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# higher education & training

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Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

T1860(E)(N12)T  
**NOVEMBER 2010**

**NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF  
COMPETENCY**

**PLANT ENGINEERING: MINES AND WORKS**

(8190306)

**12 November (X-Paper)  
09:00 – 12:00**

**CLOSED-BOOK EXAMINATION**

**This question paper consists of 7 pages and a 1-page formula sheet.**



**DEPARTMENT OF HIGHER EDUCATION AND TRAINING**  
**REPUBLIC OF SOUTH AFRICA**  
**NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF**  
**COMPETENCY**  
**PLANT ENGINEERING: MINES AND WORKS**  
**TIME: 3 HOURS**  
**MARKS: 100**

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**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. SECTION A is COMPULSORY.
  2. Answer any TWO questions in SECTION B.
  3. Read ALL the questions carefully.
  4. Number the answers correctly according to the numbering system used in this question paper.
  5. Rule off across the page on completion of each question.
  6. ALL calculations must be shown.
  7. Use only black or blue ink.
  8. NO cellular phones are allowed in the examination room.
  9. Questions are based on the requirements and practical application of the Mine Health and Safety Act, 1996 (Act 29 of 1996) and the regulations framed under Schedule 4. Answers must be confined to these requirements.
  10. Candidates arriving 30 minutes late will NOT be allowed to sit for the examination. No candidates writing the examination may leave the examination room before ONE hour after commencement of the examination.
  11. Candidates who have not been accepted by the Commission of Examiners will be disqualified.
  12. This is a CLOSED-BOOK EXAMINATION. Candidates may NOT use any notes, text books or reference works during this examination.
  13. Write neatly and legibly.
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**SECTION A: COMPULSORY****QUESTION 1**

- 1.1 A double cylindrical drum, geared, direct current man winder operates 2 cages in a vertical shaft under the following conditions:

Length of suspended rope	1 740 m
Total length of each rope	1 960 m
Mass per unit length of rope	10,5 kg/m
Maximum permitted mass load in cage	7 000 kg
Mass of cage and attachments	5 200 kg
Speed of each of the two motors	6,25 r/s
Maximum speed of the winder	15,25 m/s
Diameter of each drum	4,25 m
Diameter of each sheave	4,85 m
Moment of inertia of <u>drums and gearwheels</u>	258 000 kg/m <sup>2</sup> ✓
Moment of inertia of 2 armatures and pinions	6 800 kg/m <sup>2</sup> ✓

Assume that the friction is 5% of the static load resulting from the total travelling masses.

When a fully loaded cage is two thirds of the way down the shaft, the winder trips out due to a power failure.

Calculate the braking torque required to give a retardation of 2 m/s<sup>2</sup>. (15)

- 1.2 As an engineer at a shaft you wish to make sure whether the spectacle plate and jack catches as installed are such that they operate properly. How would you do this?

(5)  
[20]

**QUESTION 2**

- 2.1 A mine installation has a light load of 5 kW at a unity power factor in parallel with a 22 kW induction motor. The motor operates at a full load power factor of 0,8%. The supply voltage is 380 volt, three phase, 50 Hz.

Calculate the following:

- 2.1.1 The total kVA of the load
- 2.1.2 The power factor of the load
- 2.1.3 A bank of capacitors connected in delta is connected in parallel with the load and this improves the total power factor to 0,95 lagging. Each phase of the capacitors consists of 5 capacitors in series. Determine the capacitance of each. (10)
- 2.2 As a newly appointed engineer, you are to draw up a list of relevant information on the oil filled 6,6 kV transformers that would assist you in ensuring adequate protection. (5)
- 2.3 You also want the person conducting the gathering of that information in QUESTION 2.2 to carry out a safety check of the transformer without isolating the power to the transformer. Draw a checklist of these items. (5)
- [20]**

**QUESTION 3**

- 3.1 Give 10 safety aspects that should be adhered to when maintenance staff are working with vehicle tyres and rims. (5)
- 3.2 You are an appointed shaft engineer on a mine. Several 9-meter long pipe columns need to be taken down a vertical shaft to lower levels. The conveyance is 7 meters with a man hole in the roof. Draw a procedure to safely convey the columns down the shaft. (10)
- 3.3 What does the term intrinsically safe denote as applied to the following:
- 3.3.1 A circuit
- 3.3.2 An apparatus (2)
- 3.4 To which types of electrical equipment can the safe-guards of intrinsically safe circuits and apparatus be applied and what are the advantages gained in such situations over the use of flame-proof enclosures? Under what condition may extensions to intrinsically safe apparatus or circuits be made? (3)
- [20]**

**TOTAL SECTION A: 60**

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## SECTION B

Answer any TWO questions from this section.

### QUESTION 4

- 4.1 A 250 mm diameter pipe, 300 m long is fed from an underground dam and branches into two pipes - a 200 mm pipe, 300 m long and 150 mm pipe, 240 m long. Both pipes are fully open at the ends and are discharging on the same level 30 m below the constant head in the dam feeding the 250 mm pipe.

Disregard all losses except pipe friction of 0,06. Calculate the discharge in  $\text{m}^3/\text{s}$  from each branch of the pipe?

(10)

- 4.2 Draw up the requirements for an inspection report for a slime dam on a gold mine.

(10)

[20]

### QUESTION 5

- 5.1 Explain the following safety aspects with respect to boilers:

5.1.1 ASUSI – automatic start-up sequence interlock

(1)

5.1.2 LOFI – loss of flame interlock

(1)

5.1.3 PI – purge interlock

(1)

5.1.4 LFSI – low fuel supply interlock

(1)

- 5.2 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (5.2.1 – 5.2.3) in the ANSWER BOOK.

5.2.1 The group 1 refrigerants has low order toxicity and are non-flammable in any concentrations in air.

(1)

5.2.2 The group 2 refrigerants has a very low toxicity.

(1)

5.2.3 The group 3 refrigerants has a high order of toxicity.

(1)

- 5.3 When can ammonia and air mixtures be explosive and under which conditions?

(1)

- 5.4 State FOUR properties of refrigerants.

(4)

- 5.5 What is meant by the *mean time rating* of an electrical motor?

(4)

- 5.6 Name a few electrical methods of speed control that can be used on AC electrical driven motors.

(4)

[20]

PTO

### QUESTION 6

- 6.1 Give 14 items of maintenance that should be carried out regularly on a conveyor belt installation. (7)
- 6.2 Explain the correct method of storing conveyor belts. (5)
- 6.3 Explain what a Pelton wheel is, its function and its application. (8)

[20]

### QUESTION 7

- 7.1 A boiler generates 5 656 kg of wet steam per hour at 820 kPa with a dryness fraction of 0,95 from the supply water at 41,6 °C while using 620 kg of coal with a calorific value of 32 MJ/kg.

Calculate the thermal efficiency of the boiler and the equivalent evaporation from and at 100° C. (5)

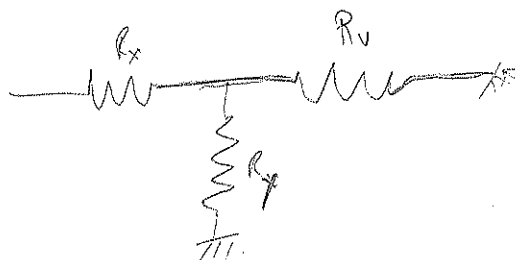
- 7.2 You are required to develop electricity savings at a process plant. Explain the process that you would follow to determine these savings. (5)

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

Distance end insulated = 7,01 Ω  
 Distance end solidly earthed = 1,85 Ω  
 Conductor resistance = 7,192 Ω/1 000 m

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

[20]



$$R_x + R_v = 7.01$$

$$R_x + \left( \frac{R_y R_v}{R_y + R_v} \right) = 1.85$$

PTO

**QUESTION 8**

A 10 t diesel locomotive has a maximum speed of 6,25 m/s and a tractive effort of 6,35 kN at this speed. The locomotive is used on a track with two sections. The loading end section is level and 1 km long. The off loading end section is 1,5 km long and slopes at a 1:400 in favour of the loaded train. The locomotive hauls hoppers having an empty mass of 1 t and a load capacity of 2 t each. The running coefficient of friction for both the hoppers and the locomotive is 0,0075 and this is reduced to 0,0025 when braking. The coefficient of friction between the locomotive wheels and rails is 0,16 for braking. The emergency braking rate is 0,2 m/s<sup>2</sup>. Allow 5 minutes per cycle for shunting.

Determine the following:

- 8.1 The number of empty hoppers that can be hauled up the incline at full speed
- 8.2 The number of full hoppers with which the train can safely stop on the level section in an emergency
- 8.3 The number of full hoppers that can be hauled along the level section at full speed
- 8.4 The cycle time of the train
- 8.5 The tonnage which can thus be conveyed per hour [20]

<b>TOTAL SECTION B:</b>	<b>40</b>
<b>GRAND TOTAL:</b>	<b>100</b>



## PLANT ENGINEERING: MINES AND WORKS

## FORMULAE AND CONSTANTS

$$P = \sqrt{3} VI \cos \theta$$

$$M = \sigma Z$$

$$Q = mC\Delta t$$

$$Z = \frac{I}{Y}$$

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

$$I_{xx} = \frac{bd^3}{12}$$

$$P = mgL \sin \theta$$

$$h = \frac{4 \sin \theta / 2}{\theta + \sin \theta} \times R$$

$$P = \mu mgL$$

$$M = fz$$

$$T/h = CW^2 \rho v$$

$$hf = \frac{4fLv^2}{2gd}$$

$$Q = \frac{UA(\theta_1 - \theta_2)}{\ln(\phi_2 / \phi_1)}$$

$$h = \frac{k v^2}{2g}$$

$$W = \frac{n}{n-1} \cdot P_1 V_1 \{ (P_2 / P_1) \exp[(n-1)/n] - 1 \}$$

$$pv = mRT$$

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$M = \frac{WL^2}{8}$$

$$M = \frac{WL}{4}$$

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