higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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APRIL EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

1 April 2016 (X-Paper)
9:00–12:00

Calculators and drawing instruments may be used.

This question paper consists of 8 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

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 following THREE steps:
   - 4.1 The formula used or the manipulation thereof
   - 4.2 The substitution of the given data in the formula
   - 4.3 The answer together with the correct SI unit
5. The following values MUST be used in this question paper, whenever applicable:

Gravitational acceleration	= 9,8 m/s²
Atmospheric pressure	= 101,3 kPa
Heat value of petrol	= 25 MJ/kg
Heat value of coal	= 30 MJ/kg
Density of water	= 1 000 kg/m^3
Specific heat capacity of water	= 4 187 J/kg °C
Specific heat capacity of steam	= 2 100 J/kg °C
Specific heat capacity of steel	= 500 J/kg °C
Specific heat capacity of copper	= 390 J/kg °C
Specific heat capacity of aluminium	= 900 J/kg °C
Linear coefficient of expansion of steel	= 0,000 012/°C
Linear coefficient of expansion of copper	= 0,000 017/°C
Linear coefficient of expansion of aluminium	= 0,000 023/°C
Resistivity of steel at 20 °C	= 0,000 000 155 Ωm
Resistivity of copper at 20 °C	= 0,000 000 018 Ωm
Resistivity of aluminium at 20 °C	= 0,000 000 028 Ωm

6. Rule off on completion of each question.
7. Subsections of questions must be kept together.
8. Write neatly and legibly.

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QUESTION 1: DYNAMICS

1.1 An aeroplane's take-off speed is 324 km/hr. The maximum acceleration of the aeroplane is 10 m/s^2.

Calculate the:

1.1.1 Time it takes the aeroplane to accelerate from rest until its wheels leave the runway

1.1.2 Absolute minimum length of runway needed for the aeroplane to take off safely

(2 x 2) (4)

1.2 Copy the TABLE shown below, in the ANSWER BOOK and write down the correct quantity in the left-hand column for each given SI unit. An example of Force and Newton is given.

QUANTITY	BASIC SI UNIT
Force	**N**
	Pa or N/m^2
	m/s^2
	Ωm
	J
	m
	J/kg °C
	/°C

(7)
[11]

QUESTION 2: STATICS

2.1 A light horizontal beam is 15 m long and is supported at the left end and 3 m from the right end.

The beam carries the following point loads:

120 N two metres from the left-hand end
80 N five metres from the left-hand end
90 N at the right-hand end

2.1.1 Make a neat line sketch of the beam and clearly show all its dimensions and loads. (2)

2.1.2 Calculate the reactions of both points of support by taking moments about both supports. (Ignore the weight of the beam.) (6)

2.1.3 Check the answer by balancing upward and downward forces. (1)

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2.2 A force of 250 N acts at 40° to the horizontal.

Calculate the vertical component of the 250 N force. (2)
[11]

QUESTION 3: ENERGY AND MOMENTUM

An object falls freely from a height of 50,5 m and has 2 486 joules of kinetic energy just before reaching ground level.

Determine the:

3.1 Velocity reached after having fallen 50,5 m (2)

3.2 Mass of the object (2)

3.3 Potential energy of the object before falling (1)

3.4 Momentum of the body just before reaching ground level. (2)
[7]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define the unit *watt*. (1)

4.2 A machine with a weight of 800 N is lifted through a height of 120 m by means of a cable winding onto a drum. The weight of the cable is 20 N/m.

4.2.1 Calculate the total weight of the cable. (1)

4.2.2 Make a neat line sketch of the force/distance graph, using the information given above. (2)

4.2.3 Calculate the work done in winding up the total length of the cable with the machine attached to the end of the cable. (3)

4.3 The turning force applied to a flywheel is 3 500 N. The diameter of the flywheel is 560 mm.

Calculate the torque delivered by the flywheel. (3)
[10]

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QUESTION 5: MECHANICAL PROPULSION AND CRANES

5.1 Define the *velocity ratio* of a lifting device. (2)

5.2 Draw a neat sketch of a differential wheel and an axle lifting machine with the ropes wound correctly. Indicate ALL the diameters and show where the load and effort is applied. (4)

5.3 The diameters of a differential wheel and axle lifting machine are 520 mm, 340 mm and 290 mm respectively. The mechanical advantage is 16 when lifting a load of 1 100 N.

Calculate the:

5.3.1 Effort required to lift the load of 1 100 N (1)

5.3.2 Velocity ratio of the machine (2)

5.3.3 Efficiency when lifting a load of 1 100 N (2)

5.4 FIGURE 1 below shows a gear drive consisting of FOUR gears.

Rotational speed of A = 1 950 rpm
No of teeth of B = 65
Rotational speed of B = 750 rpm
No of teeth of C = 20
No of teeth of D = 50

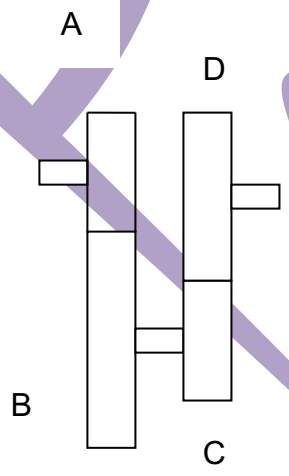

FIGURE 1

Determine the:

5.4.1 Number of teeth of A

5.4.2 Rotational speed of D

(2 × 2) (4)

5.5 The gauge pressure at the bottom of a water tank is 83,52 kPa.

Determine the height of the water in the tank. (2)
[17]

QUESTION 6: HYDRAULICS AND FRICTION

6.1 Indicate TWO ways by which friction between moving parts may be reduced. (2)

6.2 A force of 60 N is required to pull a mass of 17,9 kg over a horizontal plane at constant velocity.

Determine the:

6.2.1 Coefficient of friction

6.2.2 Friction angle

(2 × 1) (2)

6.3 A body with a mass of 20 kg is pulled at constant velocity down an incline with an angle of 11° to the horizontal. The coefficient of friction between the body and the inclined surface is 0,32.

Calculate the:

6.3.1 Weight component perpendicular to the inclined plane (1)

6.3.2 Weight component parallel to the inclined plane (1)

6.3.3 Frictional force (2)

6.3.4 External force required to pull the body down the inclined plane (2)
[10]

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QUESTION 7: HEAT

7.1 Define *specific heat capacity* of a substance. (2)

7.2 A boiler operates with an efficiency of 80%.

Determine the mass of coal supplied to the boiler per minute if the boiler delivers 50 megawatt of heat. (3)

7.3 A 6 m length of copper pipe at 20 °C is used to transport warm water, after which the pipe expands by 4 mm when it adopts the temperature of the warm water.

Determine the temperature of the warm water. (3)

7.4 With reference to water, explain what is meant by the term s*ensible heat.* (2)

7.5 Determine the heat energy required to heat 50 kg of water from 16 °C to 85 °C. (2)

[12]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 What is an ion? (1)

8. Explain how positive ions are formed. (2)

8.3 Name the THREE fundamental constituents of an atom and state the charge of each. (3 x 2) (6)

[9]

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QUESTION 9: ELECTRICITY

9.1

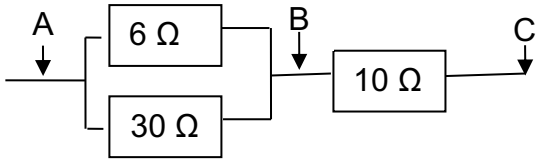

FIGURE 2

Use the circuit in FIGURE 2 to calculate:

9.1.1 Resistance between A and B

9.1.2 Resistance between A and C

(2 x 2) (4)

9.2 Make a neat, labelled sketch of an apparatus that may be used to demonstrate dynamically-induced electromagnetic induction. (3)

9.3 List any THREE factors which determine the strength of the induced current in dynamically-induced electromagnetic induction. (3)

9.4 Name ONE example where dynamically-induced electromagnetic induction is used in practice. (1)

9.5 Calculate the length of an aluminium cable with a cross-sectional area of $7,07 \times 10^{-3}$ m^2 that has a resistance of 2 Ω at 20 °C. (2)

[13]

TOTAL: 100

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FORMULA SHEET: ENGINEERING SCIENCE N2

All the formulae needed are not necessarily included.

Any applicable formula may also be used.

$w = m \,.\, g$

$W = F \,.\, s$

$P = \frac{W}{t}$

$\eta = \frac{Output}{Input} \,.\, 100\%$

$\eta = \frac{Uitset}{Inset} \,.\, 100\%$

$\mu = \frac{F_\mu}{N_R}$

$\mu = \tan \Phi$

$F_T = F_\mu \ldots \frac{horizontal}{horisontaal} \cdots a = 0$

$F_S = w \sin \theta$

$F_C = w \cos \theta$

$F_T = F_\mu \pm F_S \ldots a = 0$

$F_e = T_1 - T_2$

$\frac{T_1}{T_2} = \frac{tension\ \ ratio}{spanningsverhouding}$

$P = F_e \,.\, v$

$v = \pi \,.\, d \,.\, n$

$n = \frac{N}{60}$

$N_A \,.\, T_A = N_B \,.\, T_B$

$SV = \frac{N_A}{N_Z} = VR$

$E_p = m.g.h.$

$E_K = \frac{1}{2} .m.v^2$

$E_T = E_p + E_K$

$HV = \frac{L}{E} = MA$

$VV = \frac{S_E}{S_L} = DR$

$\frac{HV}{VV} .100\% = \eta = \frac{MA}{DR} .100\%$

$VV = \frac{2D}{(d_1 - d_2)} = DR$

$VV = \frac{2D}{(D - d)} = DR$

$Q = m \,.\, c \,.\, \Delta t$

$m.ww = Q = m.hv$

$P = \frac{Q}{t}$

$\Delta l = l_o \,.\, \alpha \,.\, \Delta t$

$l_f = l_o \pm \Delta l$

$1\ m/s = 3{,}6\ km/h$

$s = u.t + \frac{1}{2} .a.t^2$

$v = u + a.t$

$v^2 = u^2 + 2as$

$\Sigma \uparrow F = \Sigma \downarrow F$

$\Sigma \curvearrowright M = \Sigma \curvearrowleft M$

$P_{ABS} = P_{ATM} + P_{MET}$

$p = \Delta .g.h$

$\frac{1}{R_{PAR}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$

$R_{SER} = R_1 + R_2 + \ldots + R_n$

$R = \frac{\rho \,.\, l}{a}$

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