DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N3
TIME: 3 HOURS
MARKS: 100

APRIL 2012

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. ALL the calculations should consist of at least the following THREE steps:
   - 2.1 The formula used or manipulation thereof
   - 2.2 Substitution of the given data in the formula
   - 2.3 The answer with the correct SI unit
3. Read ALL the questions carefully.
4. Number the answers correctly according to the numbering system used in this question paper.
5. The constant values, as they appear on the attached information sheet, must be used where applicable.
6. Keep subsections of questions together.
7. RULE OFF on completion of each question.
8. Drawing instruments must be used for ALL drawings/diagrams. ALL drawings/diagram must be fully labelled.
9. One mark indicates one percentage point, that is 100 marks = 100%.
10. Use $g = 9,8\ m/s^2$.
11. Answers MUST be rounded off to THREE decimal places.
12. Write neatly and legibly.

QUESTION 1: MOTION, POWER AND ENERGY

1.1 Define a *force*. (1)

1.2 Define the *Law of Conservation of Energy*. (1)

1.3 A vehicle with a mass of 800 kg experiences a friction force of 180 N and travels at a constant speed of 54 km/h.

Calculate the following:

1.3.1 The momentum of the vehicle at this speed (1)

1.3.2 The power required from the engine of the vehicle to travel at the constant speed (2)

1.3.3 The work done to accelerate the vehicle from 54 km/h with an acceleration of 2 m/s^2 for 5 seconds (4)

1.4 A vehicle with a mass of 1 200 kg accelerates uniformly from rest upward with an incline of 1:25 and reaches a speed of 72 km/h after 2 minutes.

Calculate the following:

1.4.1 The kinetic energy of the vehicle after 2 minutes (1)

1.4.2 The potential energy of the vehicle after 2 minutes (5)

1.5 The ratio between the tight side and the slack side of a belt-drive system is 4:1. The force in the tight side is 400 N and the belt speed is 15 m/s. The pulley rotates at 25 rev/s.

Calculate the following:

1.5.1 The power transmitted (3)

1.5.2 The diameter of the pulley (2)
[20]

QUESTION 2: MOMENTS

2.1 Define the *Law of Moments.* (2)

2.2 FIGURE 1 below shows a light horisontal beam ABCDEF of a uniform cross-section, loaded as shown.

2.2.1 Calculate the reaction forces of B and E and test your answers. (4)

2.2.2 Draw the shear-force diagram and indicate ALL the main values on the diagram. (5)

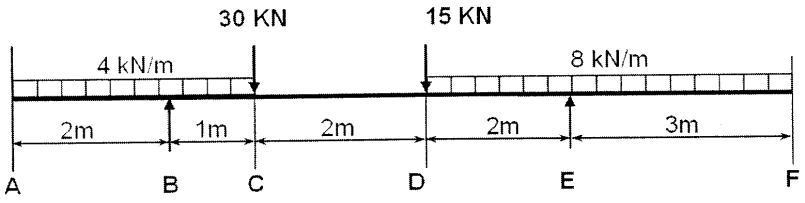

FIGURE 1

[11]

QUESTION 3: FORCES

3.1 Define the terms *strut* and *tie* when referring to structures. (2)

3.2 FIGURE 2 represents four forces acting on a point. Use FIGURE 2 to answer the questions that follow.

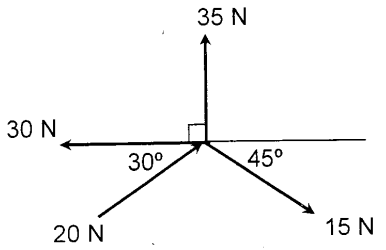

FIGURE 2

3.2.1 The sum of the vertical components (2)

3.2.2 The sum of the horizontal components (2)

3.2.3 The magnitude and direction of the resultant (2)
[8]

PTO

QUESTION 4: FRICTION

4.1 Name TWO applications of friction in practice. (2)

4.2 Define the *angle of rest (repose) of an object.* (1)

4.3 The weight of a vehicle is 60 kN and the force, Fμ, to overcome friction is 24 kN. This vehicle is on an incline of 23° to the horizontal.

Calculate the following:

4.3.1 Weight component perpendicular (F_c) to the incline plane (1)

4.3.2 Weight component parallel (F_s) to the incline plane (1)

4.3.3 The coefficient of friction of the plane (1)

4.3.4 Smallest force required to move the vehicle up the incline (2)

4.3.5 Smallest force required to move the vehicle down the incline (2)

4.4 A student is experimenting with his school desk to determine the coefficient of friction of the classroom floor. The mass of the desk is 25 kg. He notices that the spring scale indicates a reading of 180 N just as the desk starts moving, but it decreases immediately to 150 N.

Calculate the following:

4.4.1 The static coefficient of friction (2)

4.4.2 The kinetic coefficient of friction of the classroom floor (2)
[14]

QUESTION 5: HEAT AND TEMPERATURE

5.1 Define the *specific heat capacity* of a substance. (1)

5.2 Copper with a mass of 8 kg is heated to a temperature of 200 °C and is then placed in 20 kg water at a temperature of 40 °C to cool down. Calculate the final temperature of the water. (3)

5.3 A rectangular brass plate has measurements of 1 400 mm x 800 mm at a temperature of 20 °C. The coefficient of linear expansion of brass is 20×10^{-6}/°C. Calculate the new area of the plate in square metres if it is heated to a temperature of 40 °C. (3)

5.4 Steam is produced at a pressure of 640 kPa and wet steam with a dryness factor of 0,9 is formed from this. This wet steam now flows to a superheater where it is dried and superheated to a temperature of 200 °C.

Calculate the enthalpy (heat content) of 1 kg steam:

5.4.1 In the wet steam (h_{wet}) (2)

5.4.2 In the dry steam (h_g) (1)

5.4.3 Required to dry the wet steam (h) (2)
[12]

QUESTION 6: HYDRAULICS

6.1 Explain the difference between *gauge pressure* and *absolute pressure*. (2)

6.2 A single-action suction pump has a diameter of 120 mm and a delivery stroke length of 80 mm. The pump has to deliver water to a tank, 25 m above ground level.

Calculate the following:

6.2.1 The volume of the water in cubic metres, which is being pumped per delivery stroke (2)

6.2.2 The number of strokes required to deliver ONE litre of water (1)

6.2.3 The mass of the water pumped per delivery stroke (1)

6.2.4 The work done per stroke length (2)

6.3 A hydraulic press has a plunger diameter of 20 mm. The force on the plunger is 60 N while the ram diameter is 100 mm.

Calculate the following:

6.3.1 The mass in kilograms that can be raised (3)

6.3.2 The pressure in the fluid (2)
[13]

QUESTION 7: ELECTRICITY

7.1 Define *Joule's law*. (2)

7.2 An electrical circuit consists of THREE cells connected in series, each having an EMF of 2 volts and internal resistance of 0,1 ohms per cell. This is connected as shown in FIGURE 3.

Calculate the following:

7.2.1 The total resistance of the circuit (6)

7.2.2 The ammeter reading (2)

7.2.3 The voltage across AB (1 Ω resistor) (2)

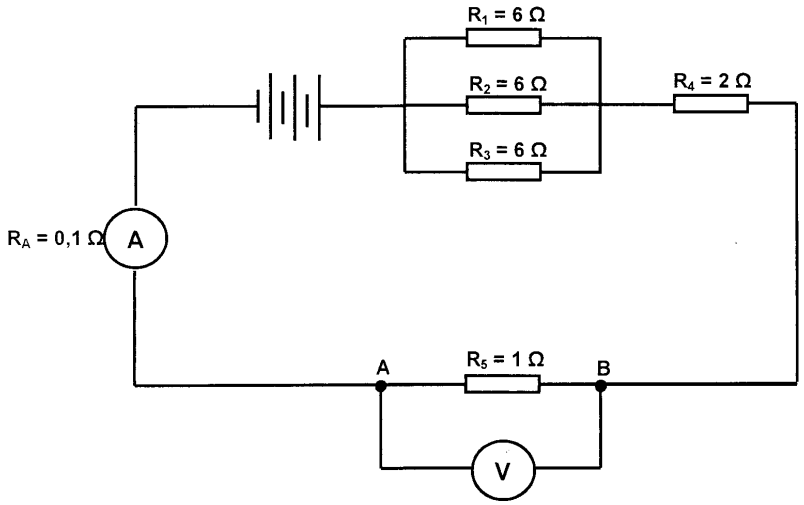

FIGURE 3

7.3 A single-phase transformer has a supply voltage of 220 V. The turn ratio primary: secondary is 10:1. The secondary current at full load is 2 A and the secondary coil has 28 windings.

Calculate the following:

7.3.1 The secondary voltage (2)

7.3.2 The primary current (2)

7.3.3 Number of windings on the primary coil (2)
[18]

QUESTION 8: CHEMISTRY

8.1 State TWO methods to combat corrosion. (2)

8.2 What is the definition of an alloy? (1)

8.3 Name ONE example of a reaction between substances that may cause corrosion. (1)
[4]

TOTAL: 100