RIVER VALLEY HIGH SCHOOL

YEAR 6 PRACTICAL EXAMINATION

H2 CHEMISTRY 9729

23RD AUG 2017

2.5 HOURS

NAME ____________________

CLASS 6 (   )

INDEX NO. ____________________

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.

Write your name, class and index number in the spaces at the top of this page.
Give details of the practical shift and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer ***all*** *questions in the spaces provided on the Question Paper.*

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.
Qualitative Analysis Notes are printed on pages 14 and 15.

Shift
Laboratory

For Examiner's Use	
1	/ 21
2	/ 15
3	/ 9
4	/ 10
Total	/ 55

Answer **all** the questions in the spaces provided.

1	**Determine the the percentage by mass of sodium ethanedioate in a mixture of sodium ethanedioate and ethanedioic acid.**

This experiment involves **two steps**.
In step one, you will carry out a titration to find the amount of acid, $H_2C_2O_4$, present in **FB 3**.
In step two, you will carry out a second titration to find the total amount of ethanedioate ion, $C_2O_4^{2-}$, present in **FB 3**.
Finally, you will use the values found in the two steps to calculate the percentage by mass of sodium ethanedioate in **FB 3**.

FB 1 is 0.100 mol dm^{-3} sodium hydroxide, NaOH.
FB 2 is 0.0200 mol dm^{-3} potassium manganate(VII), $KMnO_4$.
FB 3 is a mixture of aqueous sodium ethanedioate, $Na_2C_2O_4$, and ethanedioic acid, $H_2C_2O_4$.
FB 4 is approximately 2 mol dm^{-3} sulfuric acid.
thymolthalein indicator

Read through the whole method before starting any practical work.

(a) Method

<u>Step 1</u>

1. Fill the burette labelled **FB 1** with **FB 1**.
2. Pipette 25.0 cm^3 of **FB 3** into a conical flask.
3. Add 1 dropper full of thymolphthalein.
4. Titrate **FB 3** in the conical flask with **FB 1** until a pale blue colour is seen.
5. Carry out as many accurate titrations as you think necessary to obtain consistent results.
6. Record in a suitable form below all of your burette readings and the volume of **FB 1** added in each accurate titration.

<u>Step 2</u>

1. Pipette 25.0 cm^3 of **FB 3** into a conical flask.
2. Using a measuring cylinder, add about 25 cm^3 of 2 mol dm^{-3} sulfuric acid, **FB 4**, to the flask.
3. Place the conical flask on a hotplate and heat to about 65°C.
4. Fill the burette labelled **FB 2** with **FB 2**.
5. Use an appropriate method to carefully transfer the hot conical flask onto a white tile under the burette.
6. Titrate the mixture in the conical flask with **FB 2** until a permanent pale pink colour is seen. If a permanent brown colour is seen, stop the titration and begin **Step 2** again.
7. Carry out as many accurate titrations as you think necessary to obtain consistent results.
8. Record in a suitable form below all of your burette readings and the volume of **FB 2** added in each accurate titration.

[3]

(b) (i) From your titration results in **Step 1**, obtain a suitable value to be used in your calculations. Show clearly how you have obtained this value.

Shift 1	Shift 2	Shift 3
15.20 cm^3	15.20 cm^3	15.20 cm^3

		25.0 cm^3 of **FB 3** required ………….. cm^3 of **FB 1** [2]
	(b) (ii)	Write an equation for the reaction between sodium hydroxide and ethanedioic acid to give sodium ethanedioate and water. $H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$ …………………………………………………………………………………………………… [1]
	(b) (iii)	Use your answer from **(b)(i)** to calculate amount of sodium hydroxide, **FB 1**, required to react with 25.0 cm^3 of **FB 3** in **Step 1**. (b)(i) × 0.10}/1000 Amount of NaOH = ………………………… [1]
	(b) (iv)	Use your answer to **(b)(iii)** to determine the amount of ethanedioic acid in 25.0 cm^3 of **FB 3**. (iii)/2 Amount of $C_2O_4H_2$ in 25.0 cm^3 of **FB 3** = ………………………… [1]
	(c) (i)	From your titration results in **Step 2**, obtain a suitable value to be used in your calculations. Show clearly how you have obtained this value. Shift 1: 22.60 cm^3 ; Shift 2: 22.75 cm^3 ; Shift 3: 22.60 cm^3 25.0 cm^3 of **FB 3** required ………….. cm^3 of **FB 2**. [3]
	(c) (ii)	Use your answer from **(c)(i)** to calculate amount of potassium manganate(VII), **FB 2**, required to react with 25.0 cm^3 of **FB 3** in **Step 2**. (c)(i) × 0.02/1000 Amount of $KMnO_4$ = ………………………… [1]
	(c) (iii)	The equation for the reaction between acidified manganate(VII) ions and ethanedioate ions is shown below. $2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$ Calculate the total amount of ethanedioate ions in 25.0 cm^3 of **FB 3**. (c)(ii) × 5/2 Total amount of $C_2O_4^{2-}$ in 25.0 cm^3 of **FB 3** = ……………… [1]
	(c) (iv)	Use your answers to **(b)(iv)** and **(c)(iii)** to calculate the amount of ethanedioate ions which came from the sodium ethanedioate dissolved in 25.0 cm^3 of **FB 3**. (c)(iii) – (b)(iv)

		Amount of $C_2O_4^{2-}$ from $C_2O_4Na_2$ in 25.0 cm^3 of **FB 3** = ……………… [1]
	(d) (i)	Use your answer to **(b)(iv)** to calculate the mass of ethanedioic acid, $H_2C_2O_4$, in 25.0 cm^3 of **FB 3**. [*Ar*: H, 1.0; C, 12.0; O, 16.0] (If you were unable to answer **(b)(iv)**, you may assume that the amount of ethanedioic acid is 6.51 × 10^{-4} mol.) (b)(iv) × 90.0 Mass of ethanedioic acid = ... [1]
	(d) (ii)	Use your answer to **(c)(iv)** to calculate the mass of sodium ethanedioate, $Na_2C_2O_4$ in 25.0 cm^3 of **FB 3**. [*Ar*: C, 12.0; O, 16.0; Na, 23.0] (If you were unable to answer **(c)(iv)**, you may assume that the amount of sodium ethanedioate is 4.13 × 10^{-4} mol.) (c)(iv) × 134.0 Mass of sodium ethanedioate = ... [1]
	(d) (iii)	Calculate the percentage by mass of sodium ethanedioate present in **FB 3**. {mass $Na_2C_2O_4$ in (ii)/total mass} × 100 [total mass = (d)(i) + (d)(ii)] Percentage by mass of sodium ethanedioate present is .... [1]
	(e) (i)	A student suggested that using a burette to measure the 25.0 cm^3 of acid would give a more accurate result than using a pipette. The percentage error of a 25.0 cm^3 pipette is 0.24 %. Is the student correct? Explain your answer. [2] Student is incorrect use of burette: {0.10/25} × 100 = 0.40% compared to 0.24% or apparatus error of pipette is ±0.06 compared with apparatus error of burette is ±0.10
	(e) (ii)	A student decided to use a 25.0 cm^3 pipette instead of a measuring cylinder to measure the volume of **FB 4** in **Step 2**. State and explain whether this alteration will improve the accuracy of the calculation of the percentage by mass of sodium ethanedioate in the mixture. [2] No improvement as acid in excess

2	**Investigate how the rate of the following reaction varies with the concentration of sodium thiosulfate, $Na_2S_2O_3$.**

$$Na_2S_2O_3\,(aq) + H_2SO_4\,(aq) \rightarrow S\,(s) + Na_2SO_4\,(aq) + SO_2\,(g) + H_2O\,(l)$$

The rate can be found by measuring how long it takes for the solid sulfur formed to obscure the printing on the insert provided.

Care should be taken to avoid inhalation of SO_2(g) that is given off during this reaction.

FC 5 is 1.0 mol dm^{-3} sulfuric acid, H_2SO_4
FC 6 is 0.10 mol dm^{-3} sodium thiosulfate $Na_2S_2O_3$

(a) Method

1. Using the 50 cm^3 measuring cylinder transfer 45 cm^3 of **FC 6** into a 100 cm^3 beaker.
2. Using the 25 cm^3 measuring cylinder measure 10 cm^3 of **FC 5**.
3. Tip the **FC 5** into the **FC 6** in the beaker and **immediately** start timing.
4. Stir the mixture once with a glass rod and place the beaker on top of the printed insert. Cover the beaker with a petri dish.
5. View the printed insert from above so that it is seen through the mixture.
6. Record the time, to the nearest second, when the printing on the insert **just** disappears.
7. Empty and rinse the beaker. Shake out as much of the water as possible and dry the outside of the beaker.

You will repeat the experiment to find out how the time for the printing on the insert to disappear changes when a different volume of **FC 6** is used.

8. Using the 50 cm^3 measuring cylinder transfer 20 cm^3 of **FC 6** and 25 cm^3 of distilled water into the 100 cm^3 beaker.
9. Using the 25 cm^3 measuring cylinder, add 10 cm^3 of **FC 5** to the mixture and **immediately** start timing.
10. Stir the mixture once with a glass rod and place it on top of the printed insert.
11. View the printed insert from above so that it is seen through the mixture.
12. Record the time, to the nearest second, when the printing on the insert **just** disappears.
13. Select suitable volumes of **FC 6 and** distilled water for **two** further experiments to investigate the effect of volume of sodium thiosulfate on the time taken for the printing on the insert to **just** disappear. The volume of **FC 6** used should range from 0 cm^3 to 45 cm^3.

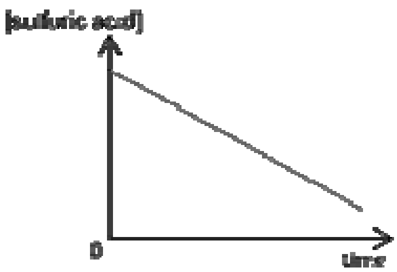
In the space below, record, in an appropriate form, all measurements of volume, time, and 1/time.

[5]

(b) Plot 1/time against the volume of **FC 6**. Draw the most appropriate line, taking into account all the points.

[3]

	(c)	Why was the total volume of solution kept constant in the experiments? [

		Volume of FC 6 is directly proportional to its concentration (if total volume is constant)
	(d)	Using the graph of 1/time against the volume of **FC 6,** draw a conclusion about the relationship between the concentration of sodium thiosulfate used and the rate of reaction. Hence, state the order of reaction with respect to sodium thiosulfate. [2] Rate of reaction is proportional to concentration of FC 6 (allow directly proportional). Order of reaction is 1.
	(e)	In the four experiments, which value of the time measured had the greatest error? Explain your answer. [2] Either shortest time as greatest percentage/ fractional error or longest time as greatest uncertainty in judging when printing is obscured
	(f)	Another student conducts another experiment for the same reaction where the sodium thiosulfate is in large excess. The concentration of acid is monitored as the reaction progresses. His results are as shown below.  Deduce the order of reaction with respect to sulfuric acid. [2] The constant gradient indicates a constant rate of reaction. Zero order with respect to sulfuric acid
		[Total: 13]

3 Organic Analysis

Before starting parts (a) and (b), half-fill a 250 cm^3 beaker with water and heat with a hotplate to approximately 60 ˚C. You will use this as a hot water bath.

(a) **FD 7**, **FD 8** and **FD 9** are solutions each containing a single compound which could be ethanol, ethanal or propanone. To identify each compound you will react the samples with Tollens' reagent and with acidified potassium manganate(VII).

Preparation of Tollens' reagent

1. To approximately 2 cm depth of aqueous silver nitrate in a boiling tube, add approximately 0.5 cm depth of aqueous sodium hydroxide.

2. Add aqueous ammonia a little at a time with continuous shaking until the brown precipitate just dissolves. Do not add an excess of ammonia.

Complete the table below

test	*observations*		
	FD 7	**FD 8**	**FD 9**
To a 1 cm depth of each solution in a clean, dry test-tube add a few drops of the Tollens' reagent that you have prepared. **Do not shake the tube**. If no reaction is seen, warm the tube in the hot water bath.	silver mirror/black or brown or grey ppt	No ppt	No ppt
To a 1 cm depth of each solution in a test-tube, add a 1 cm depth of dilute sulfuric acid. Then add a few drops of aqueous potassium manganate(VII). If no reaction is seen, warm the tube in the hot water bath.	Purple $KMnO_4$ turns colourless/ decolourised	Purple $KMnO_4$ remains purple	Purple $KMnO_4$ turns colourless/ decolourised
Identity	ethanal	propanone	ethanol

[4]

(b) **FD 10** is an aqueous solution of an organic compound. Carry out the following tests. You do not need to identify **FD 10**.

test	*observations*
To a 1 cm depth of **FD 10** in a test-tube add a 1 cm depth of dilute sulfuric acid. Then add a few drops of aqueous potassium manganate(VII). If no reaction is seen, place the test-tube in the hot water bath and leave to stand.	Purple $KMnO_4$ turns colourless/ decolourises
To a 1 cm depth of **FD 10** in a test-tube, carefully add a small spatula measure of sodium hydrogen carbonate.	Effervescence/fizzing/bubbles Colourless, odourless gas evolved that gives a white ppt with limewater

[2]

(c) State the type(s) of reactions that **FD 10** have undergone in **(b)**. [2]

	Oxidation Acid-carbonate
(d)	Given that the Mr of **FD 10** is 46.0. State its identity. [1] [Ar: C, 12.0; O, 16.0; H, 1.0; C*l*, 35.5; N, 14.0]
	HCOOH

[Total: 9]

4 Planning

When heated, aqueous hydrogen peroxide, H_2O_2, decomposes to form oxygen and water.

$$2H_2O_2\,(aq) \rightarrow 2H_2O\,(l) + O_2\,(g)$$

The decomposition can also occur at room temperature if a suitable catalyst is added. Both of the solids, manganese(IV) oxide and lead(IV) oxide, will catalyse the decomposition.

You are provided with:
- 0.150 mol dm^{-3} solution of hydrogen peroxide
- a syringe with a capacity of 100 cm^3
- apparatus normally found in a school laboratory

(a) (i) Using the information given above, you are required to write a plan to determine the more efficient catalyst for the decomposition of aqueous hydrogen peroxide. Your plan should include:

- a fully labelled diagram of the apparatus to be used
- a calculation of the volume in cm^3 of the aqueous hydrogen peroxide that could be used such that an appropriate volume of oxygen could be collected.
- the measurements you would take and how you would use them to deduce which catalyst is more efficient.

The molar volume of a gas at 20 °C is 24.0 dm^3.

- Diagram shows a container with both chemicals named and attached to a syringe connected without leaks.
- Container shows the catalyst and hydrogen peroxide separated and ready to mix.
- Rubber bung
- Well-greased 100 cm^3 syringe (labelled)
- 250 cm^3 conical flask (labelled)
- Delivery tube

At least half the capacity of syringe for M4
Amt of oxygen in 100 cm^3 of oxygen = 100/24000 = 0.00417 mol
Amt of H_2O_2 = 2 × 0.00417 = 0.00834 mol
Volume of hydrogen peroxide = (0.00834 × 1000)/0.15 = 55.6 cm^3

1. Measure 55.0 cm^3 of aqueous hydrogen peroxide into a 250 cm^3 conical flask using a 100 cm^3 measuring cylinder.
2. Weigh accurately 0.10 g (acceptable range: 0.1 to 1 g) of solid manganese(IV)

oxide into a plastic vial using the weighing balance.

3. Setup the experiment as shown in the diagram above.

4. Shake the conical flask to topple the solid into the aqueous hydrogen peroxide and start the stopwatch.

5. Record the time taken when 90 cm^3 (at least half the capacity of the collecting vessel) of gas is collected (when solid manganese(IV) oxide is used.)

6. Repeat the above steps using lead(IV) oxide instead.

7. The more efficient catalyst is the solid that requires the shorter time to collect 90.0 cm^3 of gas.

Alternative method:

- Record volume of gas in time intervals of less than 1 min and plot graphs

[9]

(ii) What other feature of the catalyst should be controlled?

Surface area

[1]

[Total : 10]

~END OF PAPER~