higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N5

(15070115)

30 November 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages, a formula sheet of 2 pages and 1 information sheet.

167Q1E2330

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING PHYSICS N5
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. Use only a black or a blue pen.
5. Write neatly and legibly.

QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.1.1 Magnetic field lines is a vector quantity.

1.1.2 Short sightedness is when an eye causes distant objects to appear blurred but close objects are seen clearly.

1.1.3 The loudness of a sound depends on the wavelength of the wave.

1.1.4 Diffusion is a process by which molecules of a solvent tend to pass through a semi-permeable membrane from a less concentrated solution to a more concentrated one.

1.1.5 According to Charles' law, the product of a volume and a given temperature of a given mass of a gas in a closed system remains constant.

(5 × 1) (5)

1.2 Define the following

1.2.1 Adhesive force

1.2.2 Refractive index

(2 × 2) (4)

1.3 List TWO types of transformers (2)

1.4 Give the SI unit of each of the following and state whether it is a scalar or a vector quantity.

1.4.1 Velocity of the sound

1.4.2 Force

(2 × 2) (4)

1.5 Provide ONE suitable example of each of the following:

1.5.1 The total reflection that causes the light to turn through 90°

1.5.2 Artificial source of light

(2 × 1) (2)

1.6 A transformer has 3 600 turns on the primary side and 900 turns on the secondary side. The primary voltage is 220 V.

Calculate the following:

1.6.1 The turns ratio

1.6.2 The secondary voltage

1.6.3 The secondary current if the primary current is 4 A

1.6.4 Power

(4 × 2) (8)
[25]

QUESTION 2

2.1 A cylinder contains 0,8 ℓ of gas at a pressure of 4 kPa and a temperature of 10 °C. The gas is compressed adiabatically to one third of the original volume. If the gas has a C_p = 385 J/Kg. K and a C_v = 210 J/Kg. K.

Calculate the following:

2.1.1 Gas constant R for this gas (1)

2.1.2 The value of the compression coefficient (1)

2.1.3 Original volume of the gas (3)

2.1.4 The final pressure of the gas (3)

2.1.5 The final temperature in °C (2)

2.2 Calculate the magnetic flux intensity in a conductor carrying a current of 9 A

2.2.1 At the centre of the circle wire with a radius of 180 mm (2)

2.2.2 Within a solenoid which is 0,7 m long and has 1 440 turns/m (3)

2.3 Name ONE use of each of the following:

2.3.1 Polarimeter

2.3.2 Oscilloscope

(2 × 1) (2)

2.4 Name THREE materials used to test polarised light. (3)

2.5 Draw and label the structure of the human eye. (5)
[25]

QUESTION 3

3.1 A mirror produces an upright image, 800 mm tall of an object 200 mm from the mirror. The height of the object is 200 mm.

Calculate the following:

3.1.1 The distance of the image from the mirror (3)

3.1.2 The radius of curvature of the mirror (2)

3.2 The index of refraction of a glass prism is 1,3 and the angle at the apex of the prism is 20°. Calculate the angle of minimum deviation of the prism. (5)

3.3 A round steel bar of 4 m undergoes a deformation of 0,4 m when a load of 45 kN is applied to it. The bar has a diameter of 30 mm.

Calculate the following:

3.3.1 The change in length (2)

3.3.2 The cross-sectional area of the steel bar (2)

3.3.3 The stress in the steel bar (3)

3.4 In what way is heat energy radiated by a body influenced by the following?

3.4.1 Texture

3.4.2 Surface area

(2 × 2) (4)

3.5 Find the velocity of the sound wave emitted by a car horn if the frequency is 45 Hz and a wave length of 2,45 m. (2)

3.6 Name TWO types of waves. (2)

[25]

QUESTION 4

4.1 A 80 W light tube has a length of 1,2 m and an external diameter of 60 mm. The working temperature of the light tube is 28 °C and it has a radiation constant of e = 0,3. Stefan's constant of the light is $4,75 \times 10^{-8}$ W/m^2.K^4

Determine the following:

4.1.1 Area of the light tube

4.1.2 Heat radiated by the light tube

4.1.3 Light energy radiated by the light tube per second

(3 × 3) (9)

4.2 Draw a neat, labelled diagram of Leslie's cube. (5)

4.3 Write short notes about a grease spot photometer. (8)

4.4 Determine the force exerted by a body if the mass of A is 860 g and the mass of B is three times that of A when the distance between two masses is 240 cm. (3)

[25]

TOTAL : 100

FORMULA SHEET

Any other applicable formula may be used.

$$B = \frac{\mu_0 I}{2r}$$

$$B = \frac{\mu_0 NI}{L}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{\mu_0 NI}{2r}$$

$$B = \frac{\phi}{A}$$

$$\phi = B\,A\sin\theta$$

$$E = \frac{I\cos\theta}{r^2}$$

$$E = \frac{\sigma}{\varepsilon} = \frac{F/A}{\Delta L/L}$$

$$E = e\sigma T^4 At$$

$$\text{emf} = \frac{N\Delta\phi}{\Delta t}$$

$$\text{emf} = \text{BLv}$$

$$F = \frac{Gm_1m_2}{r^2}$$

$$F = BIL\sin\theta$$

$$\text{f} = \text{nz}$$

$$f = f_1 - f_2$$

$$\frac{1}{f} = \frac{1}{a} + \frac{1}{b}$$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$h = \frac{2\,T\cos\alpha}{r\rho g}$$

$$n = \frac{\sin i}{\sin r}$$

$$n = \frac{\sin(A + Dm)/2}{\sin A/2}$$

$$\sin\theta_c = \frac{1}{\text{n}}$$

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

$$p = \rho gh$$

$$\rho = \frac{m}{V}$$

$$\text{pV} = \text{mRT (m} = \text{nM)}$$

$$pV = nR_0T$$

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

$$p_1V_1^{\gamma} = p_2V_2^{\gamma}$$

$$\text{Q} = \text{u} + \text{w}$$

$$Q = mc\Delta t$$

$$Q = \frac{ka\Delta T\Delta t}{L}$$

$$R_s = \frac{V_0}{I_g} - R_g$$

$$R_s = \frac{R_g I_g}{I_t - I_g}$$

$$R = c_p - c_v$$

$$\gamma = \frac{c_p}{c_v}$$

$$\frac{r_1}{r_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{M_2}{M_1}} = \frac{t_2}{t_1}$$

$$T = \frac{F}{2\ell} = \frac{F}{4\pi r}$$

$$V = \frac{b}{a}$$

$$V = \frac{0{,}25 \times d}{f_1 \times f_2}$$

$$V = \frac{4}{3}\pi r^3$$

$$v = \sqrt{\frac{3p}{\rho}} = \sqrt{\frac{3R_0T}{M}} \quad \left(n = \frac{m}{M}\right)$$

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{E}{\rho}} = \sqrt{\frac{\gamma P}{\rho_0}}$$

$$\mu = \frac{m}{L}$$

v = f8

8 = d sin 2

$$\frac{v}{v_0} = \sqrt{\frac{T}{T_0}}$$

W = VI

W = p)V

CONSTANT VALUES

Speed of light	$c = 2,99 \times 10^8$ m/s
Speed of sound at 0 °C	$v = 330$ m/s
Gravitational constant	$G = 6,673 \times 10^{-11}$ N.m^2/kg^2
Stefan-Boltzmann's constant	$\Phi = 5,67 \times 10^{-8}$ W/m^2.K^4
Universal gas constant	$R_0 = 8,314$ J/mol.K
Permeability in a vacuum	$\mu_0 = 4\ \pi \times 10^{-7}$ Wb/A.m
Specific heat capacity of water	$c = 4\ 187$ J/kg.K
Standard atmospheric pressure	$p = 1,013 \times 10^5$ Pa
Gravitational acceleration	$g = 9,8$ m/s^2
Refractive index:	
Water	$n = 1,33$
Glycerine	$n = 1,47$
Glass	$n = 1,5$
Surface tension water	$T = 0,0756$ N/m (0 °C)
	$T = 0,0728$ N/m (20 °C)
Mass:	
Sun	$m = 1,99 \times 10^{30}$ kg
Earth	$m = 5,98 \times 10^{24}$ kg
Moon	$m = 7,36 \times 10^{22}$ kg
Radius:	
Sun	$r = 6,95 \times 10^8$ m
Earth	$r = 6,38 \times 10^6$ m
Moon	$r = 1,74 \times 10^6$ m
Other:	
1 bar = 10^5 Pa	
1 ton = 10^3 kg	