DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N3
TIME: 3 HOURS
MARKS: 100 Nov 2013

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. All the calculations should consist of at least the THREE steps:
   - 4.1 The formula used or manipulation thereof
   - 4.2 Substitution of the given data in the formula
   - 4.3 The answer with the correct SI unit
5. Drawing instruments must be used for all drawings/diagrams.
6. All drawings/diagram must be fully labelled.
7. The constant values, as they appear on the attachment information sheet, must be used were ever possible.
8. Keep subsections of questions together.
9. Rule off on completion of each question.
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 Distinguish between *work done* and *power*. (2)

1.2 Define an Impulse of a force on a body. (2)

1.3 A light aircraft starts from rest and moves in a straight line at a uniform acceleration of 4 m/s^2 for 5 seconds. Then it accelerates uniformly at 6 m/s^2 for a further 5 seconds.

Calculate the following:

1.3.1 The speed in km/h of the aircraft after the first 5 seconds (2)

1.3.2 The distance travelled by the aircraft at the end of 10 seconds (4)

1.4 A motorbike with a mass of 200 000 g accelerates on a horizontal road from rest to a velocity of 5 m/s in 10 seconds. The frictional force is 90,165 N.

Determine the magnitude of the constant horizontal force exerted by the engine of the motorbike. (5)
[15]

QUESTION 2: MOMENTS

2.1 Explain what a lamina is. (2)

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

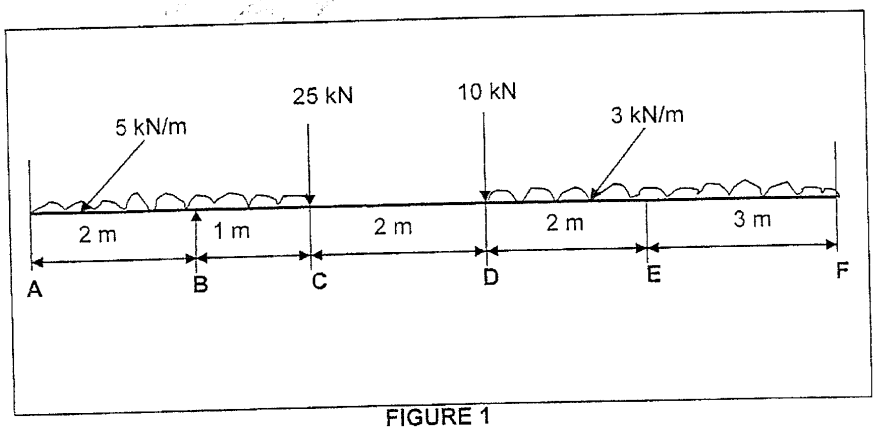


FIGURE 1

2.2.1 Calculate the reactions at the supports and test your answers. (5)

2.2.2 Draw a shear-force diagram, using a suitable scale. Show ALL the main values on the diagram. (3)

2.2.3 Determine from the diagram the maximum and minimum shear forces. (2)

[12]

QUESTION 3: FORCES

3.1 Distinguish between *resultant* and *equilibrant*. (2)

3.2 The THREE forces in FIGURE 2 show a system of forces.

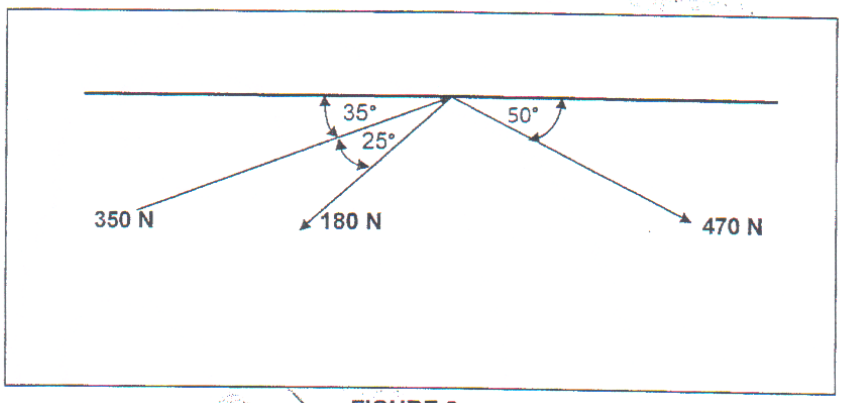


FIGURE 2

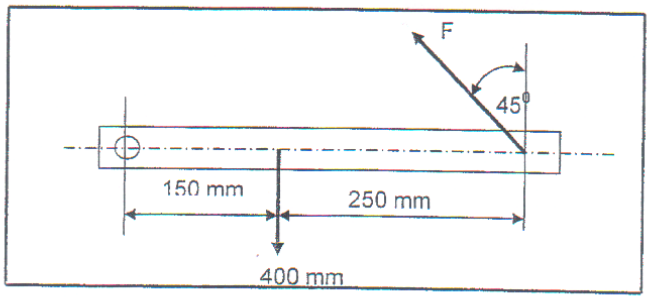
Calculate the following:

3.2.1 The sum of the horizontal components and give the direction (3)

3.2.2 The sum of the vertical components and give the direction (3)

3.2.3 The magnitude and direction of the resultant (3)

3.3 Calculate the magnitude of the unknown force in the sketch below.



(4)

[15]

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QUESTION 4: FRICTION

4.1 Name THREE applications of friction. (3)

4.2 An iron block with a mass of 45 000 g rests on an inclined plane of 16° to the horizontal. The force required to overcome friction is 65 N.

Calculate the following:

4.2.1 The weight component perpendicular to the inclined plane (1)

4.2.2 The coefficient of friction (2)

4.3 An army tank with a mass of 40 ton rests on a horizontal plane. The coefficient of friction is 0,36. A force T with an angle of 22° to the horizontal pulls the tank at a constant velocity.

Calculate the magnitude of force T. (5)
[11]

QUESTION 5: HEAT

5.1 A piece of steel with mass of 10 kg at a temperature of 89 °C is immersed in 5 litres of water at 17 °C.

Calculate the final temperature of the water if there is no heat lost to the surroundings. (3)

5.2 A lead cylinder open at both ends, has a diameter of 4,879 cm at 12 °C.

Calculate the surface area of the opening when it is heated to 150 °C. (4)

5.3 The total enthalpy of 1 kg of wet steam is 2 465,563 kJ under a pressure of 2 300 kPa.

Calculate the dryness factor of steam. (3)

5.4 It is compulsory in terms of the law that all steam boilers are equipped with essential features.

Name FIVE of these features. (5)
[15]

QUESTION 6: HYDRAULICS

6.1 Water flows out of a reservoir with a rate of 3 000 litres per minute. The reservoir is situated 100 metres above the electric turbine that is being driven by the falling water.

Calculate the following:

6.1.1 The kinetic energy of the water when it reaches the turbine (2)

6.1.2 The electrical power generated by the turbine when only 80% of the energy stored in the falling water is converted into electrical energy. (3)

6.2 The following information was gathered with a hydraulic press testing:

Diameter of ram	= 125 mm
Mass that was lifted	= 1,2 ton
Diameter of the plunger	= 50 mm
Stroke length of the plunger	= 200 mm

Ignore all losses and calculate the following:

6.2.1 The effort applied by the plunger (2)

6.2.2 The distance moved by the ram per stroke (2)

6.2.3 The work done by the ram after 10 strokes (2)

6.3 Describe the following terms with reference to centrifugal pumps:

6.3.1 Suction head (1)

6.3.2 Static head (1)

[13]

QUESTION 7: ELECTRICITY

7.1 An electrical circuit consists of three cells connecting in series, each having an EMF of 2 volts and internal resistance of 0,15 ohms, connected in series with a lamp of a resistance of 5 ohms.

Calculate the following:

7.1.1 The total EMF of the battery (1)

7.1.2 The total internal resistance of the battery (1)

7.1.3 The total resistance of the circuit (1)

7.1.4 The current flow in the circuit (1)

7.2 An electrical kettle draws 9 ampere from 220 volts and takes 3 minutes to boil. The cost of electricity is 85 cents per kWh.

How much will it cost to boil the kettle? (3)

7.3 A current of 25 A is allowed to flow through a solution of silver nitrate.

Calculate the time required to cover a metal plate with a mass of 350 grams of silver. Take the electrochemical equivalent as 0,001118 g/C. (2)

7.4 A single transformer has a primary voltage of 240 V and steps down to 6 V and a current of 12 A at full load. The secondary current is 5 A and the primary coil consists of 1200 turns.

Calculate the following:

7.4.1 The turns ratio primary to secondary turns (2)

7.4.2 The power if the power factor is 0,766 (2)
[13]

QUESTION 8: CHEMISTRY

8.1 Name the following well known compounds:

8.1.1 $HC\ell$ (1)

8.1.2 $NaC\ell$ (1)

8.1.3 $CaCO_3$ (1)

8.2 List THREE non-metals and give their symbols. (3)
[6]

TOTAL: 100

STEAM TABLE

P kPa	ts °C	hf kJ/kg	hfg kJ/kg	hg kJ/kg
10400	313.4	1425	1295	2720
10800	316.7	1442	1271	2713
11200	319.4	1459	1247	2706
11600	322.1	1475	1222	2697
12000	324.7	1492	1197	2689
12400	327.2	1508	1173	2681
12800	329.6	1524	1148	2627
13200	332.0	1540	1122	2662
13600	334.4	1556	1097	2653
14000	336.6	1572	1071	2643
14400	338.9	1587	1044	2631
14800	341.1	1603	1018	2621
15200	343.2	1619	990	2609
15600	345.3	1635	963	2598
16000	347.3	1651	934	2585
16400	349.3	1667	906	2573
16800	351.3	1683	876	2559
17200	353.2	1700	844	2544
17600	355.1	1718	812	2530
18000	357.0	1735	779	2514
18400	358.8	1752	745	2497
18800	360.6	1770	710	2480
19200	362.3	1788	673	2461
19600	364.0	1807	634	2441
20000	365.7	1827	592	2419
20400	367.4	1848	545	2393
20800	369.0	1873	492	2365
21200	370.6	1902	427	2329
21600	372.2	1940	342	2282
22000	373.7	2011	185	2195
22120	374.2	2107	0	2107

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