**2022 Unit 3 Chemistry trial exam**

**Name**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Section A: Multiple Choice section**

**Question 1**

Select the alternative that is the best description of a biodiesel molecule.

**A**. A fatty acid molecule.

**B**. The product of hydrolysis of a triglyceride.

**C**. An ester formed from the reaction between a small alcohol molecule and a long alcohol molecule.

**D**. The product of an alcohol combining with a fatty acid.

Chart, line chart

Description automatically generated**Question 2**

The molecule shown here is

**A**. palmitoleic acid

**B**. stearic acid

**C**. oleic acid

**D**. linoleic acid

**Question 3**

A Maxwell-Boltzmann curve is drawn below.

Diagram

Description automatically generated with low confidence

This graph can best be used to explain

**A**. how the introduction of a catalyst will increase the rate of a reaction.

**B**. how the proportion of particles that will react increases with temperature.

**C**. how a catalyst lowers the activation energy required for a reaction.

**D**. how increasing the surface area of a reactant increases the reaction rate.

**Question 4**

Which of the following electrolytes will produce the same products whether the electrolyte is molten or aqueous?

**A**. KCl

**B**. CuI2

**C**. KNO3

**D**. KI

**Question 5**

Which of the following will produce the greatest mass of metal at the cathode of an electrolytic cell?

**A**. a charge of 0.50 faraday through a cell containing 1.0 M NaCl

**B**. a charge of 0.20 faraday through a cell containing NaCl(l)

**C**. a charge of 0.30 faraday through a cell containing Al2O3(l)

**D**. a charge of 0.20 faraday through a cell containing 1.0 M AgNO3

*Use the galvanic cell drawn below to answer Questions 6 and 7*

Diagram

Description automatically generated

**Question 6**

The overall equation in the cell will be

**A**. Al(s) + Ni2+(aq) 🡪 Al3+(aq) + Ni(s)

**B**. 2Al(s) + Ni2+(aq) 🡪 2Al3+(aq) + 3Ni(s)

**C**. 2Al3+(aq) + 3Ni(s) 🡪2Al(s) + 3Ni2+(aq)

**D**. 2Al(s) + 3Ni2+(aq) 🡪 2Al3+(aq) + 3Ni(s)

**Question 7**

In this cell,

**A**. aluminium will be the negative electrode and the potential will be around 1.41 V

**B**. the electrons will flow from the nickel electrode to the aluminium electrode.

**C**. nickel metal is oxidised and aluminium ions are reduced.

**D**. nickel will be the positive electrode and electrons will flow to the aluminium electrode.

**Question 8**

The equation for the equilibrium that forms between hydrogen iodide and oxygen gases is

4HI(g) + O2(g) ⇌ 2H2O(g) + 2I2(g)

The volume of an equilibrium mixture of the above gases is decreased. When equilibrium is re-established,

**A**. the concentration of HI will lower than it was at the first equilibrium.

**B**. the concentration of HI will higher than it was at the first equilibrium.

**C**. the amount of HI will be higher than it was at the first equilibrium.

**D**. the value of *K*c will have increased as the forward reaction is favoured.

**Question 9**

Which of the following systems will have units of M2?

**A**. 2SO2(g) + O2(g) ⇄ 2SO3(g)

**B**. N2(g) + 3H2(g) ⇄ 2NH3(g)

**C**. H2(g) + I2(g) ⇄ 2HI(g)

**D**. CH4(g) + H2O(g) ⇄ CO(g) + 3H2(g)

Diagram

Description automatically generated**Question 10**

The change made at time *t* in this system could be

**A**. an increase in temperature of the system.

**B**. a decrease in volume of the system.

**C**. the addition of more NO gas.

**D**. the addition of a catalyst.

**Question 11**

The equation for the equilibrium between hydrogen and iodine gases is

H2(g) + I2(g) ⇌ 2HI *K*c = 64 at 240 ˚C.

For the reaction below, the value of *K*c at 240 ˚C will be

HI ⇌ ½ H2(g) + ½ I2(g)

**A**. 0.01156

**B**. 0.125

**C**. 8

**D**. -64

**Question 12**

SO42-(aq) + 10H+(aq) + 8e- 🡪 H2S(g) + 4H2O(l)

The oxidation state change of sulfur atoms in the half-equation above is

**A**. +6 to +2

**B**. +4 to +2

**C**. +6 to -2

**D**. +4 to -2

**Question 13**

Aluminium metal can be produced from molten Al2O3 in an electrolytic cell. In this cell

**A**. aluminium is reduced at the cathode and 0.12 faraday of charge will produce 0.04 mole of aluminium **B**. aluminium is reduced at the cathode and 0.12 faraday of charge will produce 0.06 mole of aluminium

**C**. aluminium is oxidised at the cathode and 0.12 faraday of charge will produce 0.04 mole of aluminium

**D**. aluminium is reduced at the anode and 0.12 faraday of charge will produce 0.04 mole of aluminium

*Use the following diagram to answer Questions 14 and 15*

The cell shown uses hydrazine, N2H4, and hydrogen peroxide,H2O2 as reactants in acid conditions..

Diagram

Description automatically generated

**Question 14**

The oxidation state change of nitrogen in anode reaction is

**A**. +3 to -2

**B**. +5 to -3

**C**. +2 to 0

**D**. +4 to -2

**Question 15**

The overall reaction occurring in this cell can be simplified to

**A**. N2H4 + NaOH + H2SO4 + 2H2O2 🡪 N2 + Na2SO4 + H2O

**B**. N2H4 + 2H2O2 🡪 N2 + H2O

**C**. N2H4 + 4OH- + 4H+ + 2H2O2 🡪 N2 + 8H2O

**D**. N2H4 + 2NaOH + H2SO4 + 2H2O2 🡪 N2 + Na2SO4

**Question 16**

Which of the following fuels has the highest melting point?

**A**. biodiesel

**B**. petrol

**C**. ethanol

**D**. petrodiesel

**Question 17**

Select the correct statement about coal-fired power stations.

**A**. The thermal energy from the coal is transformed firstly into kinetic energy.

**B**. The only reaction occurring is the complete combustion of carbon.

**C**. Chemical energy is converted directly to electrical energy but the efficiency of the process is low.

**D**. Coal releases electrons as it burns enabling the power station to produce electrical energy.

**Question 18**

Which alternative is a correct comparison of cells?

**A**. The anode is negative in both a primary cell and an electrolytic cell.

**B**. The combustion of methane can be utilised in a gas-fired plant or a fuel cell.

**C**. A fuel cell is the only type of cell that has a continuous supply of reactants.

**D**. The efficiency of a secondary cell will always be higher than that of a primary cell.

**Question 19**

Select the correct statement about natural gas.

**A**. Natural gas produces CO2 during combustion but no other harmful emissions.

**B**. Natural gas is not suitable for use in fuel cells.

**C**. Natural gas is a renewable form of energy as it can be replenished at a sustainable rate.

**D**. Natural gas produces CO2 and a range of other pollutants during combustion.

**Question 20**

Which of the following is an example of a systematic error?

**A**. A measuring cylinder is used for accurate volume measurements rather than a pipette.

**B**. The wick on an alcohol burner varies in height during the course of a trial.

**C**. A thermometer with a small air bubble causing each reading to be 1.5 ˚C above the real value.

**D**. The electrical power being delivered to a power supply has intermittent fluctuations.

**Section B: Short answer questions**

**Question 1** (8 marks)

Diagram

Description automatically generatedZinc alkaline batteries have had a long existence of powering everyday toys and devices. The technology of these batteries is still viable and scientists are regularly making further improvements to their design. The diagram below shows a typical modern version and its overall reaction. The voltage produced by the cell is 1.55 V.

**a.** Use thecircles provided to indicate the polarity of the cell. 1 mark

**b.** **i**. Use the overall equation provided to write the half-equations occurring below. Include states.

Anode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

Cathode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**ii.** The diagram provided shows the direction of ion flow in the cell during discharge and recharge.

Explain why potassium ions will flow away from the zinc electrode during discharge. 1 mark

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**c. i.** Write an equation for the reaction occurring during recharge. 1 mark

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**ii**. What voltage would you suggest be used to ensure recharging is successful? 1 mark

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**iii**. What is the oxidation state change occurring at the anode during recharging? 1 mark

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**d**. An important function of the membranes shown on the cell diagram is that they do not allow the flow

of any other ions than the ones shown. This is a very important feature for this particular cell. Examine

the half-equations you have written to suggest a reason for the need for limited ion flow in the cell.

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**Question 2** (9 marks)

The diagram below shows a potential CO2 capture system based on the action of a CO2 electrolytic cell. The cell reacts CO2 with water to produce carbon monoxide, CO, and hydrogen gas.

**A picture containing application

Description automatically generated**

**a. i**. Use the diagram to explain why scientists might be interested in this cell. 1 mark

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**ii**. Write a balanced equation to show how a car might be a source of CO2 gas. 1 mark

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**iii**. Write a balanced equation to show how a coal-fired power station might produce CO2. 1 mark

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**b**. The main products of the cell are CO, H2 and O2 gases.

**i**. Write a balanced half-equation for the production of CO and H2 from CO2. 1 mark

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**ii**. Which electrode will this reaction occur at? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**iii**. Write a balanced half-equation for the reaction of water to produce O2 gas in acid conditions.

1 mark

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**c**. Explain why the diagram features a solar panel array. 1 mark

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**d. i**. Give one use for the hydrogen gas produced in this cell. 1 mark

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**ii**. Write a thermochemical equation for the complete combustion of hydrogen gas. 1 mark

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**Question 3** (9 marks)

**a**. Determine the mass of ethanol that needs to undergo complete combustion to produce 1.00 MJ of

energy. 1 mark

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**b**. Determine the mass of CO2 formed from the complete combustion of 500 g of ethane. 3 marks

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**c**. Determine the volume of oxygen gas required at 400 0C and 220 kPa pressure for the complete

combustion of 50.0 g of butane. 3 marks

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**d**. Assuming petrol to be pure octane and a sample of E10 fuel to have exactly 10.0 % (m/m) ethanol,

determine the energy that can be obtained from a 100 g sample of E10 fuel. 2 marks

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**Question 4** (10 marks)

Diagram

Description automatically generatedA student is investigating the rate of a

reaction using the apparatus shown

here. One of the student’s graphs is shown

under the apparatus.

The chemical formula of marble chips is

CaCO3.

**a**. Write a balanced equation for

the reaction occurring. 1 mark

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Diagram

Description automatically generated \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**b**. Consider experiment 1 only.

**i**. Explain how the student is

tracking the rate of this reaction.

2 marks

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**ii**. Explain why the graph is not a straight line. 1 mark

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**c**. Compare the graph for experiment 2 with that of experiment 1. Could experiment 2 be a repeat of

experiment 1 but using HCl that has been diluted? Discuss the possibility of this being the change made.

3 marks

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**d**. Give a reason why it is difficult to get precise results when investigating the impact of surface area on

reaction rate in this experiment. 1 mark

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**e**. How will the pH change during a typical run of this experiment? Discuss. 2 marks

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**Question 5** (6 marks)

The diagram shows an energy profile diagram for a reaction with a catalyst and then without the catalyst.

Diagram

Description automatically generated

**a. i**. What is the impact of the catalyst on the magnitude of the activation energy? 1 mark

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**ii**. What is the impact of the catalyst on the magnitude of *∆H*? 1 mark

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**iii**. How does a catalyst work? 1 mark

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**b**. If the energy profile diagram refers to the reaction of methane in a fuel cell,

**i**. what is the value of *∆H*? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**ii**. Will the cell produce the same amount of energy without the catalyst as it will with the catalyst?

Explain your answer. 2 marks

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**Question 6** (10 marks)

Sulfur dioxide can react with oxygen gas to form SO3 gas. The equation for the reaction is

2SO2(g) + O2(g) ⇌ 2SO3(g) *∆H* = -ve

Graphical user interface, application, table, Excel

Description automatically generated

concentration

SO2

**a.** Equal amounts of SO2 and O2 are added to a 1.00 L reactor. The SO2 concentration is shown on the

graph above.

**i**. Use the graph provided to draw the concentrations of both O2 and SO3 up to the 3 minute

mark. 2 marks

**ii**. Use the graph to determine the value of *K*c for this reaction. 3 marks

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**b.** At the 3 minute mark, the temperature of the reactor is increased.

**i**. Use the graph to show the impact of the temperature change on the three gases present. 3 marks

**ii**. When equilibrium is re-established, how will the rate of the back reaction compare to what it was

just before the 3 minute mark? Explain your answer. 2 marks

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**Question 7** (6 marks)

A dilute solution of aluminium nitrate, Al(NO3)3 is electrolysed using graphite electrodes.

**a**. Write balanced half-equations for the reactions occurring. 2 marks

Anode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cathode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**b**. Calculate the volume of gas that could be collected from the cell at 25 ˚C and 130 kPa pressure if a

current of 4.20 amps is passed through the cell for 3.00 hours. 4 marks

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**End of Exam**

Mark section A: /20

Mark section B: /58

Total: /78