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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018
Course: Chemical Eng I (Thermodynamics & Measuring A. Inst.) - CHEG236   **Semester: III**
Programme: BTech (FSE)
Time: 03 hrs.   **Max. Marks: 100**

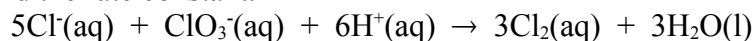**Instructions: All Questions in Section A are compulsory. Section B has 5**

SECTION A (Maximum marks 20)

S. No.		Marks	COs
Q 1	For a gas whose equation of state is $P(V - b) = RT$, the specified heat difference $c_p - c_v$ is equal to (a) R (b) R - b (c) R + b (d) 0 (e) R(1 + v/b)	2	CO1
Q2	What is specific gravity? How is it related to density?	2	CO1
Q3	Bimetal thermostats is made up of two metallic strips with different _____ a) Melting point temperature b) Coefficient of thermal expansion c) Cross sectional areas d) Density	2	CO1 , 4
Q4	IR spectrophotometer uses electromagnetic radiations in the range of a) 185 – 400 nm b) 400 – 700 nm c) 700 – 15000 nm d) 900 – 12000 nm	2	CO4
Q5	Polymers made from identical unit of monomers is called _____ a) Copolymer b) Homopolymer c) Multipolymer d) Unipolymer	2	CO5
Q6	One kmol of methane (CH_4) is burned with an unknown amount of air during a combustion process. If the combustion is complete and there are 1 kmol of free O_2 in the products, the air–fuel mass ratio is (a) 34.6 (b) 25.7	2	CO2

	(c) 17.2 (d) 14.3 (e) 11.9		

Q7	Answer the following questions. Support your answer with the help of an example.
	    a) How the density of manometric fluid effects the pressure measurement in a U-tube manometer?
	    b) Is *entropy* a conserved property? Comment
	    c) Consider a fish swimming 5 m below the free surface of water. The increase in the pressure exerted on the fish when it dives to a depth of 45 m below the free surface is:
	       (i) 392 Pa
	       (ii) 9800 Pa
	       (iii) 50,000 Pa
	       (iv) 392,000 Pa
	       (v) 441,000 Pa
		3×2 = 6	CO1 , 4

Q8	Rates of most reactions are very sensitive to temperature. A mere rise of 10°C can lead to _____ the reaction rate **(More than one option may be correct).**
	    a) Decrease in
	    b) Doubling of
	    c) Exponential rise in
	    d) Unpredictable rise in
		2	CO1 , 2

	SECTION B (Maximum marks 40)		

Q 9	For the following reaction given by equation aA + bB → cC + dD
	    i) Write the generic rate equation.
	    ii) Units of rate equation.
	    iii) State the Le Chatelier's principle.
	    iv) What effect order of reaction has on overall rate of reaction?
		8	CO2

Q10	What are controllers and what is the role of controllers in chemical process industry? Explain the various modes of control. Of the various types of controllers which one is the easiest to implement and why?	8	CO3
Q11	Explain the principle behind the working of a strain gauge. How is the resistance in a metal related to the applied force? What instrument is used to measure the change is resistance? Explain its working.	8	CO3
Q12	Explain inversion line, inversion temperature and maximum inversion temperature in context with Joule-Thompson coefficient. Which part of refrigeration cycle exploits Joule-Thompson effect and how? **Or** A Carnot heat engine receives 500 kJ of heat per cycle from a high temperature reservoir at 650 °C and rejects the heat to a low temperature sink at 30 °C. Determine: i) The thermal efficiency of this Carnot engine ii) The amount of heat rejected to the sink per cycle, and iii) Can we further increase the efficiency of this heat engine? If yes, list the possible ways that would help increase its efficiency.	8	CO1 , 3
Q13	Describe the effects of electromagnetic radiation on molecules with the help of a chart. What are the various instrument used for the determination of structure of chemicals? What is the principle on which XRD is based?	8	CO2 , 5

Or

Using the initial rate and chemical data given in the table below. Determine rate equation and the rate constant.

$$5Cl^-(aq) + ClO_3^-(aq) + 6H^+(aq) \rightarrow 3Cl_2(aq) + 3H_2O(l)$$

	$[Cl^-(aq)]$ / mol dm^{-3}	$[ClO_3^-(aq)]$ / mol dm^{-3}	$[H^+(aq)]$ / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.15	0.08	0.20	1.0×10^{-5}
2	0.15	0.08	0.40	4.0×10^{-5}
3	0.15	0.16	0.40	8.0×10^{-5}
4	0.30	0.08	0.20	2.0×10^{-5}

SECTION-C (Maximum marks 40)

Q 14	The importance of temperature measurement and control cannot be understated. Many gadgets of day to day use as well as sophisticated equipment used in industry require monitoring and control of temperature.
	  i) Which law of thermodynamics describes the absolute temperature scale?
	  ii) What are the various temperature measurement techniques? Describe the working principle of each of the temperature measurement techniques.
	  iii) Write advantage and disadvantage of various temperature measurement techniques.
		20	CO1 ,4

Q15	Discovery of synthetic polymers resulted in the age of plastic fantastic.
	  i) What are polymers? Explain the molecular structure of polymers with the help of diagrams and comment on relative strength of various polymer structures.
	  ii) How is molecular weight of a polymer calculated?
	  iii) Calculate the molecular weight for a polymer with number and mass of monomer given as below:
	
		Number of monomer units	Mass of monomer units(Kg)

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1	100
3	120
4	180
2	200

1	280 |
	
	OR
	
	Knowing kinetics of a chemical reaction is crucial for design of a chemical reactor.
	  i) What are the various methods used for the determination of rate equations?
	  ii) Give the classification of various types of chemical reactor and their
		20	CO5

		describe the principle on which they function		

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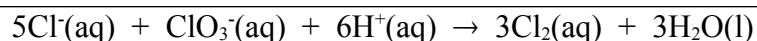Time: 03 hrs.   Max. Marks: 100
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SECTION A (Maximum marks 20)

S. No.		Marks	COs
Q 1	Ionic bonding requires _____ (Choose all the options, applicable) a)　Transfer of electrons b)　Sharing of electrons c)　Large difference in electronegativity's d)　Large number of lone pair electrons	2	CO2
Q2	Displacers used for level sensing work on _____ a)　Bernoulli's principle b)　Archimede's principle c)　Newton's 1st law d)　Newton's 2nd law	2	CO1
Q3	Bimetal thermostats is made up of two metallic strips with different _____ 　a)　Melting point temperature 　b)　Coefficient of thermal expansion 　c)　Cross sectional areas 　d)　Density	2	CO2,4
Q4	IR spectrophotometer uses electromagnetic radiations in the range of 　a)　185 – 400 nm 　b)　400 – 700 nm 　c)　700 – 15000 nm 　d)　900 – 12000 nm	2	CO2
Q5	Strain gauge is a device which is used to measure: 　a)　Temperature 　b)　Stress 　c)　Weight 　d)　Mass	2	CO2,4
Q6	One kmol of methane (CH_4) is burned with an unknown amount of air during a combustion process. If the combustion is complete and there are 1 kmol of free O_2 in the products, the air–fuel mass ratio is (a) 34.6 (b) 25.7 (c) 17.2 (d) 14.3 (e) 11.9	2	CO2
Q7	Answer the following questions. Support your answer with the help of an example. 　d)　How the density of manometric fluid effects the pressure measurement in a U-tube manometer? 　e)　Is *entropy* a conserved property? Comment 　f)　Consider a fish swimming 5 m below the free surface of water. The	3×2 = 6	CO1,4

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Q8	Rates of most reactions are very sensitive to temperature. A mere rise of 10°C can lead to _____ the reaction rate **(More than one option may be correct).** a) Decrease in b) Doubling of c) Exponential rise in d) Unpredictable rise in	**2**	**CO2**
SECTION B (Maximum marks 40)			
Q 9	For the following reaction given by equation $aA + bB \rightarrow cC + dD$ i) Write the generic rate equation. ii) Units of rate equation. iii) State the Le Chatelier's principle. iv) What effect order of reaction has on overall rate of reaction?	**8**	**CO2**
Q10	What are controllers and what is the role of controllers in chemical process industry? Explain the various modes of control. Of the various types of controllers which one is the easiest to implement and why?	**8**	**CO4**
Q11	A rigid tank contains a hot fluid that is cooled while being stirred by a paddle wheel. Initially, the internal energy of the fluid is 800 kJ. During the cooling process, the fluid loses 500 kJ of heat, and the paddle wheel does 100 kJ of work on the fluid. Determine the final internal energy of the fluid. Neglect the energy stored in the paddle wheel. Clearly explain all the assumptions made in solving the problem.	**8**	**CO1,3**
Q12	Explain inversion line, inversion temperature and maximum inversion temperature in context with Joule-Thompson coefficient. Which part of refrigeration cycle exploits Joule-Thompson effect and how? **Or** A Carnot heat engine receives 500 kJ of heat per cycle from a high temperature reservoir at 650 °C and rejects the heat to a low temperature sink at 30 °C. Determine: i) The thermal efficiency of this Carnot engine ii) The amount of heat rejected to the sink per cycle, and iii) Can we further increase the efficiency of this heat engine? If yes, list the possible ways that would help increase its efficiency.	**8**	**CO1,3**
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Q15	What factors dictate the type of bonding that may exist between various chemical species? Describe the characteristics of metallic crystals. Define Atomic packing factor (APF) and calculate the atomic packing factor for a body centered cubic structure. **OR** Knowing kinetics of a chemical reaction is crucial for design of a chemical reactor. i) What are the various methods used for the determination of rate equations? ii) Give the classification of various types of chemical reactor and their describe the principle on which they function	20	CO5