T1880(E)(N18)T
NOVEMBER 2004

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

18 November (X-Paper)
09:00 – 12:00

CLOSED-BOOK EXAMINATION

Non-programmable calculators may be used.

DEPARTMENT OF EDUCATION
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY
PLANT ENGINEERING: MINES AND WORKS
TIME: 3 HOURS
MARKS: 100

NOTE: If you answer more than the required number of questions, only the required number of questions will be marked. All work you do not want to be marked, must be clearly crossed out.

INSTRUCTIONS

1. This is NOT an open-book examination. Candidates are NOT allowed to use any notes, textbooks or references during the examination.

2. Rule off across the page on completion after each answer.

3. Answers must be clearly and correctly numbered. Answers written in pencil will not be marked. Illegible handwriting will NOT be marked.

4. Examination results will be disqualified if the Commission of Examiners has not accepted the candidate prior to the examination.

5. Candidates arriving 30 minutes late will not be allowed to sit for the examination. No candidate writing the examination may leave the examination room before one hour after commencement has elapsed.

6. No cellular phones are allowed into the examination room.

7. Show ALL the calculations.

THREE annexures are attached to this question paper.

SECTION A (COMPULSORY)

QUESTION 1

1.1 Why does a steel-wire rope need lubrication? (2)

1.2 What are the essential properties of the lubricant for a wire rope? (2)

1.3 How is the lubricant usually applied while the rope is in service? (2)

1.4 The following are particulars of a gear driven double-drum Ward-Leonard winding engine used to hoist rock in a vertical shaft:

Diameter of sheave	3,8 m
Diameter of drums	4,3 m
Mass of rope per unit length	6,2 kg/m
Length of wind	1 000 m
Length of each rope	1 200 m
Mass of overturning skip, bridle and attachments	4 800 kg
Mass of rock load in skip	5 500 kg
Maximum speed of winding	12,5 m/s
Rate of acceleration and retardation	1 m/s^2
Inertia of each sheave	24 000 kg/m^2
Combined inertia of rotating masses (referred to the drum shaft)	310 000 kg/m^2
Creep time	5 seconds
Creep speed	0,5 m/s

Neglecting the difference in diameter due to the rope being wound on the drum and assuming friction to be 5% of the static load resulting from the total travelling masses, construct the torque-time diagram of a complete winding cycle. (14)
[20]

QUESTION 2

2.1 A 1 000 kVA transformer supplied a load of 1 000 kVA, power factor 0,8 lagging. It failed and must now be substituted temporarily with two 500 kVA transformers connected in parallel on both the primary and secondary sides. The voltage ratios are the same, their resistance drops are 0,8% and 1,6% and their reactance drops are 4,5% and 3% respectively.

Calculate the kVA loading and the power factor for each transformer. Comment on the answers you derived for this temporary arrangement. (10)

2.2 A feeder cable 317 m long develops a fault to earth on the red phase. The fault is localised by the following resistance measurements obtained between one end of the faulty conductor and earth:

Distant end insulated	7,01 ohms
Distant end solidly earthed	1,85 ohms
Conductor resistance	7,192 ohm/1 000 m

Calculate the distance of the fault from the test end. (10)
[20]

QUESTION 3

3.1 A new haulage on a mine is to be developed with mechanised equipment. List the major problem areas that must be considered for this type of operation. (5)

3.2 Determine the productivity potential in tonnes/hour of an LHD machine employed on open-stope loading, operating on a zero grade under average haul road conditions:

Ore density (loose measure)	1,7 t/m^3
Bucket capacity (90% fill factor)	3 m^3
Constant speed	8,5 km/h
One-way haul distance	150 m
Acceleration	0,3 m/s^2
Deceleration	0,6 m/s^2
Estimated loading time	30 seconds
Estimated dumping time	20 seconds

(15)
[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO of the following five questions.

QUESTION 4

A new shaft is to be sunk on a mine in the North West Province.
The following data is available:

Maximum planned production	150 000 tons per month
Mean depth of workings	2 000 m
Estimated heat load in workings	210 kW per kton broken/month
Station wet-bulb temperature at mean depth	25,3°C
Downcast shaft diameter	9,0 m
Barometric pressure at 2 000 m depth	105 kPa

4.1 Calculate the mass flow rate of air required to ventilate the mine to satisfy a 27°C reject wet-bulb temperature, if no cooling is provided. (4)

4.2 What is the air mass flow rate that the shaft can handle when the mean velocity is 10 m/s at a density of 1,0 kg/m^3? (4)

4.3 With the air mass flow rate as calculated in QUESTION 4.2 above, determine how much refrigeration is required underground to ensure that reject wet-bulb temperatures do not exceed 27°C. (4)

4.4 List THREE factors that can affect the underground station wet-bulb temperature. (3)

4.5 If chilled service water is consumed at a rate of 1,2 tons per ton of rock mined, assume a suitable temperature range and calculate approximately how much cooling will be available from this water. Assume that there are 26 working days per month. (5)
[20]

QUESTION 5

5.1 A vehicle with a wheel base of 3 m travels at a speed of 36 km/h along a level road. If the centre of gravity is situated 1,2 m from the front wheels of the vehicle and 0,6 m above the road level, determine the minimum distance in which the vehicle can be stopped when:

5.1.1 The rear wheels only brake (4)
5.1.2 The front wheels only brake (4)
5.1.3 All the wheels brake (4)

Assume a coefficient of friction of 0,65.

5.2 The following particulars apply to an inclined belt conveyor:

Length of conveyor (loading to discharge end)	100 m
Speed of belt	1,5 m/s
Angle of wrap round driving pulley	220°
Coefficient of friction between belt and driving pulley	0,3
Mass of rock conveyed	300 t/h

The discharge end is 22 m higher than the loading end.
The total friction is equivalent to a force of 6,5 kN in the belt at the head pulley.
Efficiency of drive is 90%.

Calculate:

5.2.1 The power of the motor to drive the belt (4)

5.2.2 The minimum tension in the slack side of the belt as it leaves the driving pulley (4)
[20]

QUESTION 6

6.1 A refrigeration plant has an actual refrigeration effect of 500 kW. Refrigerant R22 operates with a condensing temperature of 35°C and an evaporating temperature of –10°C. The refrigerant is a dry vapour at entry to the compressor and compression occurs without change to the entropy. No undercooling occurs on the condenser. Enthalpy of refrigerant leaving the condenser is 243,1 kJ/kg.

Using the attached refrigerant R22 chart, determine:

6.1.1 The refrigerant effect in kJ/kg (2)
6.1.2 The circulation rate of refrigerant in kg/s (2)
6.1.3 The power required by the compressor in kW (2)
6.1.4 The coefficient of performance (2)
6.1.5 The compressor discharge temperature (2)

6.2 6.2.1 State the factors which need to be considered when selecting a roller bearing. (4)

6.2.2 Give the correct procedure to be used when mounting ball and roller bearings. (3)

6.2.3 What do you consider important in lubrication on these bearings? (3)
[20]

QUESTION 7

An important aid in centrifugal compressor operation is its logbook.

7.1 What should be recorded on this sheet and how would you deal with this information? (16)

7.2 What are the TWO major factors which can effect the maintenance of a centrifugal compressor? (4)
[20]

QUESTION 8

8.1 Finely ground coal of density 1,35 t/m^3 is to be pumped through a 150 mm diameter pipe line for a horizontal distance of 40 m, round a 90° bend, vertically upwards for 160 m, round another 90° bend and finally for a horizontal distance of 20 m before open discharge into a dewatering installation.

Determine the delivery pressure and the approximate input power required to pump 35 t/h of dry solids at a concentration of 15% by volume. Assume that the mixture behaves as a dense liquid and that the fluid coefficient of friction is 0,005. Pump drive efficiency is 55% and the 90° bend friction factor is 0,14. (14)

8.2 Although transformers undergo routine tests, it is necessary that the basic system is checked for correctness before commissioning.

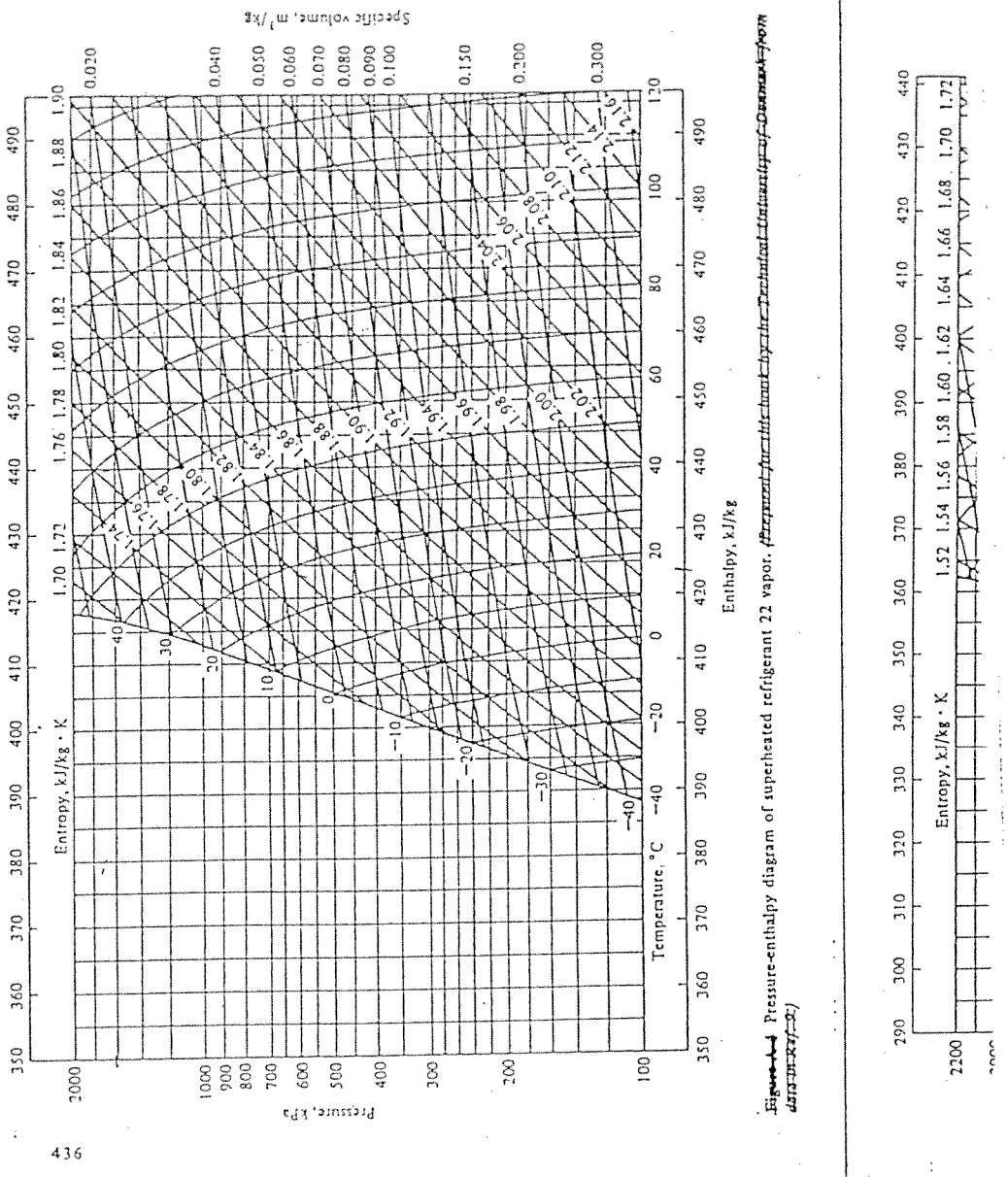
Briefly describe the reasons for the following tests:

8.2.1	Voltage ratio test	(2)
8.2.2	Vector group test	(2)
8.2.3	Insulation resistance test	(2)
		[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

--oo0oo--

ANNEXURE 1



436

Pressure-enthalpy diagram of superheated refrigerant 22 vapor.

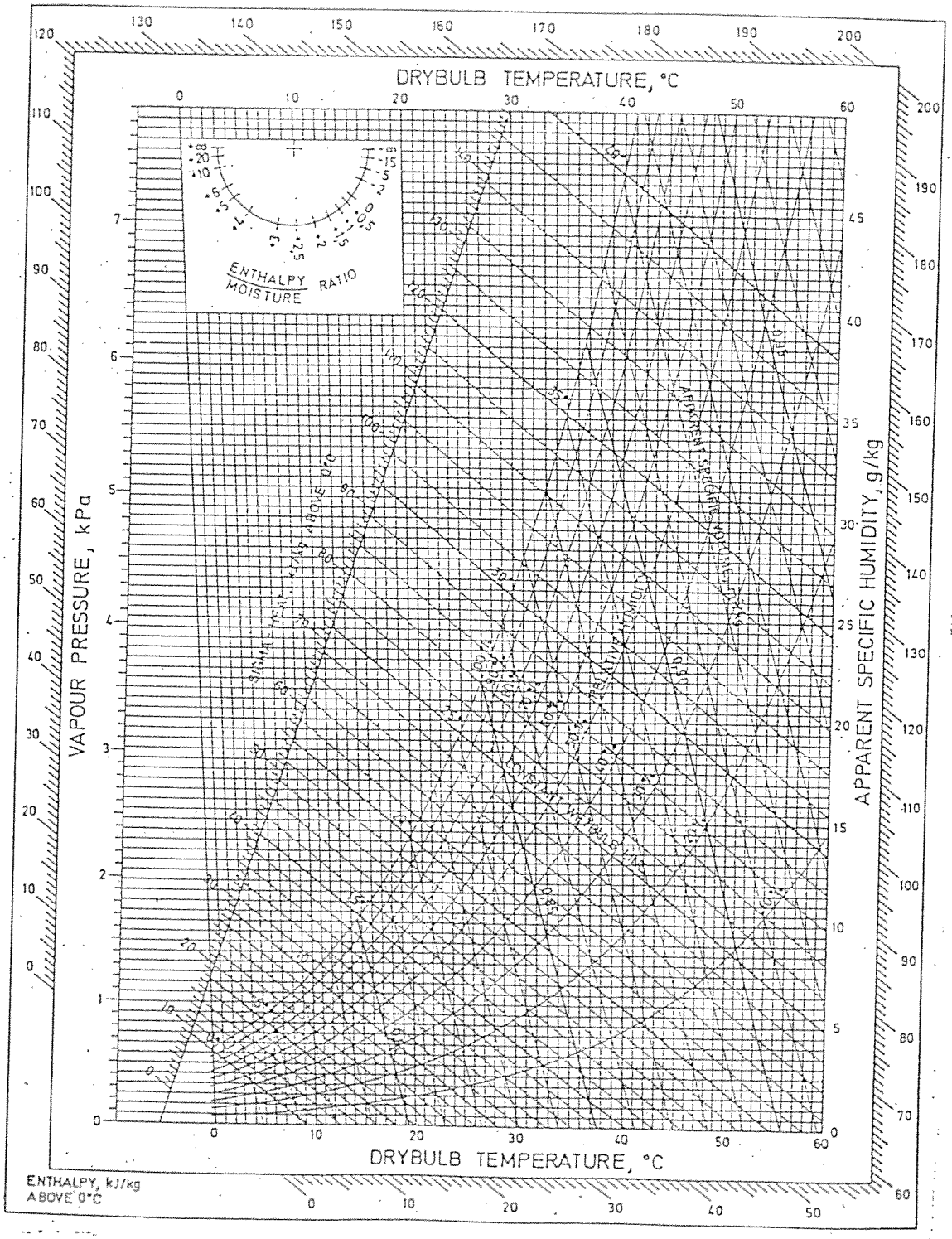
REFERENCES

1. E. Schmidt: "Properties of Water and Steam in SI-Units," Springer, New York, 1969.
2. Carrier Corporation, personal communication.
3. W. F. Stoecker, "Using SI Units in Heating, Air Conditioning, and Refrigeration, "Business News, Troy, Mich., 1977.
4. Thermodynamic Table for Refrigerant R 11 in SI-Units, International Institute of Refrigeration, Paris.
5. Thermodynamic Properties of "Freon" 12 Refrigerant, *Tech. Bull.* T-12-SI, Du Pont de Nemours International S.A., Geneva.

ANNEXURE 2

PSYCHROMETRIC CHART

105,0 kPa



ANNEXURE 3

INFORMATION SHEET

$T = i(D/d)^2 ar$ • $T = mgr$ • $S = \frac{v^2 - u^2}{2g}$ •

$Q = m(hb - ha)$ • $hf = \frac{4flv^2}{2gd}$ •

$m = \frac{wl}{8}$ •