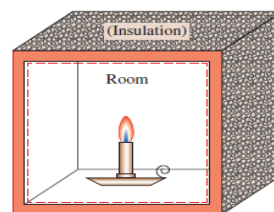


Question One: Choose the most correct answer [40 marks, 2 marks each]

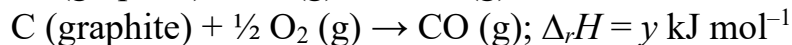
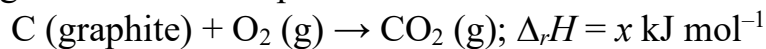
- 1- Thermodynamics can -----.
- (A) identify if a certain process is possible or not under a given set of conditions.
(B) predict the effect of different variables on the extent of a certain reaction.
(C) formulate relationships for the maximum yield of a given reaction.
(D) All of them
- 2- The following dimension is for energy **EXCEPT** -----.
- (A) kWh (B) GJ (C) N m (D) $\text{kg m}^2 \text{s}^{-3}$
- 3- Energy may transfer between systems as -----.
- (A) mass (B) heat (C) work (D) All of them
- 4- ----- is an example for state intensive properties.
- (A) internal energy (C) Volume
(B) Temperature (D) None of them
- 5- Endothermic reactions proceed with the conversion of -----.
- (A) heat into matter (C) heat into potential energy
(B) potential energy into heat (D) matter to heat
- 6- ----- equilibrium indicates the absence of chemical reactions in a system.
- (A) Thermal (B) Mechanical (C) Phase (D) Chemical
- 7- A candle is burnt in a well-insulated room. Taking the air in the room with the candle as the system, the following relations can account for the heat transfer (Q) and the change in the internal energy (ΔU) of the system during this process.
- (A) $Q = +ve, \Delta U = +ve$ (C) $Q = -ve, \Delta U = +ve$
(B) $Q = 0, \Delta U = 0$ (D) $Q = +ve, \Delta U = 0$
- 8- For a mono-atomic ideal gas, the adiabatic index, γ , equals -----.
- (A) $\frac{5}{2}R$ (B) $\frac{5}{3}$ (C) $\frac{3}{5}$ (D) $\frac{2}{5}R$
- 9- The equation representing the effect of pressure on the equilibrium temperature of phase transformations is called the ----- equation.
- (A) Joule-Thomson's (C) Dalton's
(B) Clapeyron's (D) None of them



- 10- According to Hess's law, the enthalpy of vaporization, $\Delta H_{\text{vaporization}}$, of a substance is equal to -----.
- (A) $\Delta H_{\text{fusion}} - \Delta H_{\text{sublimation}}$ (C) $2 \times \Delta H_{\text{fusion}}$
 (B) $\Delta H_{\text{sublimation}} - \Delta H_{\text{fusion}}$ (D) $\Delta H_{\text{sublimation}} + \Delta H_{\text{fusion}}$
- 11- The entropy of any pure perfectly crystalline solid is zero at -----.
- (A) 0°C (C) 273 K
 (B) 0 K (D) None of them
- 12- "The entropy of fusion at the standard (1 atm) freezing point of a solid is about $8.36 \text{ J K}^{-1} \text{ mol}^{-1}$ " is a statement for ----- rule.
- (A) Trouton's (B) Richard's (C) Clausius (D) None of them
- 13- The unit of the universal gas constant is similar to the unit of -----.
- (A) heat energy (C) specific heat capacity
 (B) molar entropy (D) None of them
- 14- Unlike all liquid/solid transformations, the freezing/melting line in the water phase diagram has a ----- slope.
- (A) positive (B) negative (C) zero (D) None of them
- 15- If the internal energy of an ideal gas decreases by the same amount as the work done by the system, the process is -----.
- (A) cyclic (B) adiabatic (C) isothermal (D) isolated
- 16- When heat is supplied to an ideal gas in an isothermal process, the -----.
- (A) gas will consume the supplied heat in doing compression
 (B) gas will consume the supplied heat in doing expansion
 (C) kinetic energy of the gas will increase
 (D) gas will not obey the law of conservation of energy
- 17- In view of the entropy change ($\Delta S = \frac{Q_{\text{rev}}}{T}$) of a system (ΔS_{sys}), its surroundings (ΔS_{surr}) and both (total entropy change, ΔS_{t}), the spontaneous adsorption of dust on the surface of glass should involve -----.
- (A) increasing all S_{sys} , S_{surr} and S_{t} .
 (B) decreasing S_{sys} , and increasing both of S_{surr} and S_{t} .
 (C) increasing S_{sys} , and decreasing both of S_{surr} and S_{t} .
 (D) decreasing both of S_{sys} and S_{surr} and increasing S_{t} .
- 18- In which of the following reactions is $\Delta H = \Delta U$?
- (A) $\text{KI (aq)} + \text{I}_2 \text{ (s)} \rightarrow \text{KI}_3 \text{ (aq)}$
 (B) $\text{H}_2 \text{ (g)} + \text{I}_2 \text{ (g)} \rightarrow 2\text{HI (g)}$

- (C) $6\text{NaOH (aq)} + 3\text{Cl}_2\text{ (g)} \rightarrow 5\text{NaCl (aq)} + \text{NaClO}_3\text{ (aq)} + 3\text{H}_2\text{O (l)}$
(D) $\text{N}_2\text{O}_4\text{ (g)} \rightarrow 2\text{NO}_2\text{ (g)}$

19- Based on the following thermochemical equations, find out which of the following algebraic relationships is correct?



- (A) $x = y - z$ (B) $x = y + z$ (C) $z = x + y$ (D) $y = 2z - x$

20- A criterion of irreversibility for a change in a closed system in absence of any additional non-expansion work is -----.

(A) $(dS)_{V,U} < 0$

(C) $(dH)_{P,S} > 0$

(B) $(dG)_{T,P} < 0$

(D) All of them

Answer only Four problems from the followings (Q2-Q6)

Question Two: Solve the following problem

[5 marks each]

Calculate the maximum annual energy recovery using domestic wastewater to a town of 2,000,000 people, assuming 300 L per day per capita, 200 mg/L of COD, and 15 kJ/g COD? (1 year = 365 days). How much is this electricity worth in a year at LE 5/kWh? How many homes would this power, assuming 2 kW/home?

Question Three: Solve the following problem**[5 marks]**

A sample containing 1.0 mol of an ideal gas is expanded isothermally and reversibly to ten times its original volume, in two separate experiments. The expansion is carried out at 300 K and at 600 K respectively. Calculate the ratio of the work done at 600 K to the work done at 300 K and the change in internal energies in both processes?

Question Four: Solve the following problem**[5 marks]**

Calculate the entropy change when one mole of water vapor is heated from 500 to 1000 K. Given the following c_p of water?

$$c_p = 7.219 + 2.374(10^{-3}T) + 2.67(10^{-7}T^2) \text{ cal } K^{-1}mol^{-1}$$

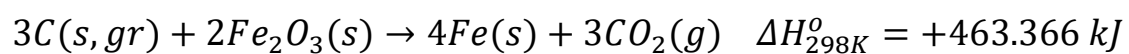
Question Five: Solve the following problem**[5 marks]**

A rigid tank contains 10 kg of saturated liquid and vapor water at 75°C. Only 3 kg of water is in liquid state. Estimate the enthalpy of the saturated mixture and the volume of the tank using the following steam table.

$T(K)$	P^{sat} (kPa)	V (cm ³ /g)		U (kJ/kg)		H (kJ/kg)		S (kJ/kg K)	
		V_l	V_g	U_l	U_g	H_l	H_g	S_l	S_g
347.15	36.96	1.025	4300.0	309.7	2474.8	309.7	2633.7	1.0034	7.6979
348.15	38.55	1.026	4134.1	313.9	2476.0	313.9	2635.4	1.0154	7.6835
349.15	40.19	1.027	3975.7	318.1	2477.3	318.1	2637.1	1.0275	7.6693
350.15	41.89	1.027	3824.3	322.3	2478.5	322.3	2638.7	1.0395	7.6551

Question Six: Solve the following problem**[5 marks]**

Calculate the standard heat of formation of $\text{Fe}_2\text{O}_3(\text{s})$ using the following equation, knowing that ΔH°_f of $\text{CO}_2(\text{g})$ is -393.317 kJ/mol ?

**[END of Questions] GOOD LUCK**