**Student Number:**_____

**Hurlstone Agricultural High School 2004**
**HSC Assessment Task 3**
**Practical and Process Exam**

**Marks will be allocated for your working**
The value for each question is at the end of the question in brackets.

# Question 1 - 6 marks

The reaction for the synthesis of ammonia is

$$N_{2(g)} + 3H_{2(g)} \leftrightarrow 2\ NH_{3(g)}$$

$\Delta H = -92\ kJ.mol^{-1}$
$K = 0.10$ at 500K (ie $227^0C$)

(a) Write the equilibrium expression for this reaction. (0.5 )

(b) (i) If at equilibrium, the concentration of nitrogen is 1 $mol.L^{-1}$ and the concentration of hydrogen is 2 $mol.L^{-1}$, find the equilibrium concentration of the ammonia at 500K. (1)

(ii) Does the equilibrium lie to the right or the left in this reaction at 500K? Justify your answer. (1)

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(c) What would be the effect of the following changes on the system:

(i) reducing the concentration of ammonia (by removing it from the reacting vessel)? (0.5)

(ii) increase the pressure? (0.5)

(d) What effect would increasing the temperature have on the value of the equilibrium constant for this reaction? (0.5)

(e) In order to synthesise ammonia the above reaction would be carried out by reacting nitrogen and hydrogen together with no ammonia initially present. Suppose that instead, only ammonia were to be placed into the reacting vessel under the same conditions. How would the equilibrium concentrations of the three substances be affected if the reaction were to be carried out in this way? (1)

(f) This reaction is usually carried out with a catalyst such as osmium.
What effect would the catalyst have on:

(i) The rate of the reverse reaction? (0.5)

(ii) The equilibrium concentrations of the reactants? (0.5)

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# Question 2 - 5 marks

Oxygen occurs in two forms, called allotropes. The most common allotrope of oxygen is oxygen gas, which occurs as diatomic molecules ($O_2$). Ozone ($O_3$ ) is an allotrope of oxygen that contains three oxygen atoms. Oxygen gas and ozone contain the same oxygen atoms, but they are arranged differently, so that the two substances have different physical properties. Oxygen also occurs as oxygen free radicals. Table 10.1 compares these three forms of oxygen.

Table 10.1 below will assist you in answering the following questions.

(a) The single bond in ozone is described as a coordinate covalent bond. Another example of a coordinate covalent bond occurs in the formation of carbon monoxide.

**:** C **::** O → **:** C **::** O **:**

Describe what is meant by a coordinate covalent bond. (0.5)

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(b) Use a diagram to show the formation of a coordinate covalent bond in the formation of nitrous oxide (dinitrogen monoxide – $N_2O$). (1)

(c) A free radical can be described as a reactive particle with unpaired electrons. Justify the description of an atom of chlorine as a chlorine free radical. Support your answer with an appropriate diagram. (1)

(d) Ozone is formed naturally by the action of ultraviolet light on oxygen molecules at high altitudes. In the presence of lightning, UV radiation or a spark, oxygen molecules break up, forming oxygen atoms which then react with oxygen molecules to form ozone. Construct two equations to illustrate this process (include states). (2)

(e) If the density of oxygen gas is 1.331 $g.L^{-1}$, estimate the density of ozone at the same temperature and pressure. Account for your answer. (1.5)

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# Question 3 - 13 marks

Sodium is an essential element in our diets. However, the amount of sodium present in some foods is often much higher than levels recommended by doctors .

A sauce was analysed using atomic absorption spectroscopy to determine the sodium content.

A 25.00 mL sample of the sample of the sauce was diluted to 1.00 L with deionised water.

Four aqueous samples of known NaCl concentration were also prepared as standard solutions. The absorbances of the four standard solutions and the diluted sauce solution were measured. The results are given in the table below.

| **concentration of $Na^+_{(aq)}$ $mg.L^{-1}$** | **absorbance** |
|---|---|
| 100 | 0.051 |
| 200 | 0.100 |
| 300 | 0.149 |
| 400 | 0.199 |
| diluted sauce | 0.185 |

(a) Use the above data for the $Na^+_{(aq)}$ standards to plot a calibration line on the graph below. (1)

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(b) Use your calibration graph to determine the sodium ion concentration in the diluted sample of the sauce and in the original sauce. Enter your answers in the table below. (2)

| Concentration of $Na^+(aq)$ in diluted solution of sauce in $mg.L^{-1}$ | Concentration of $Na^+(aq)$ in original (undiluted) sauce in $mg.L^{-1}$ |
|---|---|
| | |

(c) (i) What important assumption must you make in order to calculate the NaCl content of the sauce from the $Na^+$ concentration? (1)

(ii) Calculate the concentration of NaCl in the original (undiluted) sauce in $g.L^{-1}$. (2)

(iii) The maximum recommended daily NaCl intake for a healthy adult is 2.5 g. What percentage of a maximum daily recommended intake would be consumed by a person who eats 10 mL of the original (undiluted) sauce? (2)

(d) Why is it that AAS will measure only the sodium ion concentration in your sample and not the concentration of some other substance or substances as well? (1)

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(e) Identify :

(i) the scientist who developed AAS. (0.5)

_____

(ii) two uses of AAS. (1)

_____

_____

_____

(iii) two advantages of AAS over gravimetric analysis. (1)

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(iv) one disadvantage of AAS over gravimetric analysis. (0.5)

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