Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2022

Course: Air Fractionation and Purification of Gases **Semester: VIII**
Program: B. Tech. APE-Gas **Time : 03 hrs.**
Course Code: CHGS 4002 **Max. Marks: 100**

Instructions: Assume any missing data. The notations used here have the usual meanings. Draw the diagrams, wherever necessary.

	SECTION A **(5Q x 4M = 20 Marks)**		
S. No.		**Marks**	**CO**
Q 1	Discuss the three factors affecting the optimum recovery of Argon in liquid plants.	**4**	**CO2**
Q2	What are the applications of industrial gases in different sectors?	**4**	**CO1**
Q3	Define the Lachmann principle.	**4**	**CO3**
Q4	What are the different methods employed for the production of carbon monoxide?	**4**	**CO2**
Q5	Discuss the applications of Neon.	**4**	**CO1**
	SECTION B **(4Q x 10M = 40 Marks)**		
Q6	Discuss the functions of the three operating control valves in the operation of a standard air separation plant.	**10**	**CO4**
Q7	Discuss the recovery of carbon monoxide and hydrogen from partial oxidation of methane using a methane wash by absorption followed by fractionation	**10**	**CO3**
Q8	Discuss the separation of oxygen using vacuum pressure swing adsorption (VPSA).	**10**	**CO4**
Q9	Explain the recovery of food grade carbon dioxide from petroleum off gases.	**10**	**CO2**
	SECTION-C **(2Q x 20M = 40 Marks)**		
Q10	Helium gas is compressed from 0.303 MPa and 275 K to 4.04 MPa and 300 K in a Claude refrigerator utilizing a wet expander with a saturated-vapor compressor. Twenty percent of the compressed gas is diverted through the main expander entering at 190 K and leaving at 0.303 MPa. The helium enters the low temperature compressor at 0.101 MPa as saturated vapor and leaves at 0.303 MPa. If the compressors, expanders and heat exchangers for this refrigerator are assumed to be ideal, determine the refrigeration effect, coefficient of performance and figure of	**20**	**CO4**

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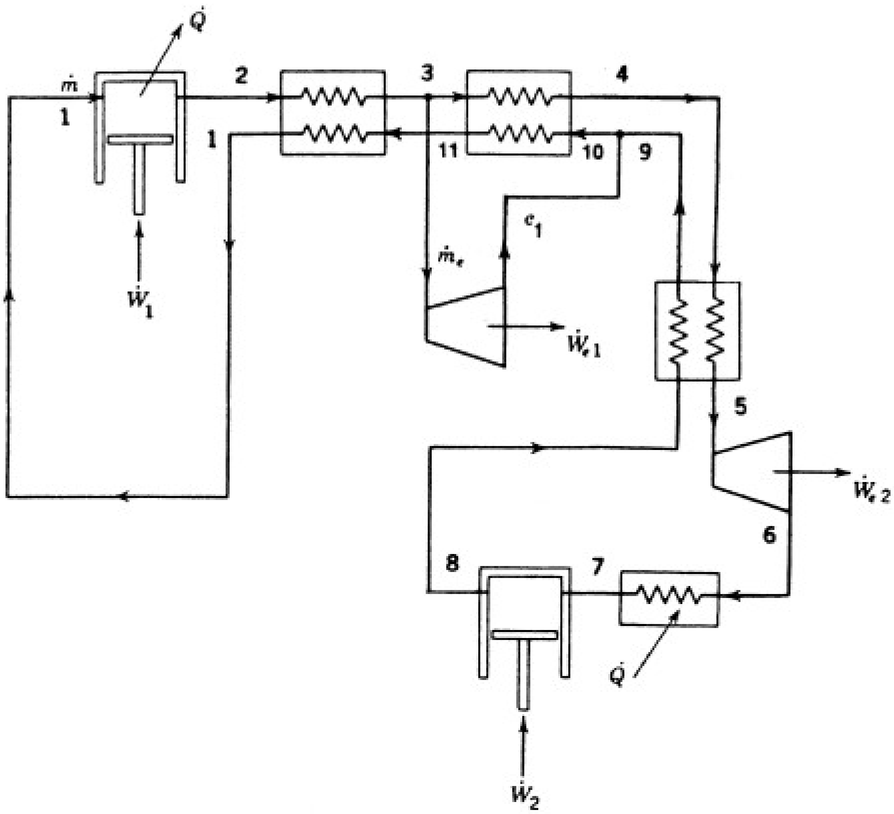
<td>merit when no expander work is recovered. The following thermodynamic properties for helium are:
h(0.303 MPa, 275 K) = 1444 kJ/kg
s(0.303 MPa, 275 K) = 28.7 kJ/kg-K
h(4.04 MPa, 300 K) = 1586 kJ/kg
s(4.04 MPa, 300 K) = 23.75 kJ/kg-K
h(4.04 MPa, 190 K) = 1013 kJ/kg
s(4.04 MPa, 190 K) = 21.4 kJ/kg-K
h (0.l01 MPa, saturated vapor) = 31 kJ/kg
s(0.101 MPa, saturated vapor) = 8.4 kJ/kg-K
h (0.101 MPa, saturated liquid) = 10 kJ/kg
s (0.101 MPa, saturated liquid) = 3.45 kJ/kg-K


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<td>Q11</td>
<td>Determine the number of theoretical plates required in a single-column distillation system to yield 70 mol % argon as the overhead product and 98 mol % oxygen as the bottom product if the feed stream in this argon recovery unit is 12 % argon and 88 % oxygen by volume with a flow rate of 12 gmol/s. The feed is a saturated vapor with an enthalpy of 6050 J/gmol; the bottoms product is a saturated liquid with an enthalpy of 235 J/gmol while the overhead product is a saturated vapor with an enthalpy of 6010 J/gmol. The average heat of vaporization of the mixture is 5815 J/gmol. Heat removed in the overhead condenser is 330 kW. The equilibrium data for the argon-oxygen system at a pressure of 0.203 MPa are given below:</td>
<td>20</td>
<td>CO5</td>
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X	0	0.05	0.1	0.15	0.20	0.25	0.3	0.35	0.4	0.45
Y	0	0.072	0.140	0.204	0.266	0.325	0.382	0.436	0.489	0.539

X	0.5	0.55	0.6	0.65	0.70	0.75	0.8	0.85	0.9	0.95
Y	0.588	0.635	0.680	0.724	0.767	0.809	0.849	0.888	0.927	0.964