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| **Name:**<br>**Enrolment No:** | UPES<br>UNIVERSITY WITH A PURPOSE |

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination (Online Mode), January 2021**

**Course:** Advanced Physical Chemistry **Semester:** I
**Program:** MSc Chemistry **Time:** 3 hrs
**Course Code:** CHEM7016 **Max. Marks:** 100

**SECTION - A** **6 x 5 = 30 Marks**

**1. Each Question will carry 5 Marks**
**2. Instruction: Complete the statement / Select the correct and type answer(s)**

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| Q 1 | Heat supplied to a carnot engine is 1897.8 kJ. How much useful work can be done by the engine which works between 0 $^oC$ and 100 $^oC$?<br>(a) 508.7 kJ (c) 948.9 kJ<br>(b) 1897.8 kJ (d) 254.3 kJ | CO1 |
| Q 2 | Ether boils at 33.5 $^oC$ at one atmosphere pressure. At what temperature will it boil at a pressure of 750 mm, given that the heat of vaporization of ether is 369.86 joules per gram.<br>(a) 33.5 $^oC$ (c) 100 $^oC$<br>(b) 32.9 $^oC$ (d) 273 $^oC$ | CO1 |
| Q 3 | A first order reaction is one-fifth completed in 40 minutes. Calculate the time required for its 100% completion.<br>(a) 200 minutes (c) 40 minutes<br>(b) 100 minutes (d) infinite | CO1 |
| Q 4 | The $t_{1/2}$ of a reaction is halved as the initial concentration of the reactant is doubled. What is the order of the reaction?<br>(a) First order (c) third order<br>(b) Second order (d) zero order | CO1 |
| Q 5 | The minimum uncertainty in the momentum of a 4He atom confined to 0.40 nm will be<br>(a) 2.02 X $10^{-25}$ kg m/s (b) 2.53 X $10^{-25}$ kg m/s<br>(c) 2.64 X $10^{-25}$ kg m/s (d) 2.89 X $10^{-25}$ kg m/s | CO1 |
| Q 6 | The function Cos ax is an eigen function of which of the following operators<br>(a) d/dx (b) $d^2/dx^2$<br>(c) Both of these (d) None of these. | CO2 |

**SECTION – B** **10 x 5 = 50 Marks**

**1. Each question will carry 10 marks**
**2. Instruction: Write short / brief notes/upload file**

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| Q 7 | The free energy change (ΔG) accompanying a given process is -85.77 kJ at 25 $^{o}$C and -83.68 kJ at 35 $^{o}$C. Calculate the change in enthalpy (ΔH) for the process at 30 $^{o}$C. | CO1 |
| Q 8 | Consider the following cell:<br>Ag(s), $Ag^{+}$ (a= 0.001 *m*) II $Ag^{+}$ (c= 0.1 *m*, a unknown), Ag(s) *m*<br>Its EMF at 25 $^{o}$C is +0.1110V. (a) Write the cell reaction, and (b) Calculate the activity coefficient of the $Ag^{+}$ ion in 0.1 *m* solution. | CO2 |
| Q 9 | Find the degree of dissociation of HF in 1M aqueous solution. The value of K for the ionic equilibrium $HF \rightleftarrows H^{+} + F^{-}$ is $7.2 \times 10^{-4}$. | CO2 |
| Q10 | Derive an expression for the operator $\left(\frac{d}{dx} + x\right)^2 \Psi(x)$ | CO2 |
| Q 11 | Apply quantum mechanical principles to calculate the coefficients of atomic orbitals in $sp^2$ hybrid orbitals and write their wave functions.<br>***OR***<br>The pure rotational spectrum of gaseous HCl contains a series of equally spaced lines separated by 20.80 $cm^{-1}$. Calculate the internuclear distance of the molecule. The atomic masses of H and Cl are $1.673 \times 10^{-27}$ kg and $58.06 \times 10^{-27}$ kg respectively. | CO3 |
| **Section – C** | | **1 x 20 = 20 Marks** |
| **1. Each Question carries 20 Marks.**<br>**2. Instruction: Write long answers /upload file.** | | |
| Q 12 | (a) The vapor pressure of liquid mercury at 433 K is 4.19 mmHg. Calculate the free energy change accompanying the expansion of one mole of mercury vapor in equilibrium with liquid at 433 K to a pressure of 1 atm at the same temperature assuming the vapor behaves like an ideal monoatomic gas.<br>***OR***<br>Calculate the activation energy of a reaction whose rate constant is tripled by a 10 $^{o}$C rise in temperature in the vicinity of 27 $^{o}$C.<br><br>(b) For the first-order isomerization of an organic compound at 130 $^{o}$C, the activation energy is 108.4 kJ $mol^{-1}$ and the rate constant is $9.12 \times 10^{-4}$ $s^{-1}$. Calculate the standard entropy of activation for this reaction.<br><br>***OR***<br>Describe the Lindemann theory of unimolecular reactions. | CO3<br>CO3<br>CO3<br>CO3 |