Name: _____
Period: ___

Heats of Reactions

(1) Classify each reaction as endothermic or exothermic and determine ΔH.

____ (a) Br_2 (l) + CH_4 (g) + 2.7 kJ/mol → CH_3Br (l) + HBr (g); ΔH = _____ kJ/mol

____ (b) H_2 (g) + O_2 (g) → $2H_2O$ (g) + 484 kJ/mol; ΔH =_____ kJ/mol

____ (c) $2C_4H_{10}$ (g) + $13O_2$ (g) → $8CO_2$ (g) + $10H_2O$ (g) + 5316.8 kJ/mol; ΔH = _____ kJ/mol

____ (d) N_2COH_4 (aq) + H_2O (l) + 28.3 kJ/mol→ $8CO_2$ (aq) + $2NH_3$ (aq); ΔH = _____ kJ/mol

(2) Classify each reaction as endothermic or exothermic and rewrite the equation to include ΔH.

____ (a) C_3H_8 (g) + $5O_2$ (g) → $3CO_2$ (g) + $4H_2O$ (g) ;ΔH = -2253.2 kJ/mol

____ (b) 2Na (s) + Cl_2 (g) → 2NaCl (s) ;ΔH = +821.8 kJ/mol

____ (c) 4Ag (s) + $2H_2S$ (g) + O_2 (g) → $2Ag_2S$ (s) + $2H_2O$ (g) ;ΔH = -507.0 kJ/mol

____ (d) $2NaHCO_3$ (s) → Na_2CO_3 (s) + H_2O (g) + CO_2 (g) ;ΔH = +135.6 kJ/mol

(3) Use the bond energies to calculate the heat of the reaction.

(a) H_2 (g) + Br_2 (g) → 2HBr (g)

(b) $3H_2$ (g) + N_2 (g) → $2NH_3$ (g)

(c) $2C_2H_6$ (g) + $7O_2$ (g) → $4CO_2$ (g) + $6H_2O$ (g)

(d) C_2H_4 (g) + $3O_2$ (g) → $2CO_2$ (g) + $2H_2O$ (g)

(4) Use the heats of formation to calculate the heat of the reaction.

(a) $2CO_2$ (g) + N_2 (g) → 2NO (g) + 2CO (g)

(b) $4CH_3OH$ (l) + $2O_2$ (g) → 2CO (g) + CO_2 (g) + $4H_2O$ (g) + C (s)

(c) C_2H_4 (g) + Cl_2 (g) → C_2H_3Cl (g) + HCl (g)

(d) $4NH_3$ (g) + $5O_2$ (g) → 4NO (g) + $6H_2O$ (g)

(e) NO (g) + $2HNO_3$ (l) → H_2O (l) + $3NO_2$ (g)

(5) Use the steps provided to calculate the overall heat of the reaction.

(a) H_2O (l) + CO_2 (g) → H_2CO_3 (l)

Steps: H_2CO_3 (l) → H_2CO (g) + O_2 (g) ΔH = + 28.0 kJ/mol

H_2O (l) + CO_2 (g) → H_2CO (g) + O_2 (g) ΔH = +12.5 kJ/mol

(b) $2F_2$ (g) + $2H_2O$ (l) → 4HF(g) + O_2 (g)

Steps: H_2 (g) + F_2 (g) → 2HF (g) ΔH = -542.2 kJ/mol

$2H_2$ (g) + O_2 (g) → $2H_2O$ (l) ΔH = -571.6 kJ/mol

(c) 2CO (g) + O_2 (g) → $2CO_2$ (g)

Steps: C (s) + O_2 (g) → CO_2 (g) ΔH = -393.5 kJ/mol

2C (s) + O_2 (g) → 2CO (g) ΔH = -221.0 kJ/mol

(d) $4PCl_3$ (g) → P_4 (s) + $6Cl_2$ (g)

Steps: P_4 (s) + $10Cl_2$ (g) → $4PCl_5$ (g) ΔH = -1910.0 kJ/mol

PCl_5 (g) → PCl_3 (g) + Cl_2 (g) ΔH = +138.7 kJ/mol

(e) H_2S (g) + $2O_2$ (g) → H_2SO_4 (l)

Steps: H_2SO_4 (l) → SO_3 (g) + H_2O (g) ΔH = +15.4 kJ/mol

H_2S (g) + $2O_2$ (g) → SO_3 (g) + H_2O (l) ΔH = -51.7 kJ/mol

H_2O (g) → H_2O (l) ΔH = -8.30 kJ/mol

Answers:
(1) (a) Endo; ΔH = +2.7 kJ/mol
(b) Exo; ΔH = -484 kJ/mol
(c) Exo; ΔH = -5316.8 kJ/mol
(d) Endo; ΔH = +28.3 kJ/mol

(2) (a) Exo; C_3H_8 (g) + $5O_2$ (g) → $3CO_2$ (g) + $4H_2O$ (g) + 2253.2 kJ/mol
(b) Endo; 2Na (s) + Cl_2 (g) 821.8 kJ/mol → 2NaCl (s)
(c) Exo; 4Ag (s) + $2H_2S$ (g) + O_2 (g) → $2Ag_2S$ (s) + $2H_2O$ (g) + 507.0 kJ/mol
(d) Endo; $2NaHCO_3$ (s) +135.6 kJ/mol → Na_2CO_3 (s) + H_2O (g) + CO_2 (g)

(3) (a) ΔH = -68 kJ/mol
(b) ΔH = -93 kJ/mol
(c) ΔH = -2870 kJ/mol
(d) ΔH = -1316 kJ/mol

(4) (a) ΔH = +746.4 kJ/mol
(b) ΔH = -626.1 kJ/mol
(c) ΔH = -107.5 kJ/mol
(d) ΔH = -907.6 kJ/mol
(e) ΔH = +71. 8 kJ/mol

(5) (a) ΔH = -15.5 kJ/mol
(b) ΔH = -512.8 kJ/mol
(c) ΔH = -566.0 kJ/mol
(d) ΔH = 1355.2 kJ/mol
(e) ΔH = -58.8 kJ/mol