Name ANSWERS Ω

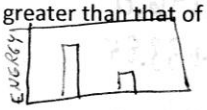
1. Formation of $Al_2O_{3(s)}$ from its elements in their standard states. (See page 316)
   $\Delta H = -1676.0\ kJ/mol$
2. Write just the reaction that describes forming each compound from its elements in their standard states:
   a. $H_2O_{(L)}$ $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(L)}$
   b. $CaCO_{3(s)}$ (the standard state of metals is a single atom, solid. For carbon, a single atom, solid)
   $2Ca_{(s)} + 2C_{(s,graphite)} + 3O_{2(g)} \rightarrow 2CaCO_3$
3. Indicate whether each item describes potential or kinetic energy:
   a. Water at the top of a waterfall POTENTIAL ENERGY
   b. Kicking a ball KINETIC ENERGY
   c. The energy in a lump of coal POTENTIAL ENERGY
   d. A skier at the top of a hill POTENTIAL ENE
4. Indicate whether each item describes potential or kinetic energy:
   a. The energy in your food Potential
   b. A tightly wound spring potential
   c. An earthquake Kinetic
   d. A car speeding down the freeway Kinetic

Units of Energy Conversions

5. A burning match releases 1100 J. Convert the energy released by 20 matches to the following energy units:
   a. Kilojoules $20\ matches \times \left(\frac{1100\ J}{1\ match}\right)\left(\frac{1\ kJ}{1000\ J}\right) = 22\ kJ$
   b. Calories $20\ matches \times \left(\frac{1100\ J}{1\ match}\right)\left(\frac{1\ cal}{4.184\ J}\right)\left(\frac{1\ Cal}{1000\ cal}\right) = 5.3\ Ca$

Energy in Chemical Reactions

6. In exothermic reactions, is the energy of the products less or greater than that of the reactants?
   reactants (more energy) → products (less energy)



7. Classify the following as exothermic or endothermic:
   a. 550 kJ is released EXOTHERMIC
   b. The energy level of the products is higher than that of the reactants. ENDOTHERMIC
   c. The metabolism of glucose in the body provides energy. EXOTHERMIC
   d. The energy level of the products is lower than that of the reactants. EXOTHERMIC
   e. 125 kJ is absorbed. ENDOTHERMIC

8. Classify the following as exothermic or endothermic reaction and give ΔH for each:
   a. Gas burning in a Bunsen burner: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 890\ kJ$ EXOTHERMIC
   b. Dehydrating limestone: $Ca(OH)_2 + 65.3\ kJ \rightarrow CaO + H_2O$ ENDOTHERMIC
   c. Formation of aluminum oxide and iron from aluminum and iron(III)oxide: Exothermic
   d. $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe + 850\ kJ$
   e. Combustion of propane: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + 2200\ kJ$ EXOTHERMIC
   f. Formation of table salt: $2Na + Cl_2 \rightarrow 2NaCl + 2H_2O + 819\ kJ$ EXOTHERMIC
   g. Decomposition of phosphorous pentachloride: $PCl_5 + 67\ kJ \rightarrow PCl_3 + Cl_2$ ENDOTHERMIC

9. In an endothermic reaction, is the energy of the products less than or greater than that of the reactants? greater

10. The equation for the formation of silicon tetrachloride from silicon and chlorine is
    $Si + 2Cl_2 \rightarrow SiCl_4 \qquad \Delta H = -657\ kJ$
    How many kilojoules are released when 125 g of Cl_2 reacts with silicon?

$$125\,g\,Cl_2 \times \left(\frac{1\ mol\,Cl_2}{70.90\ g\,Cl_2}\right) \times \left(\frac{-657\ kJ}{2\ mol\,Cl_2}\right) = 579\ kJ$$

Heat of formation

Using the table on p. 316 of your textbook write just the ΔH term for each .

11. Formation of $Fe_2O_{3(s)}$ from its elements in their standard states.
    ΔH = −822.1 kJ/mol
12. Formation of $Br_{2(L)}$ from its elements in their standard states.
    ΔH = 0
13. Write just the reaction that describes forming each compound from its elements in their standard states:
    a. $H_2O_{(L)}$ $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(L)}$

    b. $H_2O_{(g)}$ $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

14. Now put together your skills from the previous two questions. For each substance, write the ΔH term for each **and** the reaction that describes forming each compound from its elements in their standard states (p. 316 has a helpful table).
    a. $SO_{2(g)}$ ΔH = −296.8 kJ/mol reaction: $S_{8(s)} + 8O_{2(g)} \rightarrow 8SO_2$
    b. $NO_{2(g)}$ ΔH = +33.85 reaction: $N_{2(g)} + 2O_{2(g)} \rightarrow 2NO_{2(g)}$
    c. $Fe_2O_{3(s)}$ ΔH = −822.1 reaction: $4Fe_{(s)} + 3O_{2(g)} \rightarrow 2Fe_2O_{3(s)}$
    d. $N_{2(g)}$ ΔH = 0 reaction: $N_{2(g)} \rightarrow N_{2(g)}$

Table 11.4

Heats of Combustion at 25 °C

Substance	Formula	ΔH (kJ/mol)
Hydrogen	$H_2(g)$	−286
Carbon	$C(s)$, graphite	−394
Carbon monoxide	$CO(g)$	−283
Methane	$CH_4(g)$	−890
Methanol	$CH_3OH(l)$	−726
Acetylene	$C_2H_2(g)$	−1300
Ethanol	$C_2H_5OH(l)$	−1368
Propane	$C_3H_8(g)$	−2220
Benzene	$C_6H_6(l)$	−3268
Glucose	$C_6H_{12}O_6(s)$	−2808
Octane	$C_8H_{18}(l)$	−5471
Sucrose	$C_{12}H_{22}O_{11}(s)$	−5645

Table 11.5

Heats of Physical Change

Substance	Formula	Freezing point (K)	ΔH_{fus} (kJ/mol)	Boiling point (K)	ΔH_{vap} (kJ/mol)
Acetone	CH_3COCH_3	177.8	5.72	329.4	29.1
Ammonia	NH_3	195.3	5.65	239.7	23.4
Argon	Ar	83.8	1.2	87.3	6.5
Benzene	C_6H_6	278.7	9.87	353.3	30.8
Ethanol	C_2H_5OH	158.7	4.60	351.5	43.5
Helium	He	3.5	0.02	4.22	0.08
Hydrogen	H_2	14.0	0.12	20.3	0.90
Methane	CH_4	90.7	0.94	111.7	8.2
Methanol	CH_3OH	175.5	3.16	337.2	35.3
Neon	Ne	24.5	0.33	27.1	1.76
Nitrogen	N_2	63.3	0.72	77.4	5.58
Oxygen	O_2	54.8	0.44	90.2	6.82
Water	H_2O	273.2	6.01	373.2	40.7

Table 11.6

Standard Heats of Formation (ΔH_f^0) at 25 °C and 101.3 kPa

Substance	ΔH_f^0 (kJ/mol)	Substance	ΔH_f^0 (kJ/mol)	Substance	ΔH_f^0 (kJ/mol)
$Al_2O_3(s)$	−1676.0	$Fe(s)$	0.0	$NO(g)$	90.37
$Br_2(g)$	30.91	$Fe_2O_3(s)$	−822.1	$NO_2(g)$	33.85
$Br_2(l)$	0.0	$H_2(g)$	0.0	$Na_2CO_3(s)$	−1131.1
$C(s$, diamond)	1.9	$H_2O(g)$	−241.8	$NaCl(s)$	−411.2
$C(s$, graphite)	0.0	$H_2O(l)$	−285.8	$O_2(g)$	0.0
$CH_4(g)$	−74.86	$H_2O_2(l)$	−187.8	$O_3(g)$	142.0
$CO(g)$	−110.5	$HCl(g)$	−92.31	$P(s$, white)	0.0
$CO_2(g)$	−393.5	$H_2S(g)$	−20.1	$P(s$, red)	−18.4
$CaCO_3(s)$	−1207.0	$I_2(g)$	62.4	$S(s$, rhombic)	0.0
$CaO(s)$	−635.1	$I_2(s)$	0.0	$S(s$, monoclinic)	0.30
$Cl_2(g)$	0.0	$N_2(g)$	0.0	$SO_2(g)$	−296.8
$F_2(g)$	0.0	$NH_3(g)$	−46.19	$SO_3(g)$	−395.7