higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T620**(E)**(J30)T

**NATIONAL CERTIFICATE**

# ENGINEERING SCIENCE N1

(15070391)

**6 August 2019 (X-Paper)**
**09:00–12:00**

**This question paper consists of 10 pages and 1 formula sheet.**

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N1
TIME: 3 HOURS
MARKS: 100

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**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. Answers must be rounded to THREE decimals.

5. ALL calculations must have the following THREE steps:

   5.1 Formula
   5.2 Replacement of values
   5.3 Answer and correct SI unit

6. Gravitational acceleration (g) should be taken as 9,8 $m.s^{-2}$.

7. Sketches must be neatly done with pencil.

8. Write neatly and legibly.

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## SECTION A

## QUESTION 1

1.1 Give ONE word for each of the following descriptions by choosing a word from the list below. Write only the word next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

| potential energy; equilibrant; scalar; conductor; kinetic energy; resultant; vector; temperature |
|---|

1.1.1 Physical quantity which has only magnitude

1.1.2 Single force that will balance two or more forces

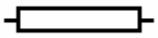
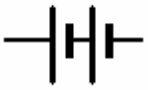
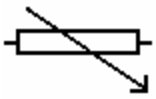
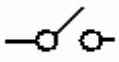
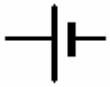
1.1.3 Energy a body possesses due to its motion

1.1.4 Degree of hotness or coldness of a body

1.1.5 Substance through which electrical current moves easily

(5 × 1) (5)

1.2 Choose a symbol from COLUMN B that matches a term in COLUMN A. Write only the letter (A–G) next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

| COLUMN A | | COLUMN B | |
|---|---|---|---|
| 1.2.1 | Volt meter | A |  |
| 1.2.2 | Resistor | B |  |
| 1.2.3 | Ammeter | C |  |
| 1.2.4 | Switch | D |  |
| 1.2.5 | Variable resistor | E |  |
| | | F |  |
| | | G |  |

(5 × 1) (5)

1.3 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 (1.3.1–1.3.5) in the ANSWER BOOK.

1.3.1 Specific heat capacity:

A Amount of heat energy needed to raise the temperature of a substance by 1 °C
B Ability of a body to do work due to the flow of electrical current
C Amount of heat energy needed to raise the temperature of 1 kg of a substance by 1 °C
D Measurement of hotness or coldness of a body

1.3.2 Which of ONE the following is NOT an effect of heat on a body?

A Change in temperature
B Change in length
C Change in type of material
D Change in resistance

1.3.3 Law of moments:

A Ratio between distance moved by effort and distance moved by load
B System of forces is in balance if sum of clockwise moments is equal to anticlockwise moments about the same point
C Ratio between load lifted and effort applied
D Turning effect of force about a point

1.3.4 A force can be regarded as a vector due to ONE of the following reasons:

A Force has only magnitude
B Force has only direction
C Force has magnitude and direction
D Force has point of application

1.3.5 Mass can be defined as the …

A attraction force between a body and the earth.
B total force that can replace two or more forces.
C change in position of a body.
D quantity of matter of which a body consists.

(5 × 1) (5)

1.4 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.4.1–1.4.5) in the ANSWER BOOK.

1.4.1 Displacement is the actual route a body follows.

1.4.2 An equilibrant is that single force that will balance two of more forces.

1.4.3 Power is when a force is applied on a body and the body is displaced through a distance.

1.4.4 The particles in a solid are far apart and move very fast.

1.4.5 The longer the conductor the lower its resistance.

(5 × 1) (5)
**[20]**

**TOTAL SECTION A: 20**

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**SECTION B:**

**QUESTION 2: DYNAMICS**

2.1 A canoeist rows upstream at 6 $m.s^{-1}$. The velocity of the river, which flows in a southwest direction, is 3 $m.s^{-1}$.

Graphically determine the resultant velocity of the canoeist. (2)

2.2 FIGURE 1 below shows the movement of three hikers (A, B and C) on a hiking trail.

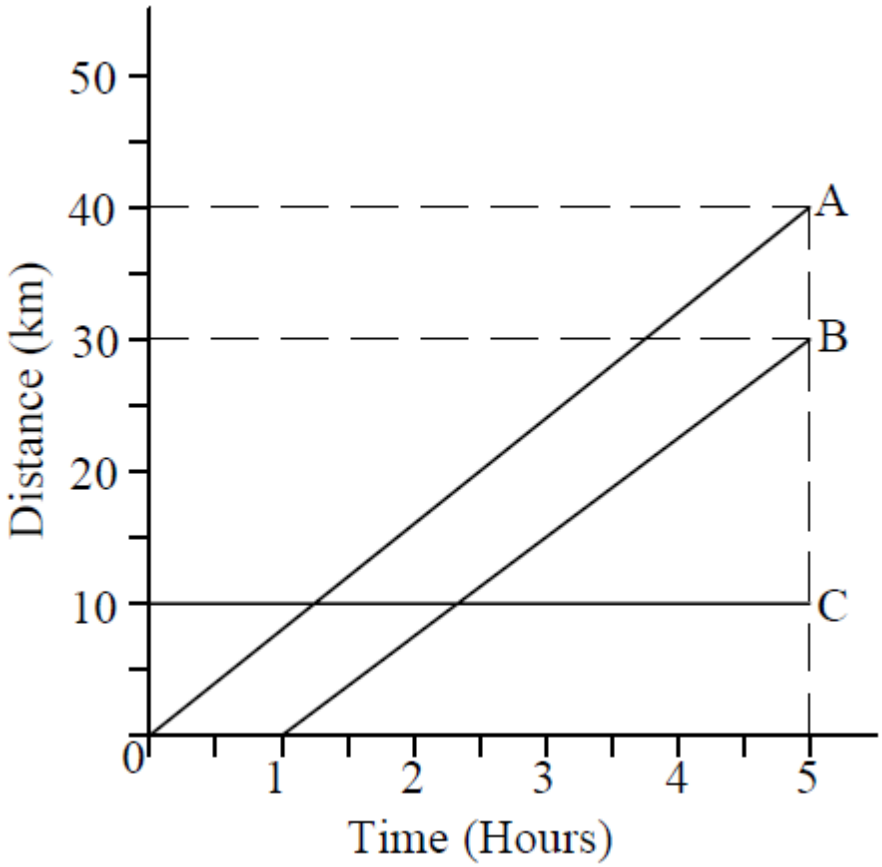


**FIGURE 1**

2.2.1 Which ONE of the three hikers has the highest speed? (1)

2.2.2 Calculate the average speed of hiker B. (1)

2.3 A train travels 80 km in 1 hr 10 min.

Calculate the average speed of the train. (1)

2.4 A rock with a mass of 2,4 kg falls from a building.

Calculate the force with which the rock hits the ground. (1)

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2.5 In an experiment about gravitation two balls are released from a three-storey building. If we assume the wind factor is zero, they hit the ground at the same instance. The time it takes the balls to reach the ground is 1,4 seconds.

2.5.1 Draw a neat, labelled velocity/time graph of the movement.

(**Hint**: Use scale 5 cm = 1 second and 5 cm = 10 m.s$^{-1}$) (2)

2.5.2 What does the gradient represent In the graph drawn in QUESTION 2.5.1? (1)

2.6 Briefly describe the relationship between the mass of a body and its weight. (1)

2.7 An astronaut weighs 282 N on the planet Mars.

Calculate the mass of the astronaut if the gravitational acceleration of Mars is 3,711 m.s$^{-2}$. (1)

**[11]**

## QUESTION 3: STATICS

3.1 Define *triangle of forces.* (1)

3.2 Use Bow's notation and draw and label the triangle of forces of the THREE forces shown in FIGURE 2.

(**Hint**: Use scale 1 N = 1 mm)

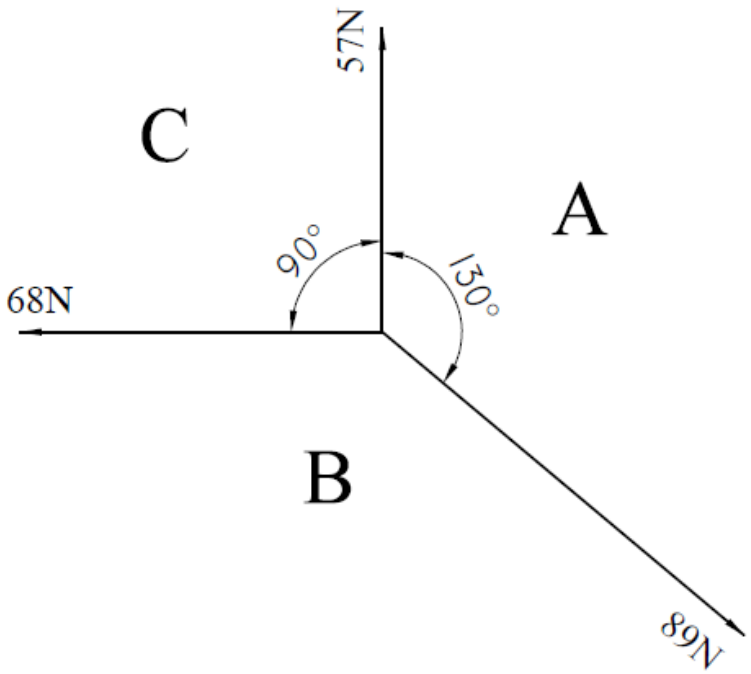


**FIGURE 2** (2)

3.3 Graphically determine the equilibrant of the TWO forces shown in FIGURE 3 by using the parallelogram method.

(**Hint**: Use scale 1N = 1 mm)

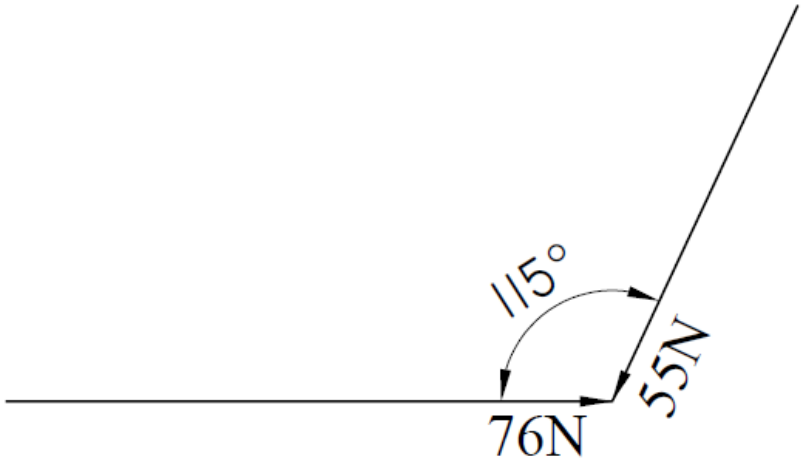


**FIGURE 3** (2)

3.4 Make a neat, labelled sketch of a wheel and axle lifting machine. The wheel has a diameter of 350 mm and the axle has a diameter of 85 mm.

Use scale 1 mm = 4 mm (2)

3.5 A lever is used to lift a motorcar engine with a mass of 210 kg through a height of 300 mm. An effort of 425 N is applied at the other end of the lever and moves through a distance of 2 m.

Calculate the following:

3.5.1 Mechanical advantage of the lever (2)

3.5.2 Velocity ratio of the lever (2)

3.6 A bolt is tightened by using a 380 mm long spanner. A force of 45 N is applied to the end of the spanner.

Calculate the torque at which the bolt is fastened. (2)

3.7 Define *torque*. (1)

**[14]**

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## QUESTION 4: ENERGY WORK AND POWER

4.1 Energy cannot be created or destroyed.

Write down the transformation of energy of a locomotive engine from stationary to moving forward. (1)

4.2 A man of 90 kg climbs 30 steps in 2,5 minutes. Each step is 300 mm high.

4.2.1 Plot a force/distance graph of the work done. Use scale 100 N = 1 cm and 1 m = 1 cm. (3)

4.2.2 Determine, from the graph, the work done. (1)

4.2.3 Calculate the power required. (1)

4.3 A car has a mass of 500 kg and travels 1,4 km in 1,5 minutes.

Calculate the following:

4.3.1 Work done in megajoules (2)

4.3.2 Power in kilowatt (2)
**[10]**

## QUESTION 5: HEAT

5.1 Distinguish between *heat* and *temperature*. (2)

5.2 Describe an alcohol thermometer with the aid of a neat, labelled sketch. (3)

5.3 Name ONE advantage and ONE disadvantage of a mercury thermometer. (2)

5.4 State the propagation of heat in liquids and in A vacuum. (2)

5.5 Make a neat, labelled sketch of a vanishing filament pyrometer (optical pyrometer). (2)

5.6 Calculate the quantity of heat which is required to increase the temperature of 60 kg water from -25 °C to 25 °C. Write your answer in megajoules. The specific heat capacity of the water is 4200 J/kg°C. (2)

5.7 A steel beam is 4290 mm long at 7 °C and 4310 mm long at 35 °C.

Calculate the expansion of the beam in meter. (2)
**[15]**

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## QUESTION 6: PARTICLE STRUCTURE OF MATTER

6.1 Name the THREE phases of matter and give an example of each. (3)

6.2 Make a neat, labelled sketch of an atom and indicate the charges. (4)

6.3 Describe the effect of heat on the motion of particles, using water as an example. (3)

6.4 What happens to the volume of most substances when heated? (1)

**[11]**

## QUESTION 7: ELECTRICITY

7.1 Give ONE example of a conductor of electricity. (2)

7.2 What is the difference between *direct current* and *alternating current*? (2)

7.3 Name the factor, other than temperature and type of material that determines the quantity of current flow in a conductor if the tension (volt) stays the same. (1)

7.4 Name TWO types of alloys that have few effects, or no effect, on its resistance if the temperature changes. (2)

7.5 Two parallel resistors of 5Ω and 10Ω are connected to a 12 V battery.

7.5.1 Make a neat, labelled sketch of the circuit. (1)

Calculate the following:

7.5.2 Total resistance of the circuit (2)

7.5.3 Current flow in the circuit (2)

7.5.4 Total power of the circuit (2)

7.6 What is the difference between a good and a bad conductor regarding resistivity? (1)

7.7 Determine the time required to generate 225 kJ of heat energy when a current of 5 A flows through the element of an electric kettle which has a resistance of 44 Ω. (2)

7.8 Give TWO ways of intensifying the magnetic field in a solenoid. (2)

**[19]**

**TOTAL SECTION B: 80**
**GRAND TOTAL: 100**

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**ENGINEERING SCIENCE N1**

**FORMULA SHEET**

Any other applicable formula may also be used

| | |
|---|---|
| 1. | $v = \frac{s}{t}$ |
| 2. | $F = m.g$ |
| 3. | $VV = \frac{M_{afst}}{L_{afst}}$ $DR = \frac{E_{dist}}{L_{dist}}$ |
| 4. | $HV = \frac{L}{M}$ $MA = \frac{L}{E}$ |
| 5. | $SV = \frac{D}{d}$ $VR = \frac{D}{d}$ |
| 6. | $Moment = F.s$ |
| 7. | $T = F.r$ |
| 8. | $W = F.s$ |
| 9. | $P = \frac{W}{t}$ |
| 10. | $P = F.v$ |
| 11. | $Q = m.c.\Delta t$ |
| 12. | $L_f = L_o + \Delta L$ |
| 13. | $L_f = L_o - \Delta L$ |
| 14. | $I = \frac{V}{R}$ |
| 15. | $R_t = R_1 + R_2 + \ ...$ |
| 16. | $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$ |
| 17. | $Heat = I^2.R.t$ |
| 18. | $P = V.I$ |
| 19. | $P = \frac{V^2}{R}$ |
| 20. | $P = I^2.R$ |

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