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CHEMICAL ENGINEERING REFRESHER PROGRAM

PHYSICAL CHEMISTRY AND CHE THERMODYNAMICS

- How many Chlorine atoms are there in the refrigerant R-151?
 - 1
 - 2
 - 3
 - 4
- An unknown compound weighing 8.05 grams was dissolved in 0.1 kg of benzene. This caused the vapor pressure of the latter to decrease to 94.8 torr from 100.0 torr. What is the molar mass of the solute?
 - 46 g/mol
 - 74 g/mol
 - 115 g/mol
 - None of the above
- Which of the following is a commonly used term referring to the Leclanche cell?
 - Galvanic cell
 - Dry cell
 - Electrolytic cell
 - None of the Above
- How much PbSO_4 will be decomposed if a 5A current will be passed through a lead storage cell during charging process that lasts for 1 hour?
 - 28 grams
 - 56 grams
 - 84 grams
 - None of the above
- Given $\Delta G_{298}/\text{kJ}\cdot\text{mol}^{-1} = 0$ for $\text{Zn}(\text{s})$ and $\text{Cu}(\text{s})$, -147.06 for $\text{Zn}^{2+}(\text{aq})$ and 65.49 for $\text{Cu}^{2+}(\text{aq})$, calculate the cell potential at the given condition.
 - 1.101 V
 - 1.011 V
 - 1.010 V
 - 1.110 V
- What can be concluded about the previously described cell?
 - It is spontaneous at the given conditions.
 - It is non-spontaneous at the given conditions.
 - It may be both spontaneous and non-spontaneous at the given conditions.
 - Its spontaneity cannot be determined at the given conditions.
- A simple cubic structure follows which formula for the volume of its unit cell? Note r = radius of the atom.
 - r^3
 - $8r^3$
 - $27 r^3$
 - None of the above

8. How many equations shown below are true?

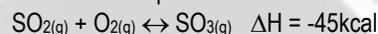
$$\left(\frac{\partial H}{\partial S}\right)_P = T$$

$$\left(\frac{\partial A}{\partial V}\right)_T = -P$$

$$\left(\frac{\partial G}{\partial T}\right)_P = -S$$

- a. 0
b. 1
- c. 2
d. 3
9. Calculate the change in the molar Gibbs free energy of hydrogen gas when it is compressed isothermally from 1 atm to 100 atm at 298K.
- a. 15 kJ/mole
b. 11 kJ/mole
- c. -15 kJ/mole
d. -11 kJ/mole
10. Consider the reaction: $\text{NO}_{2(g)} \leftrightarrow \text{N}_2\text{O}_{4(g)}$. If the equilibrium constant K_p for the said reaction is about 0.480 at room temperature, determine the value of K_c at the same temperature.
- a. 0.020
b. 3.94
c. 11.7
d. None of the above
11. What is the percentage of the lighter alcohol in the vapor above a solution that is composed of equal weights of methanol and ethanol. Assume that the solution is ideal at 60C.
- a. 28%
b. 59%
- c. 72%
d. 41%

Refer to the equilibrium reaction given below for the next two questions:



12. The concentration of SO_3 at equilibrium will increase if
- a. Temperature of the system is lowered
b. The volume of the container is increased
c. SO_2 is removed from the system
d. An inert gas is added to the system at constant volume
13. The number of moles of oxygen at equilibrium will decrease if
- a. Portion of the SO_2 is extracted from the system
b. A catalyst is added
c. An inert gas is added to the system at constant volume
d. SO_3 is removed from the system
14. Which of the following is not an allotrope of carbon?
- a. Fullerene
b. Fullerite
- c. Graphene
d. None of the Above
15. After releasing 2000 milligrams of N_2 , the remaining contents inside the tank now exerts a pressure of 480 mmHg at 30°C from initial conditions of 82°C and 940 mmHg. How many milligrams of gas were left in the same tank?
- a. 3000
b. 5000
- c. 2000
d. None of the above

For the next two numbers, consider a sample of 3 moles of an ideal diatomic gas at 200K is compressed reversibly and adiabatically until its temperature reaches 250K. Given that $C_v = 27.5 \text{ J/mol-K}$,

16. Calculate the work associated with the process.
- a. 0 J
b. $-4.1 \times 10^3 \text{ J}$
- c. $4.1 \times 10^3 \text{ J}$
d. $5.4 \times 10^3 \text{ J}$
17. Calculate the change in the enthalpy of the system.
- a. 0 J
b. $-4.1 \times 10^3 \text{ J}$
- c. $4.1 \times 10^3 \text{ J}$
d. $5.4 \times 10^3 \text{ J}$

18. The times that a steel ball ($7.80 \times 10^3 \text{ kg/m}^3$) required to drop through water and a commercial shampoo were 4.50 secs and 7.00 secs respectively. Given that the density of the latter is $1.03 \times 10^3 \text{ kg/m}^3$, how much more viscous is the shampoo?
- a. 64%
b. 44%
c. 56%
d. 32%
19. If a hydrogen gas is at 0C, calculate the most probable molecular velocity of the said gas in m/s assuming that hydrogen behaves ideally?
- a. 1075
b. 1705
c. 1057
d. None of the Above
20. Determine the heat of reaction for $\text{C}_6\text{H}_6 + \text{H}_2 \rightarrow \text{C}_6\text{H}_{12}$ if the enthalpies of combustion at 25C are -3273, -286.1 and -3924 kJ/mol for benzene, hydrogen and cyclohexane respectively.
- a. -104 kJ
b. -207 kJ
c. -311 kJ
d. None of the Above
21. What is the COP of a refrigerator when operated as a heat pump if it is 400-kW rated engine that can absorb heat of about 1600 kW?
- a. 3
b. 4
c. 5
d. None of the Above
22. According to the Second Law of Thermodynamics, calculate the the maximum power output from an engine that operates with $T_H = 1540\text{F}$ and $T_C = 40\text{F}$ while employing 10^6 BTU/hr of fuel.
- a. 295 hp
b. 1140 hp
c. 3820 hp
d. None of the Above
23. It is defined as the temperature at which real gases exhibit ideal gas behavior for an appreciably longer range of pressure compared to its other temperatures?
- a. Normal Temperature
b. Critical Temperature
c. Boyle's Temperature
d. Arrhenius Temperature
24. What is the numerical value of the gas constant when expressed in L-torr/K-mol?
- a. 63.264
b. 1.986
c. 83.145
d. None of the Above
25. The turbine in a hydroelectric plant is fed by water falling from a height of 30m. Assuming 95% efficiency in converting potential energy to electrical energy and 10% loss of resulting power during transmission, how many metric tons of water per hour are needed to keep a 100W light bulb burning?
- a. 1.43
b. 1.29
c. 1.63
d. 1.75
26. Given the reaction below, calculate the difference between its change in Gibbs and Helmholtz free energies at 25C and 1 atm.
- $$\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \leftrightarrow \text{H}_2\text{O}(\text{l})$$
- a. -256 cal
b. -888 cal
c. -904 cal
d. -1058 cal
27. What is the degree of freedom of a system that is composed of moist air and water inside a closed container?
- a. 1
b. 2
c. 3
d. 4
28. At water's triple point, steam, ice and liquid water are in equilibrium pressure of 4.58 mmHg. At this same temperature, the heats of fusion and vaporization of water is 1436 cal/mole and 10,767 cal/mole respectively. What is the corresponding entropy of sublimation per mole of water?
- a. 49.93 eu/mole
b. 28.90 eu/mole
c. 44.7 eu/mole
d. None of the Above
29. Which of the following cycle does not typically use air as its working fluid?
- a. Regenerative cycle
b. Stirling cycle
c. Neither of the above
d. Both of the above

30. A Brayton cycle compresses air to a pressure of 88.2 psia. Three moles of air are entering at 25C with a C_p of $(7/2)R$. If the cycle receives heat at 560 BTU/mol of air, what is the maximum amount of work it produces?
- 1680 BTU
 - 1008 BTU
 - 672 BTU
 - 224 BTU
31. Calculate the quality of the supplied steam if a supply line carries a two-phase mixture of steam at 300 psi and a small fraction of the flow in the line is diverted through a throttling calorimeter and exhausted to the atmosphere at ambient pressure and a temperature of 250°F.
- 96%
 - 91%
 - 86%
 - 74%
32. It is a type of process that does not involve any amount of energy transfer by heat.
- Isometric
 - Isobaric
 - Isothermal
 - Isocaloric

For the next two numbers, air will be compressed with the use of a compressor that has a shaft work of 240 KJ/kg and will be further released using a nozzle. The initial velocity is zero with 1 bar as its initial pressure under 250C temperature. The pressure at the end of the compressor has been measured to be 3 bars. The velocity and pressure after the nozzle is said to be 600 m/s and 1 bar respectively. The entire system works in an isothermal condition.

33. Calculate for the change in the kinetic energy involved in the process.
- 60 KJ/kg
 - 60 KJ/kg
 - 360 KJ/kg
 - 180 KJ/kg
34. Calculate for the heat involved for the same process in the previous problem.
- 60 KJ/kg
 - 60 KJ/kg
 - 360 KJ/kg
 - 180 KJ/kg
35. Eight grams of oxygen gas at 27C and 10 atm expands adiabatically and reversibly to a final pressure of 1 atm. The work done in the process expressed in Joules is
- 842
 - 445
 - 798
 - 752
36. If 6 liters of a gas at a pressure of 100 kPa are compressed reversibly according to $PV^2=k$ until the volume is a third of its original amount, how much work was used for the compression?
- +1.2 kJ
 - 1.2 kJ
 - 0.6 kJ
 - 0.6 kJ
37. Fifty five gallons of water passes through a heat exchanger and absorbs 28,000 BTU of heat. The exit temperature is 570 R. What is the inlet water temperature in F?
- 72
 - 68
 - 56
 - 49

For the next two numbers, consider that $C_{10}H_8$ melts at 80.2°C. The vapor pressure of its liquid form is 10 torr at 85.8°C and 40 torr at 119.3°C.

38. What is its normal boiling point?
- 453 K
 - 489 K
 - 550 K
 - 467 K
39. Calculate its entropy of vaporization at the boiling point.
- 99 KJ/mol-K
 - 9.9 J/mol-K
 - 9.9 KJ/mol-K
 - 99 J/mol-K
40. The fugacity coefficient of a certain gas at 200 K and 50 bar is 0.72. Calculate the difference of its chemical potential from that of a perfect gas in the same state.
- 0.25 kJ/mole
 - 0.25 kJ/mole
 - 0.55 kJ/mole
 - 0.55 kJ/mole