UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELORS OF ENGINEERING TECHNOLOGY MINING ENGINEERING
SUBJECT	:	**OCCUPATIONAL HYGIENE 3A**
CODE	:	**OCCUPA3**
DATE	:	FINAL SUMMATIVE ASSESSMENT 27 MAY 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 Name the three main components of the human ear, and describe the process of hearing that occurs in each. (6)

1.2 Mention two hearing disorders of which one should be associated with occupational exposure. (2)

1.3 Demonstrate your understanding of the term "Ergonomics". (2)

1.4 Making use of a neatly labelled diagram, demonstrate your understanding of the "Ergosystem". (6)

1.5 Vibration could impact on the health of mineworkers. Describe two types of vibration that mineworkers could be subjected to. Your description should include an example. Mention one disorder that could be the result of each. (8)

1.6 Explain the following terms:

1.6.1 Anthropometry. (3)
1.6.2 Circadian rhythm. (3)

[30]

QUESTION 2 Spontaneous Combustion

2.1 What are the major hazards associated with spontaneous combustion in coal mines? (6)

2.2 Discuss (briefly) three ways in which spontaneous combustion may be detected in coal mines. (6)

2.3 Explain the following terms:

2.3.1 Incubation period. (2)
2.3.2 Chimney effect. (2)
2.3.3 Hot hole. (2)
2.3.4 Hot spot. (2)

2.4 What are the main objectives of buffer blasting as associated with the prevention of spontaneous combustion in coal mines? (6)

2.5 Briefly discuss two ways in which spontaneous combustion may be controlled in coal mines. (4)

[30]

<u>QUESTION</u> 3 Heat & Refrigeration

3.1 You plan to start using chilled service water on your mine and are therefore required to evaluate the refrigeration facilities required for this purpose. The plan is to construct a dedicated refrigeration plant on surface that will chill the water before it goes down the shaft. The unit being evaluated has the specifications tabulated below and the PH cycle plot is attached. Your mine breaks 150 000 tons per month and requires 2 tons of service water for every ton broken. The electrical power tariff is 136c/kWh, and you can assume an overall pumping efficiency of 82% and a static pumping head of 2 400m.

System specifications	
Item	Value
Refrigerant mass flow	14kg/s
Compressor motor efficiency	91%
Water temperature difference	
Evaporator	14°C
Condenser	12°C

3.1.1 In order to evaluate the system, you are required to calculate the following:

a. Efficiency of compression. (2)
b. Carnot COP. (2)
c. Evaporator duty. (2)
d. Condenser duty. (2)
e. Net actual compressor COP. (2)
f. Overall compressor COP. (2)
g. Actual cycle efficiency. (2)
h. Compressor motor power consumption. (2)
i. Heat balance variance. (2)

3.1.2 Determine whether one unit would be sufficient to produce the required quantity of service water. If not, how many units would be required? (4)

3.1.3 Estimate the monthly power cost to run the compressor(s). (3)

3.1.4 Estimate the monthly cost of pumping the service water back to surface. (3)

3.2 A mining section within your area of responsibility has become too hot and you must either stop it or reduce the temperature. The intake air of 47kg/s has a wet bulb temperature of 18°C, which must be reduced to 16°C. You have an air stream available at a wet bulb temperature of 14°C that you can mix with the intake air in order to cool it down. What should the mix be, provided that the intake mass flow remains the same? The barometric pressure here is 105kPa. (6)

3.3 A water quantity of 55 liters per second enters a stope from a fissure. The VRT in the area is 42°C and the temperature of the water flowing from the stope is 32°C. Calculate the fissure water's contribution to the heat load of the stope. (3)

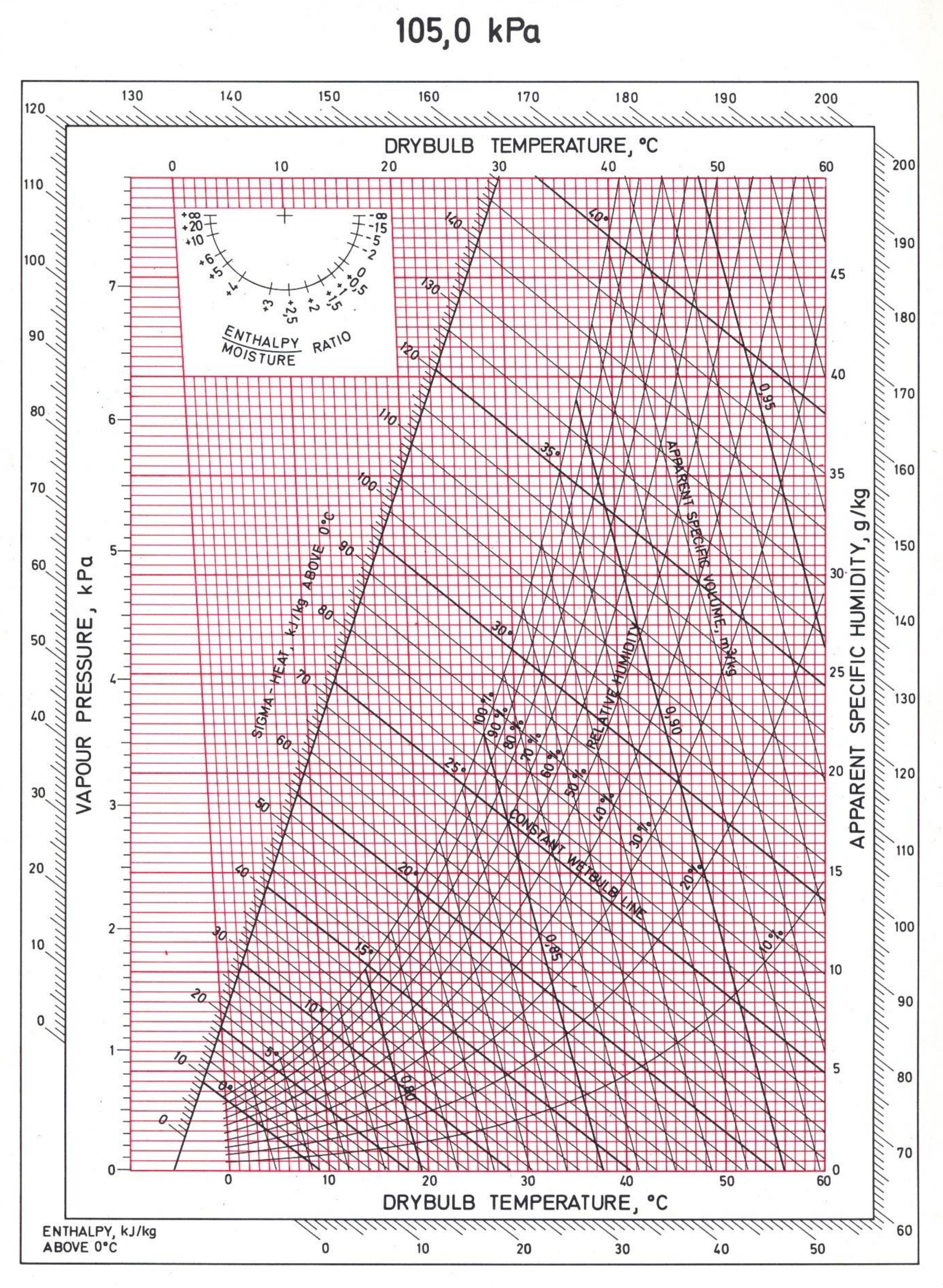
3.4 A water pump situated in a mining section pumps water from a sump to a water settler situated on a level that is 122m vertically above the sump. The pumping rate is 45kg/s, and the diameter of the pump column is 100mm. The pump motor has an efficiency of 91% and the pump itself has an efficiency of 76%. How much of the power consumed by the pump will not be converted to heat? (3)

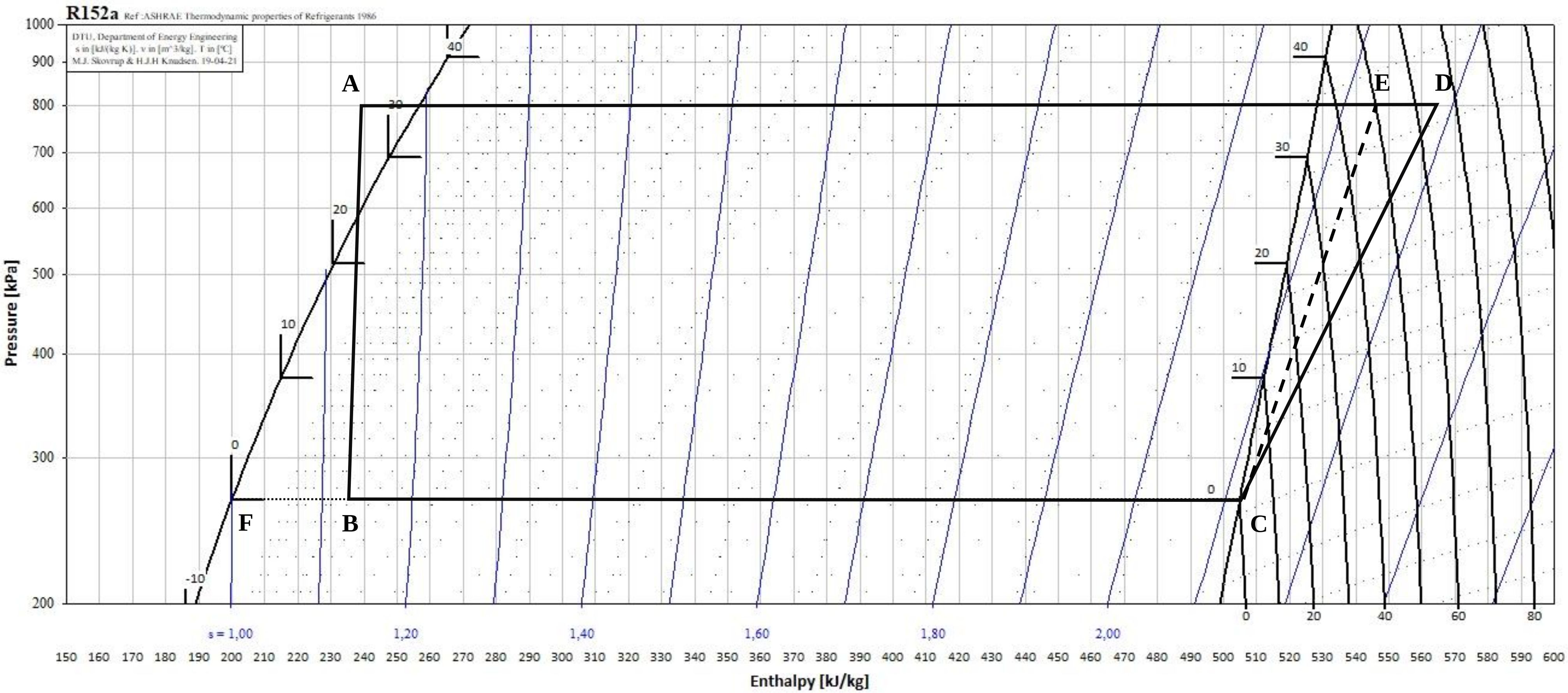
[40]

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 $r_tM_t = \sum rM$


105,0 kPa
DRYBULB TEMPERATURE, °C
ENTHALPY / MOISTURE RATIO
SIGMA - HEAT, kJ/kg ABOVE 0°C
VAPOUR PRESSURE, kPa
APPARENT SPECIFIC HUMIDITY, g/kg
APPARENT SPECIFIC VOLUME, m3/kg
RELATIVE HUMIDITY
CONSTANT WETBULB LINE
ENTHALPY, kJ/kg ABOVE 0°C



Enthalpy values (kJ/kg):
$H_A = 238$, $H_B = 236$, $H_C = 506$, $H_D = 565$, $H_E = 545$, $H_F = 200$