Date Planned : __ / __ / __	Daily Tutorial Sheet - 2	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	JEE Advanced (Archive)	Exact Duration :_____

16. In order to get maximum calorific output, a burner should have an optimum fuel to oxygen ratio which corresponds to 3 times as much oxygen as is required theoretically for complete combustion of the fuel. A burner which has been adjusted for methane as fuel (with x litre/hour of CH_4 and 6x litre/hour of O_2) is to be readjusted for butane, C_4H_{10}. **(1994)**

In order to get the same calorific output, what should be the rate of supply of butane and oxygen? Assume that losses due to incomplete combustion etc., are the same for both fuels and that the gases behave ideally. Heats of combustions:

$CH_4 = -809$ kJ / mol, $C_4H_{10} = -2878$ kJ / mol

17. The standard molar enthalpies of formation of cyclohexane (ℓ) and benzene (ℓ) at 25°C are -156 and + 49 kJ mol^{-1} respectively. The standard enthalpy of hydrogenation of cyclohexene (ℓ) at $25°C$ is -119 kJ mol^{-1}. Use these data to estimate the magnitude of the resonance energy of benzene. **(1996)**

18. Compute the heat of formation of liquid methyl alcohol in kJ mol^{-1}, using the following data. Heat of vaporization of liquid methyl alcohol = 38 kJ/mol. Heat of formation of gaseous atoms from the elements in their standard states: **(1997)**

H = 218 kJ/mol, C = 715 kJ/mol, O = 249 kJ/mol.

Average bond energies:

C – H = 415 kJ / mol, C – O = 356 kJ / mol, O – H = 463 kJ / mol

19. From the following data, calculate the enthalpy change for the combustion of cyclopropane at 298 K. The enthalpy of formation of $CO_2(g), H_2O(\ell)$ and propene (g) are -393.5, -285.8 and 20.42 kJ mol^{-1} respectively. The enthalpy of isomerisation of cyclopropane to propene is -33.0 kJ mol^{-1}. **(1998)**

20. Diborane is a potential rocket fuel which undergoes combustion according to the reaction. **(2000)**

$$B_2H_6(g) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(g)$$

From the following data, calculate the enthalpy change for combustion of diborane.

$$2B(s) + \frac{3}{2}O_2(g) \rightarrow B_2O_3(s); \qquad \Delta H = -1273 \text{ kJ mol}^{-1} \qquad \text{(i)}$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell); \qquad \Delta H = -286 \text{ kJ mol}^{-1} \qquad \text{(ii)}$$

$$H_2O(\ell) \rightarrow H_2O(g); \qquad \Delta H = 44 \text{ kJ mol}^{-1} \qquad \text{(iii)}$$

$$2B(s) + 3H_2(g) \rightarrow B_2H_6(g); \qquad \Delta H = 36 \text{ kJ mol}^{-1} \qquad \text{(iv)}$$

21. The ΔH_f° for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are $-393.5, -110.5$ and -241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ) for the reaction: $CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$ is : **(2000)**

(A) $+524.1$ **(B)** $+41.2$ **(C)** -262.5 **(D)** -41.2

22. Which of the following reactions defines ΔH_f° ? **(2003)**

(A) $C_{(diamond)} + O_2(g) \rightarrow CO_2(g)$

(B) $\frac{1}{2}H_2(g) + \frac{1}{2}F_2(g) \rightarrow HF(g)$

(C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

(D) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

23. The heats of combustion of carbon and carbon monoxide are -393.5 and $-283.5\,kJ\,mol^{-1}$, respectively. The heat of formation (in kJ) of carbon monoxide per mole is : **(2004)**

(A) 676.5 **(B)** –676.5 **(C)** –110 **(D)** 110

24. For the reaction, $2CO + O_2 \rightarrow 2CO_2$; $\Delta H = -560\,kJ$. Two moles of CO and one mole of O_2 are taken in a container of volume 1L. They completely form two moles of CO_2, the gases deviate appreciably from ideal behaviour. If the pressure in the vessel changes from 70 to 40 atm, find the magnitude (absolute value) of ΔU at 500 K. (1L atm = 0.1kJ) **(2006)**

25. In a constant volume calorimeter, 3.5 g of a gas with molecular weight 28 was burnt in excess oxygen at 298.0 K. The temperature of the calorimeter was found to increase from 298.0 K to 298.45 K due to the combustion process. Given that the heat capacity of the calorimeter is $2.5\,kJ\,K^{-1}$, the numerical value for the enthalpy of combustion of the gas in $kJ\,mol^{-1}$ is _____. **(2009)**

26. The species which by definition has zero standard molar enthalpy of formation at 298 K is : **(2010)**

(A) $Br_2(g)$ **(B)** $Cl_2(g)$

(C) $H_2O(g)$ **(D)** $CH_4(g)$

27. Using the data provided, calculate the multiple bond energy ($kJ\,mol^{-1}$) of a $C \equiv C$ bond in C_2H_2. Take the bond energy of a $C-H$ bond as $350\,kJ\,mol^{-1}$: **(2012)**

$2C(s) + H_2(g) \rightarrow C_2H_2(g)$; $\Delta H = 225\,kJ\,mol^{-1}$

$2C(s) \rightarrow 2C(g)$; $\Delta H = 1410\,kJ\,mol^{-1}$

$H_2(g) \rightarrow 2H(g)$; $\Delta H = 330\,kJ\,mol^{-1}$

(A) 1165 **(B)** 837

(C) 865 **(D)** 815

28. The standard enthalpies of formation of $CO_2(g)$, $H_2O(\ell)$ and glucose(s) at 25°C are $-400\,kJ/mol$, $-300\,kJ/mol$ and $-1300\,kJ/mol$, respectively. The standard enthalpy of combustion per gram of glucose at 25°C is : **(2013)**

(A) +2900 kJ **(B)** −2900 kJ

(C) −16.11 kJ **(D)** +16.11 kJ

29. Given : $C_{(graphite)} + O_2(g) \rightarrow CO_2(g)$; $\Delta_r H^\circ = -393.5$ kJ mol^{-1} **(2017)**

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l); \quad \Delta_r H^\circ = -285.8 \text{ kJ mol}^{-1}$$

$$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g); \Delta_r H^\circ = +890.3 \text{ kJ mol}^{-1}$$

Based on the above thermochemical equations, the value of $\Delta_r H^\circ$ at 298 K for the reaction $C_{(graphite)} + 2H_2(g) \rightarrow CH_4(g)$ will be:

(A) – 144.0 kJ mol^{-1} **(B)** +74.8 kJ mol^{-1}

(C) + 144.0 kJ mol^{-1} **(D)** – 74.8 kJ mol^{-1}

30. The surface of copper gets tarnished by the formation of copper oxide. N_2 gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the N_2 gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below : **(2018)**

$$2Cu(s) + H_2O(g) \rightarrow Cu_2O(s) + H_2(g)$$

p_{H_2} is the minimum partial pressure of H_2 (in bar) needed to prevent the oxidation at 1250 K. The value of $\ln(p_{H_2})$ is _____.

(Given: total pressure = 1 bar,
R (universal gas constant) = 8 J K^{-1} mol^{-1}, ln(10) = 2.3. Cu(s) and $Cu_2O(s)$ are mutually immiscible.

At 1250 K : $2Cu(s) + \frac{1}{2}O_2(g) \rightarrow Cu_2O(s)$; $\Delta G^- = -78000$ J mol^{-1}

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g); \quad \Delta G^- = -178000 \text{ J mol}^{-1}; \text{ (G is the Gibbs energy)}$$

31. Choose the reaction(s) from the following options, for which the standard enthalpy of reaction is equal to the standard enthalpy of formation. **(2019)**

(A) $2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$ **(B)** $2C(g) + 3H_2(g) \longrightarrow C_2H_6(g)$

(C) $\frac{1}{8}S_8(s) + O_2(g) \longrightarrow SO_2(g)$ **(D)** $\frac{3}{2}O_2(g) \longrightarrow O_3(g)$