Energy calculations

A. Changing temperature only – no phase change:

$\Delta H = mC_p\Delta T$

1. How much heat is required to raise the temperature of 68.0 grams of Sn from 25.0 ˚C to 80.0 ˚C?

2. How much heat is required to cool 5.0 liters of water from 100.0 ˚C to 0.0 ˚C?

B. Changing phase only – no temperature change

ΔH = moles × molar heat of (fusion or vaporization)*. Notice that the temperature is irrelevant!
Note: if heat of fusion or vaporization is in units/ grams, substitute mass in grams for number of moles.

1. How much heat is required to melt 20.0 grams of ice at 0.0 ˚C?

2. How much heat is required to condense 60.0 grams of steam at 100.0 ˚C?

C: Combination with temperature and phase changes

Determine the heat change in each temperature and phase change (use the above two formulas) and add up the results. Be sure values are in the same units, i.e. all in kilojoules or all in joules!

* Calculate the energy involved when 6.0 grams of - 5.0 ˚C ice changes to steam at 110 ˚C.

Steps:
a: calculate heat from temperature change from - 5.0 ˚C to 0.0 ˚C
b. calculate heat from phase change from melting
c. calculate heat from temperature change from 0.0 ˚C to 100.0 ˚C
d. calculate heat from phase change from vaporization
e. calculate heat from temperature change from 100.0 ˚C to 110.0 ˚C
f. add up the results from a to f

Modification: instead of using the mass from the problem, you may use the molar mass for the mass in the temperature change steps and 1.0 mole for moles in the phase change steps. Multiply the total in step f by the total moles present (Use the mass in the problem and find the moles, as this quantity remains constant throughout all steps).

More problems:

1. Compute the heat changes with the following:
   a. melting 55.8 grams of Ti at 1677 ˚C
   b. condensing 14.2 grams of water at 100 ˚C
   c. vaporizing 53.5 grams of benzene
   d. freezing 27.3 grams of Al
   e. melting 76.4 grams of Au at 1065 ˚C

2. Compute the heat changes with the following:
   a. 49.2 grams of acetic acid from 24.1˚C to 67.3 ˚C
   b. 9.61grams of toluene from 19.6˚C to 75.0 ˚C
   c. 2.47 grams of kerosene from 17.1˚C to 46.7 ˚C
   d. 31.9 grams of chalk from 83.2˚C to 55.5 ˚C
   e. 63.6 grams of glass acid from 95.5˚C to 42.3 ˚C

3. How much heat must be removed from 6.81 kilograms of steel to cool it from 2720 ˚C to 625 ˚C. The freezing point of steel is 1300˚C.

4. How much heat must be added to 34.4 kilograms of ice at –5.44˚C to change it to 249˚C steam?

Molar Heats of Fusion and Vaporization in **kJ/mole**

Fusion			Vaporization	
As	93.7		Al	284
Au	12.4		Benzene	30.8
Fe	15.4		He	0.0182
Steel	15.4		Se	86.2
In	3.27		Water	40.7
Al	10.8			
Ti	18.8			
Water	6.02			

Specific heat capacities **(C_P)** in **J/g °C**

Acetic acid	2.05		$Steel_{(c)}$	0.450
Al	0.903		$Steel_{(l)}$	0.719
Chalk	0.920		Sn	0.222
Glass	0.753		Toluene	1.615
$In_{(c)}$	0.238		$water_{(c)}$	2.06
$In_{(l)}$	0.216		$water_{(l)}$	4.18
Kerosene	2.09		$Water_{(g)}$	2.02