24-3-17

DOON UNIVERSITY, DEHRADUN

Mid Sem Examination, Even Semester, 2016–2017
School of Physical Sciences (SoPS)
Second semester, Integrated M.Sc. 5 Years (Chemistry)

Dated: 24 Mar 2017 (Friday)

Course: *Phys. Chem. II: Chemical Thermodynamics* **Course Code:** *CYC–152*

Time Allowed: 2Hours ***Maximum Marks: 30***

Note: Attempt All Questions from Sections A, B and C. (All terms have their usual meaning)

SECTION: A ***(Marks: 6)***

[1] Which of the following is the BEST example of an isolated system?

A). Water in a styrofoam coffee cup

B). Liquid in a beaker with a watch glass over it

C). Soda in an unopened soft drink can

D). Coffee in a closed thermos bottle [1/2]

[2] A mathematical approach to the first law of thermodynamics produced which equation?

A). $U = q + w$ B). $q = U + w$ C). $U = q - w$ D).None [1/2]

[3] The volume of an ideal gas is reduced to half from its original volume. The specific heat will

A). Reduced to half

B). Doubled

C). Remain constant

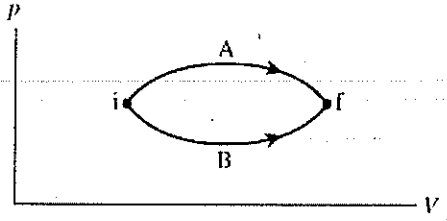
D). Increase four times [1/2]

[4] For the two processes shown, which of the following is TRUE:

A). $Q_A < Q_B$,

B). $Q_A > Q_B$,

C). $Q_A = Q_B$, D). It is a cyclic process



[1/2]

[5] Which of the following statement is CORRECT for ideal gases:

(i) Isothermal reversible work of expansion is greater in magnitude than the adiabatic reversible work of expansion

(ii) Irreversible work is less in magnitude than the respective reversible work for both isothermal and adiabatic processes

(iii) Free expansion is a reversible process

(iv) In the irreversible expansion, external pressure is much larger than the internal pressure

A). (i) and (iii) B). (i) and (ii) C). (i), (ii) and (iv) D) None [1/2]

[6] The enthalpies of elements in their standard states are taken as zero. The enthalpy of formation of the compound

A). is always negative

B). is always positive

C). may be positive or negative

D). is never negative [1/2]

[7] Define extensive and intensive properties, give some suitable examples. [1]

[8] In a Carnot cycle, write down the expression for total work done, total heat transferred, change in enthalpy and change in internal energy for one mole of an ideal gas. [1]

[9] Write Hess's law. What are its applications? [1]

SECTION: B ***(Marks: 12)***

[10] (a) Define specific heat capacity. Lead, water, sulphur and arsenic have specific heats of 0.128, 4.18, 0.706 and 0.329 J/g^{o}C, respectively. Arrange the decreasing order of heat required by these materials to increase their temperature by 10 ^{o}C (assume all samples have same mass). [1]

[10] (b) Define spontaneous process and write down second law of thermodynamics. [1]

[11] (a) Define standard enthalpy of combustion.The combustion of methane (CH_4) releases 891 kJ of energy. The heat of formations of CO_2 = -393 kJ/mol and $H_2O_{(l)}$ = -286 kJ/mol. What is the heat of formation of methane? [1]

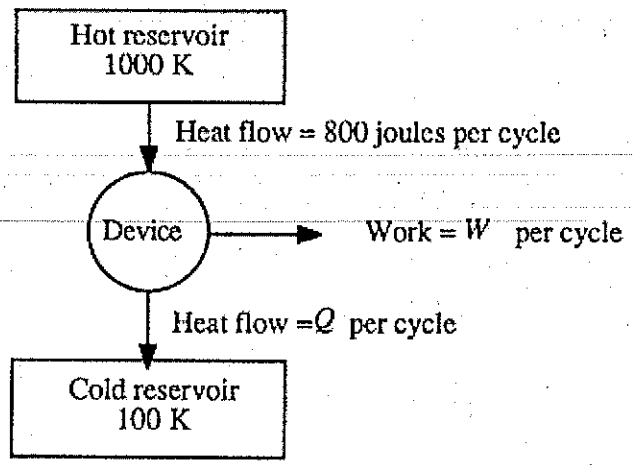
[11] (b) If 'P' is the experimental and 'Q' is the theoretical standard enthalpy of formation of benzene, from these values, how can you calculate resonance energy for benzene? [1]

[12] By taking an example (assuming same initial states and same range of volume change for isothermal and adiabatic processes), draw the PV- plots for following expansions:

(a) Reversible isothermal and adiabatic expansion [1]

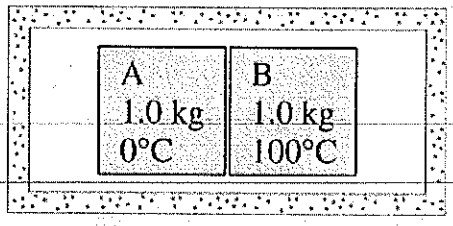
(b) Irreversible isothermal and adiabatic expansion [1]

[13] (a) Calculate the theoretical upper limit to the amount of work per cycle which can be obtained from cyclic device. Also calculate the amount of heat transferred to the cold reservoir (per cycle).



[1]

[13] (b) Object A and B are brought into close thermal contact with each other under isolated condition. Initially, $T_A = 0\ ^\circ C$ and $T_B = 100\ ^\circ C$. The specific heat of A is more than the specific heat of B. The two objects will soon reach a common temperature T_f. What will be the value of attained final temperature? (***In terms of*** greater than, less than or equal to 50 °C)



[1]

[14] (a) How much work in joules is done by an ideal gas, when a piston expands from a volume of 13.27 liters to 76.55 liters against a pressure of 14.89 atm? [1]

[14] (b) Write the expression of internal pressure $(\delta U/\delta V)_T$, for ideal and real gases. [1]

[15] Define efficiency of a heat engine. If coefficient of performance of a refrigerator and efficiency of a hot engine operating between same temperatures is 'X' and 'Y' respectively, ***establish*** the relation between X and Y. [2]

SECTION: C *(Marks: 12)*

[16] (a) Using first law of thermodynamics, establish the relation between P-V, V-T and P-T in a reversible adiabatic expansion for one mole of ideal gas. [3]

[16] (b) ΔH^{o}_{f} of SO_2 is $-297.5\ kJmol^{-1}$. Calculate the energy required for the decomposition of 5.6 liter of SO_2 (at STP). [2]

[16] (c) What is the relation between ΔH and ΔU for the following reaction:

$$C(S) + 2H_2(g) \longrightarrow CH_4(g)$$ [1]

[17] (a) Derive Kirchoff's equation depicting the variation of enthalpy of reaction with temperature. Write down the integrated form of the equation. [3]

[17] (b) A Carnot engine converts one-sixth of heat input into work. When the temperature of the sink is reduced by 62 °C, its efficiency is doubled. Find the temperature of the source and the sink. [2]

[17] (c) Define adiabatic flame temperature. In which condition (isochoric/isobaric) we can achieve higher value of adiabatic flame temperature? [1]