SCH4U1 Energy Quiz Review Name________________________

1. Calculate the enthalpy change of the following reaction between nitrogen gas and oxygen gas, given thermochemical equations (1), (2), and (3) and using the indirect method (Hess's Law). (5 marks)

$$2N_{2(g)} + 5O_{2(g)} \rightarrow 2N_2O_{5(g)}$$

−1 x (1)	$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$	$\Delta H° = -572$ kJ × −1
−2 x (2)	$N_2O_{5(g)} + H_2O_{(l)} \rightarrow 2HNO_{3(aq)}$	$\Delta H° = -77$ kJ × −2
4 x (3)	$1/2\ N_{2(g)} + 3/2O_{2(g)} + 1/2H_{2(g)} \rightarrow HNO_{3(aq)}$	$\Delta H° = -174$ kJ × 4

(2) $4HNO_3 \rightarrow 2N_2O_5 + \cancel{2H_2O}$ $\Delta H = 144$

(3) $2N_2 + \cancel{6}\,5\,O_2 + 2H_2 \rightarrow \cancel{4HNO_3}$ $\Delta H = -696$

(1) $\cancel{2H_2O} \rightarrow 2H_2 + \cancel{O_2}$ $\Delta H = 572$

$2N_2 + 5O_2 \rightarrow 2N_2O_5$ $\Delta H = 20$ kJ

2. Use the following equation to answer the questions below.

$$CH_3OH_{(l)} + 3/2\ O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

(a) Calculate the enthalpy change in kJ of the complete combustion of one mole of methanol, using enthalpies of formation from the table and the direct method. (4 marks)
(b) Is this reaction endothermic or exothermic? (1 mark)
(c) Write the thermochemical equation (1 mark)
(c) How much energy is released in when 125 g of methanol undergoes complete combustion. (Bonus)

a) $\Delta H = \sum \Delta H(\text{products}) - \sum \Delta H(\text{reactants})$
$= (CO_{2(g)} + 2(H_2O_{(g)})) - (CH_3OH + 3/2(O_2))$
$= (-393.509 + 2(-241.83)) - (-238.4 + \frac{3}{2}(0))$
$= -877.169 + 238.4 = -638.769$ kJ/mol CH_3OH

b) exothermic

c) $CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O + 638.8$ kJ

d) $n = \frac{125g}{32.042} = 0.39$ mol
$\therefore 0.39 \times -638.8 = -249.2$ kJ

3. A metal sample with a mass of 80 g at 90°C is placed into 0.5 kg of water at 25°C. If the final temperature is 29.5°C, what is the specific heat capacity of the metal sample? (Calculate the heat gained by the water and then assume that the heat gained by the water is equal to the heat lost by the metal.) $c_w = 4.184$ J/g·°C (5 marks)

metal
$m = 80g$
$\Delta T = (29.5 - 90)$

H_2O
$m = 0.5kg = 500g$
$c = 4.184$
$\Delta T = (29.5 - 25)$

$Q_l^{\text{metal}} = -Q_g^{H_2O}$
$m \cdot c \cdot \Delta t = -(m \cdot c \cdot \Delta t)$
$80(c)(29.5 - 90) = -(500(4.184)(29.5 - 25))$
$\frac{-4840c}{-4840} = \frac{-9414}{-4840}$
$c = 1.945$ J/g°C

3. The standard heats of formation of HCl (g) and HBr (g) are -92.0 kJ/mol and -36.4 kJ/mol respectively. Using this information, calculate ΔH for the following reaction:

$$Cl_{2\,(g)} + 2\ HBr_{(g)} \rightarrow 2\ HCl_{(g)} + Br_{2\,(g)}$$

ΔH for HBr(g) = −36.2 kJ/mol

$\Delta H = \sum \Delta H(\text{products}) - \sum \Delta H(\text{reactants})$
$= (2(-92.31) + 0) - (0 + 2(-36.2))$
$= -184.62 + 72.4$
$= -112.22$ kJ