GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource C

Physical and Inorganic Chemistry

1. State what is meant by a buffer solution. [1]

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2. Draw a dot and cross diagram of the ammonium ion and use it to explain the difference between covalent and coordinate bonds. [2]

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3. Calcium metal reacts slowly with water. Write an equation for this reaction. [1]

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4. Using the principles of valence shell electron pair repulsion (VSEPR) state and explain the shape of a molecule of H_2S. [2]

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5. A student is provided with a set of unknown ionic solids. She is told that the compounds could be any **four** of the following.

lead(II) carbonate	lead(II) iodide	lead(II) nitrate
sodium carbonate	sodium iodide	potassium carbonate
calcium nitrate	magnesium hydroxide	magnesium sulfate

(a) All of the samples provided were white. State which one of the compounds from the list above could **not** be amongst the samples. Give a reason for your answer. [1]

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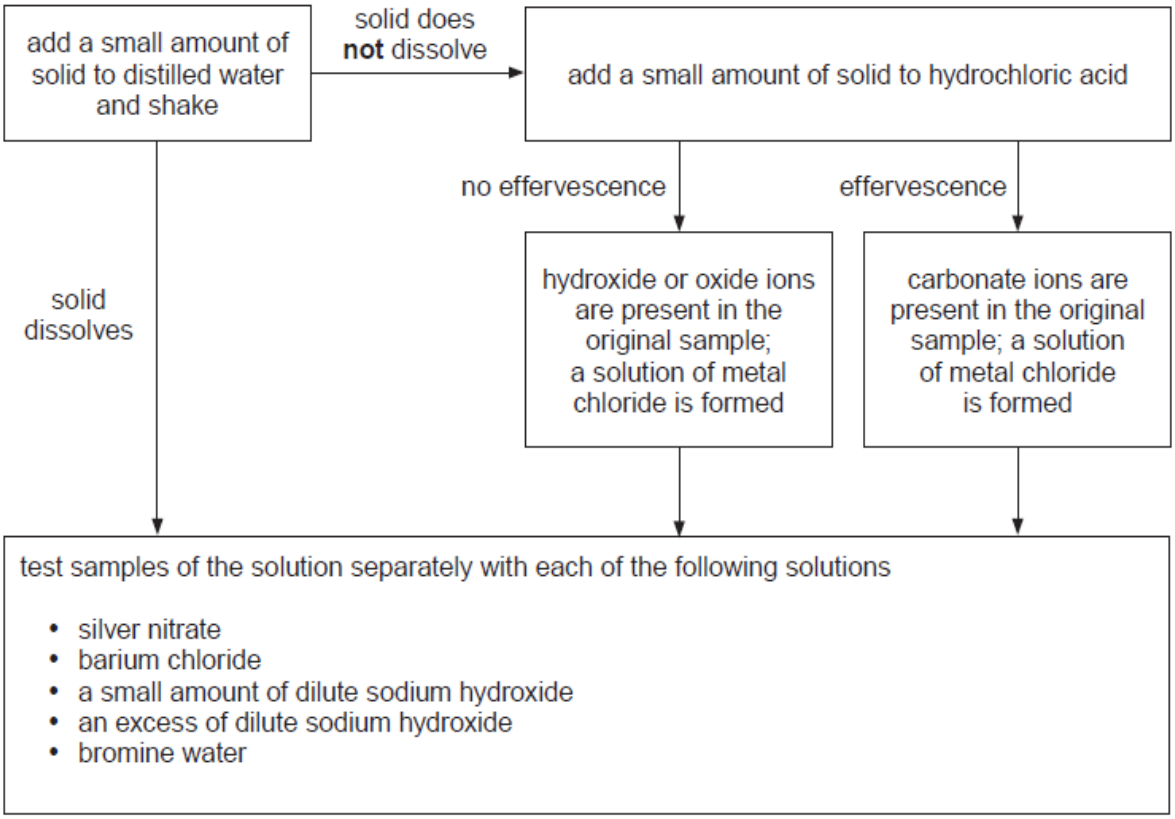
(b) She planned to test each of the samples by following the steps below.



(i) Explain why the method as written would not conclusively identify all the unknown samples that contain carbonate ions. [1]

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(ii) Her teacher says that hydrochloric acid is not the correct reagent to use in this method. Give **two** reasons why hydrochloric acid is not appropriate and suggest an alternative reagent that would avoid these problems. [3]

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(iii) Another student starts her method with a flame test. State which s-block cations she could identify by this method, giving the colours expected for each. [2]

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(iv) As time was short the teacher suggested the following simplified method.

- Look at the colour of the sample
- Carry out a flame test to identify s-block cations
- Try to dissolve the sample in water
- Add acid to the samples and look for effervescence

This method allowed seven of the nine compounds to be identified.

lead(II) carbonate	lead(II) iodide	lead(II) nitrate
sodium carbonate	sodium iodide	potassium carbonate
calcium nitrate	magnesium hydroxide	magnesium sulfate

Name the **two** compounds that could **not** be distinguished and suggest a test that would tell them apart. Give reagent(s) and observations for both compounds. [4]

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6. Materials are often classified according to their physical properties and chemists use their knowledge of their structures to explain these properties.

(a) One way to classify materials is according to their physical state.

The halogens chlorine, bromine and iodine have different physical states at room temperature. Give the physical state for each of these halogens and explain why they have different physical states. [3]

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(b) Another way to classify materials is according to their solubility in water. The solubilities of four compounds were found in an online database.

Substance	Solubility in water at 20°C/g dm^{-3}
$CaCl_2$ (anhydrous)	745
$CaCl_2.4H_2O$ (hydrated)	908
butan-1-ol ($CH_3CH_2CH_2CH_2OH$)	73
octan-1-ol ($CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$)	0.46

(i) A student says that this shows that the concentration of calcium ions in a saturated solution of calcium chloride is the same for solutions formed by dissolving anhydrous and hydrated forms of $CaCl_2$. Is he correct? Give a reason for your answer. [2]

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(ii) Explain why the alcohols butan-1-ol and octan-1-ol can dissolve in water, giving a reason why the solubility of octan-1-ol is lower than that of butan-1-ol. [3]

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(c) The physical properties of materials can be modified by using additives. AIBN is an additive used to modify the properties of rubber.

AIBN decomposes in solution in the solvent dioxane, shown as (sol) below, under standard conditions.

$$\underset{\text{AIBN}}{NC{-}C(CH_3)_2{-}N{=}N{-}C(CH_3)_2{-}CN\,(sol)} \longrightarrow 2NC{-}C(CH_3)_2\bullet\,(sol) + N_2(g)$$

(i) Give the temperature and pressure used as standard conditions. [1]

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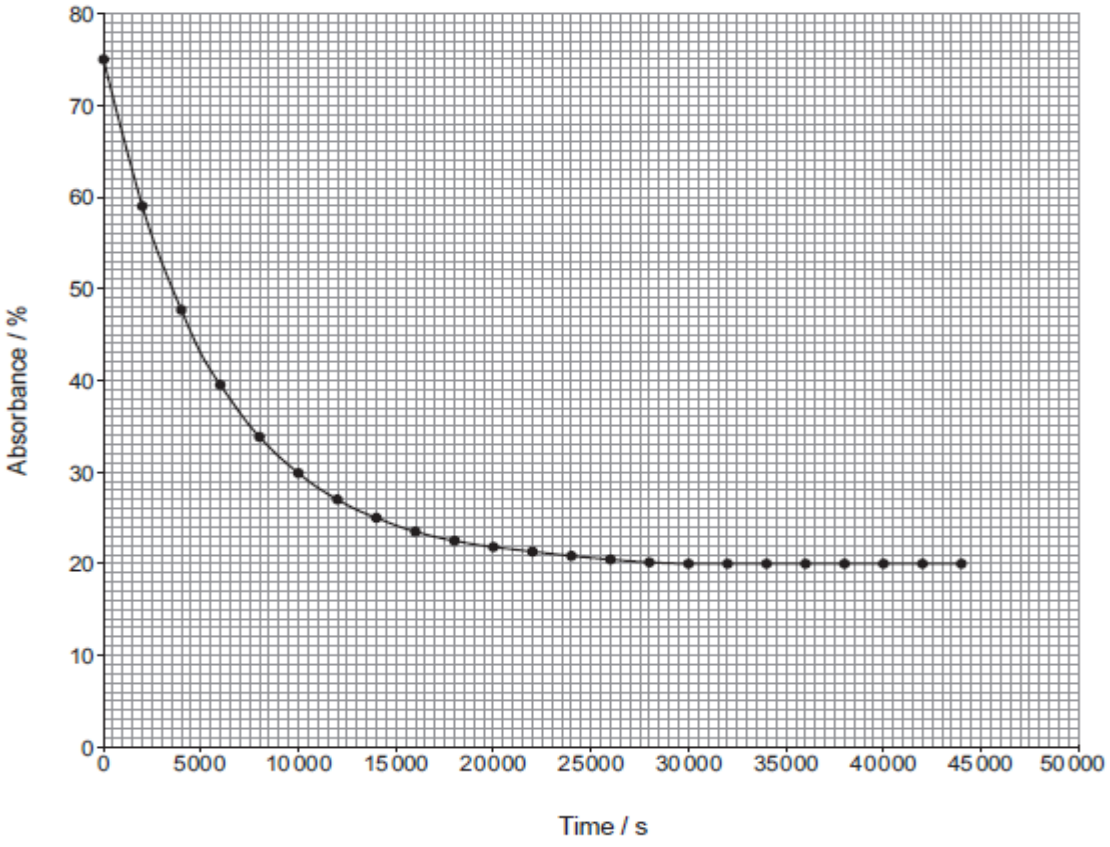
(ii) The reaction can be followed by measuring the absorbance of the reactant in the solution at a wavelength of light of 350 nm. The dioxane solvent also absorbs a certain amount of light of this wavelength. The graph below shows the results of this experiment undertaken by two students, Anna and Megan.



I. State the percentage absorbance due to the solvent. Explain how you reached your conclusion. [2]

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II. Describe and explain fully the shape of the graph. Use the graph to prove that the reaction is first order with respect to AIBN. [6 QER]

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(iii) Upon heating, AIBN decomposes extremely rapidly. The rate equation for this process is as follows.

rate = k[AIBN]

The value of the rate constant k, can be found using the Arrhenius equation. Anna **incorrectly** writes the Arrhenius equation as

$$k = A\, e^{\frac{E_a}{T}}$$

I. State the correct Arrhenius equation. [2]

II. Anna uses the correct temperature, frequency factor and activation energy in her **incorrect** Arrhenius equation. The values of two of these are given below.

frequency factor, $A = 6.92 \times 10^{9}\ s^{-1}$
temperature = 600 K

Anna calculates that the rate constant is $4.89 \times 10^{82}\ s^{-1}$.

Megan says the true value should be much smaller. Find the value of the activation energy then use the **correct** Arrhenius equation to find the true value of the rate constant. State whether Megan is correct. [4]

E_a = ... kJ mol^{-1}

k = ... s^{-1}