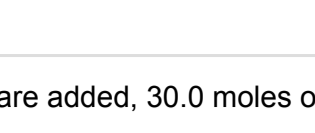


# HW01 - Phase Changes and Solutions

## Question 1

1.25 pts

Given that you have 14.5 moles of  $N_2$ , how many moles of  $H_2$  are theoretically needed to produce 30.0 moles of  $NH_3$  according to reaction below?



- 45.0 moles of  $H_2$
- 33.8 moles of  $H_2$
- No matter how many moles of  $H_2$  are added, 30.0 moles of  $NH_3$  cannot be produced.
- 15.0 moles of  $H_2$

## Question 2

1.25 pts

Consider the following reaction:



How much  $NH_3$  is needed to react completely with 34g of  $CH_3OH$ ?

- 36g  $NH_3$
- 9g  $NH_3$
- 128g  $NH_3$
- 1.3g  $NH_3$

## Question 3

1.25 pts

Ice is heated at a constant pressure until it melts and vaporizes. What signs are associated with the total change in entropy and enthalpy ( $\Delta S$  and  $\Delta H$ ) for this sample of water?

- $\Delta S = -$ ,  $\Delta H = -$
- $\Delta S = +$ ,  $\Delta H = -$
- $\Delta S = -$ ,  $\Delta H = +$
- $\Delta S = +$ ,  $\Delta H = +$

## Question 4

1.25 pts

Which of the phase changes below might have a  $\Delta H = 11.6$  kJ/mol?

- evaporation
- condensation
- freezing
- deposition

## Question 5

1.25 pts

Which of the following statements is ALWAYS true about deposition?

- None of the other answers are correct
- $\Delta H < 0$
- $\Delta G < 0$
- $\Delta S > 0$

## Question 6

1.25 pts

Consider liquid ethane ( $CH_3CH_3$ ) and liquid methanol ( $CH_3OH$ ). Which would you expect to have a larger  $\Delta H$  of vaporization?

- It is impossible to tell unless you know the amount of each liquid involved.
- Ethane, because it has stronger IMFs.
- Methanol, because it has stronger IMFs.
- Methanol because it has a larger molar mass.

## Question 7

1.25 pts

What is the change in entropy ( $\Delta S_{vap}$ ) for the vaporization of ethanol at its standard boiling temperature of 78.4°C? ( $\Delta H_{vap} = 38.6$  kJ·mol<sup>-1</sup>)

- 0.110 J·mol<sup>-1</sup>·K<sup>-1</sup>
- 110 J·mol<sup>-1</sup>·K<sup>-1</sup>
- 0.492 J·mol<sup>-1</sup>·K<sup>-1</sup>
- 492 J·mol<sup>-1</sup>·K<sup>-1</sup>

## Question 8

1.25 pts

The  $\Delta H_{vap}^\circ$  of methane is 8.519 kJ·mol<sup>-1</sup> and its  $\Delta S_{vap}^\circ$  is 85.58 J·mol<sup>-1</sup>·K<sup>-1</sup>. What is the boiling point of methane?

- 372.54 K
- 0.09954 K
- 0.09954°C
- 99.54 K

## Question 9

1.25 pts

How much heat is required to heat 2 grams of ice at -30°C to steam at 100°C. Use the values below for your calculations:

$$c_{ice} = 2 \text{ J/g } ^\circ\text{C}$$

$$\Delta H_{fus} = 340 \text{ J/g}$$

$$c_{water} = 2 \text{ J/g } ^\circ\text{C}$$

$$\Delta H_{vap} = 2260 \text{ J/g}$$

$$c_{steam} = 2 \text{ J/g } ^\circ\text{C}$$

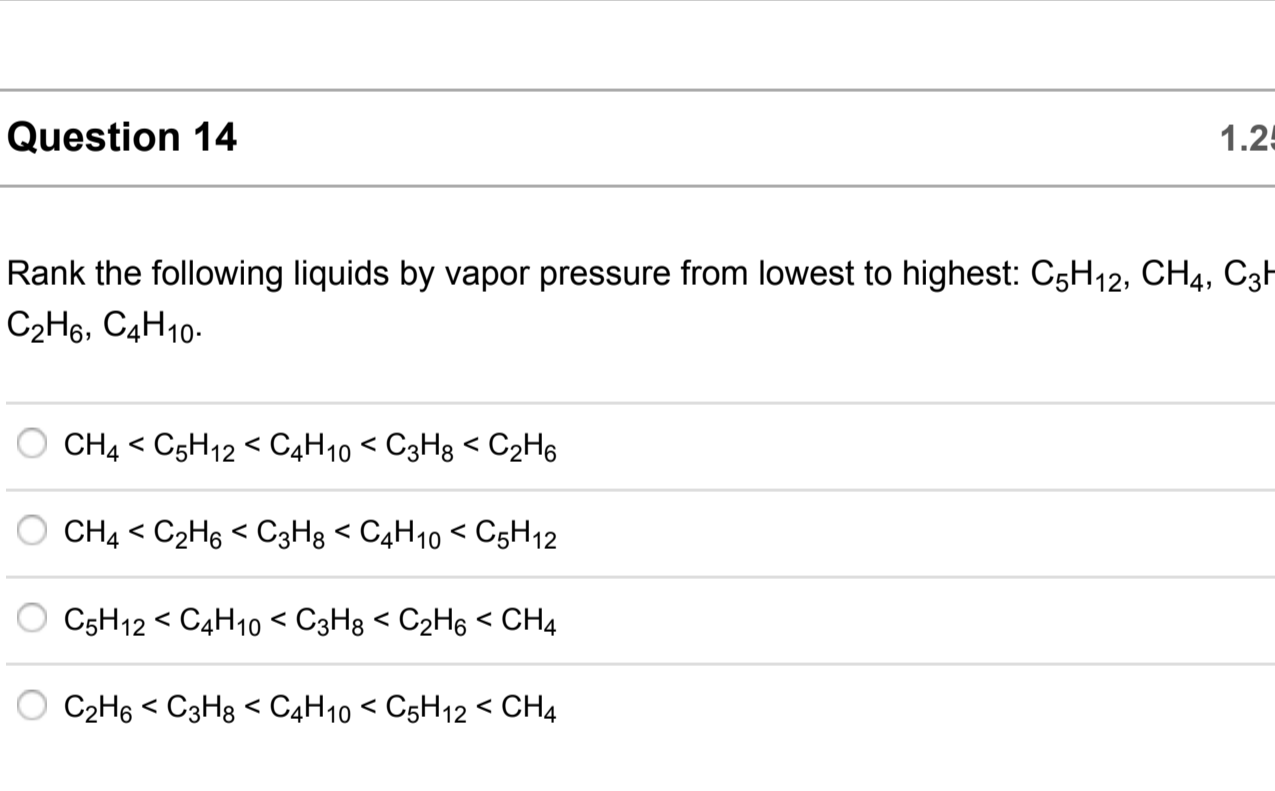
- 6.15 kJ
- 1.60 kJ
- 6150 kJ
- 6.00 kJ

## Question 10

1.25 pts

Use the phase diagram for  $CO_2$  provided below to answer the following question:

At 300K and 10 bar, what is the stable phase of carbon dioxide?



- liquid carbon dioxide
- gaseous carbon dioxide
- solid carbon dioxide
- carbon dioxide as supercritical fluid

## Question 11

1.25 pts

Use the phase diagram for  $CO_2$  in the question above to answer the following:

A sample of carbon dioxide is stored at 10,000 bar and 250K. This sample is then decompressed to 1 bar at constant temperature. Then, at constant pressure it is heated to 400K. Next, it is compressed at constant temperature to 200 bar. According to the phase diagram, how many phase transitions has the sample of carbon dioxide gone through, and what is its final state?

- 2, gas
- 3, supercritical fluid
- 3, liquid
- 2, supercritical fluid

## Question 12

1.25 pts

Which of the following would change the vapor pressure of a sample of water in a closed container?

1. decreasing the size of the container
2. lower the container temperature
3. removing water from the container
- 2 only
- 1 and 2
- 2 and 3
- 1, 2, and 3

## Question 13

1.25 pts

Which would have a higher vapor pressure: ethanol ( $C_2H_5OH$ ) or dimethyl ether ( $CH_3OCH_3$ )?

- They would have the same vapor pressure as their molecular weights are the same.
- ethanol
- dimethyl ether
- It is impossible to tell unless the amount of each substance is known.

## Question 14

1.25 pts

Rank the following liquids by vapor pressure from lowest to highest:  $C_9H_{12}$ ,  $CH_4$ ,  $C_3H_8$ ,  $C_2H_6$ ,  $C_4H_{10}$ .

- $CH_4 < C_9H_{12} < C_4H_{10} < C_3H_8 < C_2H_6$
- $CH_4 < C_2H_6 < C_3H_8 < C_4H_{10} < C_9H_{12}$
- $C_9H_{12} < C_4H_{10} < C_3H_8 < C_2H_6 < CH_4$
- $C_2H_6 < C_3H_8 < C_4H_{10} < C_9H_{12} < CH_4$

## Question 15

1.25 pts

In a closed vessel containing water, the pressure is 18 torr. If we add more water to the vessel, this equilibrium pressure would...

- change, but it is not possible to know if it will increase or decrease without more information.
- increase.
- remain the same.
- decrease.

## Question 16

1.25 pts

Consider two empty containers A and B whose volumes are 10mL and 20mL respectively. 1mL of liquid water is put into each container and the temperature of each container is adjusted to 20°C. The gas pressure in container B, which still has some liquid water in it, is found to be 17 torr. How would the pressure in container A and the amount of liquid water in container A compare to that of container B?

- the pressure would be the same, there would be an equal amount of liquid water
- the pressure would be greater, there would be less liquid water
- the pressure would be the same, there would be more liquid water
- the pressure would be greater, there would be an equal amount of liquid water

## Question 17

1.25 pts

What is the vapor pressure of carbon disulfide at its normal boiling point?

- Not enough information.
- 1.0 atm
- 22.4 atm
- 2.0 atm

## Question 18

1.25 pts

At 20°C the vapor pressure of dry ice is 56.5 atm. If 10g of dry ice (solid  $CO_2$ ) is placed in an evacuated 0.25 L chamber at a constant 20°C, will all of the solid sublime?

- None of dry ice would sublime.
- Yes.
- There is not enough information to answer this question.
- Some of the dry ice will sublime, but not all of it.

## Question 19

1.25 pts

An unknown liquid has a vapor pressure of 88 mmHg at 45°C and 39 mmHg at 25°C. What is its heat of vaporization?

- 32 kJ/mol
- 32,000 kJ/mol
- 2000 kJ/mol
- 2000 J/mol

## Question 20

1.25 pts

\_\_\_\_\_ are made when \_\_\_\_\_ are dissolved in \_\_\_\_\_.

- solutes, solutions, solvents
- solutions, solutes, solvents
- solutions, solvents, solutes
- solvents, solutes, solutions

## Question 21

1.25 pts

Both ammonia ( $NH_3$ ) and phosphine ( $PH_3$ ) are soluble in water. Which is least soluble and why?

- phosphine because it does not form hydrogen bonds with water molecules
- ammonia because it does not form hydrogen bonds with water molecules
- ammonia because the N-H bonds are so strong that they cannot break to enable the ammonia to hydrogen-bond with water
- phosphine because the P-H bonds are so strong that they cannot break to enable phosphine to hydrogen-bond with water

## Question 22

1.25 pts

Rank the following in terms of decreasing miscibility in  $C_8H_{18}$  (octane), a major component of gasoline:  $C_2H_5Cl$  (chloroethane),  $H_2O$  (water),  $C_2H_5F$  (fluoroethane), and  $C_9H_{20}$  (nonane).

- $C_9H_{20} > C_2H_5Cl > C_2H_5F > H_2O$
- $H_2O > C_9H_{20} > C_2H_5Cl > C_2H_5F$
- $C_2H_5Cl > C_2H_5F > H_2O > C_9H_{20}$
- $H_2O > C_2H_5F > C_2H_5Cl > C_9H_{20}$

## Question 23

1.25 pts

Which of the following is a possible combination of values for  $\Delta H_{lattice}$  and  $\Delta H_{hydration}$  respectively for a salt whose dissolution is endothermic?

- 200, -304
- 560, +560
- +500, -520
- +640, -620

## Question 24

1.25 pts

Which of the following would increase the solubility of a gas in water?

1. increase the temperature of the water
2. decrease the temperature of the water
3. increase the pressure of the gas above the water
- 1 only
- 2 only
- 2 and 3
- 1 and 3