Chamber of Mines of South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – INTERMEDIATE CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 2 – THERMAL ENGINEERING **SUBJECT CODE: COMIMEC** **EXAMINATION DATE: 10 MAY 2017** **TIME**: 14:30 – 17:30	**EXAMINER:** E Botha **MODERATOR:** M Biffi **TOTAL MARKS:** [100] **PASS MARK:** (60%)

NUMBER OF PAGES: 5 -6

SPECIAL REQUIREMENTS:

THIS IS NOT AN **OPEN BOOK EXAMINATION**.

INSTRUCTIONS TO CANDIDATES:

1. Answer all questions **legibly** in English.
2. Write your **ID number** on the outside cover of each book used and on any graph paper or other loose sheets handed in.

NB: Your name **must not** appear on any answer book or loose sheets.

3. Show all calculations **and check calculations on which the answers are based.**
4. Hand-held electronic calculators may be used for calculations.
5. Write **legibly** in ink on the **right hand page** only – **left hand pages will not be marked**.
6. Illustrate your answers by means of sketches or diagrams wherever possible.
7. Answers must be given to an accuracy which is typical of practical conditions.

   NB Ensure that the correct unit of measure (SI unit) are recorded as marks will be deducted from answers if the incorrect unit is used. (even if the calculated value is correct).
8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding

this examination.
10. Cell phones are **NOT** allowed in the examination room.

QUESTION 1

1.1 Briefly define each of the following terms ~~(~~and ~~also~~ state the units in which these terms are expressed.~~)~~

1.1.1 Dew point temperature (2)

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1.2 15 m³/s of air with a temperature of 29.0/31.0~~0.5~~°C with a barometric pressure of 1100~~95~~ kPa is flowing in a tunnel~~haulage~~. A cooling coil with a 22 kW fan is installed ~~to the cooling coil~~in the haulage.~~,~~ ~~water~~ Water enters~~ing~~ the coil at 6° and leaves~~ing~~ at 15~~6~~°C. The fan delivers 7.2 m³/s of air. The intake temperature

Commented [BM1]: 105.0KPa psychrometric chart is required.

of the fan is 29.0/31.00.5 °C. The delivery temperature of the cooling coil is 235.0/253.0°C.

1.2.1 Calculate the heat removed from the air. (32)

Condition of the air before entering the cooling coil at 110 kPa barometric pressure and a temperature of 29.0/31.0

1.2.2 Calculate the water flow rate (22)

1.2.3 Calculate the amount of water condensate from the air. (2)

3

1.3.1 Briefly explain describe what a closed loop cooling system is and the list its advantages. and of a closed loop cooling system. (34)

[25]

3

2.1 Describe the design considerations for the construction of an underground condenser tower. (8)

Commented [BM2]: What about the heat from the fan. Do you want this to be included in the calculation or not? Need to specify this to avoid ambiguity.

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2.2 The following conditions were measured at an underground cooling tower;
Air temperature in: T= 30.51.0/31.32. 7°C
Air temperature out: T= 40.52.0/40.52.0°C
Water temperature in: T= 43.75°C
Water temperature out: T= 36.57.4°C

2.2.1 Determine the water efficiency of this cooling tower. (2)

2.2.2 Comment your answer. (2)

2.3 Sketch the complete Refrigeration cycle including the Hot water cycle to the cooling towers and the Cold Water cycle to the cooling cars or bulk air coolers. Show all the key components and indicate areas of high or low temperatures for air, water and refrigerant cycles. (12)

2.4

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Commented [BM3]: To avoid ambiguity consider stating whether this is for a surface or underground application.

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QUESTION 3

3.1 The effects of heat on the underground personnel depend on a number of factors. List seven of these factors. Sketch and label a two-stage vapour compression refrigeration system showing areas of high/low pressure, areas of high/low temperature and liquid and vapour sections.

(76)

3.2 Briefly describe the principle of operation of this vapour compressor refrigeration system.Briefly describe six factors that influence the rate of heat flow from rock. Also give four methods to reduce the rate of heat flow from rock.

(85)

3.3 Discuss four three(4) significant sources of heat in a mine. (34)

3.4 Briefly discuss seven factors which can contribute towards heat intolerance in an underground worker. (7)

Explain the term "fouling" with regardsrelating to heat exchangers used in refrigeration plants. Include the following in your explanation.

QUESTION 4

4.1 Briefly discuss the properties of an ideal refrigerant. (54)

4.2 Briefly discuss the advantages/disadvantages of a closed loop refrigerant water system.

(2)

4.23 List the properties of a good insulant. (45)

4.34 The following measurements were taken at a surface refrigeration plant using refrigerant R134. (15)

Barometric Pressure in the plant room 85kPa

Evaporator water flow rate 153108 l/s

Evaporator inlet water temperature 16.019.2 °C

5

Evaporator outlet water temperature 5.05 °C

Evaporating temperature pressure 200 kPa (gauge0.4 °C)

Condenser water flow rate ing pressure 650 kPa (gauge)357 l/s

Condensing water temperature inlet 1927 °C

Commented [BM4]: 85kPa psychrometric chart required

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Condensing ~~inlet temperature~~ 1.0 °C~~water temperature~~

Condensing ~~outlet~~ temperature ~~49~~29.3 °C

Compressor:

Motor current	100 A
Voltage	6590 V
Power factor	0.95
No. of phases	3
Motor efficiency	97%

4.34.1 ~~From the p-h diagram, calculate the heat balance of this refrigeration plant.~~ Determine the plant duty. (2)

4.34.2 Determine ~~From the p-h diagram, calculate the heat balance of this refrigeration plant.~~ the input power to the compressor motor. (2)

4.34.3 ~~From the p-h diagram, calculate the Carnot COP of this refrigeration plant.~~ Determine the heat balance. (5)

4.34.4 ~~From the p-h diagram, calculate the Cycle COP of this refrigeration plant.~~ Determine the Carnot COP (1)

4.34.5 Determine the overall (or plant) COP (1)

~~From the p-h diagram, calculate the Cycle efficiency of this refrigeration plant.~~

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4.34.6 ~~From the p-h diagram, calculate the percentage (%) flash gas in the~~ (1)

4.3.8 Determine the actual cycle efficiency. (1)

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TOTAL MARKS:100