1-5 2pts each answer + unit
6-10 4pts each

30pts

Phase Change Worksheet

1) A 12 oz. can of soda weighs about 450 grams. How many joules are released when a can of soda is cooled from 25 degrees Celsius (room temperature) to 4 degrees Celsius (the temperature of a refrigerator). ***The heat capacity of liquid water is 4.18 J / gram x °C.*** (AKA Specific heat)

$m = 450\ g$
$q = ?\ J$
$\Delta T = 4 - 25$
$S = 4.184$

$q = 4.184(450)(4-25)$

$\boxed{q = -39{,}538\ J}$

2) How many joules are required to heat 250 grams of liquid water from 0^0 to 100^0 C ?

$m = 250\ g$
$q = ?\ J$
$\Delta T = 100 - 0$

$q = 4.184(250)(100-0)$

$\boxed{q = 104\,600\ J}$

3) How many joules are required to melt 100 grams of water? **The heat of fusion of water is 6.01 kJ / mole.**

$m = 100\ g$

$$100\ g\ H_2O \left| \frac{1\ mol}{18\ g} \right| \frac{6.01\ KJ}{1\ mol} \left| \frac{10^3\ J}{1\ KJ} \right| = \boxed{33388.8\ J}$$

4) How many joules are required to boil 150 grams of water? **The heat of vaporization of water is 40.67 kJ / mole.**

$$150\ g \left| \frac{1\ mol}{18\ g} \right| \frac{40.67\ KJ}{1\ mol} \left| \frac{10^3\ J}{1\ KJ} \right| = \boxed{3\,389\,16.6\ J}$$

5) How many joules are required to heat 200 grams of water from 25 °C to 125 °C? **The heat capacity of steam is 1.84 J / g · °C**

200g Liq H_2O (25°C) q_1 → Liq/gas (100°C) q_2 → gas (125°C) q_3

$q_1 = 4.184(200)(100-25)$

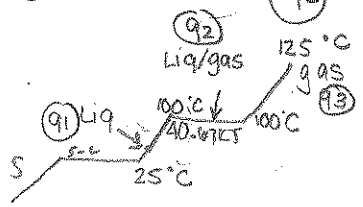
$\boxed{q_1 = 62760\ J}$

$q_2 = 200\ g\ H_2O \left| \frac{1\ mol}{18\ g} \right| \frac{40.67\ KJ}{1\ mol} \left| \frac{10^3\ J}{1\ KJ} \right| = \boxed{451888\ J}$

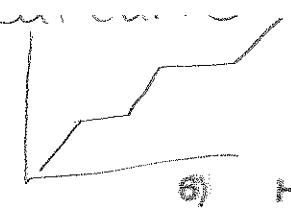
$q_3 = 1.84(200)(125-100) = \boxed{9200\ J}$

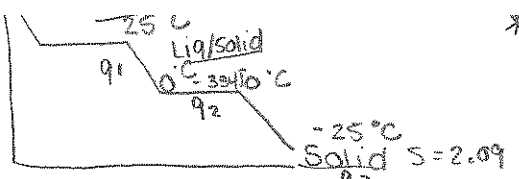
$q_1 + q_2 + q_3 =$

$\boxed{523848\ J}$



10pts





$* \ 1g\ H_2O \left|\frac{-334J}{1g}\right. = -334J$

$* \ 1g\ H_2O \left|\frac{1mol}{18g}\right|\left|\frac{6.02kJ}{1mol}\right|\left|\frac{10^3J}{1kJ}\right. = 334J$

6) How many joules are given off when 120 grams of water are cooled from 25 °C to -25°C? **The heat capacity of ice is 2.09 J / g · °C.**

Liq → Liq/solid → Solid

heat of solidification = -334 J/g°C

(AKA Sp. heat)

$q_1 = 4.184(120)(0-25)$

$q_1 = -12552J$

$q_3 = 2.09(120)(-25-0)$

$q_3 = -6270J$

$q_2 = 120g \left|\frac{1mol}{18g}\right|\left|\frac{6.02kJ}{1mol}\right|\left|\frac{10^3}{1kJ}\right.$ (or) $q_2 = 120g \left|\frac{-334J}{1g}\right.$

40133 | -40080

-58902 J

7) How many joules are required to heat 75 grams of water from -85 °C to 185°C? **The heat capacity of steam is 1.84 J / g · °C.**

(AKA Sp. heat)

$q_1 = 2.09(75)(0-(-85))$

$q_1 = 13323.75J$

$q_4 = 75 \left|\frac{40.67}{18g}\right|\left|\frac{10^3}{1mol}\right. = 169458$

$q_2 = 75g \left|\frac{1mol}{18g}\right|\left|\frac{6.01kJ}{1mol}\right|\left|\frac{10^3}{1kJ}\right. = 25045J$

$q_5 = 1.84(75)(185-100) = 11730$

$q_3 = 4.184(75)(100-0) = 31380$

$q_{total} = 2.5 \times 10^5 J$

8) How many joules are required to heat a frozen can of juice (360 grams) from -5 °C (the temperature of an overcooled refrigerator) to 110 °C (the highest practical temperature within a microwave oven)?

$q_1 = 2.09(360)(0-(-5))$

$q_1 = 3762J$

$q_4 = 360 \left|\frac{40.67}{18}\right|\left|\frac{10^3}{1mol}\right. = 813400$

$q_2 = 360g \left|\frac{6.02}{18g}\right|\left|\frac{10^3}{1mol}\right. = 120400J$

$q_5 = 1.84(360)(110-100)$

$q_5 = 6624$

$q_3 = 4.184(360)(100-0) = 150624$

$q_{total} = 1094810$

9) How many joules are released when 450 grams of water are cooled from 4×10^7 °C (~~the hottest temperature ever achieved by man~~) to 1×10^{-9} °C (~~the coldest temperature achieved by man~~).

Heat of solidification -334 J/g°C

$q_1 = 2.09(450)(1\times10^{-9}-0)$

$q_1 = 9.4 \times 10^{-7}$

$q_3 = 4.18(450)(0-100)$

$q_3 = -188100$

$* \ q_{total} = -3.31 \times 10^{10} J$

$q_2 = 450 \left|\frac{6.0}{18}\right|\left|\frac{10^3}{1mol}\right.$ (or $450|334$)

$q_2 = 150250$

$q_4 = 450 \left|\frac{40.67}{18}\right|\left|\frac{10^3}{1mol}\right.$

$q_4 = 1016750$

$q_5 = 1.84(450)(100-4.0\times10^7) = -3.3\times10^{10}$

10) How many joules are required to raise the temperature of 100 grams of water from -269 °C (the current temperature of space) to 1.6×10^{15} °C (the estimated temperature of space immediately after the big bang)?

$q_1 = 2.09(100)(0-(-269))$

$q = 56221$

$q_3 = 4.184(100)(100-0)$

$q_3 = 41800$

$q_5 = 1.84(100)(1.6\times10^{15}-100)$

$q_5 = 2.9\times10^{17}$

$q_2 = 100 \left|\frac{6.01}{18}\right|\left|\frac{10^3}{1mol}\right.$

$q_2 = 33388$

$q_4 = 100 \left|\frac{40.67}{18}\right|\left|\frac{10^3}{1mol}\right.$

$q_4 = 225944$

$q_{total} = 2.944 \times 10^{17} J$