



Barker College

Student No.

2006
YEAR 12
EXAMINATION TERM 1

Chemistry

ANSWER SHEET

Staff Involved:

- TER*
- ASH
- KHW
- RZS
- RJP

PM THURSDAY 6 APRIL

110 copies

Section I – Multiple Choice

Choose the best response and fill in the response oval completely

1.	☐ A	☐ B	☐ C	☐ D
2.	☐ A	☐ B	☐ C	☐ D
3.	☐ A	☐ B	☐ C	☐ D
4.	☐ A	☐ B	☐ C	☐ D
5.	☐ A	☐ B	☐ C	☐ D
6.	☐ A	☐ B	☐ C	☐ D
7.	☐ A	☐ B	☐ C	☐ D
8.	☐ A	☐ B	☐ C	☐ D
9.	☐ A	☐ B	☐ C	☐ D
10.	☐ A	☐ B	☐ C	☐ D
11.	☐ A	☐ B	☐ C	☐ D
12.	☐ A	☐ B	☐ C	☐ D
13.	☐ A	☐ B	☐ C	☐ D
14.	☐ A	☐ B	☐ C	☐ D
15.	☐ A	☐ B	☐ C	☐ D



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General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using blue or black pen
- Board-approved calculators may be used
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your Barker Student Number at the top of the answer sheet and at the top of ALL answer pages in Section II
- ALL working or relevant equation writing must be shown in Questions 16 – 28

Total marks – 80

Section I

Pages 2 – 7

15 marks

- Attempt Questions 1 – 15
- Indicate all answers on the Answer Sheet provided
- Allow about 25 minutes for this part

Section II

Pages 8 – 22

65 marks

- Attempt Questions 16 – 27
- Indicate all answers in the spaces provided on paper
- Allow about 1 hour 30 minutes for this section

Section I

15 marks

Attempt Questions 1–15

Allow about 25 minutes for this section

Use the multiple-choice answer sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

(A) ☐ (B) ☒ (C) ☐ (D) ☐

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(A) ☒ (B) ☒ (C) ☐ (D) ☐

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows.

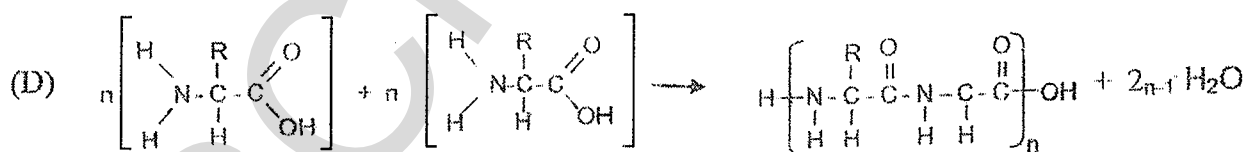
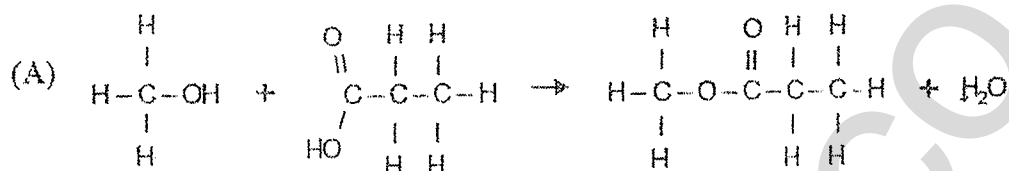
(A) ☒ (B) ☒ (C) ☐ (D) ☐

correct
↖

1. Which of the following is a systematic name for styrene?

- (A) Ethenylbenzene
- (B) Chloroethene
- (C) Benzylethene
- (D) Chlorobenzene

2. Which of the following is a condensation **polymerisation** reaction?



3. What is the best reason that ethene can be transformed easily into many useful products?

- (A) Ethene is a gas composed of non-polar molecules.
- (B) Ethene has a highly reactive double bond.
- (C) Ethene is 86% carbon by mass.
- (D) Ethene can be produced by catalytic cracking.

4. The table gives the heat of combustion in kJ.g^{-1} for a number of different fuels.

Fuel	Heat of combustion (kJ.g^{-1})
Methanol	22.7
Ethanol	29.6
Propanol	33.6
Petrol (octane)	47.8

The heat of combustion in kJ mol^{-1} for one of the fuels was calculated as 2016 kJ mol^{-1} .

What was the fuel?

- (A) Methanol
 - (B) Ethanol
 - (C) Propanol
 - (D) Petrol
5. What substance may ethanol be dehydrated to?
- (A) Ethylene
 - (B) Ethanoic acid
 - (C) Ethyne
 - (D) Ethyl ethanoate
6. The boiling points of three compounds are:

Compound A: 78.3°C

Compound B: -88.6°C

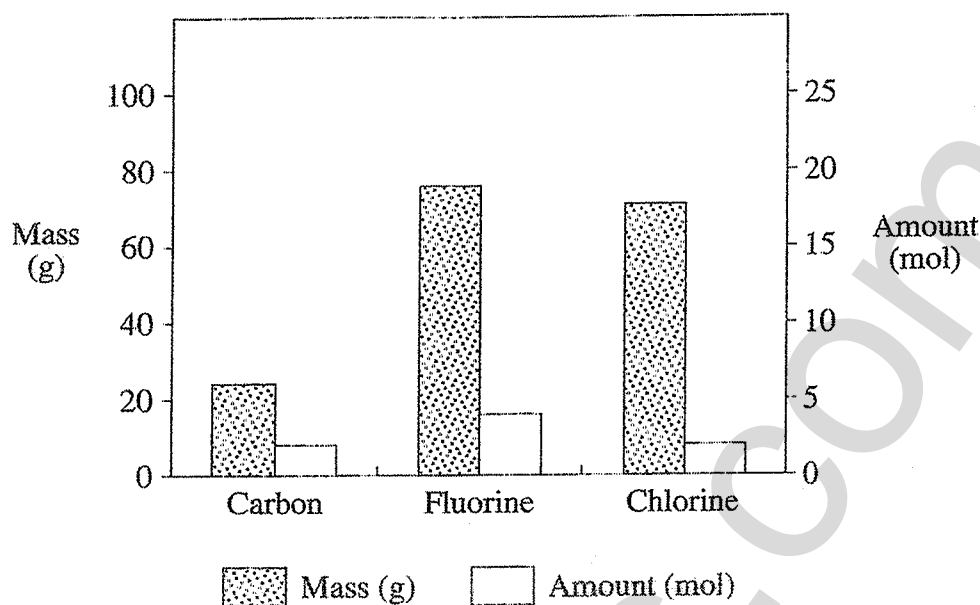
Compound C: 117.9°C

The compounds are known to be, in no particular order, ethane, ethanoic acid and ethanol.

Which of the following correctly identifies compounds A, B and C in that order?

- (A) Ethane, ethanol, ethanoic acid.
- (B) Ethanoic acid, ethane, ethanol.
- (C) Ethanoic acid, ethanol, ethane.
- (D) Ethanol, ethane, ethanoic acid.

7. The graph shows the mass and amount of carbon, fluorine and chlorine atoms in one mole of a compound.



What is the molecular formula for this compound?

- (A) CF_2Cl
- (B) CF_2Cl_2
- (C) $\text{C}_2\text{F}_3\text{Cl}_3$
- (D) $\text{C}_2\text{F}_4\text{Cl}_2$

8. The table below shows some properties of four commonly used radioisotopes.

Name of isotope	Half-life	Ionising power
Technetium-99	hours	low
Cobalt-60	years	high
Carbon-14	thousands of years	low
Uranium-238	millions of years	moderate

Which of these isotopes would be most suitable for **killing** cancerous cells in radiotherapy?

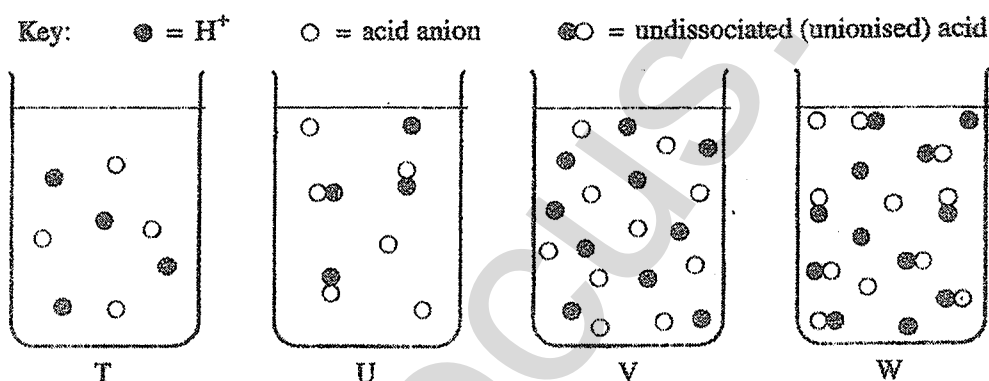
- (A) Technetium-99
- (B) Cobalt-60
- (C) Carbon-14
- (D) Uranium-238

9. Phenol red is an acid-base indicator, yellow 6.8 – red 8.4.
Methyl orange indicator, red 3.1 – yellow 4.4.

A small quantity of soil was added to 5 mL of pure water, stirred for 5 minutes, allowed to settle and filtered. When one sample of the filtrate was tested with phenol red, the colour turned yellow. When another sample was tested with methyl orange, the colour turned yellow.

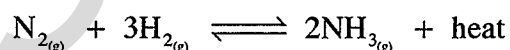
What is the best conclusion about the soil?

- (A) That it is slightly acidic and has a pH less than 8.4.
(B) That it is slightly acidic and has a pH less than 6.8.
(C) That it is slightly alkaline and has a pH less than 6.8.
(D) That it is very acidic and has a pH less than 4.4.
10. The following diagrams represent samples of four acids.



Which beaker can best be described as containing a sample of dilute, strong acid?

- (A) T
(B) U
(C) V
(D) W
11. The Haber Process is used to synthesise ammonia in the following exothermic reaction.



Which of the following procedures would increase the equilibrium yield of ammonia?

- (A) Decrease both the temperature and pressure.
(B) Decrease the temperature and increase the pressure.
(C) Decrease the pressure and increase the temperature.
(D) Increase both the temperature and the pressure.

12. Which of the following best describes a solution with a pH of 5?
- (A) Contains $[H^+]$ of concentration $10^{-5}M$.
 - (B) More acidic than a substance with a pH of 4.
 - (C) Basic
 - (D) Contains an equal concentration of hydroxide and hydronium ions.
13. The pH of unpolluted rainwater is about 6.0. Which of these gases contributes most to this?
- (A) CO_2
 - (B) N_2
 - (C) NO_2
 - (D) O_3
14. 0.40 g of sodium hydroxide was weighed and dissolved in 15.0 mL of water in a conical flask. The solution was then titrated with 0.50 M hydrochloric acid. The endpoint was detected when 19.0 mL of acid has been added. The value of 19.0 mL was less than the expected 20.0 mL. This difference could be explained if:
- (A) the burette had been rinsed with water prior to adding the hydrochloric acid solution
 - (B) the equivalence point was reached before the endpoint
 - (C) the sodium hydroxide solution had been left exposed to the air for a long period of time before the titration was performed
 - (D) the conical flask contained 25.0 mL of water instead of 15.0 mL
15. A student prepares four solutions of acids, such that they are all of the same pH (pH = 6.0). Which of the following solutions is the most dilute?
- (A) Hydrochloric acid
 - (B) Ethanoic acid
 - (C) Citric acid
 - (D) Carbonic acid

Section II – 65 marks

Attempt ALL questions

Allow about 1 hour 30 minutes for this section

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (5 marks)

Polyethylene (polyethene) is a very important chemical in today's society.

- (a) Outline the **THREE** main steps in the commercial production of polyethylene.

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- (b) By altering the conditions under which polyethylene is produced, two different polymers can be produced, LDPE and HDPE.

Compare the uses of LDPE and HDPE, relating to their physical properties.

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Question 17 (7 marks)

- (a) Using the standard electrode potentials on your data sheet and equipment from the list below, construct a fully labelled scientific diagram of a galvanic cell.

3

Equipment:

- Zinc metal, nickel metal
- Zinc nitrate solution, nickel nitrate solution, potassium nitrate solution
- Filter paper
- 2 x 100 mL beakers
- Alligator leads
- Voltmeter

Question 17 continues on page 10

Student No.

Marks

Question 17 (continued)

- (b) Write the reduction half-equation.

0.5

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- (c) Write the oxidation half-equation.

0.5

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- (d) Write the overall redox equation.

0.5

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- (e) Calculate the standard e.m.f. of the cell. Show working.

1.5

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- (f) In the laboratory, you would not obtain a voltage close to the standard e.m.f. as calculated in part (e). State **ONE** possible reason for this.

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End of Question 17

Question 18 (5 marks)

Over the past 100 years, there has been an enormous increase in the amount of fossil fuel used. As supplies of these are finite, a suitable alternative must be found.

- (a) Explain why ethanol can be regarded as both a fuel and as a renewable resource.

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- (b) Evaluate the conversion of starch (or glucose or sucrose) to ethanol as a source of ethanol.

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Question 19 (7 marks)

- (a) During your HSC course you have performed an experiment to compare the reactivities of an alkene and an alkane.

Outline how you conducted this experiment in your school laboratory using a named alkene and a named alkane.

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- (b) In this experiment, you were required to select an appropriate alkene and alkane based on safety information. Justify your choice.

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- (c) Summarise your results from this experiment and include relevant chemical equations to explain your observations.

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Question 20 (5 marks)

Since Luigi Galvani undertook his famous experiments into “animal electricity” there have been great advances in our ability to harness electrochemical energy in the form of batteries.

Using your knowledge of the dry cell or lead-acid cell, evaluate it in comparison to one of the following:

- button cell
- fuel cell
- vanadium redox cell
- lithium cell
- Gratzel cell

in terms of: chemistry, cost/practicality, impact on society, environmental impact.

5

Properties	Dry cell / lead acid	
Chemistry		
Cost/Practicality		
Impact on society		
Environmental impact		

Evaluation:

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Question 21 (7 marks)

- (a) Describe why some isotopes are stable and others are unstable.

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- (b) Write an equation to represent the alpha decay of Thorium-230.

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- (c) The Lucas Heights nuclear reactor in Sydney currently produces radioisotopes for use in a range of medical treatments and diagnoses.

Using your knowledge of a named medical radioisotope, analyse the benefits and problems associated with its use.

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Question 22 (4 marks)

- (a) Recent evidence suggests that there has been an increase in atmospheric concentrations of oxides of sulfur and nitrogen due to industrial plants and vehicle emissions through the burning of fossil fuels.

Explain, including relevant equations, how this may be contributing to the formation of acid rain.

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- (b) Outline reasons for concern about the release of these oxides with respect to the environment.

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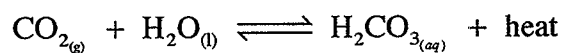
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Question 23 (4 marks)

When carbon dioxide dissolves in water the following equilibrium process occurs.



Explain, in terms of Le Chatelier's Principle, what happens:

- (i) to the solubility of carbon dioxide in a soft drink bottle if the pressure decreases (i.e. when the lid is opened).

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- (ii) when a bottle of soft drink is heated.

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Question 24 (4 marks)

A student places 2.4 g of magnesium into a beaker containing 4M nitric acid. They observed that the acid fizzed vigorously until the magnesium had disappeared and a colourless liquid remained.

- (a) Write a balanced symbol equation for this reaction.

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- (b) Calculate the number of moles of Magnesium that reacted, showing ALL working.

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- (c) Assuming that this reaction was carried out at 25°C and 100 kPa, calculate the volume of gas produced.

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Question 25 (8 marks)

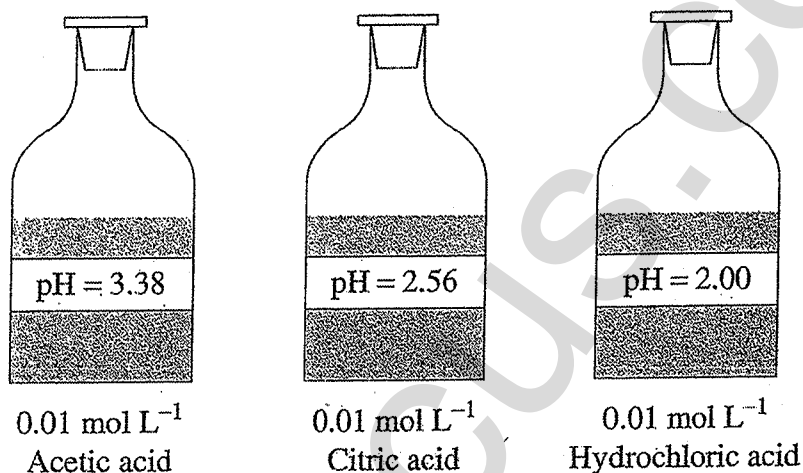
- (a) Calculate the pH of 0.0060 M hydrochloric acid.

1

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- (b) The diagram shows three reagent bottles containing acids.



Explain why the pH of these acids are different, even though they have the same concentrations. Include suitable equations for acetic acid and hydrochloric acid to assist your explanation.

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Question 25 continues on page 19

Question 25 (continued)

- (c) Define the term *amphiprotic*.

1

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- (d) Write **TWO** chemical equations to show that the dihydrogen phosphate ion (H_2PO_4^-) is amphiprotic. Identify a conjugate acid/base pair in one of your equations.

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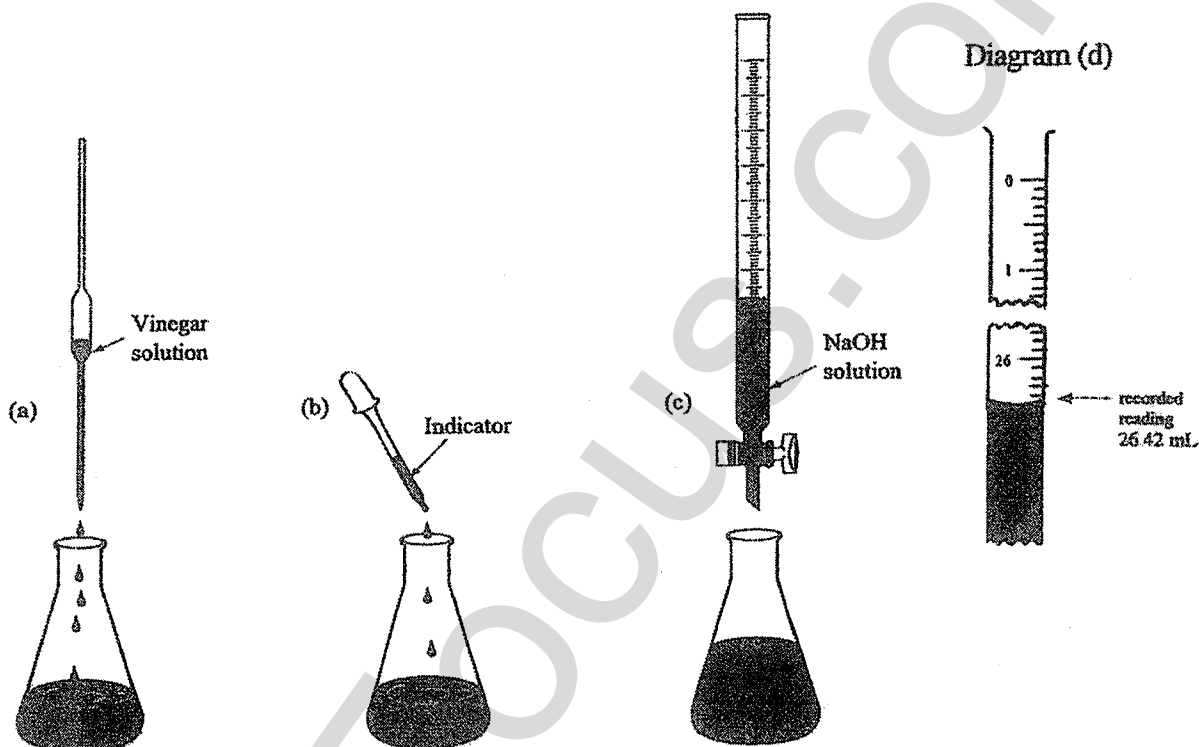
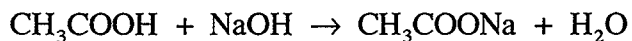
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End of Question 25

Question 26 (7 marks)

A student determines the ethanoic acid content in white vinegar by titration with a standard NaOH solution. The equation for the reaction is:



The following procedure was used:

- Step 1: Wash burette with distilled water then fill the burette with 0.100 M NaOH and record the volume
- Step 2: Wash a 20 mL pipette with distilled water and then fill with the vinegar solution and allow to run into the conical flask.
- Step 3: Add five drops of the indicator phenolphthalein to the conical flask.
- Step 4: Titrate the vinegar solution till the endpoint is reached. Record the volume as shown in diagram (d).

Question 26 continues on page 21

Question 26 (continued)

- (a) Unfortunately, the student made a number of mistakes.

State **ONE** mistake made in:

(i) Step 1:

(ii) Step 2: **2**

- (b) The student then correctly repeats the titration three times. The experimental results for the three titrations are:

Titration Number	1	2	3
Final Reading (mL)	22.48	22.55	22.43
Initial Reading (mL)	0.05	0.05	0.06
Titre (mL)			

- (i) Calculate the appropriate values of NaOH required for the titration by filling in the table above, and then calculate the average titre of the titration.
- 1**

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- (ii) From the titration, determine the number of moles of ethanoic acid in a 20 mL sample of vinegar.
- 2**

- (iii) Calculate the concentration of
- CH_3COOH
- in the 20 mL sample of vinegar in moles per litre.
- 2**

Student No.

Marks

Question 27 (2 marks)

- (a) Identify the products formed when propanoic acid and butanol are refluxed with acid catalyst.

1

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- (b) State **ONE** advantage of using reflux to prepare the ester.

1

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End of Paper

DATA SHEET

Avogadro constant, N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
Volume of 1 mole ideal gas: at 100 kPa and	
at 0°C (273.15 K)	22.71 L
at 25°C (298.15 K)	24.79 L
Ionisation constant for water at 25°C (298.15 K), K_w	1.0×10^{-14}
Specific heat capacity of water	$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$

Some useful formulae

$$\text{pH} = -\log_{10}[\text{H}^+]$$

$$\Delta H = -m C \Delta T$$

Some standard potentials

$\text{K}^+ + \text{e}^-$	$\rightleftharpoons$	K(s)	-2.94 V
$\text{Ba}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Ba(s)	-2.91 V
$\text{Ca}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Ca(s)	-2.87 V
$\text{Na}^+ + \text{e}^-$	$\rightleftharpoons$	Na(s)	-2.71 V
$\text{Mg}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Mg(s)	-2.36 V
$\text{Al}^{3+} + 3\text{e}^-$	$\rightleftharpoons$	Al(s)	-1.68 V
$\text{Mn}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Mn(s)	-1.18 V
$\text{H}_2\text{O} + \text{e}^-$	$\rightleftharpoons$	$\frac{1}{2}\text{H}_2(\text{g}) + \text{OH}^-$	-0.83 V
$\text{Zn}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Zn(s)	-0.76 V
$\text{Fe}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Fe(s)	-0.44 V
$\text{Ni}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Ni(s)	-0.24 V
$\text{Sn}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Sn(s)	-0.14 V
$\text{Pb}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Pb(s)	-0.13 V
$\text{H}^+ + \text{e}^-$	$\rightleftharpoons$	$\frac{1}{2}\text{H}_2(\text{g})$	0.00 V
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$	$\rightleftharpoons$	$\text{SO}_2(\text{aq}) + 2\text{H}_2\text{O}$	0.16 V
$\text{Cu}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	Cu(s)	0.34 V
$\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O} + 2\text{e}^-$	$\rightleftharpoons$	2OH^-	0.40 V
$\text{Cu}^+ + \text{e}^-$	$\rightleftharpoons$	Cu(s)	0.52 V
$\frac{1}{2}\text{I}_2(\text{s}) + \text{e}^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}\text{I}_2(\text{aq}) + \text{e}^-$	$\rightleftharpoons$	I^-	0.62 V
$\text{Fe}^{3+} + \text{e}^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$\text{Ag}^+ + \text{e}^-$	$\rightleftharpoons$	Ag(s)	0.80 V
$\frac{1}{2}\text{Br}_2(\text{l}) + \text{e}^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}\text{Br}_2(\text{aq}) + \text{e}^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}\text{Cl}_2(\text{g}) + \text{e}^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}\text{Cr}_2\text{O}_7^{2-} + 7\text{H}^+ + 3\text{e}^-$	$\rightleftharpoons$	$\text{Cr}^{3+} + \frac{7}{2}\text{H}_2\text{O}$	1.36 V
$\frac{1}{2}\text{Cl}_2(\text{aq}) + \text{e}^-$	$\rightleftharpoons$	Cl^-	1.40 V
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^-$	$\rightleftharpoons$	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	1.51 V
$\frac{1}{2}\text{F}_2(\text{g}) + \text{e}^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE OF THE ELEMENTS

KEY		Atomic Number	Symbol of element	Atomic Weight	Name of element
79	Au	197.0	Gold		
1	H	1.008	Hydrogen		
3	Li	6.941	Lithium		
4	Be	9.012	Beryllium		
11	Na	22.99	Sodium		
12	Mg	24.31	Magnesium		
19	K	39.10	Potassium		
20	Ca	40.08	Calcium		
37	Rb	85.47	Rubidium		
38	Sr	87.62	Strontium		
55	Cs	132.9	Cesium		
87	Fr	[223.0]	Francium		
21	Sc	44.96	Scandium		
39	Y	88.91	Yttrium		
57-71	Lanthanides				
89-103	Actinides				
22	Ti	47.87	Titanium		
40	Zr	91.22	Zirconium		
72	Hf	178.5	Hafnium		
104	Rf	[261.1]	Rutherfordium		
23	V	50.94	Vanadium		
41	Nb	92.91	Niobium		
73	Ta	180.9	Tantalum		
105	Db	[262.1]	Dubnium		
24	Cr	52.00	Chromium		
42	Mo	95.94	Molybdenum		
74	W	183.8	Tungsten		
106	Sg	[266.1]	Seaborgium		
25	Mn	54.94	Manganese		
43	Tc	[97.91]	Technetium		
75	Re	186.2	Rhenium		
107	Bh	[264.1]	Bohrium		
26	Fe	55.85	Iron		
44	Ru	101.1	Ruthenium		
76	Os	190.2	Osmium		
108	Hs	[277]	Hassium		
27	Co	58.93	Cobalt		
45	Rh	102.9	Rhodium		
77	Ir	192.2	Iridium		
109	Mt	[268]	Meitnerium		
28	Ni	58.69	Nickel		
46	Pd	106.4	Palladium		
78	Pt	195.1	Platinum		
110	Ds	[271]	Darmstadtium		
29	Cu	63.55	Copper		
47	Ag	107.9	Silver		
79	Au	197.0	Gold		
111	Rg	[272]	Roentgenium		
30	Zn	65.41	Zinc		
48	Cd	112.4	Cadmium		
80	Hg	200.6	Mercury		
112	Cn	[285]	Ununbium		
50	Sn	118.7	Tin		
82	Pb	207.2	Lead		
114	Fl	[289]	Ununquadium		
51	Sb	121.8	Antimony		
83	Bi	209.0	Bismuth		
115	Mc	[288]	Ununpentium		
52	Te	127.6	Tellurium		
84	Po	[209.0]	Polonium		
116	Lv	[293]	Ununhexium		
53	I	126.9	Iodine		
85	At	[210.0]	Astatine		
117	Ts	[289]	Ununseptium		
54	Xe	131.3	Xenon		
86	Rn	[222.0]	Radon		
118	Og	[294]	Ununoctium		
55	Cs	132.9	Cesium		
87	Fr	[223.0]	Francium		
56	Ba	137.3	Barium		
88	Ra	[226.0]	Radium		
57	La	138.9	Lanthanum		
58	Ce	140.1	Cerium		
59	Pr	140.9	Praseodymium		
60	Nd	144.2	Neodymium		
61	Pm	[144.9]	Promethium		
62	Sm	150.4	Samarium		
63	Eu	152.0	Europium		
64	Gd	157.3	Gadolinium		
65	Tb	158.9	Terbium		
66	Dy	162.5	Dysprosium		
67	Ho	164.9	Holmium		
68	Er	167.3	Erbium		
69	Tm	168.9	Thulium		
70	Yb	173.0	Ytterbium		
71	Lu	175.0	Lutetium		
89	Ac	[227.0]	Actinium		
90	Th	232.0	Thorium		
91	Pa	231.0	Protactinium		
92	U	238.0	Uranium		
93	Np	[237.0]	Neptunium		
94	Pu	[244.1]	Plutonium		
95	Am	[243.1]	Americium		
96	Cm	[247.1]	Curium		
97	Bk	[247.1]	Berkelium		
98	Cf	[251.1]	Californium		
99	Es	[252.1]	Einsteinium		
100	Fm	[257.1]	Fermium		
101	Md	[258.1]	Mendelevium		
102	No	[259.1]	Nobelium		
103	Lr	[262.1]	Lawrencium		

Lanthanides

57	La	138.9	Lanthanum
58	Ce	140.1	Cerium
59	Pr	140.9	Praseodymium
60	Nd	144.2	Neodymium
61	Pm	[144.9]	Promethium
62	Sm	150.4	Samarium
63	Eu	152.0	Europium
64	Gd	157.3	Gadolinium
65	Tb	158.9	Terbium
66	Dy	162.5	Dysprosium
67	Ho	164.9	Holmium
68	Er	167.3	Erbium
69	Tm	168.9	Thulium
70	Yb	173.0	Ytterbium
71	Lu	175.0	Lutetium

Actinides

89	Ac	[227.0]	Actinium
90	Th	232.0	Thorium
91	Pa	231.0	Protactinium
92	U	238.0	Uranium
93	Np	[237.0]	Neptunium
94	Pu	[244.1]	Plutonium
95	Am	[243.1]	Americium
96	Cm	[247.1]	Curium
97	Bk	[247.1]	Berkelium
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100	Fm	[257.1]	Fermium
101	Md	[258.1]	Mendelevium
102	No	[259.1]	Nobelium
103	Lr	[262.1]	Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ²³⁷Np and ⁹⁹Tc.