higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T630**(E)**(J27)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

27 July 2018 (X-Paper)
09:00–12:00

Drawing instruments will be needed.

This question paper consists of 7 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

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 the manipulation thereof
   2.2 The substitution of the given data in the formula
   2.3 The answer together with the correct SI-unit

3. Number the answers according to the numbering system used in this question paper.

4. The following values MUST be used in this question paper, whenever applicable:

Gravitational acceleration	$= 9{,}8\ m/s^2$
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	$= 4\,187\ J/kg\ ℃$
Specific heat capacity of steam	$= 2\,100\ J/kg\ ℃$
Specific heat capacity of steel	$= 500\ J/kg\ ℃$
Specific heat capacity of copper	$= 390\ J/kg\ ℃$
Specific heat capacity of aluminium	$= 900\ J/kg\ ℃$
Linear coefficient of expansion of steel	$= 0,000\,012/℃$
Linear coefficient of expansion of copper	$= 0,000\,017/℃$
Linear coefficient of expansion of aluminium	$= 0,000\,023/℃$
Resistivity of steel at 20 °C	$= 0,000\,000\,155\ \Omega m$
Resistivity of copper at 20 °C	$= 0,000\,000\,018\ \Omega m$
Resistivity of aluminium at 20 °C	$= 0,000\,000\,028\ \Omega m$

5. Rule off on completion of each question.

6. Drawing instruments MUST be used for all the drawings.

7. Subsections of questions must be kept together.

8. Write neatly and legibly.

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QUESTION 1: DYNAMICS

1.1 Briefly explain the following:

1.1.1 Speed

1.1.2 Displacement

(2 × 1) (2)

1.2 Khopho started jogging from rest and accelerated uniformly along a straight road at $2\ m/s^2$ for 4 s. He then reached a maximum velocity and maintained this velocity for another $14\ s$, after which he took $2\ s$ to slow down uniformly and stopped at the stop sign.

1.2.1 Calculate the maximum velocity during the first $4\ s$. (2)

1.2.2 Describe the velocity between 0s and $4\ s$. (1)

1.2.3 Draw a fully labelled velocity/time graph representing Khopho's whole journey and mark the following points on your time axis: $4\ s; 18\ s$ and $20\ s$ and the velocities reached on the velocity axis. (4)

1.2.4 Calculate from the graph that you drew for QUESTION 1.2.3, his acceleration for the last $2\ s$. (2)

1.2.5 Calculate the total displacement covered for his whole journey from the graph without using the equations of motion. (2)

[13]

QUESTION 2: STATICS

2.1 Define the *equilibrant of forces.* (2)

2.2 A light horizontal beam is 12 m long and is supported at A at the left end and at B 2 m from the right end. The beam carries a load of 100 N which is at the right-hand end and it carries a load of $90\ N$ which is 7 m from the right-hand end and 130 N which is 3 m from the left-hand end.

2.2.1 Make a neat, fully labelled drawing representing the light horizontal beam and clearly show all the distances and loads on the beam. (3)

2.2.2 Ignore the weight of the beam and calculate reactions of the supports of the beam by taking the moments about each support. (6)

2.2.3 Check your answer. (1)

[12]

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QUESTION 3: ENERGY AND MOMENTUM

3.1 State the law of conservation of energy. (2)

3.2 An object with a mass of 5 kg is dropped down from a platform which is 10 m above the ground.

3.2.1 Calculate the potential energy of the object at the top of the platform.

3.2.2 Calculate the velocity of the object as it hits the ground.

3.2.3 Calculate the momentum of the object as it hits the ground.

(3 × 2) (6)

[8]

QUESTION 4: WORK, ENERGY AND EFFICIENCY

4.1 Define the term *work done.* (2)

4.2 A steel block with a weight of 1 000 N is hoisted vertically up a building by means of a chain wounded onto a drum. The weight of the chain is 30 N/m and the building is 15 m high.

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

4.2.2 Make a neat, fully labelled sketch of a graph of force versus distance using the information given in QUESTION 4.2 above. (3)

4.2.3 Calculate the total work done in hoisting the steel block up the total length of the chain with the steel block attached to the end of the chain. (3)

4.3 The wheel of a motor car has a diameter of 600 mm and a turning force of 400 N is applied to it at the circumference of the wheel.

Calculate the torque transmitted by the wheel of the motor car. (2)

[11]

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QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 State THREE methods of reducing belt slip. (3)

5.2 Define the *velocity ratio* of a lifting device. (1)

5.3 State TWO advantages of using chain drives over belt drives. (2)

5.4 Belt drives have more varied applications than other drives.

A certain belt drive has a tension ratio between the slack and tight side of 8 and the force in the slack side is 1 000 N. The diameter of the driving pulley is 500 mm and the rotational frequency of this driving pulley is 70 r/s.

Calculate:

5.4.1 The linear speed of the belt in m/s

5.4.2 The tension in the tight side

5.4.3 The power transmitted by the belt

(3 × 2) (6)

5.5 Name ONE type of lifting devices. (1)

5.6 State Pascal's law. (2)

[15]

QUESTION 6: FRICTION

6.1 Define *kinetic friction.* (1)

6.2 An object weighs $40\ kg$ and is placed on the incline plane which is at an angle of 25° with the horizontal. The coefficient of friction between the plane and the object is 0,3.

Calculate:

6.2.1 The weight component parallel to the plane (2)

6.2.2 The weight component perpendicular to the plane (2)

6.2.3 The frictional force (2)

6.2.4 The minimum force needed to pull the object up the incline (3)

[10]

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QUESTION 7: HEAT

7.1 Define the term *specific heat capacity.* (2)

7.2 A mass of 50 kg of coal is used to boil water in a boiler per hour. 20% of the heat energy is lost due to incomplete combustion and the heat energy value of this specific coal is 100 MJ/kg.

Calculate:

7.2.1 The energy released per hour

7.2.2 The power available from the coal.

(2 × 3) (6)

7.3 A steel bar has a length of 20 m long at 30 °C and the bar is then heated up to 300 ° C.

Calculate the change in length of the steel bar in mm. (3)

[11]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Define the term *atom.*

8.2 State the composition of a nucleus and give the polarities.

8.3 State TWO uses of electrolysis.

8.4 Give TWO reasons why objects are electroplated.

(4 × 2) **[8]**

QUESTION 9: ELECTRICITY

9.1 Give the relationship between the resistance of a resistor and the length of a conductor and the cross-sectional area in terms of proportion. (2)

9.2 An electrical circuit has a supply of $100\,V$ and two resistors of $R_1 = 9\,\Omega$ and $R_2 = 18\,\Omega$ connected in parallel and connected in series with a third resistor $R_3 = 36\,\Omega$ and an ammeter with a reading of $1{,}3\,A$.

9.2.1 Compare the value of the currents in the two parallel resistors and make comments with relation to the current flow and voltages across these resistors. NO calculations are required.

9.2.2 Calculate the total resistance of the circuit.

(2 × 2) (4)

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9.3 Calculate the total resistance of an aluminium conductor with a length of 3 000 m and a diameter of 150 mm at 20 °C. (3)

9.4 Students conducted an experiment in class by using a bar magnet and a coil connected to a galvanometer.

Briefly explain what would happen in the following situations:

9.4.1 Move the magnet towards the coil.

9.4.2 Move the magnet away from the coil in the opposite direction.

9.4.3 Both the magnet and the coil are held stationary.

(3 × 1) (3)
[12]

TOTAL: 100

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FORMULA SHEET

All the formulae needed are not necessarily included.

Any applicable formula may also be used.

$w = m \,.\, g$

$W = F \,.\, s$

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

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

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

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

$\mu = \tan\Phi$

$F_T = F_\mu \ldots \begin{matrix} horizontal \\ horisontaal \end{matrix} \cdots a = 0$

$F_S = w\sin\theta$

$F_C = w\cos\theta$

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

$F_e = T_1 - T_2$

$\frac{T_1}{T_2} = \begin{matrix} tension\ \ ratio \\ spanningsverhouding \end{matrix}$

$P = F_e \,.\, v$

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

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

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

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

$E_p = m.g.h.$

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

$E_T = E_p + E_K$

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

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

$l_f = l_o \pm \Delta l$

1 m/s = 3,6 km/h

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

$v = u + a.t$

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

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

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

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

$p = \rho.g.h$

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

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

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

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