Year 12 Chemistry Test **NAME**_____

Topic 3: Using and Controlling Reactions

TOTAL MARKS: 79

1.

(a) State whether respiration absorbs or releases energy.

_____ (1)

(b) Write a balanced equation for the complete combustion of butane (C_4H_{10}).

_____ (2)

(c) The ΔH of combustion of butane is 2870 kJ mol^{-1}. Calculate the heat released per gram of butane.

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_____ (2)

(d) Calculate the mass of butane which must be burnt to heat 1.0 L of water to 100 °C from an initial temperature of 25 °C, if 50% of the heat from the butane is lost to the surroundings.

The specific heat capacity of water is 4.18 J g^{-1} $°K^{-1}$.

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_____ (3)

(e) Explain one undesirable environmental consequence of burning butane in air.

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_____ (2)

(f) State one advantage and one disadvantage (other than effects on the environment) of using carbon-based fuels as sources of heat energy

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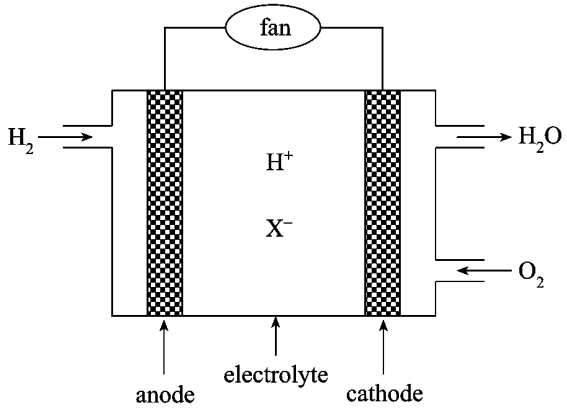
_____ (2)

2. Fuel cells use hydrogen as a fuel to produce energy. A diagram of a fuel cell is shown below:



(a) Write the half-equation for the reaction at the cathode.

_____ (2)

(b) Identify whether the anode or cathode is the negative electrode.

_____ (1)

(c) On the diagram above, draw an arrow to indicate the direction in which the negative ion, X−, moves. (1)

(d) On the diagram above, draw an arrow to indicate the direction in which electrons flow through the fan. (1)

(e) State one advantage for the consumer of using fuel cells rather than other galvanic cells to produce energy.

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_____ (1)

(f) State one disadvantage of the fuel cell compared with ordinary galvanic cells.

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_____ (1)

3. Rechargeable batteries act as galvanic cells when discharging.
Half-equations for the discharging of one particular rechargeable battery are shown below:

$2NiOOH + 2H_2O + 2e^- \rightarrow 2Ni(OH)_2 + 2OH^-$

$Fe + 2OH^- \rightarrow Fe(OH)_2 + 2e^-$

(a) Identify the type of cell that operates during the recharging process.

_____ (1)

(b) Identify the products formed at the cathode during the recharging process.

_____ (1)

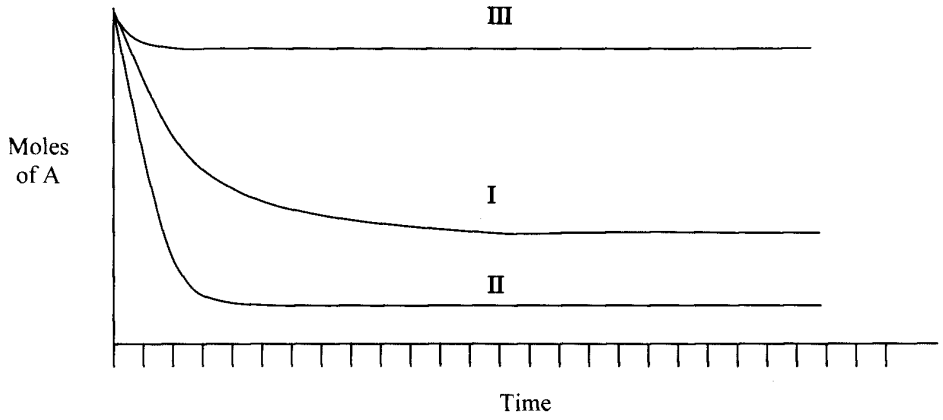
4. Chemicals A and B react to form a dynamic equilibrium mixture with chemical Z according to the equation:

$$A_{(g)} + B_{(g)} \rightleftharpoons Z_{(g)} \quad \Delta H = -101 \text{ kJ mol}^{-1}$$

(a) State what it means for the chemicals to be in dynamic equilibrium.

_____ (1)

(b) Graph I on the axes below shows the change in the moles of A, when equal moles of A and B were allowed to reach dynamic equilibrium in a closed vessel at a particular temperature and pressure.
The experiment was repeated to obtain graphs II and III, in each case only changing one condition.



State and explain which graph shows the experiment which used the following different condition:

(i) A higher temperature

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_____ (3)

(ii) A higher pressure

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_____

_____ (3)

(c) State and explain the effect of a suitable catalyst on the reaction.

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_____ (3)

5. Consider the equilibrium mixture below:

$$2SO_{2\,(g)} + O_{2(g)} \rightleftharpoons 2SO_{3\,(g)} \qquad \Delta H = -198 \text{ kJ mol}^{-1}$$

(a) Write the equilibrium expression for the reaction.

(1)

(b) 1.0 moles of each of the three gases were mixed and allowed to reach equilibrium in a closed 2.0 litre vessel.
If 0.80 mol of SO_2 changed to SO_3 in reaching equilibrium, calculate the concentration of O_2 at equilibrium.

(4)

(c) State the effect increasing the temperature will have on the value of K_c.

_____ (1)

(d) State and explain whether high or low pressure conditions should be used to maximise yield of SO_3.

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_____ (3)

6.

(a) State and explain which of silver or aluminium is more likely to occur uncombined in nature.

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_____ (3)

(b) State the four stages in the production of a metal from its ore.

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_____ (4)

(c) Explain why zinc can be obtained by reduction using carbon whereas this is not possible for aluminium.

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_____ (2)

(d) Describe, with the aid of one half equation, the likely method of reduction of potassium from KCl.

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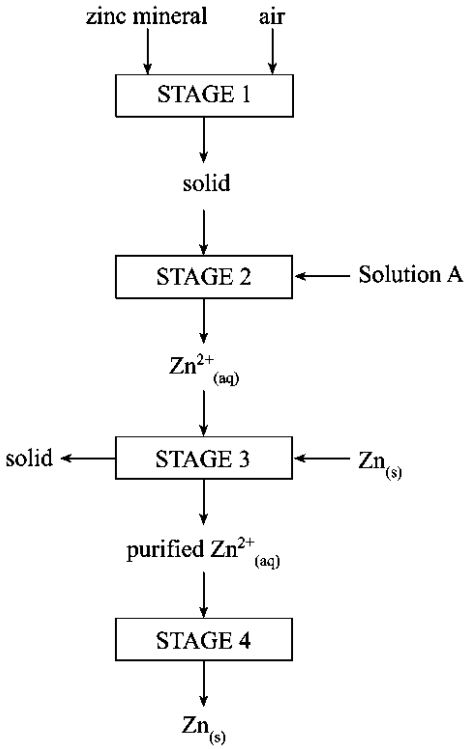
_____ (3)

7. The conversion of zinc mineral into zinc metal is summarised in the flow chart below:



(a) Write the formula of the zinc mineral that is commonly used to produce zinc.

_____ (1)

(b) Identify the component of air that is involved in Stage 1.

_____ (1)

(c) Identify the reactant shown as Solution A.

_____ (1)

(d) In Stage 4 the solution containing zinc ions is electrolysed and zinc is produced at one of the electrodes.

(i) Write a half-equation for the electrode reaction in which zinc is produced.

(2)

(ii) State the electrode at which zinc is produced.

_____ (1)

(iii) State how the final product of Stage 4 will differ if Stage 3 is omitted.

_____ (1)

(e) Explain why reduction using electrolysis of a solution is preferable to electrolysis of a melt.

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_____ (2)

8. When solid ammonium nitrate (NH_4NO_3) is dissolved in water, a noticeable cooling is observed.

(a) State whether the reaction is exothermic or endothermic.

_____ (1)

(b) If the enthalpy change involves 26.0 kJ mol^{-1} of energy, write a thermochemical equation for this reaction.

_____ (4)

(c) Sketch an energy profile graph for this reaction on the axes below. Label ΔH and the activation energy.

(3)

(d) An experiment is conducted to investigate the temperature change caused by dissolving ammonium nitrate, following the procedure below:

1. Fill a beaker with 100mL of water, and place a thermometer in it.
2. Measure 4g of NH_4NO_3 into another beaker.
3. Tip the NH_4NO_3 into the water, and begin timing with a stopwatch.
4. After 2 minutes, record the temperature of the water in the 'Final temperature' column.
5. Wait for the water temperature to increase to at least 18°C.
6. Repeat steps 3 to 5 for 8g, 12g, 16g, and 20g of NH_4NO_3.

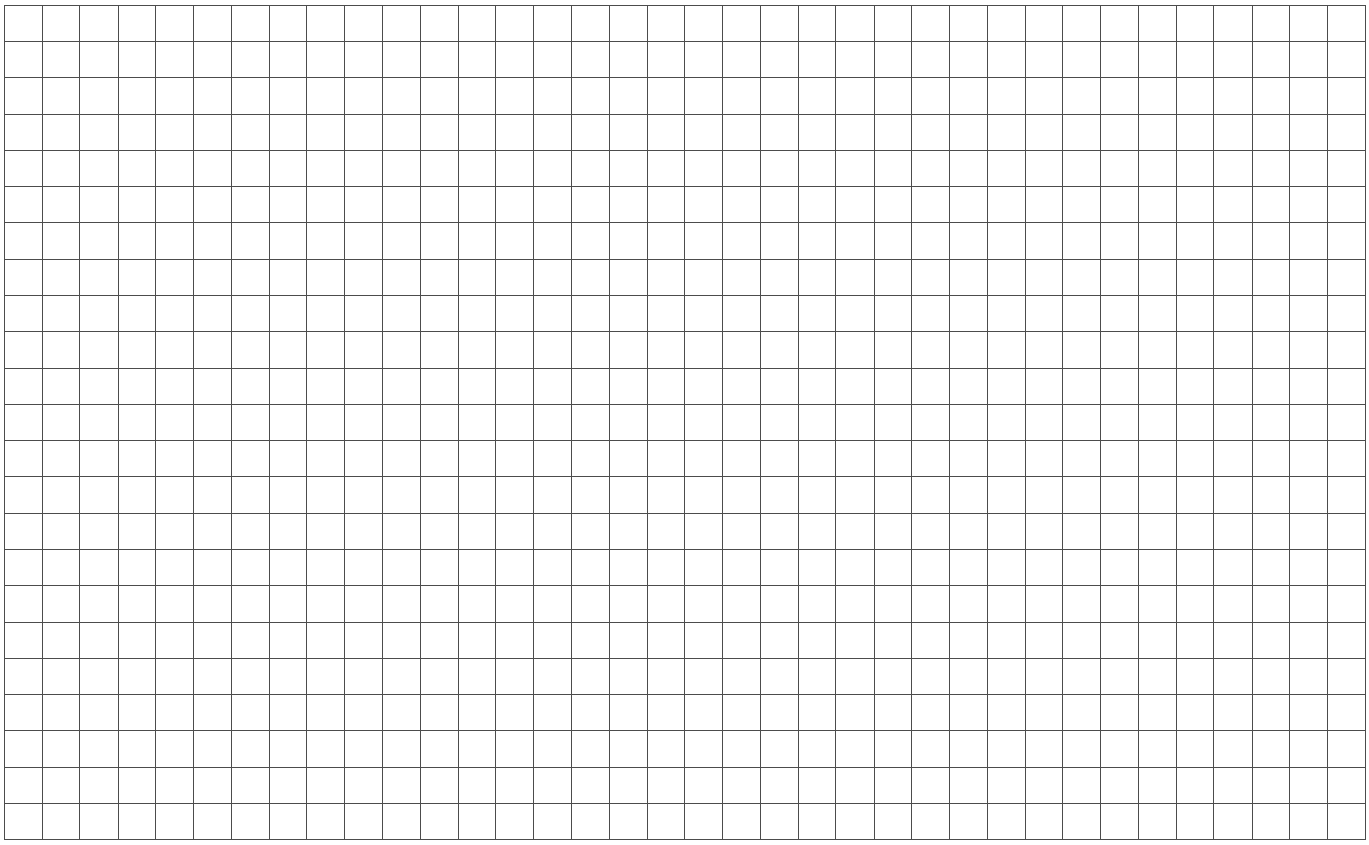
The results of the experiment are shown below:

Mass of NH_4NO_3 (g)	Initial temperature (°C)	Final temperature (°C)	Temperature change (°C)
4.0	25	22	
8.0	23	18	
12	19	11	
16	18	8	
20	19	6	

(i) Complete the table above by calculating the temperature change for each mass of NH_4NO_3.

(2)

(ii) Plot a graph of temperature change against mass of NH_4NO_3 on the grid below. Draw a line of best fit.



(4)

(iii) If the hypothesis for this experiment was "The temperature change caused by dissolving ammonium nitrate in water is proportional to the mass of ammonium nitrate", write a conclusion.

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_____ (2)

(iv) Suggest and explain one improvement to the procedure.

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_____ (2)