Government of South Australia

SACE Board of SA | South Australian Certificate of Education

The external assessment requirements of this subject are listed on page 13.

Chemistry
November 2018 sample paper

Question Booklet 2

2

- (Questions 5 to 9) 60 marks
- Answer ***all*** questions
- Write your answers in this question booklet
- You may write on page 12 if you need more space
- Allow approximately 60 minutes

Copy the information from your SACE label here

SEQ	FIGURES	CHECK LETTER	BIN

For office use only

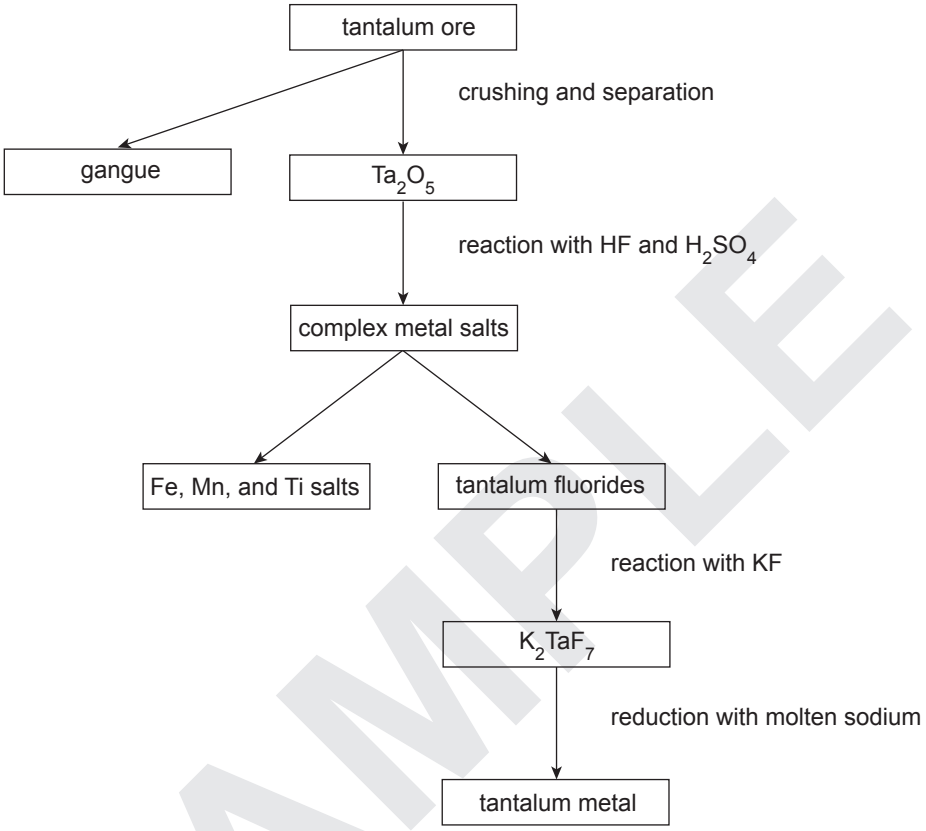
Supervisor check	Re-marked

5. Tantalum (Ta) is a metal that occurs, in combination with other elements, in small quantities in the Earth's crust.

(a) State why tantalum is not naturally found in its pure metallic state.

_____ (1 mark)

(b) The production of tantalum from its ore involves a number of steps, as shown in the flow chart below.



(i) Explain why the crushing of the ore is an important step in the extraction process.

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_____

_____ (2 marks)

(ii) Write the formula of *one* compound that may be obtained as a by-product of the process shown in the flow chart.

_____ (1 mark)

(iii) Identify the reagent used to prepare the tantalum salt, K_2TaF_7, that undergoes reduction.

_____ (1 mark)

(iv) Molten sodium is able to reduce the tantalum in K_2TaF_7 to tantalum metal.

(1) Explain why molten sodium is able to act as a reducing agent in this reaction.

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_____ (2 marks)

(2) Balance the following equation for the reaction that produces tantalum:

$K_2TaF_7 + Na \longrightarrow Ta + NaF + KF$

(1 mark)

6. Various processes are used to treat water, depending on the origin and intended use of the water.

(a) Fine clay particles can be removed from domestic water supplies.

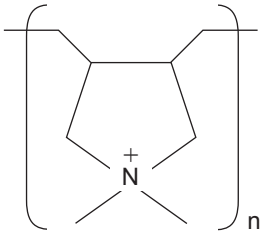
(i) State *one* reason for removing fine clay particles from water.

_____

_____ (1 mark)

(ii) In some regions polyDADMAC is used to remove fine clay particles from water.

The structural formula of one repeating unit of a polyDADMAC chain is shown below.



Explain how polyDADMAC removes fine clay particles from water.

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_____ (3 marks)

(b) $Na_3P_3O_9$ is added to some commercial detergent formulations to remove Ca^{2+} from washing water.

(i) State *one* potential environmental consequence of adding $Na_3P_3O_9$ to commercial detergent formulations.

_____

_____ (1 mark)

(ii) The Ca^{2+} concentration in a sample of tap water was determined, using atomic absorption spectroscopy.

Some calcium ions, with an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ 4s^1$, emitted light as they passed through the flame.

(1) Explain why calcium ions with this electron configuration emitted light.

_____

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_____ (2 marks)

(2) Using subshell notation, write the electron configuration of *one* of these calcium ions after it has emitted light.

_____ (1 mark)

(c) The desalination process removes dissolved salts from saline water, using reverse osmosis.

(i) Describe how reverse osmosis lowers the concentration of dissolved salts in water.

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_____ (3 marks)

(ii) State *one* environmental disadvantage of the desalination process.

_____

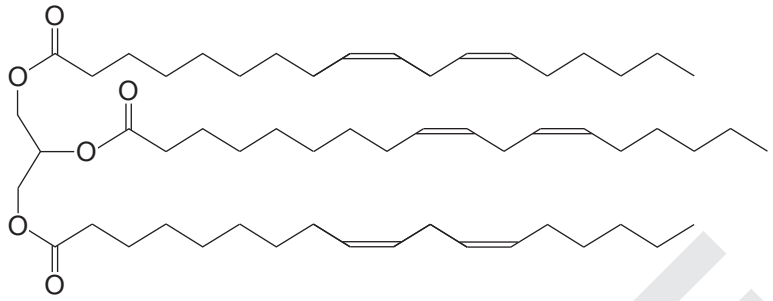
_____ (1 mark)

7. Long-chain carboxylic acids are components of triglycerides found in vegetable oils.

(a) State the feature that identifies a long-chain carboxylic acid molecule as being unsaturated.

_____ (1 mark)

(b) Trilinolein is a triglyceride found in safflower oil and is derived from three linoleic acid molecules. The structure of trilinolein is shown below.



(i) Explain why trilinolein is a liquid at room temperature.

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_____ (3 marks)

(ii) Draw the structural formula of linoleic acid.

(2 marks)

Credit will be given for the correct use of significant figures in answers to part (iii). (1 mark)

(iii) Safflower oil hydrolyses over time to form linoleic acid molecules. The concentration of acid in an open bottle of safflower oil was measured by titration with a solution of potassium hydroxide (KOH).

(1) A solution of KOH was prepared and shown to have a concentration of 0.0250 mol L^{-1}.

Calculate the mass, in g, of KOH in 0.2500 L of this solution.

(3 marks)

(2) Three 20.00 mL samples of safflower oil were titrated with the 0.0250 mol L^{-1} KOH solution.

(A) Name the apparatus used to accurately transfer a sample of safflower oil to the titration flask.

_____ (1 mark)

(B) The average titre was 7.12 mL.

Calculate the concentration of acid (in mol L^{-1}) in the safflower oil.

(3 marks)

(C) State why an average of the three titres, rather than just one titre value, was used to calculate the concentration of acid.

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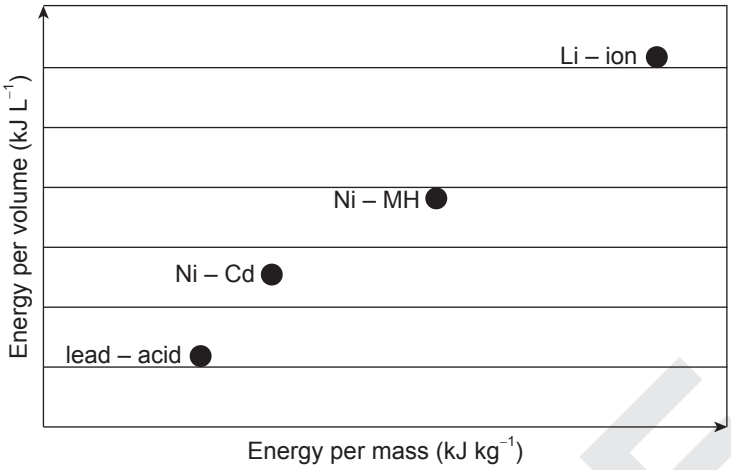
_____ (1 mark)

8. Sustainable, affordable, and plentiful electricity production is a challenge for countries around the world.

(a) The graph below shows the relationship between the average energy generated per volume and per mass for four types of rechargeable battery.



By referring to the graph, explain the convenience to consumers of using a Li–ion battery rather than a Ni-Cd battery.

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_____ (2 marks)

(b) Large vanadium flow cells are a recent innovation in battery-storage technology. They are rechargeable due to conversions between vanadium ions of various oxidation states.

(i) Complete the following half-equation for the conversion of V^{2+} to V^{3+}:

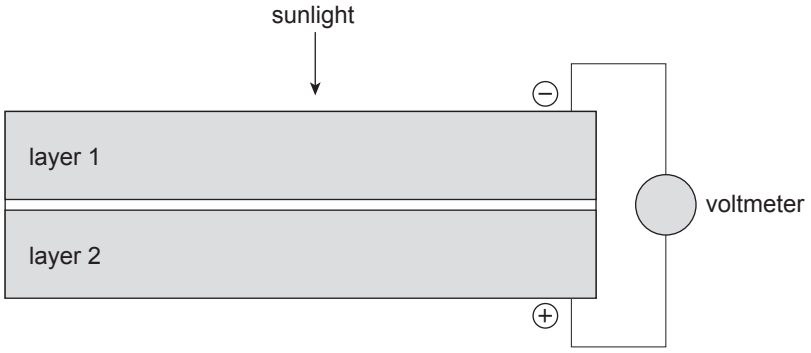
$$V^{2+} \longrightarrow V^{3+}$$

(1 mark)

(ii) State whether this reaction represents oxidation or reduction.

_____ (1 mark)

(c) Photovoltaic cells are now used to generate electricity in countries around the world. A diagram of a photovoltaic cell is shown below.



(i) State why a photovoltaic cell is classified as a galvanic cell.

_____

_____ (1 mark)

(ii) On the diagram above, draw the direction of the electron flow through the external circuit. (1 mark)

(iii) Explain *two* environmental advantages of generating electricity by using a photovoltaic cell rather than a steam turbine.

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_____ (4 marks)

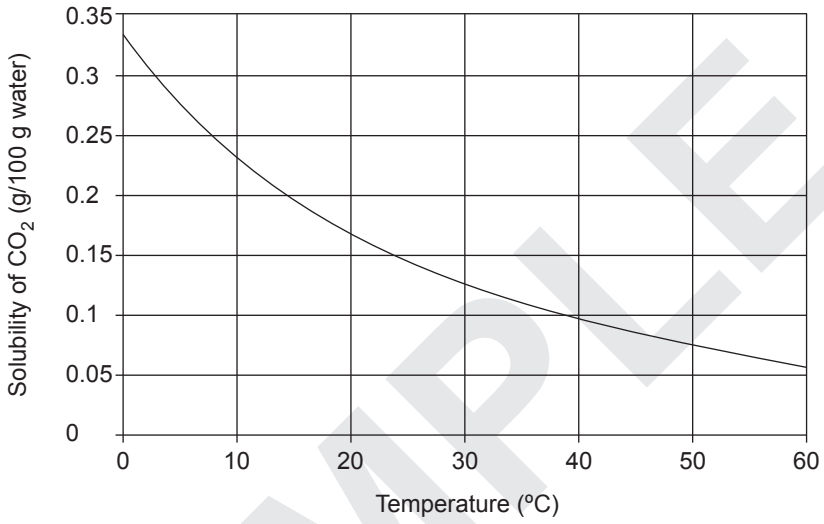
9. Carbon dioxide gas, CO_2, is present in small concentrations in the atmosphere.

(a) CO_2 gas dissolves to a limited extent in rainwater. Some of the CO_2 then reacts with the water.

(i) Write an equation for the reaction of CO_2 with water.

(2 marks)

(ii) The solubility of CO_2 in water varies with temperature, as shown in the graph below.



State the effect that increasing temperature has on the solubility of CO_2 in water.

_____

_____ (1 mark)

(iii) Using the graph above, explain the effect that increasing temperature has on the pH of rainwater.

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_____ (3 marks)

(b) Despite the low solubility of CO_2 in water, oceans may have absorbed more than half of the CO_2 generated by human activity in the last two centuries. The increased level of CO_2 in the oceans has been accompanied by a relatively constant average ocean temperature.

Calcium carbonate in the shells of many marine organisms reacts with H^+.

(i) Write an equation for the reaction of calcium carbonate with H^+.

(2 marks)

(ii) State the effect of this reaction on the shells of marine organisms.

_____ (1 mark)

(c) Globally, more than 20 large carbon capture and storage (CCS) projects are in operation. An industrial-scale CCS project in Australia has successfully stored 80 000 tonnes of CO_2 underground, preventing more than 95% of CO_2 emissions from reaching the atmosphere. Australian scientists have shared information about the effectiveness of the new technologies used in this project with scientists around the world.

Discuss how international collaboration and communication between scientists contributes to the effectiveness of new CCS technologies, and the benefits that these technologies will have for the global community.

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_____ (6 marks)

You may write on this page if you need more space to finish your answers to Question Booklet 2. Make sure to label each answer carefully (e.g. 9(a)(iii) continued).

NOVEMBER 2018 SAMPLE CHEMISTRY PAPER

The purpose of this sample paper is to show the structure of the Chemistry examination and the style of questions that may be used. The following extract is from the 2018 subject outline for Chemistry:

EXTERNAL ASSESSMENT

Assessment Type 3: Examination (30%)

Students undertake one 2-hour examination.

Stage 2 science inquiry skills and science understanding from all topics may be assessed.

Questions:

- will be of different types
- may require students to show an understanding of science as a human endeavour
- may require students to apply their science understanding from more than one topic.

For the examination, students are given a sheet containing a periodic table, standard SI prefixes, symbols of common quantities, some physical constants, some mathematical relationships, and a table showing the relative activities of a number of metals.

All specific features of the assessment design criteria for this subject may be assessed in the external examination.

Source: *2018 Chemistry Subject Outline Stage 2 (for teaching in 2018)*, pp. 47–8, on the SACE website, www.sace.sa.edu.au

This sample Chemistry paper shows the format of the examination for November 2018.