higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

22 November 2024 (X-paper)
09:00–12:00

Nonprogrammable calculators may be used.

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

078Q1E2422

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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 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 rounded to three decimal places (where applicable) 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/m³
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 Define the following terms:

1.1.1 Acceleration

1.1.2 Speed

(2 × 2) (4)

1.2 FIGURE 1 shows the movement of a train on a horizontal plane in a straight line.

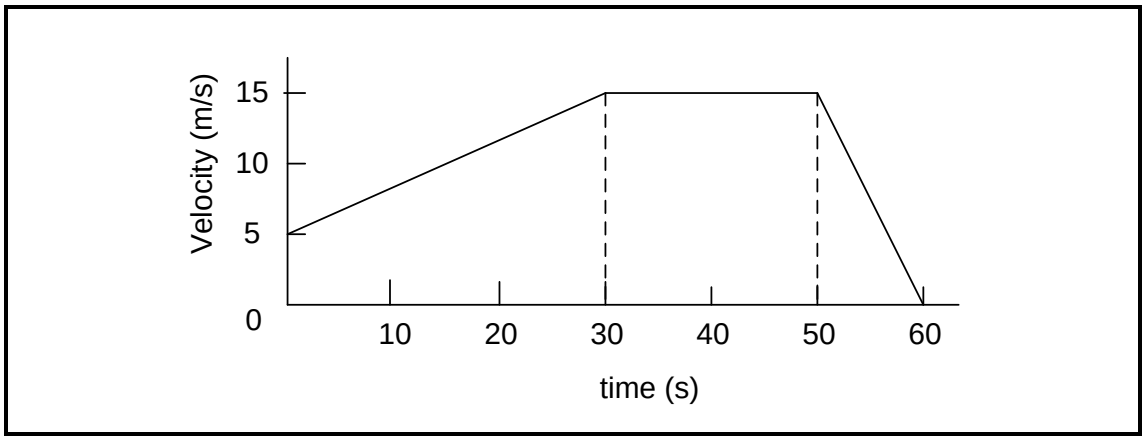

FIGURE 1

Calculate the following from the graph:

1.2.1 Acceleration of the train during the first 30 seconds (2)

1.2.2 Displacement of the train during the first 30 seconds (2)

1.2.3 Average velocity of the train during the first 50 seconds (3)

1.3 The acceleration of a racing car is 12 m/s^2. The racing car reaches 150 km/h from rest.

Calculate:

1.3.1 The time it takes to reach its final velocity

1.3.2 The distance it covered to reach 150 km/h

(2 × 2) (4)

[15]

QUESTION 2: STATICS

2.1 Name TWO examples of appliances where a turning force is applicable. (2)

2.2 State Newton's third law of motion. (2)

2.3 The horizontal beam shown in FIGURE 2, rests on two supports L and R.

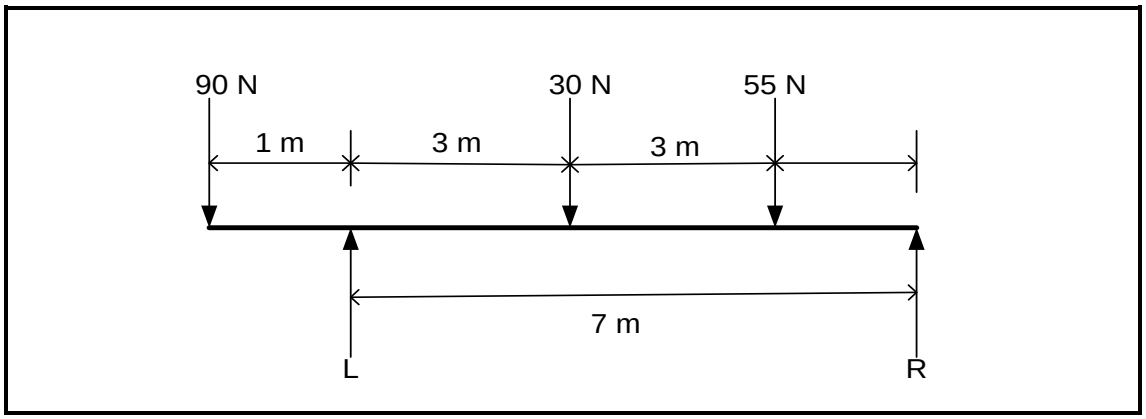

FIGURE 2

Determine the reactions of both supports L and R by taking moments about each support. Ignore the weight of the beam. (6)
[10]

QUESTION 3: ENERGY AND MOMENTUM

3.1 Define the term *kinetic energy.* (1)

3.2 A 20 kg toolbox fell vertically from the roof of a building. It took the toolbox 2.5 seconds to reach the ground.

Calculate:

3.2.1 The height from which the toolbox fell with reference to the ground

3.2.2 The velocity with which the toolbox hit the ground

3.2.3 The momentum of the toolbox as it hits the ground

(3 × 2) (6)
[7]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define the term *power*. (1)

4.2 A cable with a weight of 445 N is used to lift a load with a weight of 1 kN off the ground to be wound onto a drum 15 m high.

Calculate:

4.2.1 The weight of the cable per metre length (1)

4.2.2 The work done in winding the total length of the cable and the load onto the drum. (3)

4.2.3 The power applied when the cable and the load are halfway from the drum and moving with a constant velocity of 5 m/s. (2)

4.3 A trailer with a mass of 250 t has a tractive resistance of 30 N/t of its mass. The trailer travels at a constant speed of 15 m/s.

Calculate:

4.3.1 The total tractive resistance (1)

4.3.2 The power required to maintain the speed (2)

[10]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 Calculate the absolute pressure if the gauge reading is 400KPa. (1)

5.2 Calculate the pressure in a hydraulic lift which supports a mass of 1450kg if the ram diameter is 35 cm. (2)

5.3 A pulley with a diameter of 150 mm is driven by a flat belt. The tension in the tight side is 642 N, the tension ratio is 3:1 and the pulley rotates at 200 r/min.

Calculate the following:

5.3.1 Tension on the slack side

5.3.2 Effective force in the belt

5.3.3 Speed of the belt

5.3.4 Power transferred by the belt

(4 × 2) (8)

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5.4 The diameter of the larger pulley of a Weston differential pulley (differential pulley system) is 500 mm. The efficiency of the system is 25% and the mechanical advantage is 5. The load to be lifted is 300 kg.

Calculate:

5.4.1 The effort in Newton required to lift the load (2)

5.4.2 The diameter of the smaller pulley (4)

[17]

QUESTION 6: FRICTION

6.1 Define *kinetic friction.* (1)

6.2 Name TWO advantages of friction. (2)

6.3 An object with a mass of 11 kg is placed on a sloping surface which forms an angle of 35^0 with the horizontal. The resistance to motion is 200 N.

Calculate the parallel force required to pull the object down the slope. (2)

6.4 A force of 30N is needed to move a wooden block of 18kg across a horizontal plane.

Calculate the following:

6.4.1 The coefficient of friction

6.4.2 The angle of friction

(2 × 2) (4)

[9]

QUESTION 7: HEAT

7.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (7.1.1–7.1.3) in the ANSWER BOOK.

7.1.1 An object gives off heat as its temperature rises.

7.1.2 Specific fluid enthalpy is the quantity of heat required to evaporate 1 kg of boiling water at its saturation temperature.

7.1.3 Temperature is determined by the speed of the molecular motion.

(3 × 1) (3)

7.2 5 litres of seawater at freezing point of −1.8 °C is heated to 90 °C.

Calculate the heat energy required to heat the temperature of the seawater to 90 °C. (Assume the density and specific heat capacity of seawater to be 1025 kg/m^3 and 3850 J/kg. °C respectively.) (2)

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7.3 A steel ball at 130 °C is cooled down in 4,5 litres of water with a temperature of 12 °C.

Calculate the mass of the steel object if the final temperature of the water is 65 °C. (3)

7.4 A wire has a length of 25 m at 17 ^{0}C and expands by 15 mm at midday when the temperature rises to 36 °C.

Calculate the linear expansion coefficient of the wire. (3)
[11]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Define the following terms:

8.1.1 Compound

8.1.2 An ion

8.1.3 Electroplating

8.1.4 An atom

(4 × 1) (4)

8.2 Name FOUR components of an atom and state the charge of each. (4)
[8]

QUESTION 9: ELECTRICITY

9.1 Define *potential difference* as applied in electrical circuits. (2)

9.2 Three equal resistors in a circuit are connected in parallel .Their total resistance is 9 Ω when a current of 0,5 A is flowing through each resistor.

Calculate the following:

9.2.1 Resistance of each resistor

9.2.2 Total current flow in the circuit

9.2.3 Supply voltage

(3 × 2) (6)

9.3 Name ONE example where electromagnetic induction is used in practice. (1)

9.4 Name FOUR factors in words that influence the resistance of a conductor. (4)
[13]

TOTAL: 100

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ENGINEERING SCIENCE N2: FORMULA SHEET

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

$w = m.g$

$W = F.s$

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

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

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

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

$\mu = \tan\Phi$

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

$F_S = w\sin\theta$

$F_C = w\cos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e . v$

$v = \pi . d . n$

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

$N_A . T_A = N_B . T_B$

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

$E_p = m.g.h.$

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

$E_T = E_p + E_K$

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

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

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

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

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

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

$m.ww = Q = m.hv$

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

$P = FV$

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

$l_f = l_o \pm \Delta l$

1 m/s = 3,6 km/h

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

$v = u + a.t$

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

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

$\Sigma \circlearrowleft M = \Sigma \circlearrowright M$

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

$p = \Delta.g.h$

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

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

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

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