higher education & training

Department:
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NATIONAL CERTIFICATE

ENGINEERING PHYSICS N5

(15070115)

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This question paper consists of 5 pages and a formula sheet of 3 pages.

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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. Start each section on a new page.
5. 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 (1.2.1–1.2.10) in the ANSWER BOOK.

1.1.1 Stress is the intensity of an external force acting at a point in an object.

1.1.2 Osmosis is diffusion taking place in two directions.

1.1.3 Reflection of a ray of light is the amount of refraction, the ray undergoes differs from one optical medium to another.

1.1.4 The speed of sound in an open tube can be calculated by v = 2 fl.

1.1.5 Boyle's law state that the product of the absolute pressure and the volume of a gas of a closed system at constant temperature remain constant.

(5 × 1) (5)

1.2 Define each of the following:

1.2.1 Stefan Boltzman's law (3)

1.2.2 Far-sighted (3)

1.2.3 Strain (2)

1.2.4 Magnetic flux density (3)

1.2.5 Transverse wave (2)

1.3 Name ONE use of each of the following:

1.3.1 Air thermometer

1.3.2 Magnetometer

(2 × 2) (4)

1.4 Provide a suitable example of each of the following statements:

1.4.1 Object that seldom produces pure tone and overtones

1.4.2 Semi-permeable membrane

1.4.3 Total reflection that causes light to turn through 180°

(3 × 1) (3)

[25]

QUESTION 2

2.1 Differentiate between *cohesive* and *adhesive force*. (4)

2.2 In what way is the amount of heat energy radiated by the body influenced by each of the following?

2.2.1 Temperature

2.2.2 Colour

2.2.3 Texture

2.2.4 Surface area

(4 × 1) (4)

2.3 Briefly explain what will happen during image formation through lenses when the object is at the radius of the curvature. (4)

2.4 During an experiment to investigate Charles's law the following results were obtained:

Volume in m^3	0,6	1,8	B
Temperature in K	200	A	800

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

2.4.2 Give Charles's law in words. (3)

2.4.3 Draw a graph that best describes Charles's law. (3)

2.5 A string is 6 m long and has a mass of 9,5 g. One end of the string hangs over a drum and is fastened to a copper mass of 18 kg. The density of the copper is 8500 kg/m^3.

Calculate each of the following:

2.5.1 Tension exerted on the string (1)

2.5.3 Velocity of the sound transmission along the string (2)

2.5.3 Wavelength of the waves emitted if the note has a frequency of 200 Hz (2)

[25]

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QUESTION 3

3.1 An object is placed at a distance of 400 mm from a concave mirror with a focal length of 150 m.

Determine each of the following:

3.1.1 Position of the image (2)

3.1.2 Nature of the image (2)

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

3.2 24 g is a by-product of a waste-water purification plant. The gas has a volume of 0,0065 m^3 at a pressure of 4,5 bar and a temperature of 114 °C. The gas is allowed to expand to 0,25 bar when the volume is 0,028 m^3.

Calculate each of the following if the C_v = 1,47 KJ/Kg.K:

3.2.1 Gas constant (3)

3.2.2 Change in internal energy (5)

3.3.3 Work done by gas while expanding (3)

3.3 Draw a neatly labelled structure of the human eye. (7)

[25]

QUESTION 4

4.1 A circular disc has 30 small evenly-spaced holes. A jet of air is blown over the holes into a closed pipe 200 mm long.

Given: The velocity of sound at room temperature is 345 m/s.

Calculate the speed in r/min at which the disc must rotate to cause the air in the pipe to resonate. (6)

4.2 A galvanometer has an internal resistance of 60 Ω and must be converted into an ammeter which can measure 20 A. The coil of the galvanometer can tolerate a maximum of 30 mA.

Calculate the size of the additional resistance which must be used. (3)

4.3 Calculate the magnetic flux density at point Q that is 80 mm from a straight wire through which a current of 12 A is flowing (3)

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4.4 Given : $H = \frac{2\pi I \mu_0}{T^2 R^3 \tan \theta}$

Give the meaning of each symbol in the formula. (6)

4.5 Calculate the illumination intensity of a light of 80 cd at a point 500 mm away if the normal to the surface forms an angle of 40° with the light rays. (2)

4.6 Determine the surface tension of a soap solution at 20° that requires a force of 0.025 N to hold a wire frame 230 mm wide in equilibrium (2)

4.7 Calculate the gas constant (R) if 18 g of a gas has a volume of 0.025 m^3 at a pressure of 4 bar and a temperature of 95 °C. (3)

[25]

TOTAL: 100

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FORMULA SHEET

Any other applicable formula may also be used.

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

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

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

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

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

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

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

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

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

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

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

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

$$F = BIL\sin\theta$$

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

$$f = f_1 - f_2$$

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

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

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

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

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

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

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

$$p = \rho g h$$

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

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

$$pV = nR_0 T$$

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

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

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

$$Q = mc\Delta t$$

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

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

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

$$R = c_p - c_v$$

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

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

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

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

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

$$V = {}^{4}\!/_{3}\,\pi\, r^3$$

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

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

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

v = f8

8 = d sin 2

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

W = VI

W = p)V

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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	

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