UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELORS OF ENGINEERING TECHNOLOGY MINING ENGINEERING
SUBJECT	:	**OCCUPATIONAL HYGIENE 3A**
CODE	:	**OCCUPA3**
DATE	:	SUPPLEMENTARY SUMMATIVE ASSESSMENT 15 JULY 2019
DURATION	:	3 HOURS
WEIGHT	:	60% OF FM
TOTAL MARKS	:	100

EXAMINER	:	MR H STRAUSS
MODERATOR	:	MR E M MOCHUBELE
NUMBER OF PAGES	:	7 PAGES

INSTRUCTIONS	:	QUESTION PAPERS MUST BE HANDED IN
REQUIREMENTS	:	1 SCRIPT, SECOND ON REQUEST

INSTRUCTIONS TO CANDIDATES:

WRITE YOUR STUDENT NUMBER ON THE FRONT PAGE OF YOUR QUESTION PAPER BEFORE YOU START ANSWERING QUESTIONS.

ANSWER ALL THE QUESTIONS.

HAND IN YOUR QUESTION PAPER WITH YOUR SCRIPT.

QUESTION 1 Occupational Hygiene

1.1 The three main components of the human respiratory system are the nose, the pharynx and the lungs. Briefly describe the purpose of each. (6)

1.2 Describe two natural defense mechanisms of the respiratory tract. (4)

1.3 What are the main objectives of industrial audiometry? (2)

1.4 The application of ergonomics is important in order to prevent work related musculoskeletal disorders (WMSD).

1.4.1 Name and describe two of these disorders that, in your opinion, could result from working underground in a mine. For each disorder, mention a mining-related activity that, in your opinion could be the cause. (6)

1.4.2 State four concerns that should be addressed in the workplace in order to minimize the occurrence of MWSD. (4)

1.5 Shift work could impact negatively on the health and safety of mineworkers.

1.5.1 Describe two ways in which this could be true. (4)

1.5.2 Mention two principles that you would apply when designing a shift system. (4)

[30]

QUESTION 2 Spontaneous Combustion

2.1 Describe the sequence of events leading to spontaneous combustion as associated with coal mining. (6)

2.2 Name two noxious gases and two flammable that are produced by spontaneous combustion in coal mines. (4)

2.3 Explain the following terms:

2.3.1 Efflorescence. (2)
2.3.2 Reactive ground. (2)
2.3.3 Water gas. (2)
2.3.4 Buffer blasting. (2)

2.4 Describe six precautions that you would implement when conducting blasting operations in reactive ground. (12)

[30]

QUESTION 3 Heat & Refrigeration

3.1 The measurements taken at a refrigerant using R134a are tabulated in Appendix A. Using the PH diagram attached to this question paper:

3.1.1 Plot the actual and the ideal cycles. Assume that expansion is isentropic. Show the enthalpy values at each point of the circuit. (10)

3.1.2 Calculate:

3.1.2.1 The efficiency of compression. (3)

3.1.2.2 The Carnot COP. (2)

3.1.2.3 The Net actual compressor COP. (2)

3.1.2.4 The Overall compressor COP. (2)

3.1.2.5 Both cycle efficiencies. (2)

3.1.3 Conduct a heat balance based on the measurements of the water circuits and comment on the result. (6)

3.1.4 What proportion of the refrigerant evaporates inside the evaporator? (2)

3.1.5 What is the total refrigerant mass flow? (2)

3.2 You have been tasked to conduct a pre-feasibility study for a new shaft that will be breaking 150 000tpm. You have the following data:

Ventilating air required	5 kg/s for every 1 000tpm (broken)
Downcast air temperature	4°C (saturated) (87,5kPa)
Ambient air temperature	24/27°C (87,5kPa)

Assume that the positional efficiency between the surface bulk air cooler and the evaporator is 88% and that the water temperature increase in the BAC is 14°C.

3.2.1 Calculate the total mass flow of cooling water that is required. (7)

3.2.2 Calculate the required plant duty. (2)

Show all calculations and assumptions.

[40]

TOTAL **[100]**

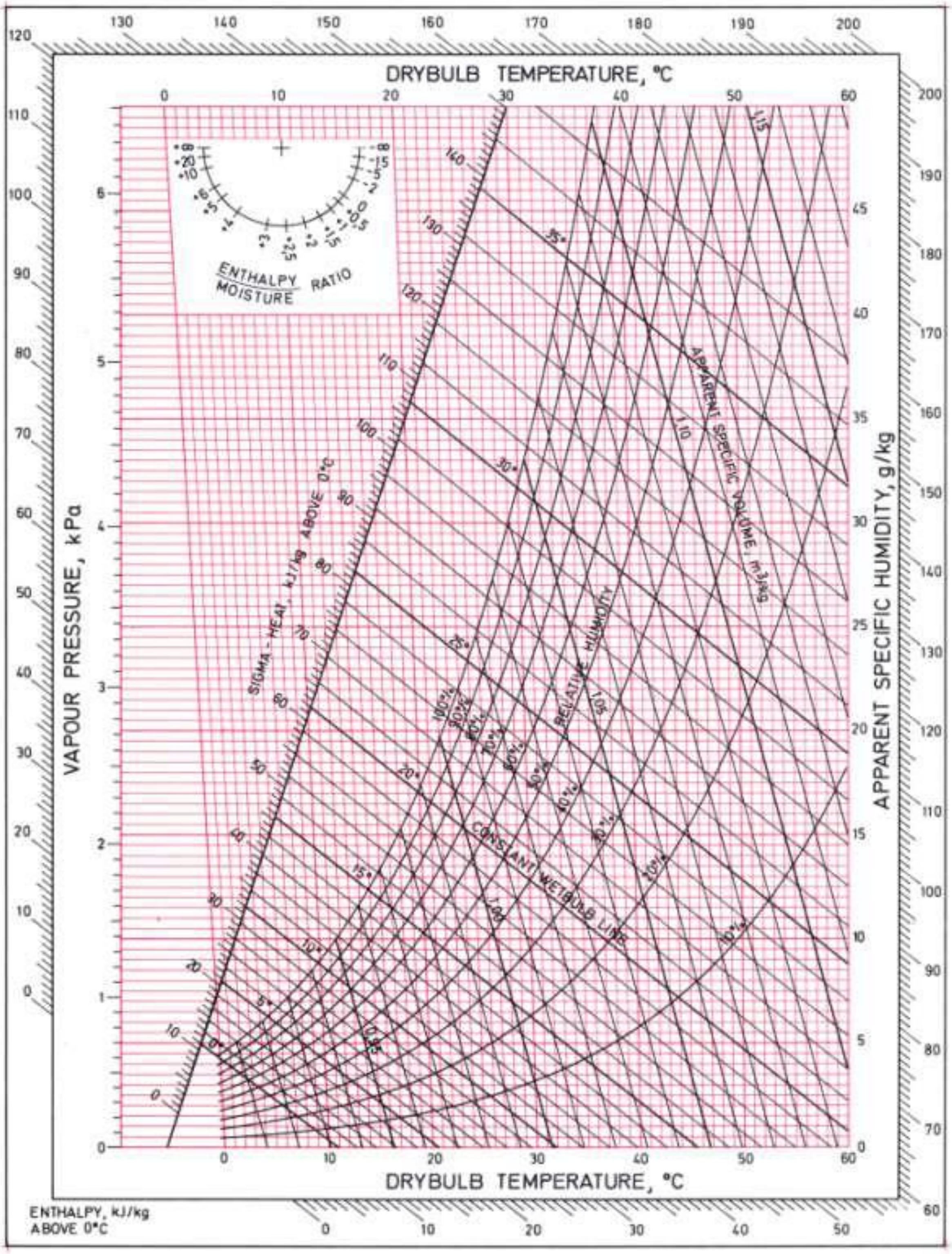
Formula sheet

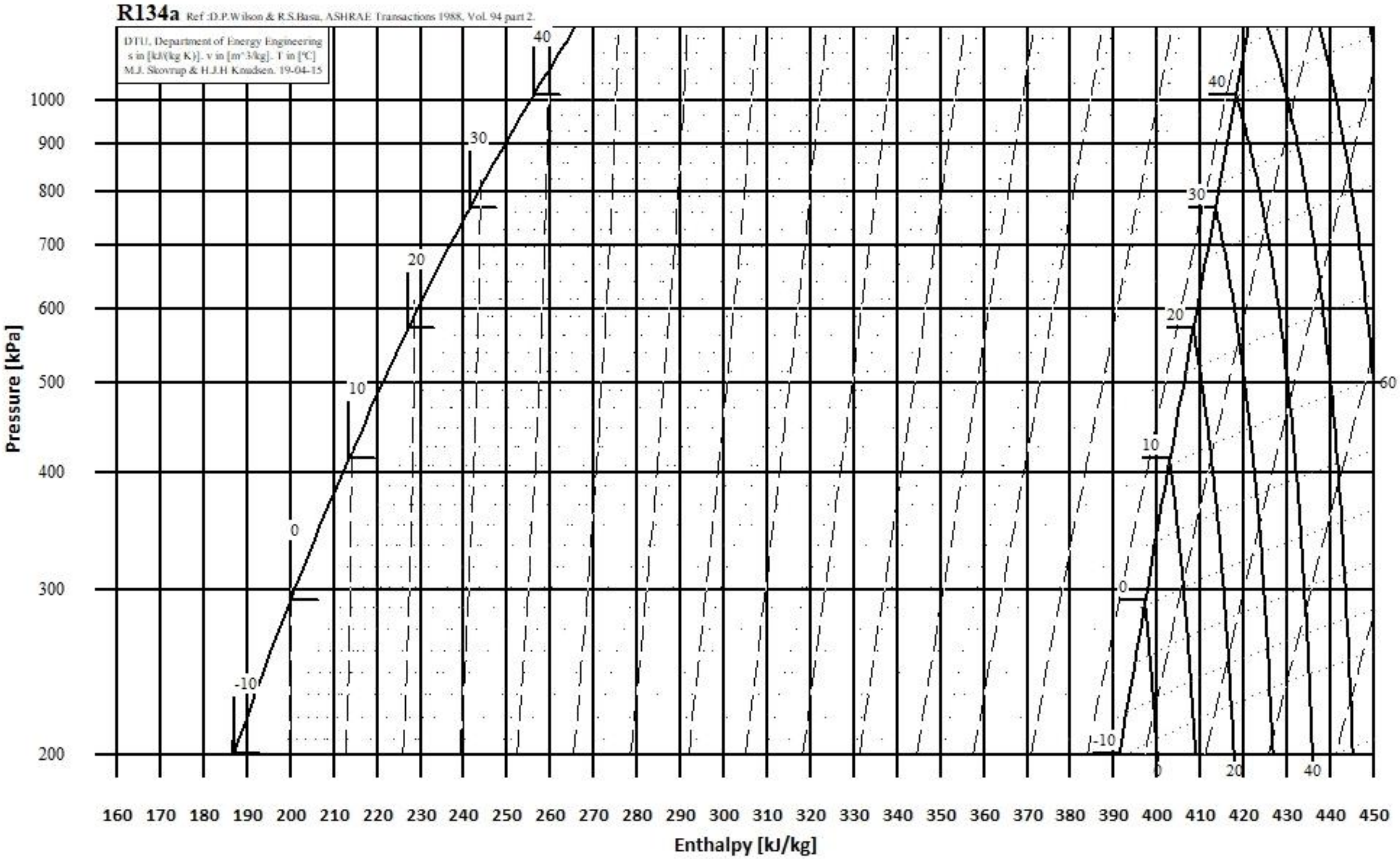
Specific heat	$H = MC_P\Delta t$
Three phase power consumption	$P_{In} = VI \times pf \times \sqrt{n}$
Machine efficiency	$\eta = \frac{P_{Out}}{P_{In}} \times 100\%$
Pumping power	$P_{In} = \frac{M \times g \times h_{Static}}{\eta_{Pump}}$
Efficiency of compression	$\eta_{Compr} = \frac{\Delta H_{Ideal}}{\Delta H_{Actual}} \times 100\%$
Saturated vapour pressure	$P'_{ws} = 0{,}6105\exp\left(\frac{17{,}27t_{wb}}{237{,}3+t_{wb}}\right)$
Vapour pressure	$P_w = P'_{ws} - AP(t_{db} - t_{wb})$
Absolute pressure (P)	Barometric pressure
Psychrometric constant (A)	0,000644 ($^0C^{-1}$)
Vapour content	$r = \frac{0{,}622P_w}{P-P_w}$ (kg/kg)
Specific volume	$v = \frac{0{,}287035T}{P-P_w}$ $[m^3/kg]$ $T = t_{db} + 273{,}15$
Density	$\rho = \frac{1+r}{v}$
Enthalpy (kJ/kg)	$H = H_a + H_w = 1{,}005t_{db} + r(1{,}8t_{db} + 2501)$
Enthalpy of dry air (kJ/kg)	$H_a = C_{pa} \times t_{db} = 1{,}005t_{db}$
Enthalpy of water vapour (kJ/kg)	$H_w = r(1{,}8t_{db} + 2501)$
Sigma heat (kJ/kg)	$S = H - r(4{,}183t_{wb} + 0{,}2)$
Carnot COP	$= \frac{T_{evaporator}}{T_{condenser} - T_{evaporator}}$
Overall compressor COP	$= \frac{\text{Evaporator duty}}{\text{Compressor motor input power}}$
Net actual compressor COP	$= \frac{\text{Evaporator duty}}{\text{Compressor motor output power}}$
Overall plant COP	$= \frac{\text{Evaporator duty}}{\text{Total electric input power}}$
Overall cycle efficiency	$= \frac{\text{Overall compressor COP}}{\text{Carnot COP}} \times 100\%$
Actual cycle efficiency	$= \frac{\text{Actual compressor COP}}{\text{Carnot COP}} \times 100\%$
Positional Efficiency	$= \frac{\text{Final cooling}}{\text{Evaporator duty}} \times 100\%$
Mass Flow	$M = \frac{Q}{v}$
Mixing of air steams	$S_tM_t = \sum SM$ and $r_tM_t = \sum rM$

Appendix A.

Evaporator		
Water mass flow	98	kg/s
Water temperature in	18	°C
Water temperature out	3	°C
Refrigerant temperature	0	°C
Compressor		
Voltage	5500	V
Current	119	A
Power factor	0,91	
Motor efficiency	89	%
Outlet temperature	50	°C
Condenser		
Water mass flow	154	kg/s
Water temperature in	16	°C
Water temperature out	28	°C
Outlet refrigerant temperature	30	°C
Outlet refrigerant absolute pressure	1 000	kPa

87,5 kPa


DRYBULB TEMPERATURE, °C
VAPOUR PRESSURE, kPa
APPARENT SPECIFIC HUMIDITY, g/kg
ENTHALPY / MOISTURE RATIO
SIGMA - HEAT, kJ/kg ABOVE 0°C
APPARENT SPECIFIC VOLUME, m³/kg
RELATIVE HUMIDITY
CONSTANT WETBULB LINE
ENTHALPY, kJ/kg ABOVE 0°C


R134a Ref :D.P.Wilson & R.S.Basu, ASHRAE Transactions 1988, Vol. 94 part 2.
DTU, Department of Energy Engineering
s in [kJ/(kg K)]. v in [m^3/kg]. T in [ºC]
M.J. Skovrup & H.J.H Knudsen. 19-04-15
Pressure [kPa]
1000
900
800
700
600
500
400
300
200
Enthalpy [kJ/kg]
160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450
-10
0
10
20
30
40
60