Energetics Test

Name: _____

1. Which combination of ionic charge and ionic radius give the largest lattice enthalpy for an ionic compound?

	Ionic charge	Ionic radius
A.	high	large
B.	high	small
C.	low	small
D.	low	large

(1)

2. What is ΔH for the reaction below in kJ?

$$CS_2(g) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)$$

[ΔH_f / kJ mol^{-1}: $CS_2(g)$ 110, $CO_2(g)$ – 390, $SO_2(g)$ – 290]

A. −570

B. −790

C. −860

D. -1080

(1)

3. What is the energy change (in kJ) when the temperature of 20 g of water increases by 10°C?

A. $20 \times 10 \times 4.18$

B. $20 \times 283 \times 4.18$

C. $\frac{20 \times 10 \times 4.18}{1000}$

D. $\frac{20 \times 283 \times 4.18}{1000}$

(1)

4. The lattice enthalpy values for lithium fluoride and calcium fluoride are shown below.

$LiF(s) \quad \Delta H^{\ominus} = +1022 \text{ kJ mol}^{-1}$
$CaF_2(s) \quad \Delta H^{\ominus} = +2602 \text{ kJ mol}^{-1}$

Which of the following statements help(s) to explain why the value for lithium fluoride is less than that for calcium fluoride?

I. The ionic radius of lithium is less than that of calcium.

II. The ionic charge of lithium is less than that of calcium.

A. I only

B. II only

C. I and II

D. Neither I nor II

(1)

5. Which reaction has the most negative $\Delta H^{\ominus}$ value?

A. $LiF(s) \rightarrow Li^{+}(g) + F^{-}(g)$

B. $Li^{+}(g) + F^{-}(g) \rightarrow LiF(s)$

C. $NaCl(s) \rightarrow Na^{+}(g) + Cl^{-}(g)$

D. $Na^{+}(g) + Cl^{-}(g) \rightarrow NaCl(s)$

(1)

6. Some chlorine gas is placed in a flask of fixed volume at room temperature. Which change will cause a decrease in entropy?

A. adding a small amount of hydrogen

B. adding a small amount of chlorine

C. cooling the flask

D. exposing the flask to sunlight

(1)

7. Which type of reaction is referred to in the definition of *standard enthalpy change of formation*?

A. the formation of a compound from its elements

B. the formation of a crystal from its ions

C. the formation of a molecule from its atoms

D. the formation of a compound from other compounds

(1)

Short Answer

1. (a) For the process

$$C_6H_6(l) \rightarrow C_6H_6(s)$$

$\Delta H^{\ominus} = -9.83$ kJ mol^{-1} and $\Delta S^{\ominus} = -35.2$J K^{-1} mol^{-1}. Calculate the temperature (in °C) at which $\Delta G = 0$ for the above process and explain the significance of this temperature.

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(Total 3 marks)

2. The standard enthalpy change for the combustion of phenol, $C_6H_5OH(s)$, is -3050 kJ mol^{-1} at 298 K.

(a) Write an equation for the complete combustion of phenol.

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(1)

(b) The standard enthalpy changes of formation of carbon dioxide, $CO_2(g)$, and of water, $H_2O(l)$, are -394 kJ mol^{-1} and -286 kJ mol^{-1} respectively.

Calculate the standard enthalpy change of formation of phenol, $C_6H_5OH(s)$.

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(3)

(c) The standard entropy change of formation, $\Delta S^{\ominus}$, of phenol, $C_6H_5OH(s)$ at 298 K is -385 J K^{-1} mol^{-1}. Calculate the standard free energy change of formation, $\Delta G^{\ominus}$, of phenol at 298 K.

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(3)

(d) Determine whether the reaction is spontaneous at 298 K, and give a reason.

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(2)

(e) Predict the effect, if any, of an increase in temperature on the spontaneity of this reaction.

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(2)

(Total 11 marks)

3. Explain in terms of $\Delta G^{\ominus}$, why a reaction for which both $\Delta H^{\ominus}$ and $\Delta S^{\ominus}$ are positive is sometimes spontaneous and sometimes not.

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(Total 4 marks)

4. Consider the following reaction.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

(i) Using the average bond enthalpy values in Table 10 of the Data Booklet, calculate the standard enthalpy change for this reaction.

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(4)

(ii) The absolute entropy values, S, at 300 K for $N_2(g)$, $H_3(g)$ and $NH_3(g)$ are 193, 131 and 192 JK^{-1} mol^{-1} respectively. Calculate $\Delta S^{\ominus}$ for the reaction and explain the sign of $\Delta S^{\ominus}$.

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(3)

(iii) Calculate $\Delta G^{\ominus}$ for the reaction at 300 K.

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(1)

(iv) If the ammonia were produced as a **liquid** and not as a gas, state and explain the effect this would have on the value of $\Delta H^{\ominus}$ for the reaction.

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(2)

(Total 10 marks)

5. Define the term *standard enthalpy of formation*, and write the equation for the standard enthalpy of formation of ethanol.

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(Total 5 marks)