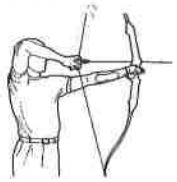
# Thermochemistry Exam Review KEY

1) List two forms of kinetic energy (energy of motion) and two forms of potential energy (stored energy) shown in this picture.



a. Potential

i. stretched bow

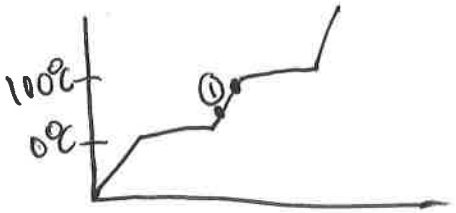
ii. distance of the bow arrow from the ground

b. Kinetic (requires imagination!)

i. releasing the bow

ii. the arrow moving

2) How much energy must be added to 50.0 grams of water to raise its temperature from 40.0°C to 45.0°C.




$q = mC\Delta T$

$m = 50.0\,g$

$C = 4.18\,J/g°C$

$T_i = 40.0°C$

$T_f = 45.0°C$

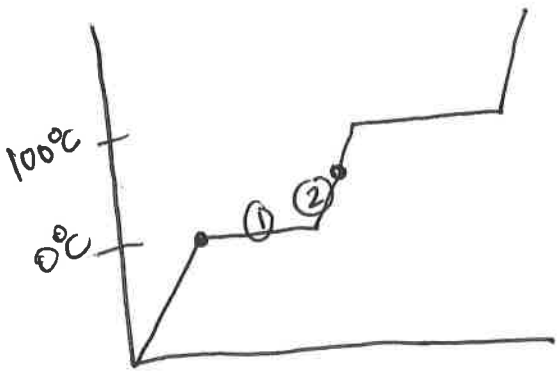
$\Delta T = 5.0°C$

$q = (50.0)(4.18)(5.0)$

$q = 1045\,J$

**1050 J**

3) How much energy must be added to 36.1g of ice at 0°C in order to raise its temperature to 25°C?




① $q = mH_f$

$m = 36.1\,g$

$H_f = 334\,J/g$

$q = (36.1)(334)$

$q = 12100\,J$

② $q = mC\Delta T$

$m = 36.1\,g$

$C = 4.18\,J/g°C$

~~$T_i = 0°C$~~

~~$T_f = 25°C$~~

$\Delta T = 25°C$

$q = (36.1)(4.18)(25)$

$q = 3800\,J$

add for total!

$12100 + 3800 =$ **15900 J**

4) When a 255g sample of Al is cooled by 8.0°C, it is found to have lost 1794 J of energy. What is the specific heat of Al?

$q = 1794\,J$ $\quad m = 255\,g$ $\quad c = x$ $\quad \Delta T = 8.0°C$

$q = mc\Delta T$

$1794 = 255(x)(8.0)$

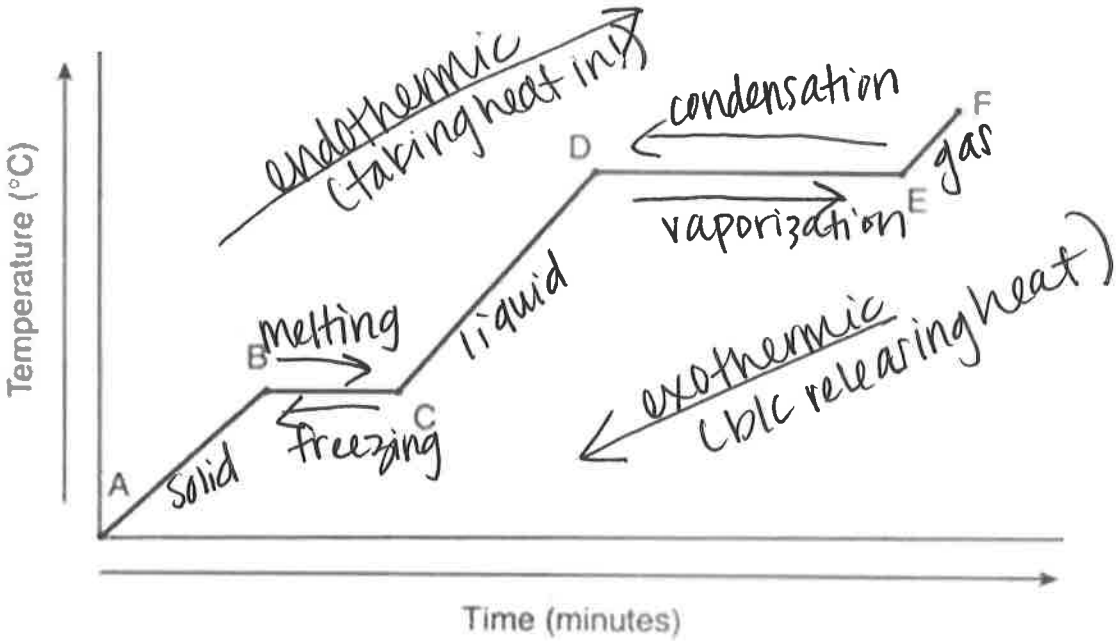
$1794 = 2040x$

$\frac{1794}{2040}$

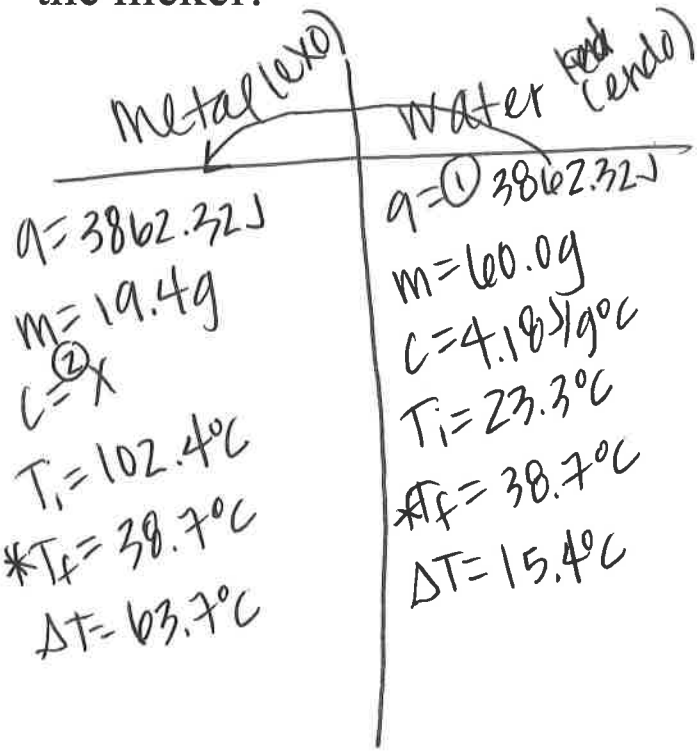
$c = 0.88\ J/g°C$

5) On the heating curve at right, label the following terms:

a. Condensation $g \rightarrow l$
b. Melting $s \rightarrow l$
c. Freezing $l \rightarrow s$
d. Vaporization $l \rightarrow g$
e. Solid
f. Liquid
g. Gas
h. Endothermic
i. Exothermic



6) In a calorimeter, the temperature of 60.0g of water increases from 23.3°C to 38.7°C when a 102.4°C block of Ni is dropped in. If the mass of the block is 19.4g, what is the specific heat of the nickel?




① $q = mc\Delta T$

$x = (60.0)(4.18)(15.4)$

$X = 3862.32\,J$

② $q = mc\Delta T$

$3862.32 = (19.4)(x)(63.7)$

$\frac{3862.32}{1235.78} = \frac{1235.78x}{1235.78}$

$c = 3.13\,J/g°C$

| Substance | ~~$\Delta H_f$~~ (kJ/mol) |
|---|---|
| $Fe_3O_4(s)$ | -1118.0 |
| $H_2S(g)$ | -20.6 |
| $CO(g)$ | -110.5 |
| $Ag_2S(s)$ | -32.6 |
| $H_2O(l)$ | -285.8 |
| $FeO(s)$ | -272 |
| $CO_2(g)$ | 393.5 |

$\Delta H = P - R$

7) Using the chart at right, find the heats of formation of the following:

a. $Fe_3O_4(s) + CO(g) \rightarrow 3\,FeO(s) + CO_2(g)$

R: $-1118.0 + -110.5 = -1228.5$

P: $3(-272) + 393.5 = -422.5$

$\Delta H = P - R$

$= -422.5 - (-1228.5) =$ **806 kJ/mol**

endo b/c $+\Delta H$

b. $4\,Ag(s) + 2\,H_2S(g) + O_2(g) \rightarrow 2\,Ag_2S(s) + 2\,H_2O(l)$

R: $4(0) + 2(-20.6) + 0 = -41.2$

P: $2(-32.6) + 2(-285.8) = -636.8$

$\Delta H = P - R$

$= -636.8 - (-41.2) =$ **-595.6 kJ/mol**

exo b/c $-\Delta H$

8) It takes 679 J of energy to raise the temperature of 132.6 g of mercury from 20.0°C to 68.9°C. Calculate the specific heat of mercury.

$q = mC\Delta T$

$q = 679\ J$
$m = 132.6\ g$
$C = x$
$T_i = 20.0°C$
$T_f = 68.9°C$
$\Delta T = 48.9°C$

$679 = (132.6)(x)(48.9)$

$679 = 6484.14x$

$x = C = 0.105\ J/g°C$

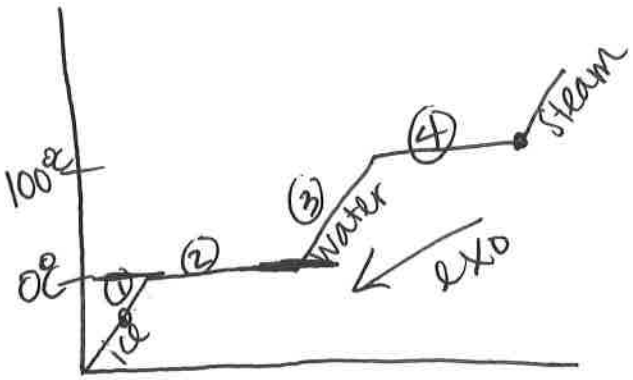
9) A 45g piece of metal was heated to 45.9°C and then placed in a calorimeter containing 100.0 g of water at 18.6°C. The final temperature of the mixture was 33.7°C. Calculate the heat capacity of the metal.

| metal | water |
|---|---|
| $q = 6311.8\ J$ | $q = ①\ 6311.8\ J$ |
| $m = 45g$ | $m = 100.0g$ |
| $C = ②\ x$ | $C = 4.18\ J/g°C$ |
| $T_i = 45.9°C$ | $T_i = 18.6°C$ |
| $T_f = 33.7°C$ | $T_f = 33.7°C$ |
| $\Delta T = 12.2°C$ | $\Delta T = 15.1°C$ |

① $q = mC\Delta T$
$x = (100.0)(4.18)(15.1)$
$q = 6311.8\ J$

② $q = mC\Delta T$
$6311.8 = 45(x)(12.2)$
$6311.8 = 549x$
$x = 11\ J/g°C = C_{metal}$

10) How much energy in joules is required to change 76g to steam at 100°C to ice at -10.0°C?




① $q = mc\Delta T$
$m = 76g$
$c = 2.1 J/g°C$
$T_i = -10°C$
$T_f = 0°C$
$\Delta T = 10°C$
$q = (76)(2.1)(10)$
$q = 1600J$

② $q = mH_f$
$m = 76g$
$H_f = 334 J/g$
$q = (76)(334)$
$q = 25000J$

③ $q = mc\Delta T$
$m = 76g$
$c = 4.18 J/g°C$
$T_i = 0°C$
$T_f = 100°C$
$\Delta T = 100°C$
$q = (76)(4.18)(100)$
$q = 32000J$

④ $q = mH_v$
$m = 76g$
$H_v = 22600 J/g$
$q = (76)(22600)$
$q = 170000J$

$q_{tot} = 1600 + 25000 + 32000 + 170000$

$q = 228600 J$

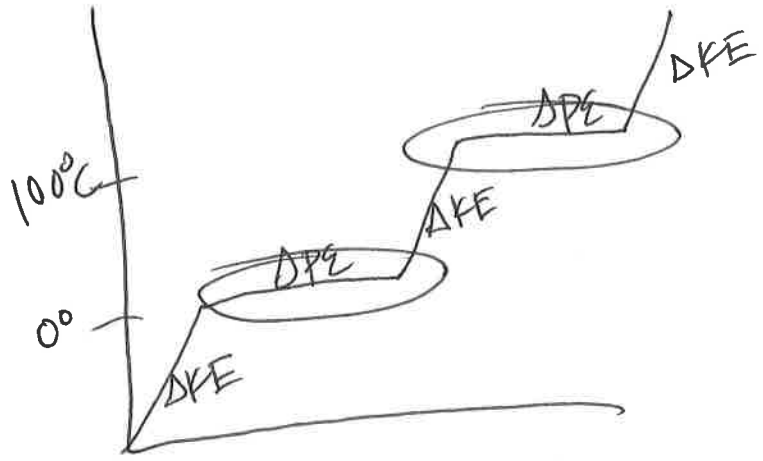
11) Which value is higher, the heat of fusion or the heat of vaporization and why?

334J/g

2260J/g

Heat of vaporization b/c it requires more energy to change liquid → gas than solid → liquid. (Hv) (Hf)

12) Referencing the heat curve, when the slope of the line is horizontal, is it changing temperature?




NO b/c all of the energy is going into changing the state of matter.