Department of Chemistry
University of Texas at Austin

Name:____________________

Thermodynamics Unit - Practice Thermodynamics problems

True/False

T F For an isothermal process, ΔS_{SYS} can never decrease.

False. For example vaporization.

T F For all phase transitions, $\Delta H = 0$

False. ΔH is never zero for a phase transition

T F A process that doubles the number of microstates of system will double the entropy of the system.

False. Entropy is proportional to the natural log of the number of microstates.

T F Dropping an eraser from a height of three feet to the floor leads to an increase in the entropy of the Universe.

True. This is a spontaneous procress.

T F The standard entropy of an element in its standard state at 298.15 K and 1 bar is zero.

False. The standard entropy of a perfect crystal of a substance at absolute zero is zero.

T F Conservation of energy tells that $\Delta U = 0$ for all processes.

False. Enegy can be exchanged between system and surroundings. $\Delta U_{Universe} = 0$.

T F If adding 25 J of heat to a 5.6 g block of iron increases it temperature by 10° C, then adding 25 J of heat to a 2.8 g block of iron will increase its temperature by 20°C.

True. The heat capacity of a 2.8 g block will be half of that of a 5.6g block. Therefore the temperature change will be double.

T F When the heat for a process is positive, there is always an increase in temperature of the system.

False. Not for a phase change or chemistry.

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For each of the following note what you would expect for the entropy of the system, surroundings, and total.

A container of liquid honey (the system) sitting in your kitchen (the surroundings) crystallizes

ΔS_{SYS} Increase Decrease Stay the Same No Way to Know

Going from liquid to solid

ΔS_{SURR} Increase Decrease Stay the Same No Way to Know

It must be if the total is increasing

ΔS_{TOTAL} Increase Decrease Stay the Same No Way to Know

Spontaneous so it is increasing

1 mole of an ideal gas initially at a pressure of 10 bar, expanding isothermally against a constant
external pressure of 1 bar until mechanical equilibrium is reached.

ΔS_{SYS} Increase Decrease Stay the Same No Way to Know

Volume is going up

ΔS_{SURR} Increase Decrease Stay the Same No Way to Know

This must be endothermic. Work out and heat in. no change internal energy

ΔS_{TOTAL} Increase Decrease Stay the Same No Way to Know

Spontaneous.

A 25 g block of solid iron at a temperature 50 °C is dropped into a glass of ice water that contains 50 g of solid water and 50 g of liquid water at 0°C? Does all the ice melt?

$C_{P,\text{solid water}} = 36\ \text{J K}^{-1}\ \text{mol}^{-1}$
$C_{P,\text{liquid water}} = 75.3\ \text{J K}^{-1}\ \text{mol}^{-1}$
$C_{P,\text{solid iron}} = 25.1\ \text{J K}^{-1}\ \text{mol}^{-1}$
$\Delta_{FUS}H° = 6.02\ \text{kJ mol}^{-1}$

How much heat is required to cool the block from 50°C to 0°C (a change of + 50K)?

$$q = nC\Delta T = \left(\frac{25g}{55.8g\ mol^{-1}}\right)(25.1\ J\ K^{-1}mol^{-1})(50K) = 562.3\ J$$

will that melt all the ice?

How much heat is required to melt 50g of ice?

$$q = n\Delta H_{fus} = \left(\frac{50g}{18g\ mol^{-1}}\right)(6020\ J\ mol^{-1}) = 16722\ J$$

So the iron block will cool to 0°C and there will be lots of ice left over. The heat from the iron is only enough to melt 0.11 moles of water (or 1.8g)

$$n = \frac{q}{\Delta H_{fus}} = \left(\frac{562.3J}{6020\ J\ mol^{-1}}\right) = 0.11\ mol$$

(note : for this problem there are several "extra" piece of data that are not needed)