higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# NATIONAL CERTIFICATE

# ENGINEERING PHYSICS N5

(15070115)

**23 November 2022 (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.**

160Q1E2223

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

NATIONAL CERTIFICATE
ENGINEERING PHYSICS N5
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. Start each section on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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## QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Period of a wave is the number of vibrations in one second.

1.1.2 Standing waves are formed when a wave does not move forward through a medium but reflected as much as it is transmitted so that the total movement of the wave is zero.

1.1.3 A sugar solution will diffuse more rapidly than the same concentration of starch at the same temperature.

1.1.4 The diameter of a solenoid does not affect the magnetic flux density inside the solenoid.

1.1.5 It is possible to obtain an angle of contact of 0° between a liquid and a solid.

(5 × 1) (5)

1.2 Explain the following terms:

1.2.1 Charles's law (2)

1.2.2 Cohesion (1)

1.2.3 Diffusion (2)

1.2.4 The law of refraction (2)

1.3 Give the SI unit of the following:

1.3.1 Intensity of light

1.3.2 Electrical energy

1.3.3 Velocity of sound

(3 × 1) (3)

1.4 Name ONE use of each of the following:

1.4.1 Diffusing grating

1.4.2 Magnetometer

1.4.3 Tourmaline crystal

1.4.4 Oscilloscope

(4 × 1) (4)

1.5 Give ONE suitable example of each of the following:

1.5.1 Artificial source of light

1.5.2 The total reflection that causes light to turn through 180°

1.5.3 An object that seldom produces pure tone and overtones

(3 × 1) (3)

1.6 Find the intensity of a source of light 20 m from a surface on which the illumination intensity is 1 000 lux. (3)

**[25]**

## QUESTION 2

2.1 Choose a term from COLUMN B that matches a description 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 | Boyle's apparatus | A | Alternating current |
| 2.1.2 | Slip rings | B | Convex lens |
| 2.1.3 | Farsightedness | C | Galvanometer |
| 2.1.4 | Three images | D | Air pressure |
| 2.1.5 | Current size | E | Two rectangular mirrors |

(5 × 1) (5)

2.2 Name THREE things that occur when light strikes a surface. (3)

2.3 Given: $h = \frac{2\,T\,Cos\,\alpha}{r\rho g}$

2.3.1 Give the meaning of each of the following: T, α , r and ρ. (4)

2.3.2 Calculate h if T = 3 kN, α = 20 °C, r = 4 cm and ρ =1400 kg/m$^3$. (3)

2.4 Make a neat, labelled sketch of diffraction with light. (3)

2.5 Two similar balls with a mass of 4 kg and a force of 2 MN attract each other. Find the distance between them. (4)

2.6 Calculate the magnetic flux density at the point P, which is 90 mm from a straight wire through which a current of 12 A is flowing. (3)

**[25]**

## QUESTION 3

3.1 An object is placed at a distance of 250 mm from a concave mirror with a focal length of 125 mm.

Find the following:

3.1.1 Position of the image (2)

3.1.2 Nature of the image (2)

3.1.3 Size of the image formed if the height of the object is 50 mm (3)

3.2 A container has a volume of 0,08 $m^3$ gas at 1,2 bar and 25 °C. Calculate the number of moles of gas in the container. (2)

3.3 A cylinder contains 0,44 ℓ gas at a pressure of 3 kPa and a temperature of 46 °C. The gas is compressed adiabatically to three quarters of the original volume. The gas has $C_p$ = 279 J/kg.K and R = 74 J/kg.K.

Determine the following:

3.3.1 The value of the compression coefficient (2)

3.3.2 The original volume of the gas (3)

3.3.3 The final pressure of the gas (3)

3.3.4 The final temperature of the gas (2)

3.3.5 Root mean square velocity of the gas molecules at the final stage (3)

3.4 Illustrate osmotic pressure with the aid of a diagram using a sugar solution and semi-permeable membrane (3)

**[25]**

## QUESTION 4

4.1 Calculate the kinetic energy of a lead bullet with a mass of 40 g travelling at a speed of 300 m/s. (3)

4.2 Make a neat, labelled sketch of the human eye. (7)

4.3 A transformer has 3 000 turns at the primary side and 500 turns on the secondary side. The supply voltage is 120 V.

Calculate the following:

4.3.1 Secondary voltage

4.3.2 Secondary current if the primary current is 3 A

4.3.3 Turn ratio

(3 × 2) (6)

4.4 A wire of 5 m long carries a current of 10 A in a magnetic field with a flux density of 1,17 Wb/m$^2$. Find the force exerted on the wire if the wire is perpendicular to the field. (2)

4.5 Calculate the frequency of the fundamental as well as the first overtone of an open tube at 28 °C, if the tube is 550 mm long.

Hint: In the tube, the antinode is always at the open end of the tube. At overtones, loops are added to each other. (7)

**[25]**

**TOTAL: 100**

## FORMULA SHEET

Any other applicable formula may be used.

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

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

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

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

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

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

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

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

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

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

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

$$F = \frac{Gm_1 m_2}{r^2}$$

$$F = BIL\sin\theta$$

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

$$f = f_1 - f_2$$

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

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

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

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

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

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

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

$$p = \rho g h$$

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

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

$$pV = nR_0 T$$

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$p_1 V_1^{\gamma} = p_2 V_2^{\gamma}$$

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

$$Q = mc\Delta t$$

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

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

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

$$R = c_p - c_v$$

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



 

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

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

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

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

$$V = 4/3\,\pi\, r^3$$

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

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

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

$$v = f8$$

$$8 = d \sin 2$$

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

$$W = VI$$

$$W = p)V$$

## 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 of 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 | |