200711T354

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

T1860**(E)**(N15)T
NOVEMBER 2007

NON-NATIONAL CERTIFICATE
ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

15 November (X-Paper)
09:00 – 12:00

CLOSED-BOOK EXAMINATION

Alpha-numerical or programmable calculators may NOT be used.
ONLY non-programmable calculators may be used.

This question paper consists of 9 pages, a 1-page psychrometric chart graph paper and a 1-page formula sheet.

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 AND INFORMATION

1. This is NOT an open-book examination. Candidates are NOT allowed to use any notes, textbooks, references or cell-phones during the examination.
2. Rule off across the page on completion of each question.
3. Read ALL the questions carefully.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Answers written in pencil will NOT be marked.
6. Illegible handwriting will NOT be marked.
7. Examination results will be disqualified if the candidate had not been accepted by the Commission of Examiners prior to the examination.
8. 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.
9. Show ALL the calculations.

SECTION A (COMPULSORY)

QUESTION 1

1.1 Describe how you, a member of the senior management team on a mine, would start to introduce a new safety culture onto the mine. (10)

1.2 As an engineer responsible for a surface ammonia refrigeration plant, explain your responsibility once the audible alarm sounds in an emergency refrigerant leak. (10)

[20]

QUESTION 2

2 The following particulars apply to a double-drum AC winding plant:

Torque at commencement of wind	600 kNm
Torque at the end of acceleration period	580 kNm
Torque at the beginning of constant velocity period	34 kNm
Torque at the end of constant velocity period	-55 kNm
Torque at the beginning of the retardation period	-310 kNm
Torque at the end of wind	-340 kNm
Depth of wind	1 800 m
Diameter of drum	4,3 m
Rate of acceleration and retardation	1 m/s^2
Maximum rope speed	14 m/s
Loading time	8 sec

2.1.1 Draw the power time diagram for the winder. (6)

2.1.2 Calculate the RMS power of the naturally cooled motor, required to drive the winder. (8)

NOTE: AC (naturally cooled)
$= 2/3\ t_a + t_{cv} + 2/3td + 1/3t_{\text{loading and tipping}}$

2.2 According to the directive C-2 (8 December 2003) 'Dynamic test of winding plant', how should the brake static holding power test be done? (6)

[20]

QUESTION 3

3.1 Why is a two-part tariff used by electricity supply authorities to bill bulk consumers and how is it typically compiled? (4)

3.2 State and briefly discuss the main functions of transformer oil. (4)

3.3 A consumer of electricity is billed at the following monthly rates:

Service fee	R2 000,00
Maximum demand	R25/kW
Unit charge	R0,555kWh
10% discount on the amount exceeding	R50 000,00

The maximum demand is 641 kVA at an average power factor of 0,695 and load factor of 0,59. Calculate the monthly account for 500 hours and the average cost per unit.

Production is increased by installation of a synchronous motor drawing 235 kVA continuously for 500 hours at a leading power factor of 0,721. Calculate the new monthly account and average cost per unit. (12)
[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions.

QUESTION 4

4.1 Steam with a dryness fraction of 0,9 enters a two-pass surface condenser at a rate of 65 000 kg/h. The condenser vacuum is 735 mm Hg (barometer 762 mm Hg). The mean water velocity in the tubes is 2,13 m/s and the temperature of the water at inlet is 18 °C and at outlet is 7,7 °C below the condensing temperature. The condensate is undercooled by 3 °C and the overall rate of heat transfer, based on the tube outer surface is 2,9 kW/m^{2}K. The outside diameter of the tubes is 25 mm, and the tube wall thickness is 1,5 mm.

Determine the following:

4.1.1 The quantity of cooling water required (3)
4.1.2 The number of tubes (4)
4.1.3 The length of the tubes (3)

4.2 The following data is for a direct steam injection system:

Mass of water to be heated	12 000 kg/2 hours
Initial temperature of water	8 °C
Final temperature of water	60 °C
Steam pressure	260 kPa
Steam is initially dry saturated	
Enthalpy of steam entering system	2 733,89 kJ/kg
Energy lost through tank material	14 kW
Specific heat capacity of tank material	0,5 kJ/kg °C

Determine the following:

4.2.1 The energy gained by the water from the steam (2)

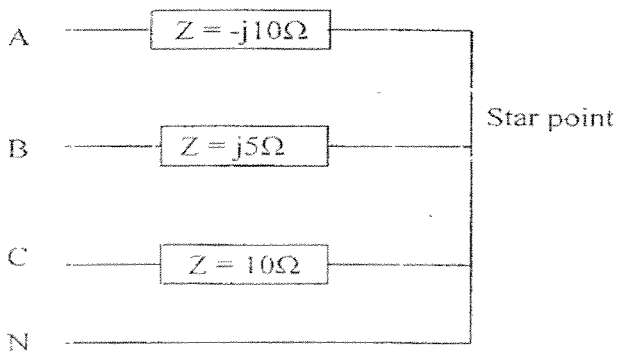
4.2.2 The steam flow rate to heat the water (2)

4.2.3 The mean steam flow rate to heat the tank material (2)

4.2.4 The steam load to heat a tank of water by means of steam injection (4)
[20]

QUESTION 5

5.1 The load is connected to a 4-wire, 3-phase supply with V_{BC} = 380 V as the reference voltage of the ABC-rotation system. The neutral conductor is severed by an earth moving machine while the other three conductors remain intact. Calculate the current I_{AS} and draw a phasor diagram of the values you calculated.



(8)

5.2 Define the following in terms of SANS 10108:

5.2.1	Double-protected explosion-protected apparatus	(2)
5.2.2	Dust-ignition-protected electrical apparatus	(2)
5.2.3	Encapsulated electrical apparatus	(2)
5.2.4	Flameproof apparatus	(2)
5.2.5	Intrinsically safe circuit	(2)
5.2.6	Intrinsically safe electrical apparatus	(2)
		[20]

QUESTION 6

6.1 The ventilation fan of a sinking shaft has been supplied complete with a 38 kW motor and a V-belt drive for a final duty of 710 m^3/min at 150 mm WG with a fan speed of 1 200 r/min. For initial operations, the required output is 426 m^3/min.

Calculate the following:

6.1.1	The delivery pressure	(2)
6.1.2	The fan shaft speed	(2)
6.1.3	The fan shaft power	(2)
6.1.4	The electrical units consumed per 8 hour shift	(2)

Assume: Fan efficiency of 60% and a motor and drive efficiency of 80%.

6.2 An underground coal transfer point deals with 220 t/hr and is provided with suppression sprays which deliver water at a rate of 52 ℓ/min water. The water not absorbed by the coal is evaporated into the ventilating air. The air approaching the transfer point, measured at 37 m^3/s is 26 °C and has a relative humidity of 52%. The temperature of the air leaving the transfer point is 21 °C with a relative humidity of 76%. The air pressure remains at 90 kPa.

Use a psychrometric chart (attached) to solve the problem.

Determine the following:

6.2.1	The specific humidity of the air entering the transfer point	(2)
6.2.2	The specific humidity of the air leaving the transfer point	(2)
6.2.3	The change in specific humidity	(2)

6.2.4 The mass of moisture taken up by the air in kg/s (2)

6.2.5 The percentage moisture in the coal leaving the transfer point if the initial moisture content is 8% (4)
[20]

QUESTION 7

7.1 The run-off water from a slimes dam is pumped from a large shallow pan to the evaporation ponds through a straight pipeline. The pump delivers 190 ℓ/s when pumping against a static head of 4 m and has a performance curve as given below:

Head (m)	23,5	24,3	24,9	25	24,8	23,5	21,3	18	14,2
Flow (ℓ/s)	0	25	50	75	100	125	150	175	200
Efficiency (%)	0	29	49	64	75	82	83	80	68

7.1.1 Plot the H-Q as well as the η - Q curves on graph paper and determine the quantity of water delivered if the static head and the length of piping are both increased by 50%. (8)

7.1.2 Calculate the power that is saved by driving the pump. (4)

7.2 A load of 1 000 kg has to be raised from the bottom tie-beam of a roof truss. The tie-beam is simply supported and consists of a 305 mm x 102 mm x 28,6 kg/m I-beam. Although the beam can support the load, the deflection is excessive.

Calculate the width of two 15 mm thick steel plates to be welded to the top and bottom of the I-beam to ensure that the bending stress does not exceed 50 MPa. Ignore the tension in the beam.

			About the x-x axis		
Size mm	Mass kg/m	h mm	I 10^{-6} m^4	Z_e 10^{-6} m^4	Z_{pl} 10^{-6} m^4
305 x 102	28,6	308,9	54,39	352,1	408,4

NOTE: Use the mass of the beam and not the mass of the plates in your calculations. The beam has a length of 12 m. (8)
[20]

QUESTION 8

8.1 A belt conveyor is required to transport 100 tons of coal per hour up an incline. The slope is 17 ° and the length of the conveyor is 1,2 km.

If the belt speed is 2,5 m/s, calculate the following:

8.1.1 The conveyor belt width (2)

8.1.2 The power required to drive the fully laden belt conveyor (4)

8.1.3 The size and type of electric motors required if FOUR similar motors are utilised (2)

8.1.4 The maximum tension in the conveyor belt (4)

Given:

A Angle of wrap = 240 °

B Mass of belt is 60 kg/metre length/metre width of belt

C Coefficient of friction between the drive pulleys and the belt = 0,7

D Coefficient of friction between laden and unladen belt and idlers = 0,04

E Drive efficiency = 90%

$C = 0{,}084\ W^2 v \beta$

Where W = Belt width in m
V = Velocity in m/s
β = Density of coal = 800 kg/m^3
C = Capacity of belt conveyor in kg/s

8.2 During the inspection of an ammonia refrigeration plant, the following observations were made:

Pressure limits	207,7kPa and 1,47 MPa
Temperature on condensate before throttling	24 °C
Temperature of refrigerant leaving the compressor	100 °C
Dryness fraction of vapour exiting the evaporator	0,95
Only dry saturated vapour is drawn into the compressor	
Evaporator circulation	4,5 kg/min

From the refrigerant tables:

The enthalpy of saturated liquid refrigerant at low pressure	98,8kJ/kg
The enthalpy of saturated vapour at low pressure	1 422,7 kJ/kg
The enthalpy of refrigerant entering the expansion valve	294,1 kJ/kg
The enthalpy of refrigerant entering the condenser	1 717,5 kJ/kg

Calculate the refrigeration capacity and the coefficient of performance of the plant. (8)
[20]

QUESTION 9

9.1 An endless rope haulage delivers 8 640 tons/day up an incline of 7,5 ° inclination and 900 m long. If three ton capacity cars, each having a mass of 1 800 kg, are used, determine the power required to drive the haulage engine which has an efficiency of 80%.

Assume the same number of empty cars on the down going rope as full ones on the up going rope.

Rope speed	60 m/min
Rolling friction	175 N/t
Number of shifts per day	3
Running time	20 hours

(8)

9.2 An electric winch with an overall gear ratio of 50:1 is used to haul a hopper of gross mass 10 t up an incline of 1 in 20. The hopper has a frictional resistance of 110 N/t and the winch drum is 1 m in diameter.

The rotating parts of the drum and gearbox have a mass of 1,3 t and equivalent radius of gyration of 400 mm. The motor armature has a mass of 130 kg with a radius of gyration of 110 mm.

If the efficiency of the gear drive is 85%, calculate the power being developed by the motor at the instant when the hopper is travelling at a speed of 2 m/s and accelerating at 0,15 m/s^2. (12)
[20]

TOTAL SECTION B: 40

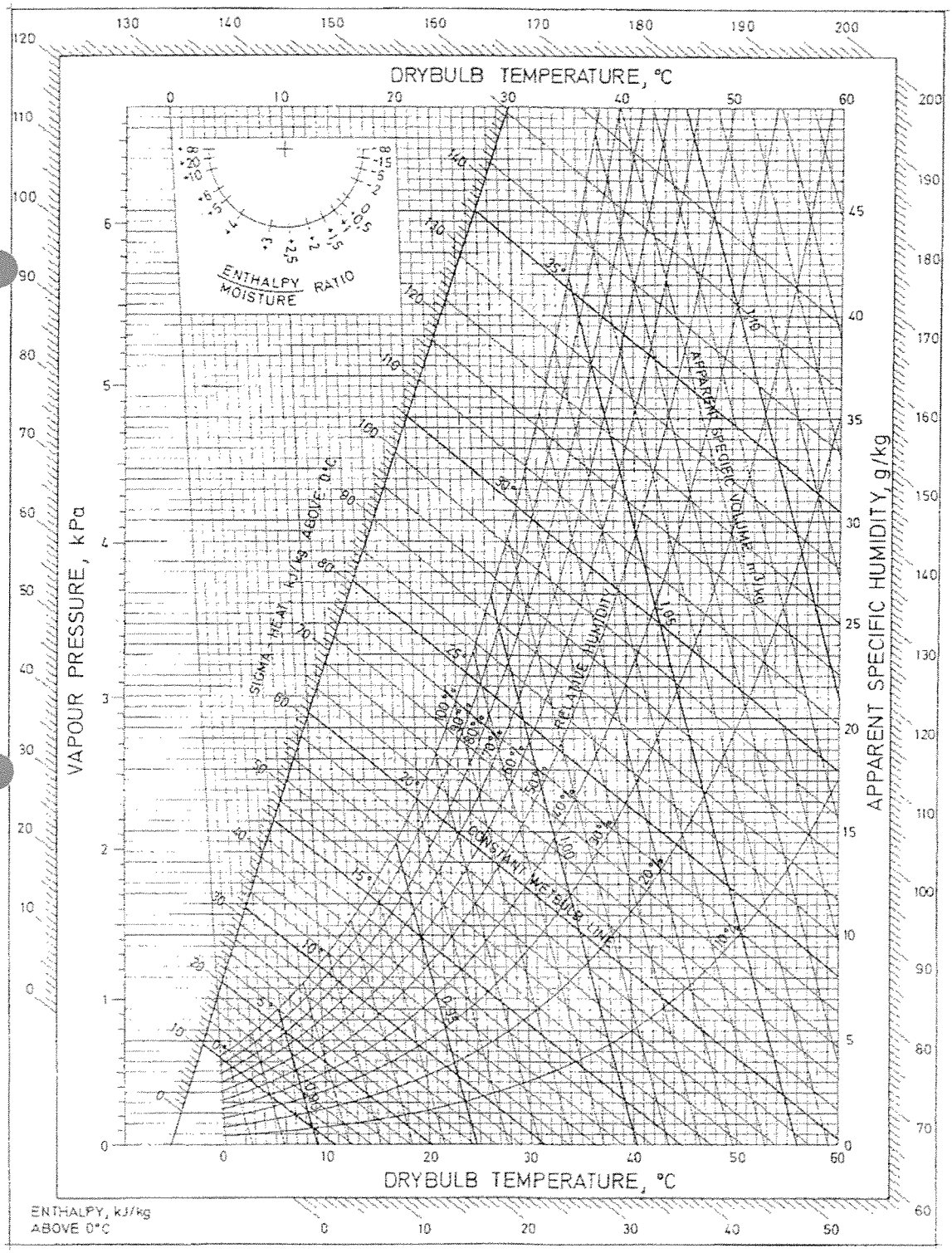
GRAND TOTAL: 100

T1860**(E)**(N15)T

EXAMINATION NUMBER:

PSYCHROMETRIC CHART

90,0 kPa



PLANT ENGINEERING: MINES AND WORKS

FORMULAES

$$T = i\left(\frac{D}{d}\right)^2 ar$$

$$T = mar$$

$$T = mgr$$

$$S = \frac{v^2 - u^2}{2g}$$

$$Q = m(hb - ha)$$

$$P = (T_1 - T_2)v$$

$$h = \frac{4flv^2}{2gd}$$

$$m = \frac{wl}{8}$$

$$WD = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{p_2}{P_{1_1}}\right)^{\frac{n}{n-1}} - 1\right] \quad or \quad WD = \frac{n}{n-1} P_1 V_{1_1} \left[\left(\frac{p_2}{P_{1_1}}\right)^{\frac{n}{n-1}} - 1\right] - P_2 V \log_e \frac{P_2}{P_1}$$

$$I_{sh} = I.\frac{100}{\%X}$$

$$\Delta p = pc(V_2 - V_2) \quad where \quad c = \sqrt{\frac{\text{bulk modulus of water}}{\text{density of water}}}$$

$$Tan\phi = \frac{2y}{x} \qquad T_0 = \frac{wx^2}{2y} \qquad T\frac{2}{r} = w^2x^2\left[\frac{x^2}{4y^2} + 1\right]$$

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$\text{Regulation} = \text{I(Rco}\phi + \text{Xsin}\phi)\ V$$

$$f = 3{,}242\,\frac{flQ^2}{gd^5}$$

$$f = \frac{4flv^2}{2gd}$$