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Year 12 *Trial Exam Paper*
2018
CHEMISTRY
Written examination

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

STUDENT NAME:

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	10	10	90
			Total 120

- Students are permitted to bring the following items into the examination: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring sheets of paper or correction fluid into the examination.

Materials provided
- The question and answer book of 31 pages
- A data book
- An answer sheet for multiple-choice questions

Instructions
- Write your **name** in the box provided.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- You must answer the questions in English.

At the end of the examination
- Place the multiple-choice answer sheet inside the front cover of this book.
- You may keep the data book

Students are NOT permitted to bring mobile phones or any other unauthorised electronic devices into the examination.

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SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Use the following information to answer Questions 1 and 2.

Last summer, the Victorian government authorised the hire of 105 portable diesel generators for the La Trobe Valley. The generators were brought in as a backup system in case summer electricity demand exceeded supply. The closure of the Hazelwood coal-fired power station led to concerns about Victoria's ability to generate sufficient energy on very hot days.

Question 1

The main reason behind the selection of diesel generators for this use was that diesel generators

A. produce low levels of emissions.

B. use fuel that is renewable.

C. are the most efficient way of producing electrical energy.

D. produce electrical energy very quickly after start up.

Question 2

A typical component of diesel is dodecane. Each molecule of dodecane contains 38 atoms. The molecular formula of dodecane is

A. $C_{12}H_{26}$

B. $C_{13}H_{26}$

C. $C_{18}H_{38}$

D. $C_{38}H_{78}$

Question 3

The volume, in litres, of CO_2 produced by the complete combustion of 116 g of butane at 200 °C and 100 kPa will be

A. 78

B. 157

C. 314

D. 628

Question 4

What volume of ethane at standard laboratory conditions (SLC) is required to produce the same amount of energy as 150 g of butane?

A. 24.8 L

B. 119 L

C. 1560 L

D. 7460 L

Use the following information to answer Questions 5 and 6.

The reaction between methane and steam can be used to produce hydrogen gas. The equation for this reaction is shown below.

$$CH_4(g) + 2H_2O(g) \rightleftarrows CO_2(g) + 4H_2(g) \qquad \Delta H < 0$$

Question 5

What will the units be for the equilibrium constant for this reaction?

A. M

B. M^{-1}

C. M^2

D. M^{-2}

Question 6

Which of the following changes would result in an increased yield of hydrogen gas?

A. an increase in temperature

B. a decrease in pressure

C. a decrease in volume

D. the addition of extra CO_2

Question 7

An energy profile diagram for a reaction is shown below.

This energy profile diagram represents

A. very stable reactants that will require significant amounts of energy to cause a reaction.

B. very stable reactants that will release significant amounts of energy upon reaction.

C. very unstable reactants that will release a small amount of energy upon reaction.

D. very unstable reactants that will release significant amounts of energy upon reaction.

Question 8

Ammonia is manufactured through the reaction between nitrogen and hydrogen gases. The equation for this exothermic, reversible reaction is shown below.

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g)$$

The temperature of an equilibrium mixture of these gases is increased. Which alternative is consistent with an increase in temperature of this system?

	Amount N_2	**Amount H_2**	**Amount NH_3**
A.	increase 0.4 mol	increase 1.2 mol	decrease 0.8 mol
B.	increase 0.4 mol	increase 0.4 mol	decrease 0.4 mol
C.	increase 0.4 mol	increase 1.2 mol	increase 0.8 mol
D.	decrease 0.4 mol	decrease 1.2 mol	increase 0.8 mol

Question 9

Ethanol can be oxidised in acidic conditions to ethanoic acid. The half-equation for this reaction is

A. $C_2H_5O(aq) + H_2O(l) \rightarrow C_2H_4O_2(aq) + 3H^+(aq) + 4e^-$

B. $C_2H_6O(aq) + H_2O(l) + 4e^- \rightarrow C_2H_4O_2(aq) + 4H^+(aq)$

C. $C_2H_6O(aq) + H_2O(l) \rightarrow C_2H_4O_2(aq) + 4H^+(aq) + 4e^-$

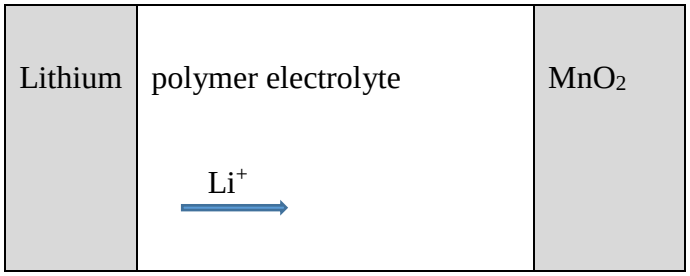
D. $C_2H_6O(aq) + OH^-(aq) \rightarrow C_2H_4O_2(aq) + H_2(g) + 2e^-$

Use the following information to answer Questions 10 to 12.

Lithium and manganese dioxide are used in a commercial secondary cell. The cell is relatively inexpensive and produces a voltage of 3.0 V.

The cathode reaction in this cell is

$MnO_2(s) + Li^+ + e^- \rightarrow LiMnO_2(s)$



Question 10

The overall equation in this cell during discharge will be

A. $MnO_2(s) + Li^+ + Li \rightarrow Li_2MnO_2(s)$

B. $Mn(s) + Li^+ + O_2 \rightarrow LiMnO_2(s)$

C. $MnO_2(s) + Li^+ \rightarrow Li(s) + MnO_2(s)$

D. $Li(s) + MnO_2(s) \rightarrow LiMnO_2(s)$

Question 11

During discharge, the oxidation state change at the cathode is

A. Li(s) to Li^+

B. Mn^{4+} to Mn^{2+}

C. Mn^{4+} to Mn^{3+}

D. Mn^{4+} to Mn(s)

Question 12

When this cell is being recharged, the half-equation occurring at the anode will be

A. $MnO_2(s) + Li^+ + e^- \rightarrow LiMnO_2(s)$

B. $LiMnO_2(s) \rightarrow MnO_2(s) + Li^+ + e^-$

C. $Li^+ + e^- \rightarrow Li(s)$

D. $Li(s) \rightarrow Li^+ + e^-$

Question 13

A galvanic cell is constructed from standard iodine and aluminium half-cells. In this cell

A. aluminium will be the reducing agent and electrons will flow to the iodine terminal.

B. aluminium ions are the oxidising agent and aluminium is the negative terminal.

C. iodine is oxidised and aluminium ions are reduced.

D. iodide ions will be oxidised and aluminium will be the positive terminal.

Question 14

Copper electrodes are placed in a dilute solution of $ZnSO_4$. When a current is passed through the solution, which one of the following will occur?

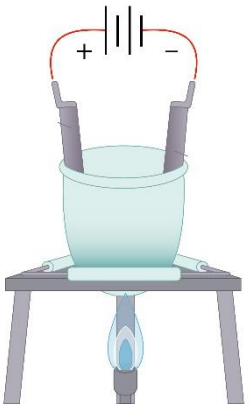
A. Oxygen gas will be produced at the anode and zinc metal deposited at the cathode.

B. Oxygen gas will be produced at the anode and hydrogen gas at the cathode.

C. The copper anode will react and form ions and copper metal is deposited at the cathode.

D. The copper anode will react and form ions and zinc metal is deposited at the cathode.

Use the following information to answer Questions 15 and 16.



A white, crystalline powder is added to a crucible and heated in a fume cupboard until it melts. Inert electrodes are placed in the crucible and a current passed through the solution.

A current of 10 A running for 193 s causes an increase in mass at the cathode of 0.138 g. A gas is collected above the anode. The volume of the gas after it has cooled to SLC is 0.248 L.

Question 15

The equation for the reaction occurring at the cathode in this cell is

A. $2Br^-(l) \rightarrow Br_2(l) + 2e^-$

B. $Li(l) \rightarrow Li^+(l) + e^-$

C. $Li^+(l) + e^- \rightarrow Li(l)$

D. $Na^+(l) + e^- \rightarrow Na(l)$

Question 16

What is the gas produced at the anode?

A. chlorine

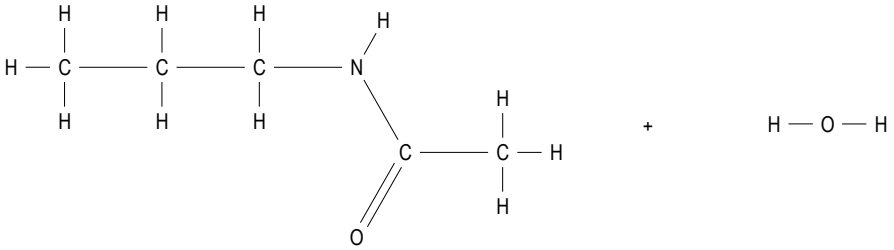
B. oxygen

C. carbon dioxide

D. nitrogen

Question 17

The reaction of molecules A and B forms the products shown below.



Molecules A and B could be

A. propan-1-amide and ethanol.

B. propan-1-amine and ethanoic acid.

C. butan-1-amine and ethanoic acid.

D. butan-1-amide and ethanol.

Question 18

Which one of the following molecules has geometric isomers?

A. CH_2CCl_2

B. CH_3CCl_3

C. CH_2CHCl

D. CHClCHCl

Question 19

An organic molecule is tested and found to turn bromine colourless and to react with NaOH, but not react with acidified $Cr_2O_7^{2-}$ ions. The molecule could be

A. CH_2CHCH_2COOH

B. $CH_3CH_2CH_2COOH$

C. $CH_3CH_2CH_2CH_2OH$

D. $CH_2CHCH_2CH_2OH$

Use the following information to answer Questions 20 and 21.

A titration against 0.100 M NaOH is used to determine the concentration of an organic acid. 20.0 mL aliquots of base are added to conical flasks and the acid is titrated from the burette. The mean titre of acid is 15.0 mL.

Question 20

The concentration of the acid is

A. also 0.100 M.

B. 0.075 M, if the acid is monoprotic.

C. 0.066 M, if the acid is diprotic.

D. 0.133 M, if the acid is diprotic.

Question 21

The burette is rinsed with deionised water before it is filled with acid. The use of water for rinsing

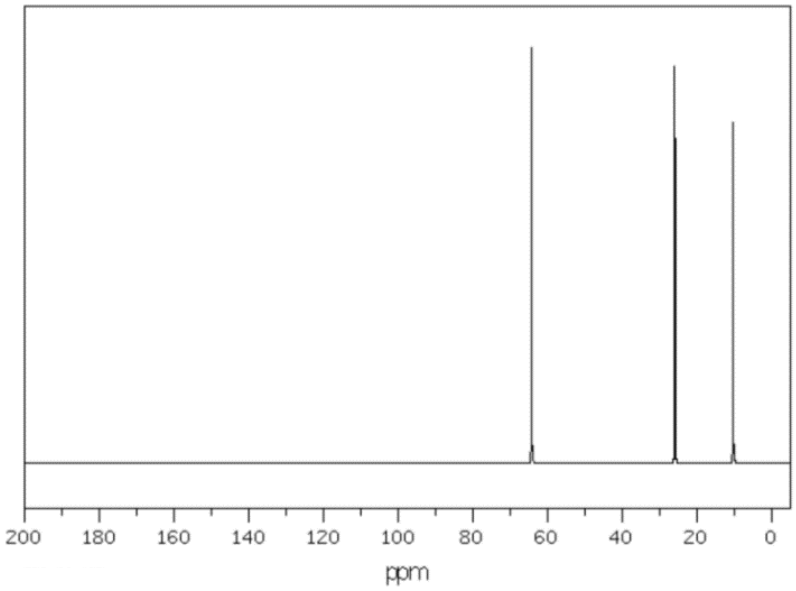
A. is good practice.

B. will lead to a low titre and a high estimate of acid concentration.

C. will lead to a low titre and a low estimate of acid concentration.

D. will lead to a high titre and a low estimate of acid concentration.

Question 22



Data: SDBSWeb; http://sdbs.db.aist.go.jp
National Institute of Advanced Industrial Science and Technology

The ^{13}C NMR spectrum shown above is that of

A. propan-2-ol

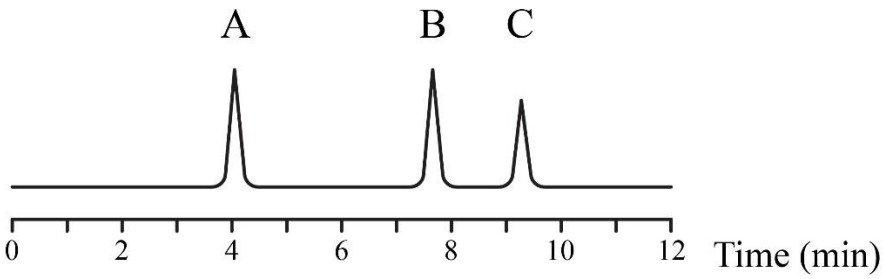
B. propanone

C. propanoic acid

D. propan-1-ol

Question 23

A sample of petrol is injected into a high-performance liquid chromatography (HPLC) instrument. The stationary phase used is polar and the mobile phase is non-polar.



Select the correct conclusion from the following alternatives.

A. There are three components only in the sample.

B. Molecule A is likely to be the hydrocarbon of lowest molecular mass.

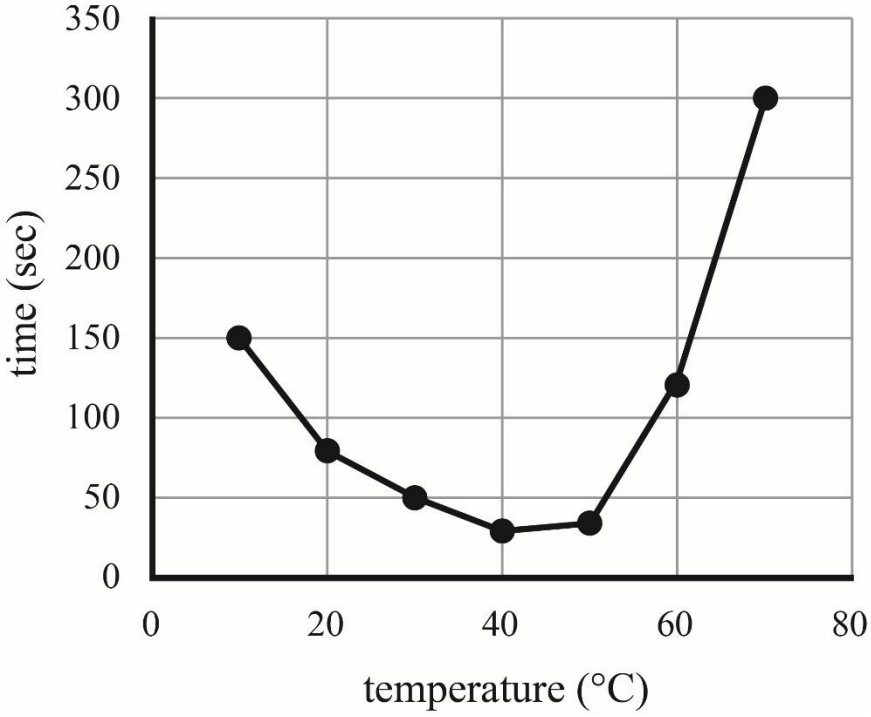
C. Molecule C is likely to be the hydrocarbon of lowest molecular mass.

D. The concentration of each component is similar.

Use the following information to answer Questions 24 and 25.

Invertase is an enzyme responsible for the hydrolysis of sucrose. A common experiment is for students to add invertase to sucrose solutions at different temperatures. Benedict's Solution can be added to help compare the rate of reaction at each temperature. As hydrolysis progresses, Benedict's Solution turns from blue to a reddish brown.

The graph below is of the time taken for a colour change to be evident for solutions of each temperature.



Question 24

The rate of reaction is highest at

A. 10 °C

B. 40 °C

C. 50 °C

D. 70 °C

Question 25

Which of the following is the most likely trigger for the colour change?

A. a reaction occurring between Benedict's Solution and glucose

B. a reaction occurring between Benedict's Solution and sucrose

C. a reaction occurring between Benedict's Solution and invertase

D. the Benedict's Solution denaturing when the reaction mixtures are heated

Question 26

A piece of bread sitting in someone's mouth will taste sweet after a few minutes. The best explanation for this effect is that

A. the physical action of chewing breaks starch molecules into smaller sugar molecules.

B. amylase in saliva has hydrolysed some starch molecules.

C. pepsin in saliva has hydrolysed some protein molecules.

D. the action of chewing has allowed sugar molecules to reach the taste buds.

Question 27

How many different tripeptides can be formed from reaction of the three amino acids leucine, lysine and isoleucine?

A. 1

B. 3

C. 4

D. 6

Question 28

Select the alternative that best describes the role of lipase in digestion.

A. Lipase catalyses the hydrolysis of ester bonds in foods.

B. Lipase acts to transport fatty acid molecules around the body.

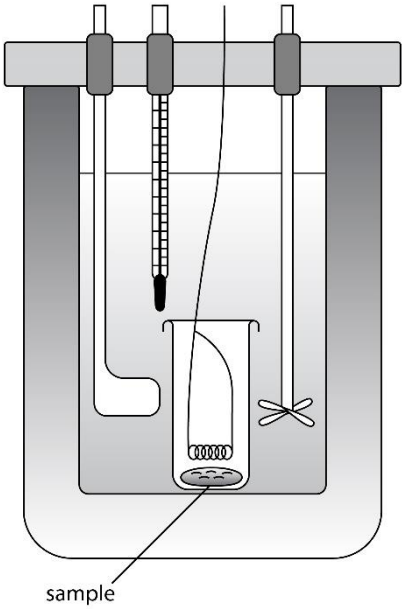
C. Lipase hydrolyses the amide bonds in proteins to produce smaller amino acids.

D. Lipase acts to break large blobs of fat into much smaller, more manageable globules.

Use the following information to answer Questions 29 and 30.

A bomb calorimeter is used to measure the energy content of foods. A sketch of one is shown below.

The measurements taken by a student are also shown below.



mass of biscuit 1.12 g

temperature of water before biscuit burnt 18.8 °C

temperature of water after biscuit burnt 29.6 °C

calibration

voltage 5.40 V current 3.40 A time 5.00 min

temperature of water before calibration 21.2 °C

temperature of water after calibration 27.6 °C

Question 29

In J °C^{-1}, the calibration factor for the calorimeter will be

A. 14.3

B. 86.1

C. 861

D. 1720

Question 30

The heat of combustion of the biscuit will be

A. 212 J g^{-1}

B. 8.30 kJ g^{-1}

C. 9.30 kJ g^{-1}

D. 9.30 kJ mol^{-1}

END OF SECTION A
TURN OVER

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using black or blue pen.

Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.

Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$, NaCl(s).

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (10 marks)

a. Several energy transformations occur when electricity is generated in a coal-fired power station.

For each energy transformation listed below, explain what is occurring in the coal-fired plant.

i. chemical potential energy to thermal energy

1 mark

_____

ii. thermal energy to mechanical energy

1 mark

_____

iii. mechanical energy to electrical energy

1 mark

_____

b. The activation energy required for the conversion of 1 mole of CO_2 and water to methane and oxygen is 1440 kJ.

i. Write a balanced equation for the complete combustion of 1 mole of methane gas.

1 mark

_____

ii. Use the axis provided, and initial enthalpy value, to show the energy profile diagram for this reaction.

2 marks

c. Natural gas is being trialled as a fuel in buses and trucks in Australia. The density of liquid natural gas is 0.66 g mL^{-1}.

i. Assuming natural gas is pure methane, determine the energy that could be produced from a 50.0 L sample of liquid methane.

1 mark

_____

_____

ii. Combustion of natural gas occurs at temperatures around 800 °C and pressures of 250 kPa. Calculate the volume of the CO_2 produced at these conditions from the combustion of 50.0 L of methane.

3 marks

_____

_____

Question 2 (10 marks)

One of the first commercial secondary cells was the nickel-cadmium (or Ni-Cd) cell. The voltage produced in each cell is 1.2 volts. Ni-Cd batteries are still popular in devices due to the high number of recharges they can sustain.

The reduction half-equation occurring during discharge is

$NiO(OH)(s) + H_2O(l) + e^- \rightarrow Ni(OH)_2(s) + OH^-(aq)$

The overall equation is

$2NiO(OH)(s) + Cd(s) + 2H_2O(l) \rightarrow 2Ni(OH)_2(s) + Cd(OH)_2(s)$

a. **i.** What is the oxidation state change of nickel ions during discharge?

1 mark

_____

ii. Which metal is the stronger reductant, nickel or cadmium?

1 mark

_____

iii. Write a balanced half-equation for the oxidation reaction occurring.

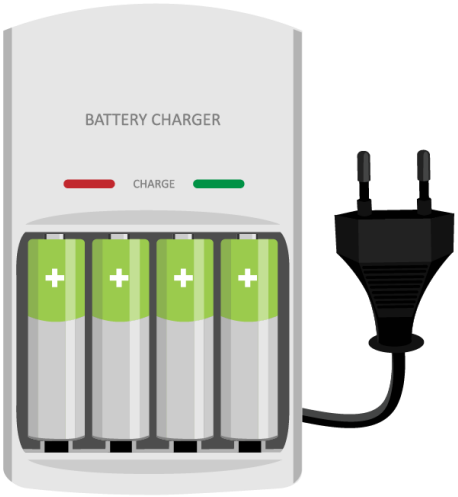
1 mark

_____

b. A set of nickel-cadmium cells, as shown below, is in the process of being recharged.

Positive electrode:

Negative electrode:



i. Use the boxes provided to write balanced half-equations for the reactions occurring during recharge of this cell.

2 marks

ii. What voltage should the recharger be using in this process?

1 mark

_____

iii. List one similarity between nickel-cadmium cells and fuel cells.

1 mark

_____

_____

c. Methane can be used to power fuel cells. Using the spaces provided below, show the equations that occur when a methane fuel cell is operating in acidic conditions.

3 marks

Anode half-equation: _____

Cathode half-equation: _____

Overall equation: _____

Question 3 (8 marks)

Methanol gas is unstable and can decompose to hydrogen and carbon monoxide in a reversible reaction.

The equation for the reaction is $CH_3OH(g) \rightleftarrows CO(g) + 2H_2(g)$ $\Delta H > 0$

The value of K for this reaction at 760 °C is 3.52×10^{-3} M^2.

a. A sample of methanol is added to an empty reactor at 760 °C. When equilibrium is established, the concentration of methanol is determined to be 0.84 M.

Calculate the equilibrium concentration of CO.

4 marks

_____

_____

_____

_____

b. A reactor contains an equilibrium mixture of the aforementioned gases. The volume of the reactor is halved.

i. Explain the impact of this change on the position of equilibrium of this reaction.

2 marks

_____

_____

ii. How will the concentration of CO after equilibrium is re-established compare with its value before the volume was changed?

1 mark

_____

_____

iii. How will the rate of reaction in the system after equilibrium is re-established compare with the rate before the volume was changed?

1 mark

_____

_____

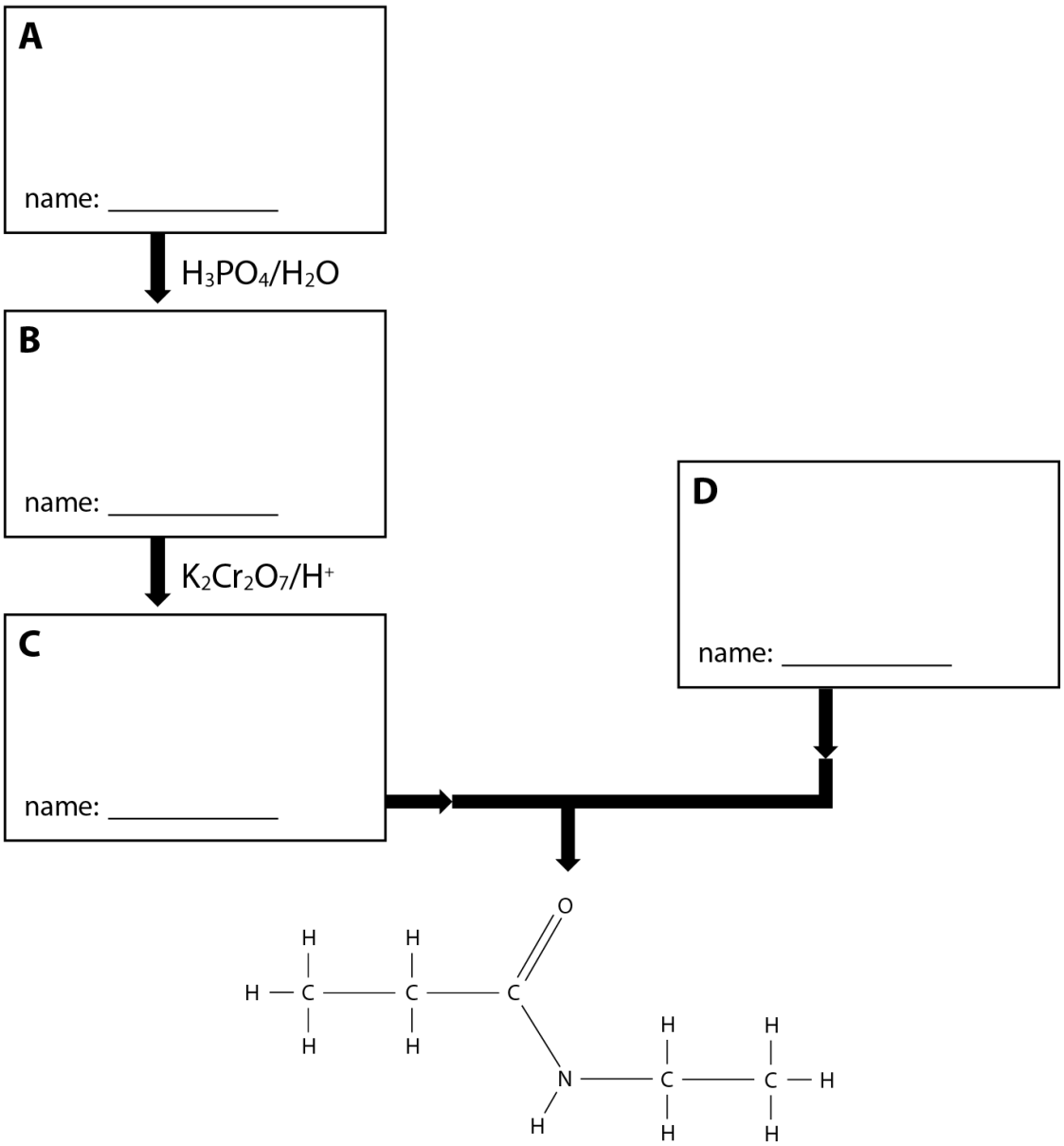
CONTINUES OVER PAGE

Question 4 (12 marks)

The flowchart below can be followed to produce the amide molecule shown. In the final step of the flowchart, a condensation reaction occurs between molecules C and D.

a. Use the boxes provided to draw and name molecules A, B, C and D.

8 marks



b. In the production of molecule C, dichromate ions are reduced to Cr^{3+} ions.

Write a balanced half-equation for this reaction.

1 mark

_____

c. The concentration of a solution of molecule D can be determined by titration with a standardised solution of HCl acid.

i. Write a balanced equation for the reaction between molecule D and HCl.

1 mark

_____

ii. A 50.0 mL sample of solution of molecule D is neutralised by 16.5 mL of 0.25 M HCl.

Determine the concentration of the solution of molecule D.

2 marks

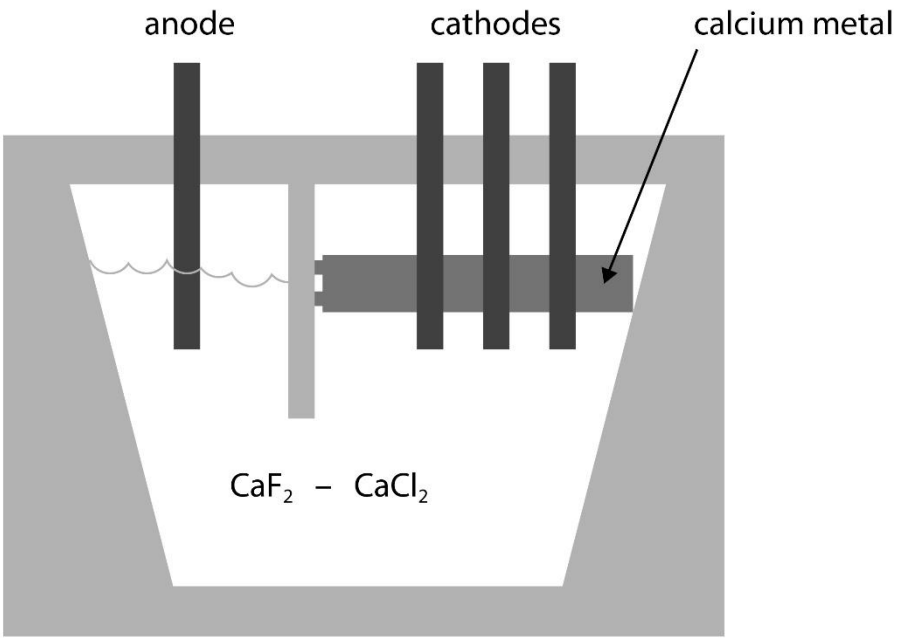
_____

_____

_____

Question 5 (9 marks)

Calcium is manufactured in the United States by the reduction of lime (CaO) using aluminium metal. An alternative process is being trialled, however, whereby a molten mixture of calcium fluoride and calcium chloride is electrolysed. The electricity costs of this method are high but the purity of the calcium obtained is superior to that by other methods. An outline of the cell used is shown below.



a. Write a balanced equation for the reduction of CaO by aluminium metal.

1 mark

_____

b. The electrolyte used in the cell shown above is a mixture of CaF_2 and $CaCl_2$.

Write balanced half-equations for the

i. reaction at the anode.

1 mark

_____

ii. reaction at the cathode.

1 mark

_____

iii. overall reaction.

1 mark

_____

c. The current in the cell is high: 125 000 A. How long will it take (in hours) to obtain 1.00 tonne of calcium metal?

3 marks

_____

_____

_____

_____

_____

d. Potassium salts are often found in the same deposits as calcium salts. Use your knowledge of the electrochemical series to explain whether the presence of potassium salts is likely to interfere with the operation of the calcium cell.

2 marks

_____

_____

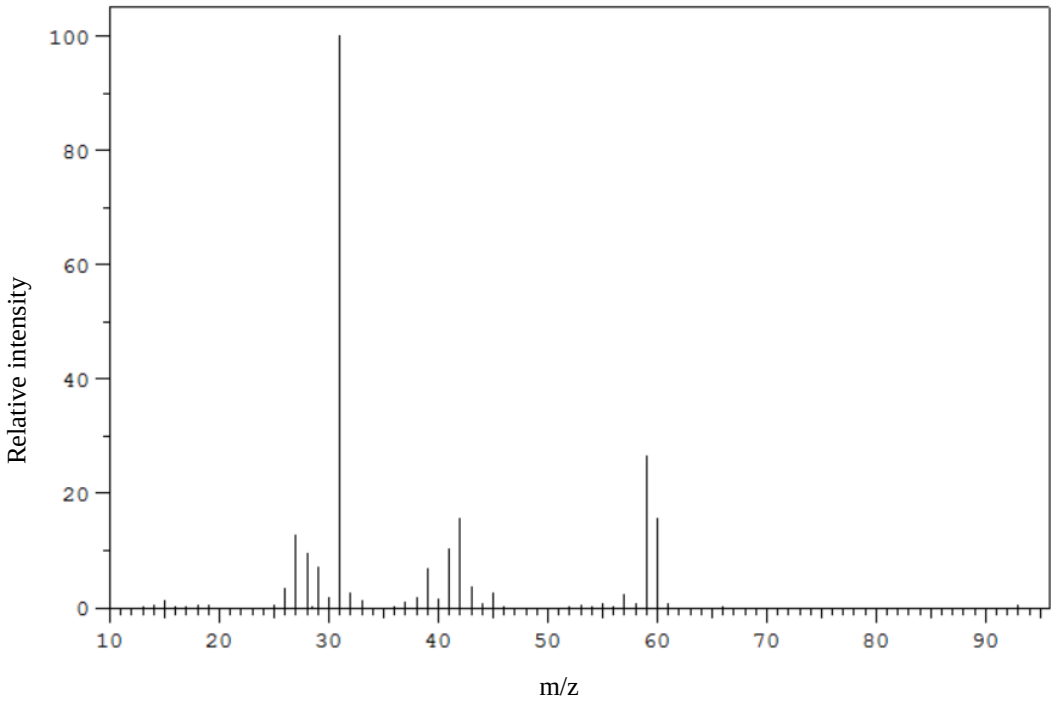
_____

_____

_____

Question 6 (11 marks)

A chemist has a sample of a liquid that is known to be either propan-1-ol or ethanoic acid. The liquid is tested with a mass spectrometer and the spectrum shown below is obtained.

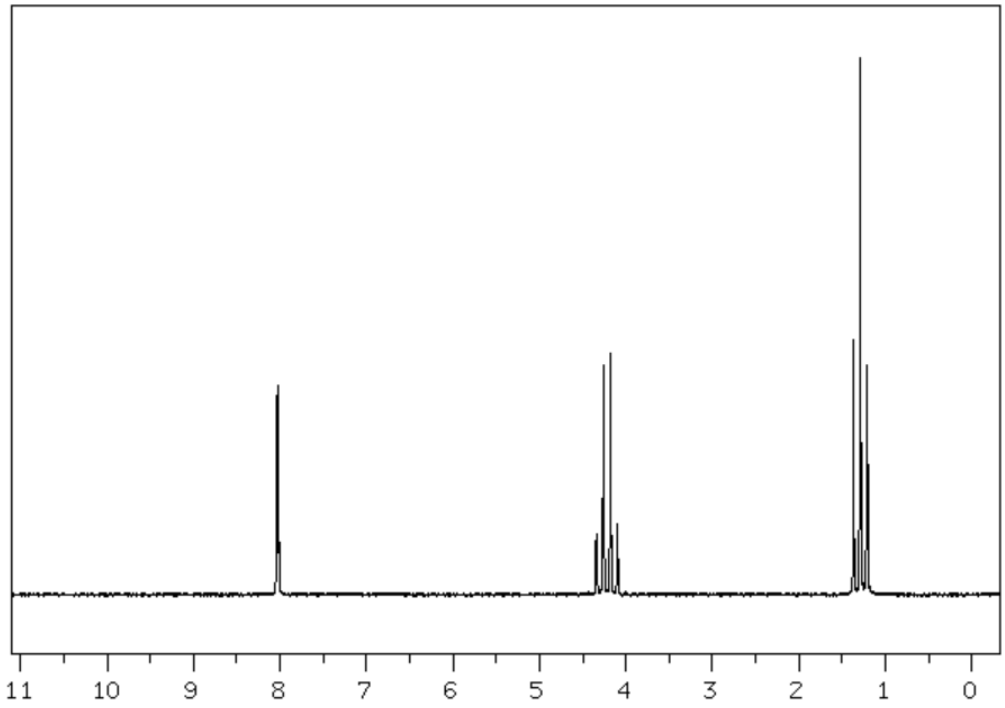


Data: SDBSWeb; http://sdbs.db.aist.go.jp,
National Institute of Advanced Industrial Science and Technology

a. Identify whether propan-1-ol or ethanoic acid has produced this spectrum.
Justify your answer.

3 marks

A proton-NMR is conducted on a liquid with molecular formula $C_3H_6O_2$ to determine its identity.



SDBSWeb; http://sdbs.db.aist.go.jp,
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b. Use the spectrum provided above to suggest a structure for the molecule. Justify your answer.

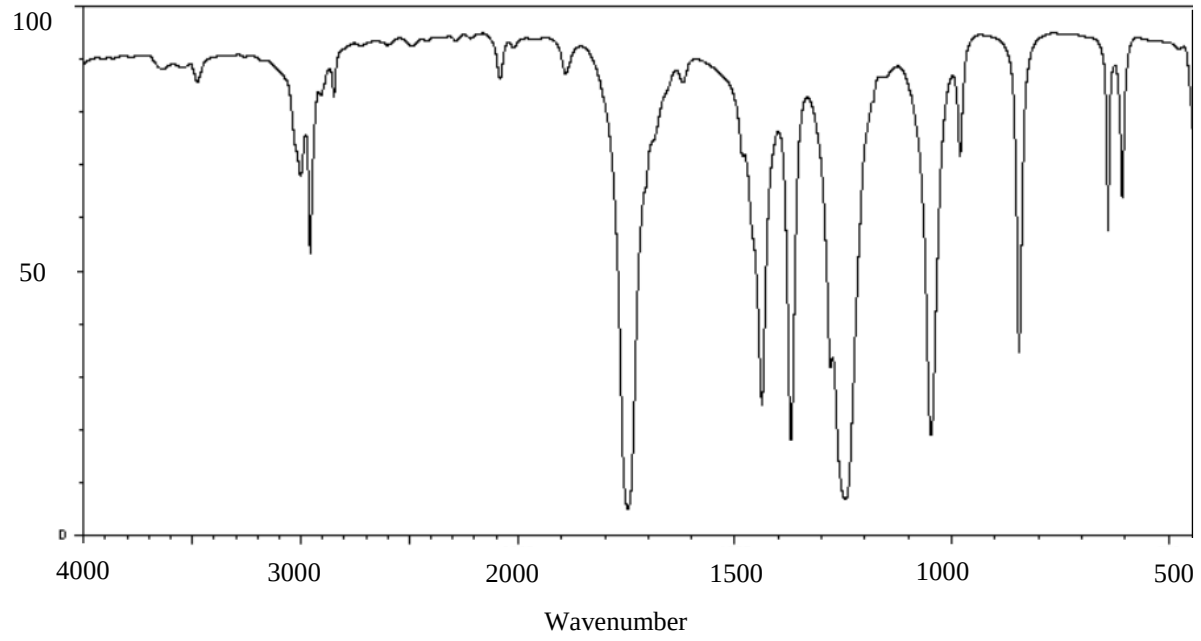
3 marks

_____

_____

_____

The infra-red spectrum below is from a molecule that is known to be one of either propanoic acid, methyl ethanoate or propan-1-ol.



Data: SDBSWeb; http://sdbs.db.aist.go.jp,
National Institute of Advanced Industrial Science and Technology

c. Use the spectrum provided to identify the molecule. Justify your answer.

3 marks

_____

_____

_____

_____

_____

d. A contaminated sample of water is known to contain propan-1-ol, hexan-2-ol and pentan-1-amine. A sample of this mixture is injected into a HPLC column that uses ethanol as a solvent and a non-polar stationary phase. Which of the three molecules will have the shortest retention time? Justify your answer.

2 marks

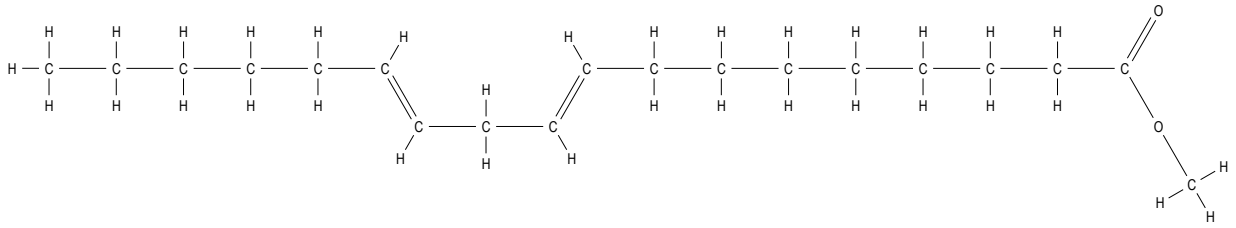
_____

_____

_____

Question 7 (6 marks)

The structure of the main component of a sample of biodiesel is shown below.



a. This ester was formed in a condensation reaction between two smaller molecules, a fatty acid and an alcohol.

i. Use a semi-structural formula to draw the fatty acid molecule.

1 mark

ii. Name the fatty acid.

1 mark

_____

iii. This fatty acid is an example of an omega-6 fatty acid. Explain what omega-6 means.

1 mark

_____

iv. Are the carbon-to-carbon bonds in this fatty acid in *cis* or *trans* formation?

1 mark

_____

b. Use a semi-structural formula to draw the triglyceride that could be formed from a sample of this fatty acid.

2 marks

Question 8 (6 marks)

Gluthathione is a tripeptide with an important role to play in the human body. It is formed in the liver and it acts as an antioxidant to prevent deterioration of many components of our body cells. The sequence of amino acids in this tripeptide is Glu-Cys-Gly.

a. Draw a molecule of this tripeptide using a structural formula.

3 marks

b. Nominate the type of tertiary bonding that is likely to occur

i. with glutamic acid.

1 mark

_____

ii. with cysteine.

1 mark

_____

iii. with glycine.

1 mark

_____

Question 9 (7 marks)

a. The nutritional information displayed on a packet of Anzac biscuits is shown below.

NUTRITION INFORMATION Serving, per recipe: 16 Average serving size: 31g (1 biscuit)		
	Per serve	**Per 100g**
Kilojoules (kJ)	495	1603
Protein (g)	1.6	5.0
Total fat (g)	4.2	13.5
- Saturated fat (g)	1.0	3.4
Carbohydrates (g)	18.6	60.1
- Sugars (g)	9.7	31.4
Fibre (g)	1.1	3.5
Sodium (mg)	102	331

i. Use the masses of protein, carbohydrate and fat to calculate the available energy in each biscuit.

1 mark

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ii. Explain why the energy value you obtained does not match that of the label.

1 mark

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b. A single Anzac biscuit is burnt under a beaker containing 2.50 kg of water. The initial temperature of the water is 18.6 °C.

Assuming the transfer of energy to the water is 100% efficient, use the energy value provided on the label to determine the final temperature of the water.

3 marks

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c. This brand of biscuit is rated as mid-range on the GI (glycaemic index) scale.

Use the information on the label to discuss the appropriateness of this rating.

2 marks

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Question 10 (11 marks)

A student conducts an investigation of the rate of reaction for the reaction between magnesium and hydrochloric acid (HCl).

The details of the experiment are outlined below.

Hypothesis
The rate of reaction will be directly proportional to the concentration of the hydrochloric acid.

Design

1. The student prepares a solution of 1.0 M HCl, and uses pipettes and deionised water to make a range of dilutions to this solution.
2. Five 250 mL flasks are assembled, ready to be attached to five corresponding gas syringes.
3. Using a beaker, 50.0 mL of solution is added to each flask.
4. A 1 cm piece of magnesium is added to each flask and the stopper inserted quickly so the gas generated is trapped in the gas syringe.
5. The time taken for the volume collected to reach 20 mL is recorded.

Results

Concentration of HCl (M)	Time (s)
0.2	140
0.4	60
0.6	35
0.8	15
1.0	7

Conclusion
The rate of reaction drops as the concentration increases.

a. Write a balanced equation for the reaction occurring.

1 mark

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b. Identify

i. the independent variable.

1 mark

_____

ii. the dependent variable.

1 mark

_____

iii. **two** examples of controlled variables.

2 marks

_____

c. Identify **two** steps of the procedure that limit the accuracy of the results. Explain your answers.

2 marks

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d. Is the student's conclusion valid? Justify your answer.

2 marks

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_____

e. The student's results are significantly influenced by the action of a variable that the student thought was controlled. What is that variable and how has it influenced the results obtained?

2 marks

_____

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_____

END OF QUESTION AND ANSWER BOOK