellow R	10.1 – 13.0	✗

(d) Each student used a pipette to measure 25.0 cm^3 of the ethanoic acid solution into four separate conical flasks and added an indicator.

The results of one student's titrations are shown in the table.

Titration number	1	2	3	4
Final burette reading / cm^3	13.00	25.50	37.90	50.00
Initial burette reading / cm^3	0.25	13.00	25.50	37.90
Titre / cm^3	12.75	12.50	12.40	12.10
Concordant titres (✓)		✓	✓	

(i) Complete the table.

(1)

(ii) The low titre for titration **4** was queried by the teacher. The student had wanted to refill the burette and continue the titration but had been told the measurement uncertainty would increase if this was done.

Calculate the total percentage measurement uncertainty if the burette had been refilled to 0.00, and then a further 0.30 cm^3 had been added from the burette, to the conical flask.

The measurement uncertainty for each burette reading is ±0.05 cm^3.

(1)

initial 37.90
final 50.00
new initial 0.00
new final 0.30

} ±0.05 × 4 times

$$\frac{0.05 \times 4}{12.10 + 0.30} \times 100 = \frac{0.2}{12.40} \times 100 = 1.61\%$$

(e) The teacher carried out the experiment and obtained the following results.

Mass of sodium hydroxide used to make 250.0 cm^3 solution = 3.80 g

Volume of ethanoic acid solution = 25.00 cm^3

Mean titre of sodium hydroxide = 11.90 cm^3

$$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$$

Calculate the concentration of the ethanoic acid solution in **g dm^{-3}**.
Give your answer to an appropriate number of significant figures.

(5)

conc of NaOH $= \frac{m}{v} = \frac{3.8}{250 \times 10^{-3}} = 15.2\ g\ dm^{-3}$

$\therefore$ mass reacted $= cv = 15.2 \times 11.9 \times 10^{-3} = 0.181\ g$

$n = \frac{m}{mr} = \frac{0.181}{40} = 4.53 \times 10^{-3}$ mol

$\Rightarrow$ n of acid $= 4.53 \times 10^{-3}$ mol

$\therefore$ m acid $= n \times mr = 4.53 \times 10^{-3} \times 60 = 0.272\ g$

$c = \frac{m}{v} = \frac{0.272}{25 \times 10^{-3}} = 10.9\ g\ dm^{-3}$

(Total for Question 3 = 18 marks)

8 1-bromobutane can be prepared from butan-1-ol and hydrogen bromide.

$$CH_3CH_2CH_2CH_2OH + HBr \rightarrow CH_3CH_2CH_2CH_2Br + H_2O$$

Hydrogen bromide can be made from sodium bromide and 50% concentrated sulfuric acid.

(a) The steps for the preparation of impure 1-bromobutane are summarised.

Step **1** Dissolve the sodium bromide in distilled water in a pear-shaped flask and then add 20.0 cm^3 of butan-1-ol.

Step **2** Surround the flask with an ice bath to **cool the mixture**, before adding concentrated sulfuric acid drop by drop.

Step **3** Remove the flask from the ice bath and add a few **anti-bumping granules** to the reaction mixture.

Step **4** Set up the apparatus for **heating under reflux**. Heat the mixture in the flask for 30 minutes and then allow the apparatus to cool.

Step **5** Rearrange the apparatus for distillation and heat the mixture until no more 1-bromobutane distils over.

(i) Parts of the method are given in **bold** type in Steps **2**, **3** and **4**.
Give a reason why each of these parts is necessary.

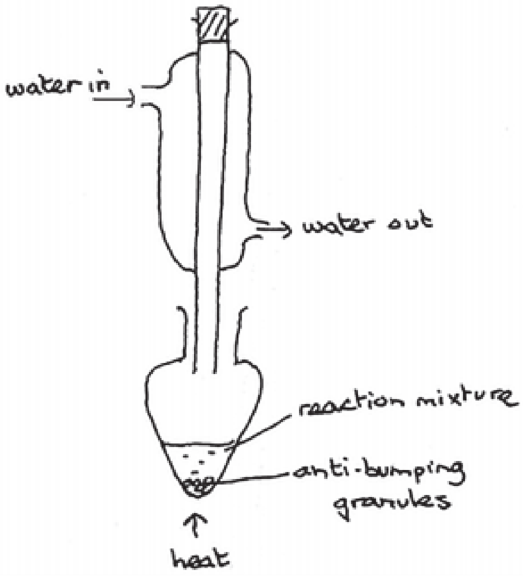
(3)

The reaction in step 2 is very exothermic, so if it is not cooled it will bubble and cause dangerous splashing of concentrated sulfuric acid.

Anti-bumping granules present to prevent the vigorous bubbling, promoting smooth boiling when heating under reflux

The mixture in step 4 is heated under reflux in order to prevent the chemicals evaporating and being lost, and so desired reaction has all occurred.

(ii) A student drew a diagram of the apparatus used for heating under reflux in Step **4**. There are three errors in the apparatus shown in the diagram. Assume the apparatus is suitably clamped.



Identify the three errors, including the effect of each error.

(3)

The pear shaped flask and the condenser should be joined in a way that seals them, with a bung or suitable ground-glass joints. Having them unsealed as in the diagram will allow gasses to escape.

Water should flow into the lower inlet and out of the upper one, this prevents uneven cooling by ensuring there are no air bubbles

There should not be a stopper in the top of the condenser, this will result in a closed system, pressure build up and potentially exploding equipment.

(iii) The student corrected the errors.
While the mixture was heating under reflux, the student noticed a small amount of a brown vapour was formed.

Explain why the brown vapour forms.

(2)

During the substitution, Br^- ions are formed.
Some of these join to form Br_2, a brown vapour. (gas)

(b) The distillate collected in Step **5** is a mixture consisting of two layers.
There is an aqueous layer and a layer containing impure 1-bromobutane.

Data

Densities:

water	$1.00\ g\ cm^{-3}$
butan-1-ol	$0.81\ g\ cm^{-3}$
1-bromobutane	$1.27\ g\ cm^{-3}$

Boiling temperature of 1-bromobutane = 102 °C

The steps for the purification of the 1-bromobutane are summarised.

Step **6** Transfer the mixture from Step **5** to a separating funnel and remove the aqueous layer.

Step **7** Wash the impure 1-bromobutane with concentrated hydrochloric acid in the separating funnel. Remove the aqueous layer.

Step **8** Add aqueous sodium hydrogencarbonate to the impure 1-bromobutane in the separating funnel.

Step **9** Shake the mixture in the separating funnel and, from time to time, invert the funnel and open the tap.

Step **10** Collect the 1-bromobutane layer from Step **9** in a small conical flask. Add anhydrous sodium sulfate and swirl the flask until the liquid becomes clear.

Step **11** Decant the 1-bromobutane into a clean pear-shaped flask and redistil it. Measure the volume of 1-bromobutane produced.

(i) State the position of the aqueous layer in the separating funnel at the start of Step **6**. Justify your answer.

(1)

The lowest, as it has a lower density than 1-bromobutane.

(ii) Concentrated hydrochloric acid is used to remove any unreacted butan-1-ol in the mixture in Step **7**.

Give the reasons for carrying out Steps **8**, **9** and **10**.

(3)

The sodium hydrogen carbonate reacts with left over HCl from step 7, and removes it from being dissolved in the 1-bromobutane. → to ensure everything in flask is mixed
Inverting the flask and opening the tap allows pressure from CO_2 production in step 7 to be released. Without this the bung would be blown off and the product lost.
Anhydrous sodium sulfate removes water, this is done until the solution goes clear because it is the water droplets that cause the cloudiness.

(iii) Give a suitable temperature **range** over which to collect the pure 1-bromobutane in the redistillation in Step **11**.

(1)

99 - 102 °C

(iv) The volume of 1-bromobutane collected was 12.0 cm³.

Calculate the number of molecules of 1-bromobutane produced in this experiment.

Give your answer to an appropriate number of significant figures.

(2)

$\rho = \frac{m}{v} \Rightarrow m = \rho v = 1.27 \times 12 = 15.24$ g

$n = \frac{m}{M_r} = \frac{15.24}{136.9} = 0.111$ mol

no. molecules $= n \times N_A = 0.111 \times 6.02 \times 10^{23} = 6.70 \times 10^{22}$

(Total for Question 8 = 15 marks)

1 This question is about some halogens and their compounds.

(a) The intermolecular attractions between halogen molecules are London forces.

(ii) The boiling temperatures of chlorine and bromine are shown in the table.

Halogen	Boiling temperature / °C
chlorine	−34
bromine	59

Explain why bromine has a higher boiling temperature than chlorine.

(2)

Halogens exist as diatomic molecules. They are held together with van-der-waals' forces between the molecules. The greater number of electrons in Br_2 molecules, as compared to Cl_2 molecules means these v.d.w forces are greater in bromine than they are in chlorine, so Br_2 require greater amount of energy to overcome forces.

(b) A student carries out experiments to determine the order of reactivity of three halogens: bromine, chlorine and iodine.
The student is provided with aqueous solutions of the following five substances:

- bromine
- iodine
- potassium chloride
- potassium bromide
- potassium iodide.

The student has **no** access to chlorine gas or chlorine water.
The student uses cyclohexane, an organic solvent, to identify the halogen present at the end of each experiment.

The student carries out the **smallest** number of experiments required to determine the order of reactivity of the halogens.

Describe the experiments and the expected observations.

Include in your answer **ionic** equations for any reactions that occur.

State symbols are **not** required.

(5)

· mix Br_2 and KCl, no reaction.

In cyclohexane, orange colour of bromine is seen, meaning chloride has not been displaced, chlorine is more reactive than bromine.

- mix Br_2 with KI: $Br_2 + 2I^- \rightarrow 2Br^- + I_2$

In cyclohexane, purple colour of iodine is seen, meaning iodide has been displaced by bromine, bromine is more reactive than iodine

· This also tells us that chlorine is more reactive than iodine.

Total for Question 1 = 7 marks

Total for Paper = 40 marks