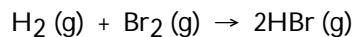Exam

Name_____
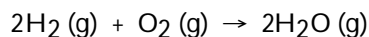
MULTIPLE CHOICE.  Choose the one alternative that best completes the statement or answers the question.

1) The value of $\Delta H°$ for the reaction below is -72 kJ. _____ kJ of heat are released when 1.0 mol    1) _____
of HBr is formed in this reaction.

$H_2$ (g) + $Br_2$ (g) → 2HBr (g)
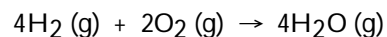
A) 0.44              B) -72              C) 72              D) 144              E) 36

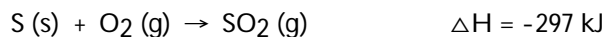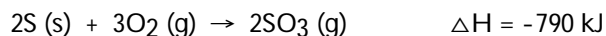2) The enthalpy change for the following reaction is -483.6 kJ:                                                    2) _____

$2H_2$ (g) + $O_2$ (g) → $2H_2O$ (g)

Therefore, the enthalpy change for the following reaction is _____ kJ:

$4H_2$ (g) + $2O_2$ (g) → $4H_2O$ (g)

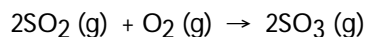A) 483.6              B) 967.2              C) -483.6              D) $2.34 \times 10^5$              E) -967.2

3) Calculate $\Delta H°$ (in kJ) for reaction 3.                                                                  3) _____

$2S$ (s) + $3O_2$ (g) → $2SO_3$ (g)          $\Delta H$ = -790 kJ
$S$ (s) + $O_2$ (g) → $SO_2$ (g)              $\Delta H$ = -297 kJ

the enthalpy of the reaction in which sulfur dioxide is oxidized to sulfur trioxide

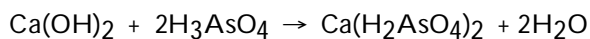$2SO_2$ (g) + $O_2$ (g) → $2SO_3$ (g)

is _____ kJ.

A) 196              B) -543              C) -1384              D) -196              E) 1087

1

4) Given the data in the table below, $\Delta H°_{rxn}$ for the reaction

$$Ca(OH)_2 + 2H_3AsO_4 \rightarrow Ca(H_2AsO_4)_2 + 2H_2O$$

is _____ kJ.

| Substance | $\Delta H_f°$ (kJ/mol) |
|---|---|
| $Ca(OH)_2$ | -986.6 |
| $H_3AsO_4$ | -900.4 |
| $Ca(H_2AsO_4)_2$ | -2346.0 |
| $H_2O$ | -285.9 |

A) -744.9          B) -4519          C) -130.4          D) -76.4          E) -4219

5) Which of the following is a statement of the first law of thermodynamics?

A) A negative $\Delta H$ corresponds to an exothermic process.

B) $\Delta E = E_{final} - E_{initial}$

C) Energy lost by the system must be gained by the surroundings.

D) 1 cal = 4.184 J (exactly)

E) $E_k = \frac{1}{2}mv^2$

6) For a given process at constant pressure, $\Delta H$ is negative. This means that the process is _____.

A) endothermic

B) energy

C) a state function

D) equithermic

E) exothermic

7) In the reaction below, $\Delta H_f°$ is zero for _____.

$$Ni\ (s) + 2CO\ (g) + 2PF_3\ (g) \rightarrow Ni(CO)_2(PF_3)_2\ (l)$$
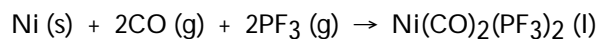
A) CO (g)

B) $Ni(CO)_2(PF_3)_2$ (l)

C) Ni (s)

D) $PF_3$ (g)

E) both CO (g) and $PF_3$ (g)

4) _____

5) _____

6) _____

7) _____

*Use the table below to answer the questions that follow.*

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

| Substance | $\Delta H°_f$ (kJ/mol) | $\Delta G°_f$ (kJ/mol) | S (J/K-mol) |
|---|---|---|---|
| **Calcium** | | | |
| Ca (s) | 0 | 0 | 41.4 |
| $CaCl_2$ (s) | -795.8 | -748.1 | 104.6 |
| $Ca_2^+$ (aq) | 226.7 | 209.2 | 200.8 |
| | | | |
| **Chlorine** | | | |
| $Cl_2$ (g) | 0 | 0 | 222.96 |
| Cl- (aq) | -167.2 | -131.2 | 56.5 |
| | | | |
| **Oxygen** | | | |
| $O_2$ (g) | 0 | 0 | 205.0 |
| $H_2O$ (l) | -285.83 | -237.13 | 69.91 |
| | | | |
| **Phosphorus** | | | |
| $P_2$ (g) | 144.3 | 103.7 | 218.1 |
| $PCl_3$ (g) | -288.1 | -269.6 | 311.7 |
| $POCl_3$ (g) | -542.2 | -502.5 | 325 |
| | | | |
| **Sulfur** | | | |
| S (s, rhombic) | 0 | 0 | 31.88 |
| $SO_2$(g) | -269.9 | -300.4 | 248.5 |
| $SO_3$(g) | -395.2 | -370.4 | 256.2 |

8) The value of $\Delta S°$ for the oxidation of solid elemental sulfur to gaseous sulfur trioxide,          8) _____

$$2S \text{ (s, rhombic)} + 3O_2(g) \rightarrow 2SO_3 \text{ (g)}$$
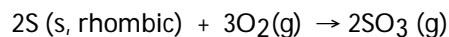
is _____ J/K.

   A) +19.3          B) +493.1          C) -19.3          D) -493.1          E) -166.4


9) The value of $\Delta H°$ for the oxidation of solid elemental sulfur to gaseous sulfur trioxide,          9) _____

$$2S \text{ (s, rhombic)} + 3O_2(g) \rightarrow 2SO_3 \text{ (g)}$$
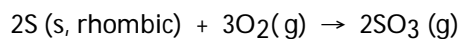
is _____ kJ/mol.

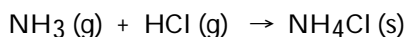   A) +395.2          B) -790.4          C) +105.1          D) -395.2          E) +790.4

10) The value of $\Delta G°$ at 25 °C for the oxidation of solid elemental sulfur to gaseous sulfur dioxide,     10) _____

$$S \text{ (s, rhombic)} + O_2(g) \rightarrow SO_2 \text{ (g)}$$
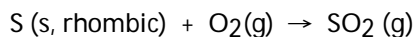
is _____ kJ/mol.

A) +300.4          B) +395.2          C) -269.9          D) -300.4          E) +269.9

11) Consider the reaction:     11) _____

$$NH_3 \text{ (g)} + HCl \text{ (g)} \rightarrow NH_4Cl \text{ (s)}$$

Given the following table of thermodynamic data at 298 °K:

| Substance | $\Delta H_f°$ (kJ/mol) | $S°$ (J/K · mol) |
|-----------|------------------------|------------------|
| $NH_3$ (g) | -46.19 | 192.5 |
| $HCl$ (g) | -92.30 | 186.69 |
| $NH_4Cl$ (s) | -314.4 | 94.6 |

The value of K for the reaction at 25 °C is _____.

A) $1.1 \times 10^{-16}$

B) $8.4 \times 10^4$

C) $9.3 \times 10^{15}$

D) 150

E) $1.4 \times 10^8$

12) A reaction that is spontaneous as written _____.     12) _____

A) will proceed without outside intervention

B) is very slow

C) has an equilibrium position that lies far to the left

D) is very rapid

E) is also spontaneous in the reverse direction

13) Which one of the following is always positive when a spontaneous process occurs?     13) _____

A) $\Delta H_{surroundings}$

B) $\Delta S_{system}$

C) $\Delta S_{surroundings}$

D) $\Delta H_{universe}$

E) $\Delta S_{universe}$