higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T630**(E)**(A3)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

3 April 2018 (X-Paper)
09:00–12:00

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

Copyright reserved

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 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.

Copyright reserved

QUESTION 1: DYNAMICS

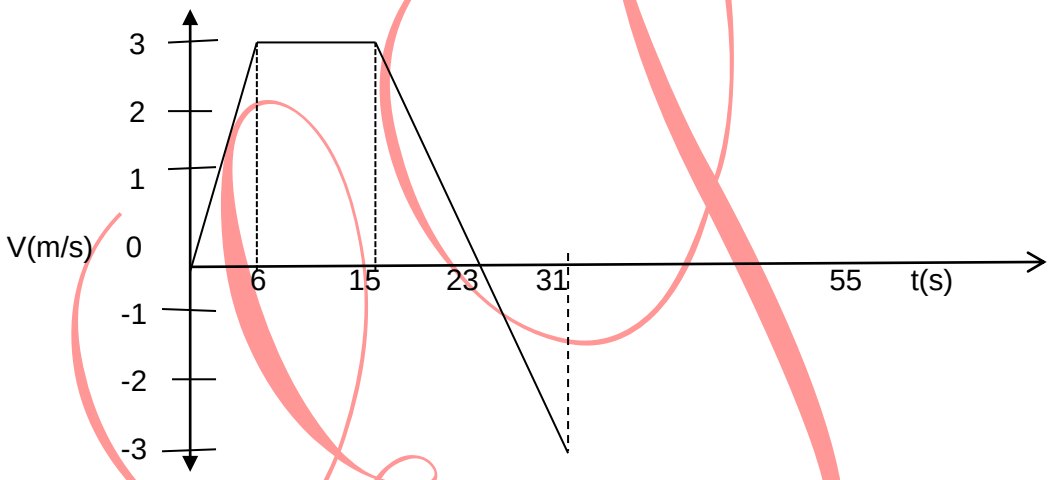
1.1 Define each of the following terms:

1.1.1 Velocity

1.1.2 Acceleration

(2 × 1) (2)

1.2 The velocity/time graph below represents the motion of a bus from rest till 31s has elapsed.



1.2.1 Calculate the acceleration of the bus in the first 6 s. (2)

1.2.2 Describe the motion of the bus from 15 s to 23 s and its direction. (2)

1.2.3 Calculate the displacement of the bus from 0 s to 31 s. Do NOT use the equations of motions. Use the graph provided. (3)

1.2.4 Calculate the average velocity of the bus throughout the journey. (2)

1.3 A motorist drives at 30 m/s along a straight road. The speed limit on the road is 72 km/h. The motorist applies brakes 25 m before crossing a speed trap.

What must the car's acceleration be to reduce its speed to 72 km/h as it reaches the speed trap? (4)

[15]

QUESTION 2: STATICS

2.1 Which are the TWO graphical methods that can be used to determine the resultant of two forces acting on a point? (2)

2.2 Two forces of 60 N and 80 N respectively act at a point. The direction of the 80 N is 90° (east) from the north and the angle between the forces is 60°.

2.2.1 Determine the resultant of the forces graphically using a parallelogram method and clearly indicate the most suitable scale used. (5)

2.2.2 What is the equilibrant of the system? (1)

2.3 Define *couples.* (2)

2.4 Name two practical examples of couples. (2)
[12]

QUESTION 3: ENERGY AND MOMENTUM

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

3.2 A motor car with a mass of 40 kg climbs an inclined plane which forms an angle of 30° with the horizontal and has a displacement of 100 m from the bottom to the top of the slope.

3.2.1 Calculate the potential energy of the motor car at the top of the inclined plane. (2)

3.2.2 Calculate the kinetic energy of the motor car when it rolls down the plane from the top starting from rest when the car is at the height of 30m. (4)

3.2.3 Calculate the total mechanical energy of the motor car at the bottom of the plane when it has travelled 100m down from the height as in 3.2. (2)
[10]

Copyright reserved

QUESTION 4: WORK, ENERGY AND EFFICIENCY

4.1 Define *power.* (1)

4.2 A bucket has a mass of 50 kg as it carries bricks and it is tied with a rope which has a weight of 20 N/m. The bucket is hoisted to the top of a building which is 12 m high.

4.2.1 Make a neat, labelled sketch of the force/distance graph using the information above and show all the important points.

4.2.2 Calculate the work done in hoisting the bucket up the building to the end of the rope.

(2 × 3) (6)

4.3 A motorcycle has a wheel with a radius of 400 mm. The turning force applied by the wheel on the tar is 1 000 N.

Calculate the torque executed by the wheel. (2)
[9]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

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

5.2 Name THREE advantages of belt drives. (3)

5.3 A differential wheel and axle lifting device has an effort distance of 600 mm and load distances of d_1 = 300 m and d_2 = 200 m. It also has an effort of 600 N and a load of 600 kg.

5.3.1 Calculate the mechanical advantage of the lifting device. (2)

5.3.2 Calculate the velocity ratio of the lifting device. (3)

5.3.3 Calculate the efficiency of the lifting device. (2)

5.4 A container full of water has a mass of 10 000 kg and a volume of 10 m^3. The height of the container is 500 mm.

Calculate the gauge pressure at the bottom of the container. (3)
[15]

Copyright reserved

QUESTION 6: FRICTION

6.1 Define *coefficient of friction.* (1)

6.2 A body 5 kg in mass is pulled up an incline plane. The incline plane has an angle of 40° formed between it and the horizontal. It also has a coefficient of friction of 0,25.

6.2.1 Calculate the weight component parallel to the plane.

6.2.2 Calculate the weight component perpendicular to the plane.

6.2.3 Calculate the frictional force.

6.2.4 Calculate the minimum force needed to pull the body up the incline. (4 × 2) (8)

[9]

QUESTION 7: HEAT

7.1 Give TWO forms of combustibles. (2)

7.2 A 40-kg steel rod with a temperature of 80 °C is immersed in water at 20 °C.

What mass of water is required if the final temperature of the mixture is 60 °C? (3)

7.3 Ice at -20 °C changes to water.

Indicate the changes graphically and explain in words what happens during each of these changes. (6)

[11]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Name the THREE subatomic particles and their charges. (6)

8.2 How could distilled water be converted to an electrolyte? (2)

[8]

Copyright reserved

QUESTION 9: ELECTRICITY

9.1 An electrical circuit consists of a supply of 12 V and is connected in series with an ammeter and two parallel external resistors R_1 = 4 Ω and R_2 = 3 Ω which are then connected in series with another resistor R_3 = 2 Ω.

9.1.1 Briefly differentiate, without calculations, between the magnitudes of currents that flow in each resistor connected in parallel. (2)

9.1.2 Calculate the total resistance of the circuit. (3)

9.2 Calculate the resistance of a copper conductor with a length of 25 m and a diameter of 1.5 mm at 20 °C. (3)

9.3 Name THREE practical applications of mutual inductance. (3)
[11]

TOTAL: 100

Copyright reserved

ENGINEERING SCIENCE N2

FORMULA SHEET

All formulae needed are not necessarily included. Any other applicable formula may also be used.

$w = m \cdot g$

$W = F \cdot s$

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

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

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

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

$\mu = \tan\Phi$

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

$F_S = w\sin\theta$

$F_C = w\cos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e \cdot v$

$v = \pi \cdot d \cdot n$

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

$N_A \cdot T_A = N_B \cdot T_B$

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

$E_p = m.g.h.$

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

$E_T = E_p + E_K$

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

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

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

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

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

$Q = m \cdot c \cdot \Delta t$

$m.ww = Q = m.hv$

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

$\Delta l = l_o \cdot \alpha \cdot \Delta t$

$l_f = l_o \pm \Delta l$

1 m/s = 3,6 km/h

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

$v = u + a.t$

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

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

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

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

$p = \Delta.g.h$

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

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

$R = \frac{\rho \cdot l}{a}$

Copyright reserved