higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T610**(E)**(J26)T

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

(15070126)

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09:00–12:00

This question paper consists of 6 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING PHYSICS N6
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 manipulation thereof
   2.2 Substitution of the given data in the formula
   2.3 The answer with the correct SI unit

3. The constant values, as they appear on the attached information sheet, must be used where possible.

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

5. Keep subsections of questions together.

6. Rule off on completion of each question.

7. Drawing instruments must be used for ALL drawings/diagrams.

8. ALL drawings/diagram must be fully labelled.

9. Use g = 9,8 m/s^2.

10. Answers must be rounded off to THREE decimal places.

11. Write neatly and legibly.

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QUESTION 1: SOUND

1.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 The amplitude of wave is also called the minimum deviation.

1.1.2 A wave length is measured from the peak of one wave to the peak of the adjacent wave.

1.1.3 The frequency of a wave is the number of vibration in one second.

1.1.4 The frequency will be affected as soon as a source moves while it transmits sound, the waves in front will be compressed and at the back they will be more drawn out.

1.1.5 The frequency of a bass voice is about 100 Hz.

(5 × 1) (5)

1.2 The horn of a steam locomotive with a frequency of 950 Hz is sounded. The velocity of sound in air is 340 m/s.

1.2.1 What is the frequency heard by a person, standing on the platform while the train approaches him/her at a speed of 45 km/h?

1.2.2 What is the frequency heard by the person when the train moves away from him/her?

(2 × 2) (4)

1.3 As a gramophone record turn, a certain groove passes the needle at a speed of 25 cm/s. If the wiggles in the groove are 0,1 mm apart, what is the frequency of the produced sound? (3)

1.4 A bat travels towards an obstacle that is stationary. The bat emits sound waves at a frequency of 51 000 Hz and detects sound waves of 50 000 Hz. Use the velocity of sound as 344 m/s.

Calculate the following:

The speed of the bat (4)

1.5 A metal guitar string with a mass of $5,8 \times 10^{-4}$ kg and which is 0,731 long, has reference. The tension in the string is 80 N.

Determine the following:

1.5.1 The velocity of a transverse wave

1.5.2 The frequency of the fundamental note and the first and second overtone.

(2 × 3) (6)

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1.6 Determine the longest- and shortest length of an organ pipe, open at both ends, of which the frequency must be between 58,5 to 2 625 Hz.

The velocity of sound in air is 350 m/s. (3)
[25]

QUESTION 2: THERMODYNAMICS

2.1 During atest run of a turbine the following data where obtain through run:

Initial pressure	P_1 = 700 kPa
Initial temperature	T_1 = 1 100 °C
Initial volume	V_1 = 2,5 dm^3
Final pressure	P_2 = 270 kPa

Use R = 289 J/kg°C, Cv = 710 J/kg°C and $PV^{1,3}$ = C

Calculate the following:

2.1.1 The final volume

2.1.2 The final temperature

2.1.3 The work done

2.1.4 The change of internal energy during the expansion

(4 × 2) (8)

2.2 Cool water enters the condenser of a steam plant at a temperature of 10 °C and leaves it at 40 °C. The steam enters the condenser at 100 °C and leaves it as water at 70 °C. Steam condenses at the pressure concerned at 100 °C and 19 litres of water is required to condense one kilogram of steam.

Calculate the specific latent heat of vaporisation of water. (3)

2.3 Make a neat label sketch and describe the function of a porous plug experiment. (5)

2.4 A mass of 250 g of a gas is taken through a Carnot cycle. The maximum and minimum temperatures are respectively 320 ^{0}C and 60 °C and the volume ratio of the isothermal process, is 2,2. Take R = 0,28 kJ/kg. K

2.4.1 The thermal efficiency of the process.

2.4.2 The work done during one cycle.

(2 × 2) (4)

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2.5 A vacuum bottle contains 200 g of water at 70 °C. If 50 g of ice is added to the water and all the ice has melted then the final temperature is 40 °C. If a further 80 g of ice is added, the final temperature is 10 °C after all the ice has melted. Specific heat capacity of water is 4,187 kJ/kg°C.

Calculate the specific latent heat of fusion of ice, disregarding all heat losses. (5)
[25]

QUESTION 3: ELECTROSTATICS

3.1 Describe the term *time constant* of a capacitor. (3)

3.2 Give a definition of the unit of electrical charge. (2)

3.3 Explain why the surface charge density of a conductor is the largest where the curvature is the largest. (2)

3.4 Four point charges are placed at the angles of a square in FIGURE 1 (below). Determine the electrical field strength due to the charges at the intersection O of the diagonals of the square.

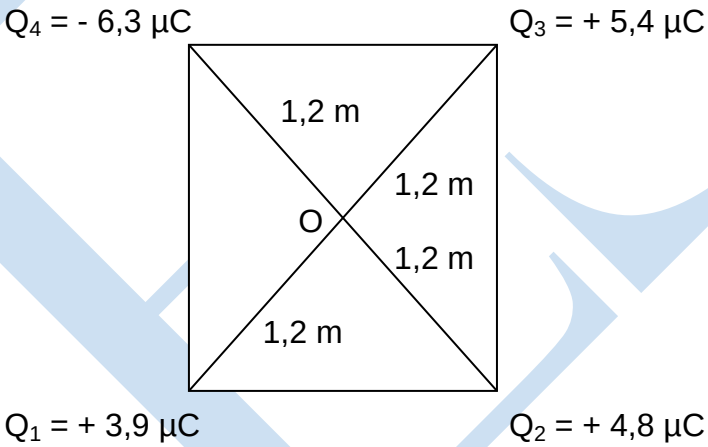

FIGURE 1

(6)

3.5 Determine the electric field strength in air midway between two point charges of $+23 \times 10^{-8}$ C and $-4,85 \times 10^{-8}$ C separated by a distance of 12 cm. Also determine the force on a $+4,35 \times 10^{-8}$ C point charge placed midway between the charges. Use $k = 9 \times 10^{9}$ Nm^2/c. (4)

3.6 During an oil-drop experiment, Millikan has found that the distance between the plates are 35 mm apart. A mass of equal to $4,75 \times 10^{-15}$ kg that has a positive charge, is balanced (in equilibrium) when the potential difference (V) between the plates is measured at 6 000 V.

3.6.1 Derive an equation (in terms of the data given above) whereby the charge on the drop may be calculated.

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3.6.2 The charge on the oil drop.

3.6.3 The number of electrons that have been removed from the oil drop.

3.6.4 The charge in electrical potential energy when a charge of 8×10^{-16} C moves from the one plate to the other.

(4 × 2) (8)

[25]

QUESTION 4: ATOMIC PHYSICS

4.1 Name THREE properties of an electron. (3)

4.2 Describe the term *thermionic emission*. (4)

4.3 With which instrument can the mass of the parts of a certain substance be determined? (1)

4.4 A 1,5 µF television set capacitor is subjected to a 3 200 V potential difference across its terminals.

Determine the energy stored in the capacitor. (2)

4.5 In a cathode-ray tube, the number of electrons striking the screen each second is $6{,}0 \times 10^{14}$, the average kinetic energy as they reach the screen is $4{,}8 \times 10^{-16}$ J per electron.

Calculate the following:

4.5.1 The current in the electron beam (2)

4.5.2 The potential difference through which the electrons have been accelerated (3)

4.6 Calculate the kinetic energy in eV of an electron whose velocity is 10^7 m/s. Take the mass of an electron equal to $9{,}1 \times 10^{-31}$ kg. (3)

4.7 A student is doing an experiment on a metal. The following information is documented by using a red light on a metal. The red light of wave length $8{,}1 \times 10^{7}$ m is shone onto a particular metal. The minimum amount of energy required to release an electron from this metal is $1{,}75 \times 10^{-19}$ J.

Determine the following:

4.7.1 The energy of a photon of this red light.

4.7.2 The maximum kinetic energy of each ejected electron.

(2 × 2) (4)

4.8 A hydrogen atom consists of a proton (charge +e) and an electron (charge -e) that are an average of $4{,}5 \times 10^{-11}$ apart.

Calculate the attractive force between them. (3)

[25]

TOTAL : 100

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