**YEAR 12 CHEMISTRY**

**CHEMICAL SYNTHESIS TOPIC TEST**

**Term 3, 2016**

**NAME: ………………………………………………………….**

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|  | MARKS AVAILABLE | MARK |
| MULTIPLE CHOICE QUESTIONS | 15 |  |
| SHORT  ANSWER QUESTIONS | 35 |  |
| TOTAL | 50 |  |

**MULTIPLE CHOICE SECTION**

1. Assuming equilibrium is reached in the reaction:

2 CO(g) + O2(g)  2 CO2(g) ∆ = - 565 kJ

A greater yield of carbon dioxide will be best obtained by:

a) raising the temperature and pressure.

b) lowering the temperature and pressure.

c) raising the temperature and lowering the pressure.

d) lowering the temperature and raising the pressure.

e) adding a catalyst and raising the pressure.

2. In the manufacture of an important organic solvent, toluene, C7H8(g), from methyl cyclohexane, C7H14(g), the following occurs:

C7H14(g)  C7H8(g) + 3 H2(g)

Calorimetric studies show that the forward reaction is endothermic. Based on this information, which one, if any, of the following additional changes would increase the molar concentration of C7H8(g) at equilibrium ?

a) Increase the pressure at constant temperature.

b) Increase the temperature.

c) Decrease the concentration of C7H14(g).

d) Add a catalyst.

e) None of the above.

3. The Haber process is based on the reaction between nitrogen gas and hydrogen gas to form ammonia gas, as shown by the following equation:

N2(g) + 3 H2(g)  2 NH3(g) + Heat

The reaction conditions are 400°C to 500°C and 350 atmospheres pressure in the presence of a catalyst. Which of the following statements is TRUE ?

a) The equilibrium amount of NH3(g) is increased as the temperature is further increased.

b) The equilibrium amount of NH3(g) is increased as the pressure is further increased.

c) The equilibrium amount of NH3(g) is increased as additional catalyst is added.

d) The rate of the reaction is decreased as the temperature is further increased.

4. Equilibrium is established rapidly at 500°C for the exothermic reaction:

X(s) + Y(g)  Z(s)

However, the yield of **Z** is low.

In order to increase the yield of **Z**, which one of the following modifications should **NOT** be used ?

a) Raising the temperature to 700°C.

b) Increasing the amount of Y(g).

c) Raising the pressure.

d) Halving the volume of the system.

e) Adding a catalyst.

5. A laboratory technician was asked to get the reagents for preparing the compound with the general formula CH3CH2COOCH2CH3. Which of the following pairs of reagents should the laboratory technician obtain ?

a) CH3CH2COOH and CH3CH3

b) CH3CH2COOH and CH3CH2OH

d) CH3COOH and CH3CH2OH

e) CH3COOH and CH3CH2CH2OH

6. The reagents used in Q5 above would, in turn, have been synthesized from a pair of simpler compounds. The identities of these compounds would **most likely** have been

a) ethane and propane.

b) ethene and propanoic acid.

c) propene and ethene.

d) propanol and ethanoic acid.

7. The most important raw material in the polymer industry is:

a) starch.

b) cellulose.

c) petroleum.

d) plant oils.

8. The two main types of polymerisation reactions are addition and condensation. Which of the following polymers results from condensation polymerisation ?

a) Nylon.

b) Polythene.

c) Polyvinyl chloride.

d) Polystyrene.

9. Which of the following compounds would be an effective soap ?

a) CH3(CH2)14COOH

b) CH3COONa

c) [CH3(CH2)14COO]2Mg

d) CH3(CH2)14COONa

10. Synthetic detergents may be considered superior to soaps because:

a) their calcium and magnesium salts are soluble in water.

b) only detergents are biodegradable.

c) they can easily be manufactured by saponification of fats.

d) they oxidise the dirt and grease before removing them.

11.

**SHORT ANSWER SECTION**

1. A solution containing 1.42 g of phosphoric acid is added to 2.60 g of sodium carbonate and the expected acid-carbonate reaction occurs.

(a) Write a balanced equation for the above reaction.

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(b) Calculate the number of moles of each reactant.

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(c) Which is the limiting reagent? Show your reasoning.

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(d) Calculate the mass of salt that could be recovered from the resulting mixture.

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(e) If the experiment was conducted at 25o C and 103.7 kPa what volume of carbon dioxide was produced?

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2. The Ostwald Process is the most widely used method for making nitric acid. In one step of the process ammonia is burnt in air at 900ºC, at atmospheric pressure, and in the presence of a platinum/rhodium catalyst. The equation for the process is

4 NH3 (g) + 5 O2 (g) 🡪 4 NO (g) + 6 H2O (g) H = -905 kJ

The system eventually comes to equilibrium. Explain how each of the following factors affects **both** the **rate of formation** of nitrogen monoxide and the **yield** of nitrogen monoxide.

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|  | Explanation in terms of both rate of reaction and yield. |
| Why is a temperature of 900ºC used rather than a higher or lower temperature? |  |
| Why is a pressure of 1 atmosphere used rather than a higher or lower pressure? |  |
| Why is a catalyst used? |  |

3. Ammonium nitrate is an important fertilizer and is made by reacting ammonia solution with nitric acid and the salt formed dried to a certain extent for commercial purposes. A chemical supply factory wants to create 15.0 tonnes of NH4NO3 per day. The reaction is

N2 + 3H2 → 2NH3

NH3(aq) + HNO3 → NH4NO3

a) If a factory is capable of making the ammonia on site from hydrogen and nitrogen gases according to the equation N2 + 3 H2 → 2 NH3 then how many tonnes of nitrogen gas will be consumed per day? [3 marks]

b) What volume of N2 gas measured at 25oC and 101.3 kPa would be consumed per day? [2 marks]

c) The nitric acid used in the process is 4.00M, what volume of this acid, in kilolitres, is required for full production in one day? [3 marks]

d) The conversion of nitrogen gas to ammonia is never 100%. If the yield at that step for ammonia is actually 87% then what ***mass*** of nitrogen is required for full production in one day? [2 marks]

4. The Ostwald Process is a chemical process used for producing nitric acid. In the first reaction, ammonia is oxidised by heating with oxygen in the presence of a platinum catalyst.

4 NH3(g) + 5 O2 🡪 4 NO(g) + 6 H2O(g) ∆H = -951 kJ mol-1

In the second reaction, Nitric oxide is converted into Nitrogen dioxide.

2 NO(g) + O2(g) 🡪 2 NO2(g) ∆H = -115 kJ mol-1

And finally, the Nitrogen dioxide is absorbed by water to yield the Nitric acid. The nitric oxide product is recycled.

3 NO2(g) + H2O(l) 🡪 2HNO3(aq) + NO(g) ∆H = -117 kJ mol-1

In the first step, a side reaction takes place which can reduce the percentage yield of nitric acid. The ammonia is converted into nitrogen gas. This equation is shown below.

4 NH3(g) + 6NO(g) 🡪 5 N2(g) + 6 H2O(g)

1. Calculate the mass of nitric acid produced if 2.80 tonnes of ammonia is reacted. The efficiency of the process is 95.1% (5 marks)

(b) Mary theorises in a chemistry class that the optimum conditions for the first reaction would be a very high pressure and temperature. Explain, using the collision theory, why this is, or is not, so. (3 marks)



























(c) The remainder of the ammonia is consumed in the side reaction shown. Calculate the pressure of steam produced in the side reaction if the reaction takes place at 462oC and the volume of nitrogen collected was 58.2kL. (4 marks)

5. The production of photochemical smog is a complicated process involving a number of steps. One part of the process involves the production of ozone (O3) by the following sequence of reactions.

2 NO (g) + O2 (g) 🡪 2 NO2 (g)

2 NO2 (g) + 2 O2 (g) 🡪 2 NO (g) + 2 O3 (g)

Justify the statement that nitrogen monoxide (NO (g)) acts as a **catalyst** in the production of ozone. [2]

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