higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N1

(15070391)

7 April 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators and drawing instruments may be used.

This question paper consists of 12 pages and 1 formula sheet.

060Q1A2107

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N1
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. Start each section on a new page.
5. Answers must be rounded to THREE decimals.
6. Calculations must show the following THREE steps:

   - Formulae
   - Replacement of values
   - Answer and correct SI-unit

7. Gravitational acceleration (g) should be taken as 9.8 m.s-2.
8. Work neatly.

Copyright reserved

SECTION A

QUESTION 1

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 Which one of the following statements is not an effect of a force on a body?

A Changes shape of body
B Changes direction of body
C Changes weight of body
D Rotates body

1.2 Weight in Newton (N) of a body with a mass of 100 kg:

A 100
B 98
C 980
D 9,8

1.3 Work done is …

A force applied over a certain time.
B the same as power.
C measured in Newton.
D the application of a force over a certain distance.

1.4 A falcon lets a mouse fall from its claws.

Which transfer of energy has taken place with respect to the mouse?

A Potential energy to kinetic energy
B No energy transfer has taken place
C Kinetic energy to potential energy
D Potential energy to electrical energy

1.5 Which one is not an example of potential energy?

A Compressed spring
B Stationary ca
C Flowing stream
D Rock resting on edge of cliff

(5 × 1) **[5]**

Copyright reserved

QUESTION 2

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 An electrical circuit consists of a single resistor and a battery. If the voltage of the battery is increased and the resistance stays the same, the current in the circuit also increases.

2.2 The direction of a magnetic field around a solenoid can be determined by Fleming's left-hand rule.

2.3 The length of a conductor doesn't influence the heat generated in that conductor.

2.4 The nucleus of an atom has no charge.

2.5 Particles in a liquid are farther away from one another than particles in a solid.

(5 × 1) **[5]**

QUESTION 3

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (3.1–3.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1	Measures high temperatures in furnace	A	thermocouple
3.2	Time is an example of this	B	acceleration
3.3	Spanner used to tighten nut is an example of this	C	radiation pyrometer
3.4	Gradient of velocity/time graph	D	turning moment
3.5	Measures temperature of a person	E	alcohol thermometer
		F	scalar

(5 × 1) **[5]**

Copyright reserved

QUESTION 4

Choose ONE term from the list below for each of the following descriptions and write it next to the question number (4.1–4.5) in the ANSWER BOOK.

mechanical advantage; displacement; equilibrant; insulator; solid; distance; velocity ratio; conductor; resultant; gas

4.1 Ratio of distance moved by effort as opposed to distance moved by load

4.2 Single force having same effect on body as system of forces

4.3 Straight line between two points

4.4 Nitrogen is an example of this phase

4.5 Material through which electric current cannot flow

(5 × 1) **[5]**

TOTAL SECTION A: 20

SECTION B

QUESTION 5

5.1 A ship sails at a velocity of 36 m.s-1 due North experiencing a current moving at a velocity of 12 m.s-1 due South.

Calculate the magnitude and direction of the resultant velocity. (2)

5.2 FIGURE 1 shows the movement of an athlete running at a constant velocity.

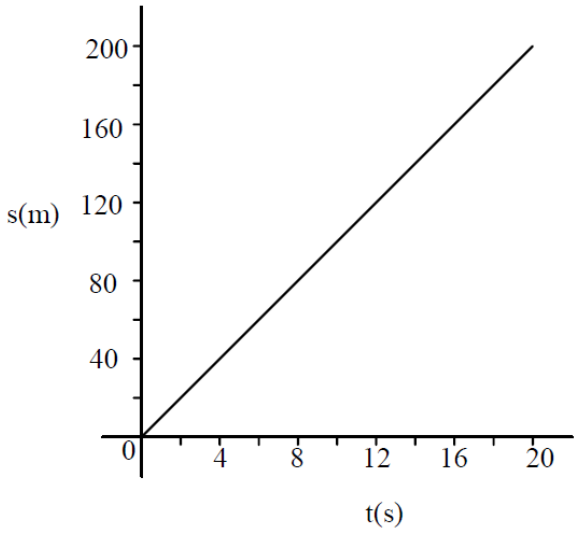


FIGURE 1

Determine the following from the graph:

5.2.1 Velocity of athlete (2)

5.2.2 Displacement after 12 seconds (1)

5.3 In an experiment dropping a 1 kg metal ball off a building to determine the effects of gravitation on the ball the following information were recorded:

Time (s)	0	1	2	3	4	5	6	7	8
Velocity ($m.s^{-1}$)	0	9,8	19,6	29,4	39,2	49	58,8	68,6	78,4

5.3.1 Draw a velocity/time graph of the experiment. (3)

5.3.2 Calculate the acceleration of the metal ball (2)

Copyright reserved

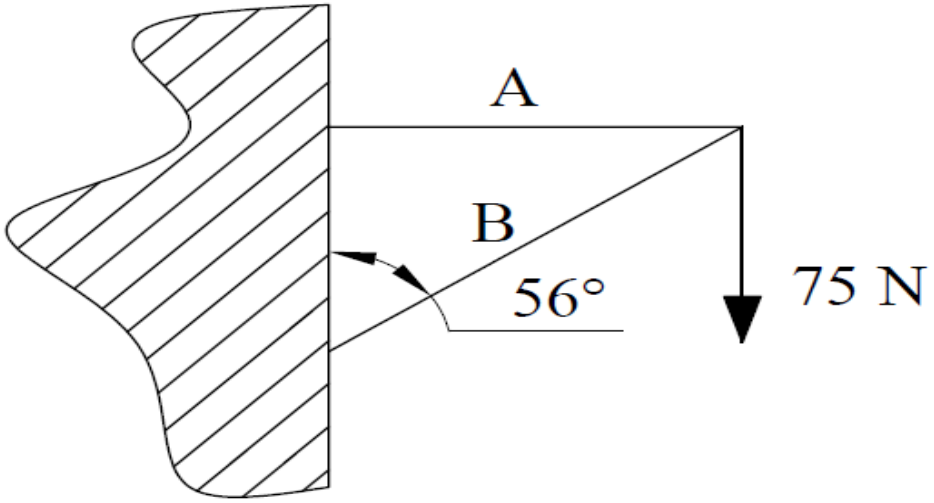
5.4 A mass of 15,6 kg is suspended from a rope.

Calculate the force in the rope. (1)

[11]

QUESTION 6

6.1 FIGURE 2 below shows three forces in equilibrium.



Use Bow's notation to determine the magnitude of forces A and B and do the following:

6.1.1 Draw a space diagram of the THREE forces.

HINT: Label the areas P, Q and R. (2)

6.1.2 Draw a vector diagram of the THREE forces. No values are necessary.

HINT: Apply Bow's notation clockwise. (2)

Copyright reserved

6.2 FIGURE 3 shows two forces working on a body.

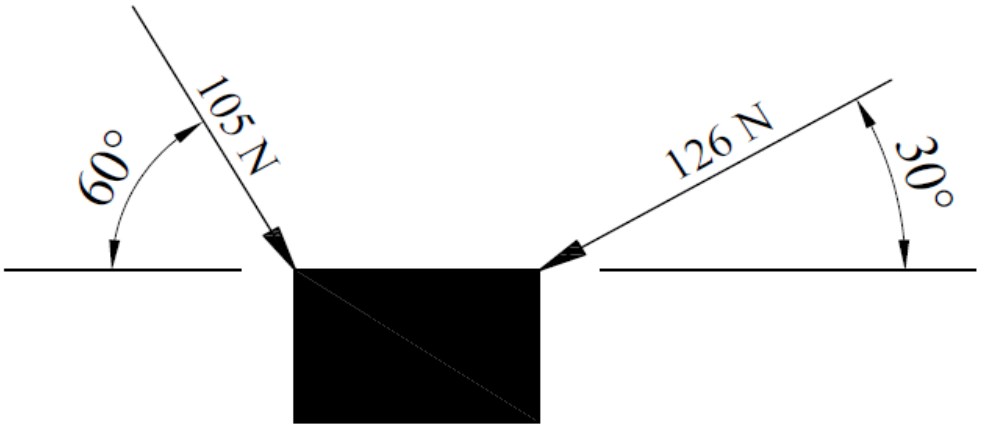


FIGURE 3

Determine the resultant force of the TWO forces.

HINT: Use scale 10 N = 10 mm (2)

6.3 A wheel and axle lifting machine needs an effort of 250 N to lift a load of 1200 N. The diameter of the wheel is 280 mm and the diameter of the axle is 56 mm.

6.3.1 Make a neat, labelled drawing of the wheel and axle system. (2)

6.3.2 Calculate the mechanical advantage of the system in QUESTION 6.2. (1)

6.3.3 Calculate the velocity ratio of the system in QUESTION 6.2. (1)

6.4 A force of 55 N acts on the end of a lever.

Calculate the distance from the force to the point of rotation to ensure a moment of 357,5 Nm. (2)

6.5 Name TWO effects of a force on a body. (2)
[14]

Copyright reserved

QUESTION 7

7.1 A bus with a pulling force of 3 200 N at 60 km/h moves from a depot to the first bus stop 3,2 km away.

7.1.1 Make a neat, labelled force/distance graph of the movement. (4)

HINT: Use scale 500 N = 2 cm and 0,5 km = 2 cm

7.1.2 Calculate the work done by the bus. (2)

7.1.3 Calculate the power of the engine of the bus. (2)

7.2 A car travels at a velocity of 70 km/h on a horizontal road.

Calculate the power required to maintain the motion if the force needed to keep it in motion is 265 N. (2)
[10]

QUESTION 8

8.1 Describe the difference between heat and temperature. (2)

8.2 Name the type of heat propagation that takes place in each of the following substances:

8.2.1 Solids like steel

8.2.2 Vacuums like outer space

(2 × 1) (2)

8.3 Heat has certain effects on a substance, for example when a block of steel is heated its dimensions can change.

Give an example of each of the effects below:

8.3.1 Heat changing the composition of a substance

8.3.2 Heat changing the phase of a substance

(2 × 1) (2)

8.4 Define *specific heat capacity*. (2)

8.5 There is T356,56 kJ of heat energy needed to raise the temperature of a block of copper from 250 K to 333 K.

Calculate the mass of the copper block. (2)

HINT: Specific heat capacity of copper is 385 J/kg.K

8.6 A steam pipe has a length of 5,35 m on a cold winter morning when the temperature is -3,6 °C. As the day progresses the steam pipe reaches a length of 5,358 m at a maximum temperature of 124,4 °C.

Calculate each of the following:

8.6.1 Difference in temperature in °C

8.6.2 Difference in length in mm

(2 × 1) (2)

8.7 Describe Gravesand's ball and ring experiment. (2)

8.8 A glowing-hot iron rod is submerged in a bucket of water.

8.8.1 Which substance loses heat energy? (1)

8.8.2 Which substance gains heat energy? (1)

[16]

QUESTION 9

9.1 Describe the movement of molecules in each of the following phases of matter:

9.1.1 Gas

9.1.2 Liquid

9.1.3 Solid

(3 × 1) (3)

9.2 Complete the following table by writing the missing information next to the question number (9.2.1–9.2.3) in the ANSWER BOOK.

DESCRIPTION	TERM
Anything occupying space and having mass	Matter
9.2.1	Atom
Built up from more than one atom	9.2.2
Substance having only one kind of atom	9.2.3

(3 × 1) (3)

9. 3 When the temperature of a substance changes it can change from one phase to another.

Complete the TABLE below by filling in the missing words. Write only the answer next to the question number (9.3.1–9.3.3) in the ANSWER BOOK.

HINT: A liquid that changes to a solid, solidifies.

Solids	Gases
9.3.1	9.3.3
to change to	to change to
liquids.	liquids.
Liquids	Liquids
9.3.2	solidify
to change to	to change to
gases.	solids.

(3 × 1) (3)
[9]

QUESTION 10

10.1 Different materials react differently to the flow of electrical current.

Give ONE example of each of the following:

10.1.1 Conductors

10.1.2 Insulators

(2 × 1) (2)

10.2 Draw the IEC symbol for each of the following components:

10.2.1 Variable resistor

10.2.2 Ammeter

10.2.3 Battery

(3 × 1) (3)

10.3 Define *alternating current (AC).* (1)

10.4 A current of 6,4 A flows through a resistor connected to a 24 V battery in a DC electrical circuit.

Calculate the value of the resistor. (2)

10.5 Three resistors with the values of 15 Ω, 28 Ω and 34 Ω respectively are connected in series with a battery of 12 V.

Calculate the total resistance of the THREE resistors. (2)

10.6 Name TWO factors influencing the resistance of a conductor. (2)

10.7 If an insulator like PVC heats up, what will happen to its resistance? (1)

10.8 The label on an electrical kettle reads 1000 W; 220V.

Use the data and calculate each of the following:

10.8.1 Current flowing through kettle

10.8.2 Work done when kettle is switched on for 1½ minutes.

(2 × 2) (4)

10.9 Make a neat, labelled sketch of the magnetic field around a bar magnet. (3)

[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

Copyright reserved

ENGINEERING SCIENCE N1

FORMULA SHEET

Any other applicable formula can also be used.

$$V = I \times R$$

$$P = \frac{V^2}{R}$$

$$P = I^2 R$$

$$P = V \times I$$

$$I = \frac{E}{R + r}$$

$$Q = C \times V$$

$$R = \frac{\rho \ell}{A}$$

$$R_t = R_o(1 + \alpha_o \Delta t)$$

$$R_t = R_1 + R_2 + R_3 ..... R_n$$

$$C_t = C_1 + C_2 + C_3 ..... C_n$$

$$L_t = L_1 + L_2 + L_3 ..... L_n$$

$$\frac{1}{C_t} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} ..... \frac{1}{C_n}$$

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} ..... \frac{1}{R_n}$$

$$\frac{1}{L_t} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} ..... \frac{1}{L_n}$$

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$$

Copyright reserved