higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N5

(15070115)

4 August 2021 (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.

175Q1G2104

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE 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. Keep the subsections of questions together.
5. Start each answer with the formula and the substituted values.
6. Each final answer must be rounded off to THREE decimal numbers.
7. Use only a black or blue pen.
8. 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 (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 A positive charge experiences a force in an electrical field in the same direction as a field.

1.1.2 Magnetic flux is measured in weber.

1.1.3 A long tense string will produce a wave with a short amplitude.

1.1.4 Diffraction of light can be seen with the naked eye at the edge of a razor blade.

1.1.5 Incident light rays, refracted rays and normal rays through the point of incidence on the interface between the two media all lie on a different plane.

(5 × 1) (5)

1.2 Define the following:

1.2.1 Refraction of light rays

1.2.2 Adhesion

1.2.3 Candela

1.2.4 Magnetic flux

1.2.5 Boyle's law

(5 × 2) (10)

1.3 Indicate whether the following statements apply to an adiabatic, isothermic or polytropic process by writing only 'Adiabatic', 'Isothermic' or 'Polytropic' next to the question number (1.3.1–1.3.5) in the ANSWER BOOK

1.3.1 The formula is $\frac{PV}{T} = k$

1.3.2 Molecules of the solution on the opposite side of a semi-permeable membrane.

1.3.3 Gas formed in this process cannot be transferred to the surroundings.

1.3.4 The reversible process in any open or closed system of gas which involves heat and work transfer.

1.3.5 Work done is due to the change in internal energy.

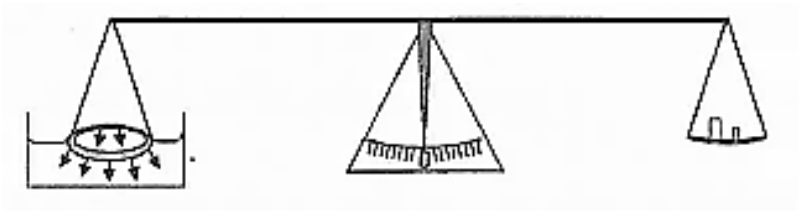
(5 × 1) (5)

1.4 List THREE natural sources of light (3)

1.5 Name TWO primary colours of light (2)
[25]

QUESTION 2

2.1 Study the diagram below:



DIAGRAM

2.1.1 Give the appropriate name for this diagram (2)

2.1.2 What is the use of this diagram? (2)

2.1.3 Determine the surface tension of a liquid that requires a force of 0,0095 N to hold a wire frame 200 mm wide in equilibrium. (3)

2.2 Draw and label a diagram that can illustrate the relationship between stress and deformation. (7)

2.3 During an experiment to investigate Boyle's law, the following results have been obtained.

Volume in m^3	0.3	0.6	B
Pressure in KPa	50	A	20

2.3.1 Find the possible values of A and B. (2)

2.3.2 Draw a diagram to represent this law. (3)

2.4 Name FOUR factors that influence the tempo of the diffusion. (4)

2.5 List TWO types of waves. (2)
[25]

QUESTION 3

3.1 5×10^6 cm^3 of a gas at a pressure of 4,5 KPa and 20 °C is compressed adiabatically in accordance with the formula $P.V^{1.3}$ = constant until the pressure is 9 KPa.

Calculate the following:

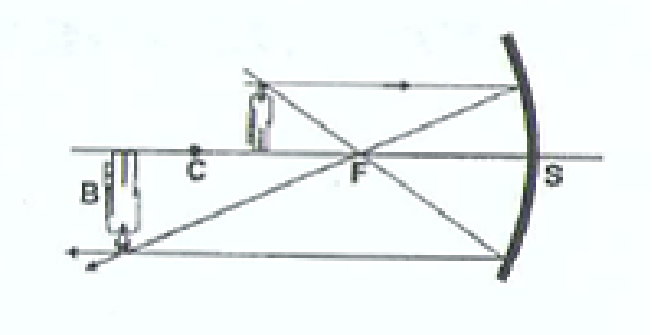
3.1.1 Initial volume of the gas in m^3. (1)

3.1.2 New volume of the gas. (3)

3.1.3 Mass of the gas if the gas constant R = 0.185 KJ/Kg. K. (2)

3.1.4 Density of the gas. (2)

3.2 Study the figure of the image formation in a concave mirror below:



FIGURE

Write short notes to indicate what happened to the object between F and C. (4)

3.3 15 g of a gas is a by-product at a waste water treatment plant. The gas has a volume of 0,0123 m^3 at a pressure of 2 bar and a temperature of 48 °C. The gas is allowed to expand to 0,25 bar when the volume is 0,0318 m^3 if the c_v = 1,54 KJ/Kg.K.

Calculate the following :

3.3.1 Gas constant for this gas (3)

3.3.2 Change in internal energy (5)

3.3.3 Work done by the gas while expanding (3)

3.4 Explain how the colour, white, can be formed in a laboratory. (2)

[25]

QUESTION 4

4.1 Calculate the frequency of the fundamental as well as the first overtone of an open tube at 25 °C if each tube is 70 cm long.

HINT: in the tube, the antinode is always at the open end of the tube; at the overtone one loop is added to each other. (5)

4.2 A transformer has 3 600 turns on the primary side and 800 turns on the secondary side. The supply voltage is 220 V.

Calculate the following:

4.2.1 Secondary voltage

4.2.2 Secondary current if the primary current is 4 A

4.2.3 Turn ratio

(3 × 3) (9)

4.3 The index of refraction of a glass prism is 1,5 and the angle at the apex of the prism is 40°.

Calculate the angle of minimum deviation of the prism. (4)

4.4 An object is placed at a distance of 300 mm from a concave mirror with a focal length of 200 m.

Determine the following:

4.4.1 Position of the image (2)

4.4.2 Nature of the image (2)

4.4.3 The size of the image formed if the height of the object is 40 mm (3)

[25]

TOTAL: 100

ENGINEERING PHYSICS N5

FORMULA SHEET

Any applicable formula may be used.

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

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

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

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

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

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

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

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

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

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

$$\text{emf} = BLv$$

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

$$F = BIL\sin\theta$$

$$f = nz$$

$$f = f_1 - f_2$$

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

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

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

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

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

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

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

$$p = \rho gh$$

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

$$pV = mRT\ (m = nM)$$

$$pV = nR_0T$$

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

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

$$Q = u + w$$

$$Q = mc\Delta t$$

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

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

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

$$R = c_p - c_v$$

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

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

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

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

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

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

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

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

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

$$v = f\lambda$$

$$\lambda = d \sin \theta$$

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

$$W = VI$$

$$W = pV$$

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	$R_0 = 8314$ 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) T = 0.0662 N/m (60 °C) T = 0.0589 N/m (100 °C)
Surface tension of glycerine	T = 0.0631 N/m (20 °C)
Surface tension of mercury	T = 0.4 N/m (0 °C) T = 0.465 N/m (20 °C)
Surface tension of kerosene	T = 0.026 N/m (20 °C)
Density of water	1000 Kg/m^3
Density of kerosene	820 Kg/m^3
Density of mercury	13600 Kg/m^3
Density of glycerine	1260 Kg/m^3
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	