DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

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

NOVEMBER 2012

INSTRUCTIONS AND INFORMATION

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

QUESTION 1: MOTION, POWER AND ENERGY

1.1 A vehicle with a mass of 2 tons travels on a horizontal road at a speed of 126 km/h. The driver notices a donkey at the side of the road and decides to reduce speed. The brakes are applied and the vehicle slows down to 72 km/h after 5 seconds.

Calculate the following:

1.1.1 The acceleration of the vehicle (2)

1.1.2 The distance travelled during the acceleration (3)

1.1.3 The initial momentum of the vehicle (2)

1.1.4 The change in kinetic energy of the vehicle (3)

1.1.5 The force required on the brakes for the deceleration (2)

1.2 The driving pulley of a motorbike rotates at 3 r/s and has a diameter of 300 mm. The pulley exerts an effective force of 2 000 N at a point on its periphery.

Calculate the following:

1.2.1 The turning moment (torque) (2)

1.2.2 The power in kW (2)
[16]

QUESTION 2: MOMENTS

2.1 State TWO general purposes of a machine. (2)

2.2 FIGURE 1 shows a simple supported loaded beam.

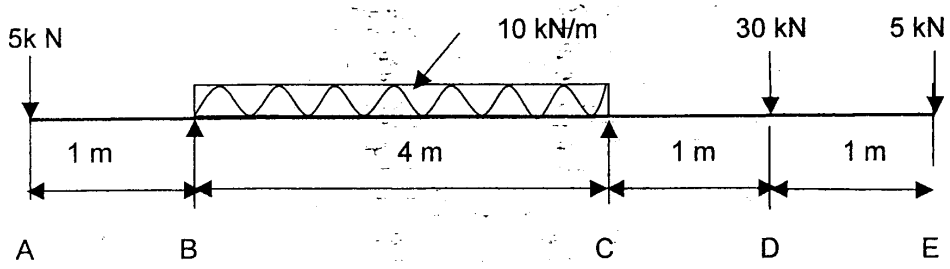

FIGURE 1

2.2.1 Calculate the magnitude of the reactions at the supports. (4)

2.2.2 Draw a shear force diagram to scale 10 mm = 10 kN. (6)
[12]

QUESTION 3: FORCES

3.1 **FIGURE 2** below shows a system of forces. Calculate the magnitude and direction of the force that will keep the three forces shown in equilibrium.

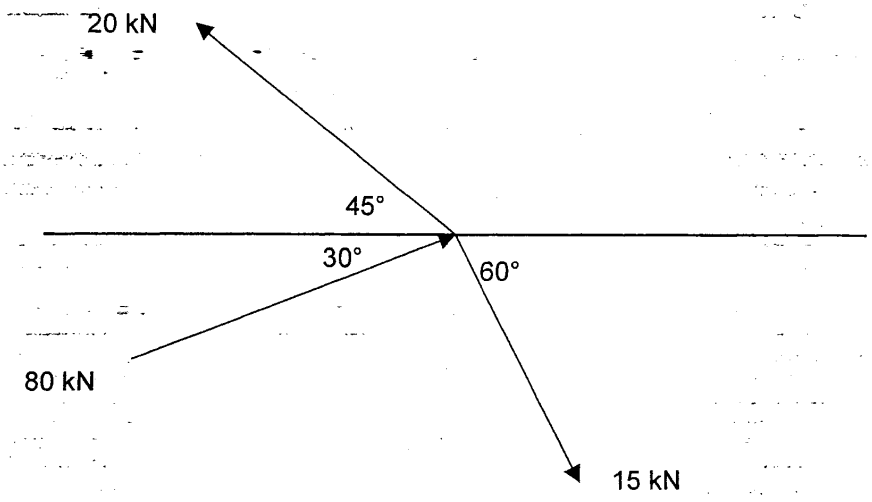

FIGURE 2

(9)

3.2 **FIGURE 3** below shows a structure. Determine graphically or calculate the magnitude and nature of the forces in members AB and AC

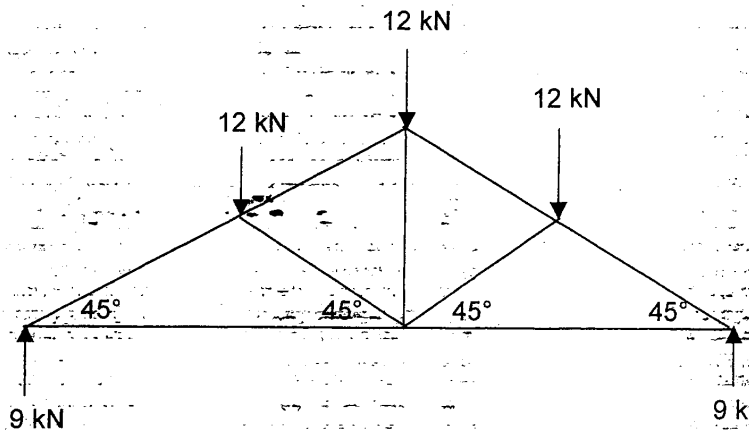

FIGURE 3

(6)
[15]

QUESTION 4: FRICTION

4.1 Name TWO applications of the angle of repose. (2)

4.2 A granite block with mass of 180 kg is pulled up an incline of 15° by a force F. Take the coefficient of friction as 0,3.

4.2.1 Draw the diagram in the **ANSWER BOOK** and show ALL the forces and components of the forces as well as ALL the directions of the forces and its components. (4)

4.2.2 Calculate the magnitude of the force if it causes an acceleration of 0,4 m/s^2. (5)
[11]

QUESTION 5: HEAT

5.1 A container of oil with a density of 0.8 kg per litre and a specific heat capacity of 3.14 kJ/kg.°C is used to temper 4 kg steel at a temperature of 667 °C. The temperature of steel decreases to 27 °C. The rise in the temperature of the oil may not exceed to 25 °C.

Calculate the following:

5.1.1 The heat released by the steel if the specific heat capacity for steel is 460 J/kg.°C (2)

5.1.2 The amount of oil required in litres (3)

5.2 A rectangular aluminum plate at 25 °C with dimension of 20 cm by 10 cm is heated to a temperature of 50 °C.

Calculate the final area of the plate in millimetres. (3)

5.3 The dryness factor of 1 kg wet steam is 0.94. This steam is generated at a boiler pressure of 2.5 Mpa.

Calculate the specific enthalpy (heat energy) of the following:

5.3.1 The liquid at saturated temperature (h_f) (1)

5.3.2 The dry steam (h_g) (1)

5.3.3 To evaporate the liquid (h_{fg}) (1)

5.3.4 The wet steam (h_{wet}) (2)

5.3.5 To dry the wet steam ($h_{(1-x)}$) (2)
[15]

QUESTION 6: HYDRAULICS

6.1 A pump needs to pump all the water from a circular dam with a diameter of 15 m. The depth of the water in the dam is 2 m. The water must also be pumped through a height of 2 m.

Calculate the following:

6.1.1 The work done by the pump (2)

6.1.2 The power required to empty the dam within 10 hours. (3)

6.2 The information below refers to a hydraulic jack:

Diameter of the plunger	=	70 mm
Diameter of ram	=	0.25 m
Stroke length of plunger	=	80 cm
Effort on the plunger	=	300 kN

Calculate the following:

6.2.1 The force exerted by the ram (2)

6.2.2 The distance the ram moved per stroke of the plunger (2)

6.2.3 The number of pumping strokes required by the plunger to lift the load to a height of 46 m (1)

6.2.4 The volume of liquid received by the ram cylinder (2)

[12]

QUESTION 7: ELECTRICITY

7.1 A battery has an EMF of 20 Volt and a total internal resistance of 0,5 Ω when connected as shown in FIGURE 4 below.

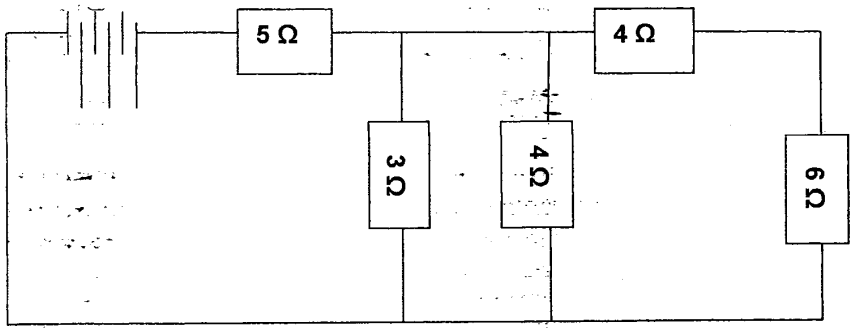

FIGURE 4

Calculate the following:

7.1.1 The total resistance of the circuit (3)

7.1.2 The total current flow in the circuit (3)

7.2 An electrical lamp is marked 240 V and 150 W.

Calculate the following:

7.2.1 Current flowing through the lamp (2)

7.2.2 Resistance of the lamp (2)

7.2.3 Cost to operate the lamp for 3 hours at 6 cent per unit (3)
[13]

QUESTION 8: CHEMISTRY

8.1 Explain the difference between reduction and oxidation. (2)

8.2 State TWO precautions against corrosion of iron. (2)

8.3 Name and describe TWO types of corrosion. (2)
[6]

TOTAL: 100