higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T610**(E)**(M29)T

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

(15070126)

29 March 2018 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and a 2 page formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINERING PHYSICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Read ALL the questions carefully.

3. ALL the calculations should consist of at least the following THREE steps:

   3.1 The formula used or manipulation thereof
   3.2 Substitution of the given data in the formula
   3.3 The answer with the correct SI unit

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

5. The constant values, as they appear on the attached formula sheet, must be used were possible.

6. Keep subsections of questions together.

7. Rule OFF on completion of each question.

8. Drawing instruments must be used for all drawings/diagrams. All drawings/ diagrams 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 only 'true' or 'false' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Sound arises as a result of vibrations.

1.1.2 Sound does not need a medium through which to be transmitted.

1.1.3 Sound waves can be either a transverse wave or a longitudinal wave.

1.1.4 The speed of a wave = the frequency ÷ wavelength.

1.1.5 The pitch of a sound depends on its frequency.

(5 × 1) (5)

1.2 Complete the following expressions by using the words provided in the list below. Write only the word next to the question number (1.2.1–1.2.4) in the ANSWER BOOK. Each word can only be used ONCE.

loudness; closed tube; transverse; stationary waves; amplitude; pure tone

The (1.2.1 ...) of a sound depends on the (1.2.2 ...) of the wave. A (1.2.3 ...) is free of overtones. Waves in strings are of a (1.2.4 …) nature because the vibration is at right angles to the direction of the movement of the wave. (4)

1.3 A string of mass 0,925 g and length 52,5 cm is under a tension of 750 N.

Calculate the following:

1.3.1 The velocity of a transverse wave in the string. (3)

1.3.2 The frequency of its fundamental note and the frequency of the first and second overtone. (4)

1.4 A test is done with a Kundt's tube which is filled with hydrogen at 15 °C and a frequency of 3 450 Hz is produced in the rod.

Determine the following:

1.4.1 Determine the distance between two dust heaps when the tube is filled with hydrogen of 15 °C and the speed of sound in hydrogen at 15 °C is 1 329 m/s. (3)

1.4.2 Determine the speed of sound in air if the tube is now filled with air at 15 °C and the distance between two dust heaps is 4,65 cm. (2)

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1.5 What is meant by the *law of forces* (Coulomb's law)? (2)

1.6 What is meant by fundamental tone and overtones in pipes? (2)
[25]

QUESTION 2: THERMODYNAMICS

2.1 Choose a description from COLUMN B that matches an option in COLUMN A. Write only the letter (A–E) next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1.1	$Q = U + W$	A	during an isothermic process the temperature remains constant during compression
2.1.2	$P_1V_1 = P_2V_2$	B	a machine that operates on reversible process has the highest possible efficiency.
2.1.3	Carnot's principled	C	joule steam calory meter
2.1.4	Carnot Cycle	D	a series of pressure, volume and temperature changes that proceeds in the following order, is called the …
2.1.5	Cv of a gas can be determined by which instrument	E	the first law of thermodynamics states that in a closed system the total amount of energy is constant

(5 × 1) (5)

2.2 Calculate the amount of steam that is produced when two and a half million joules of heat are added to 4,5 kg of water at a temperature of 120 °C.

The specific heat capacity of water is 4 186 J/kg °C.

The heat of vaporisation of water is $2,26 \times 10^6$ J/kg. (5)

2.3 A student is running a few tests in a laboratory with a quantity of gas. The information that relates to the gas is as follows: initial pressure of 150 kPa, volume of 0,18 m^3 and temperature of 25 °C. It is compressed to a pressure of 1,5 MPa according to the law $PV^{1,4} = C$.

Take Cp = 1,041 kJ/kg. K and Cv = 0,743 kJ/kg.K

Calculate the following:

2.3.1 The mass of the gas (3)

2.3.2 The volume of the gas at P_2 (2)

2.3.3 The change of entropy (3)

2.3.4 The work done on the gas (3)

2.4 Distinguish between *temperature* and *heat* when we refer to the following concepts:

2.4.1 Kinetic energy (2)

2.4.2 Internal energy (1)

2.4.3 Atoms or molecules which are in rapid motion (1)
[25]

QUESTION 3: ELECTROSTATICS

3.1 Complete the following sentences by writing down the missing word(s) next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

The force between two charge Q_1 and Q_2 is inversely proportional to the (3.1.1 …) between the charges and proportional to the charges.

The electrical field strength at a point is the (3.1.2 …) exerted on a positive unity charge placed at that point.

The (3.1.3 …) at a point in an electric field is the work required to attract 1 Coulomb of infinite distance to that point. The potential (3.1.4 …) between two points is thus the work required to shift 1 Coulomb from one point to the other.

Capacitance is the (3.1.5 …), of the capacitor charge over potential, and has the ability to store energy. (5 × 1) (5)

3.2 Two point charges of 8 µC and 12µC each are 35 cm apart.

Calculate at what distance from the 8 µC charge, along a straight line connecting the two charges, the electric field strength will be zero, due to the two charges. (8)

3.3 A positive charge of 30 µC is placed 2 m away from a negative charge of 25 µC.

Determine the electric field intensity at P, 2 m from each charge. (6)

3.4 A capacitor is made of two foils, each with a surface area of 1,2 m², separated by paper 0,06 mm thick.

Calculate the capacitance of the capacitor. The permittivity of free space is $8{,}85 \times 10^{-12}$ F/m and the dielectric constant for paper is 3,6. (3)

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3.5 One square centimetre of membrane has a capacitance of $7{,}1 \times 10^{-7}$ F. If the potential difference across the membrane is 0,125 V, determine the electric energy stored in 1,2 cm² of membrane. (3)

[25]

QUESTION 4: ATOMIC PHYSICS

4.1 Explain the difference between *nuclear fission* and *nuclear fusion.* (4)

4.2 In a typical fission reaction, a $^{235}_{92}U$ nucleus absorbs a neutron and splits into a $^{140}_{54}Xe$ nucleus and a $^{94}_{38}Sr$ nucleus**.**

Determine how many neutrons are liberated in this process. (3)

4.3 If 100 grams of an isotope has a half-life of 5 hours, determine the mass of the isotope that will be left decayed after 15 hours. (3)

4.4 A microwave oven emits electromagnetic waves of frequency 3×10^{9} Hz. Calculate the energy of one of the photons of these waves. Use Planck's constant = $6{,}626 \times 10^{-34}$ Js in your calculation. (3)

4.5 What happens to the atomic number and mass number of a nucleus that:

4.5.1 emits an electron

4.5.2 undergoes electron capture

4.5.3 emits an alpha particle

(3 × 2) (6)

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, 1×10^{-31} kg. (3)

4.7 Light is shone on the cathode of a photo cell, which is connected to a micrometer, and the micrometer gives a reading. The intensity of the light is increased.

What will happen to the reading on the micrometer? Explain your answer. (3)

[25]

TOTAL: 100

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ENGINEERING PHYSICS N6

FORMULA SHEET

Any other applicable formula can be used.
The list is not necessarily complete.

$$E = \frac{T_1 - T_2}{T_1} = 100\%$$

$$\frac{\gamma P}{\rho} = \frac{\gamma RT}{m} = v^2$$

$$\eta = \frac{W}{Q_1} = 1 - \frac{T_2}{T_1} \times 100\%$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$W = mC_v(T_2 - T_1)$$

$$Q = W = P_1V_1 \ln \frac{V_2}{V_1}$$

$$S_f = 4{,}187 \ln \frac{T_f}{273}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$$

$$PV = mRT$$

$$Q_1 = m_1 c \Delta T$$

$$Q = mL_v$$

$$U = mC_v(T_2 - T_1)$$

$$\left(\frac{V_2}{V_1}\right)^{\gamma-1} = \frac{T_1}{T_2}$$

$$\gamma = \frac{C_p}{C_v}$$

$$R = C_p - C_v$$

$$W = mRT_1 \ln\left(\frac{P_1}{P_2}\right)$$

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

$$W = mR \ln \frac{V_1}{V_2}(T_1 - T_2)$$

$$f' = \frac{fV}{V - v}$$

$$f' = \frac{F(V + v)}{V}$$

$$v = \lambda f$$

$$f = \frac{C}{2l}$$

$$V = \sqrt{\frac{\gamma P}{\rho}} = \sqrt{\frac{\gamma RT}{m}}$$

$$v = \sqrt{\frac{F}{\mu}}$$

$$\frac{V_1}{\lambda_1} = \frac{V_2}{\lambda_2}$$

$$f' = f\left(\frac{v \pm v_o}{v \pm v_z}\right)$$

$$f = \frac{1}{2L}\sqrt{\frac{P}{m}}$$

$$E = \frac{F}{Q_1} = \frac{Q}{4\pi e_o r^2}$$

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$W = QV$

$E = \frac{mg}{q}$

$E_k = W = Vq$

$Q = CV$

$E = hf$

$F = qE$

$E = \frac{1}{2}CV^2$

$V = \frac{mgr}{Q}$

$t = RC$

$S = \frac{W}{F}$

$E_k = hf - W$

$r = \frac{Q}{4\pi \in_o r}$

$v = \frac{kQ}{r}$

$C = \in_r . \in_o . \frac{A}{d}$

$F = \frac{kq_1q_2}{r^2}$

$E_k = QV$

$e = \frac{v}{d}$

$\frac{1}{c} = \frac{1}{c_1} + \frac{1}{c_2}$

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

$v = \lambda f$

$\mathrm{W} = \frac{1}{2}\mathrm{QV}$

$m = EQ = \left(\frac{V}{r}\right)Q$

$C = k \in_o \frac{A}{d}$

$a = \frac{F}{m} = \frac{Eq}{m} = \frac{Vq}{S_m}$

$W = Vq = \frac{1}{2}mv^2$

$r = \sqrt{\frac{kq_1q_2}{F}}$

$\sigma = \frac{Q}{4\pi r^2}$

$W = \frac{1}{2}cv^2$

$T = \frac{1}{\lambda} . \ln 2$

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