higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N5

(15070115)

28 November 2024 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages, a formula sheet of 2 pages and 1 information sheet.

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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. Sketches must be large, neat and fully labelled.
5. Keep the subsections of questions together.
6. Start each question with the formula and then substituted values.
7. Each final answer must be rounded off to THREE decimal numbers.
8. Use only a black or blue pen.
9. 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 (1.1.1–1.1.10) in the ANSWER BOOK.

1.1.1 Charles' law can be represented graphically by a straight line.

1.1.2 An exponent of the expansion of gases (gamma) does not have a unit of measurement.

1.1.3 An internal resistor of a circuit is measured in ohms.

1.1.4 The pressure in STP is assumed to be 1 atm.

1.1.5 A grease spot photometer can be used to see if enough light is available to take a photo without using a flashlight.

1.1.6 A diffraction grating is used to polarise the light.

1.1.7 In the formula for the calculation of the energy (E) radiated by a body, e (emissivity) can have values between 0 and 2.

1.1.8 At a triangular glass prism, the refracted rays will never be parallel to the incident light rays.

1.1.9 Diffraction of light waves will be influenced by the width of the slit and the length of the waves.

1.1.10 It is possible to obtain an angle of contact between a liquid and a solid.

(10 × 1) (10)

1.2 Make a neat, labelled sketch of the interference of light. (2)

1.3 Van Der Waals derived an equation for a gas subjected to a very high pressure.

Give the equation of Van Der Waals. (3)

1.4 A current carrying conductor of 0,45 m length moves at 30 m/s perpendicular to a magnetic field of 3 Tesla. The resistance of the wire is 0,32 Ω.

Calculate the:

1.4.1 induced emf (2)

1.4.2 force exerted on the conductor (4)

1.5 Explain the meaning of each symbol in this formula: $\mathbf{v} = \sqrt{\frac{3\,R_0 T}{M}}$ (4)

[25]

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QUESTION 2

2.1 0,09 m^3 of a gas at a pressure of 20 kPa is allowed to expand adiabatically until the volume is tripled. The gas constant for the gas is 120 J/Kg. K and Cp = 0,37 KJ/Kg.K.

Calculate the final pressure of the gas. (6)

2.2 Two marbles respectively have masses of 40 kg and unknown. The force exerted by the masses is 0,25 KN.

Determine the unknown mass if the distance between two masses is 840 m. (3)

2.3 A galvanometer with a resistance of 60 Ω can handle up to 1,85 mA. This galvanometer must be used in an electrical circuit of 220 V.

Calculate the voltage drop that the galvanometer can read. (2)

2.4 Two light sources of different intensity are placed 1,4 m apart. A grease spot photometer is placed between the two sources and the distance adjusted until the grease spot becomes invisible.

If the photometer is 0,4 m away from a 400 cd light source, calculate the intensity of the other source. (4)

2.5 Carbon monoxide of 850 g is a byproduct during the production of petrol. The gas has a volume of 0,0099 m^2 at a pressure of 3 bar and a temperature of 96 °C and the gas is allowed to expand to 0,44 bar when its volume is 0,056 m^2. If R = 0,195 KJ/Kg.K and C_v = 148 J/Kg.K,

calculate the change in internal energy. (6)

2.6 How long does it take for Mars to orbit the sun, if the mass of the sun is $1{,}99 \times 10^{30}\ \text{kg}$ and the orbital speed of $5{,}2 \times 10^{6}\text{m/s}$? (4)

[25]

QUESTION 3

3.1 List TWO properties of an image. (2)

3.2 A cylinder contains 6 m^3 carbon dioxide gas at a pressure of 190 kPa and a temperature of 33 °C.

Calculate the mass of the carbon dioxide gas if R = 395 J/Kg. K. (3)

3.3 State Coulomb 's law and indicate whether it is a vector or scalar quantity. (5)

3.4 Two resistors of 3 Ω and 4 Ω are connected in parallel and another of 6 Ω is also connected in a circuit diagram. Calculate the total current following through the circuit if the battery has an EMF of 12 V. (5)

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3.5 Define *Graham's law of diffusion.* (2)

3.6 An enlarger consists of a front lens of 20 dioptres and a rear lens of 12 dioptres and the lenses are placed 350 mm apart. An object is placed 120 mm in front of the lens.

Calculate the:

3.6.1 enlargement of the front lens (6)

3.6.2 enlargement of the enlarger (2)

[25]

QUESTION 4

4.1 Define the following terms:

4.1.1 Magnetic flux

4.1.2 Cohesive force

4.1.3 Radiation

(3 × 2) (6)

4.2 What is meant by the C_p and C_v of a gas? (2)

4.3 A 12 m long copper wire carries a current of 2 A.

Calculate the

4.3.1 magnetic flux density of B that is 20 mm from the copper wire. (2)

4.3.2 magnetic flux density of B inside the centre of a ring of loops of with a 20 mm diameter when the entire wire is used to turn loops. (4)

4.4 Explain how osmotic pressure is measured. (4)

4.5 A needle can float on water. Insects can walk on water. Using physics, discuss this phenomenon. (3)

4.6 Find the surface tension of a sugar solution if the mass of a moveable wire is 0,8 g and the length of the moveable wire is 240 mm. (4)

[25]

TOTAL: 100

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ENGINEERING PHYSICS N5

FORMULA SHEET

Any applicable formula may be used.

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

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

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

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

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

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

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

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

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

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

$$\text{emf} = BLv$$

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

$$F = K\,\frac{Q_1 \times Q_2}{r^2}$$

$$PF = \frac{P}{S} \times 100$$

$$\frac{I_1}{r_1^2} = \frac{I_2}{r_2^2}$$

$$v^2 = \frac{GM}{r}$$

$$v = \frac{2\pi r}{T}$$

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

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

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

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

$$p = \rho gh$$

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

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

$$pV = nR_0T$$

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

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

$$Q = u + w$$

$$Q = mc\Delta t$$

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

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

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

$$R = c_p - c_v$$

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

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$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$F = BIL\sin\theta$$

$$f = nz$$

$$f = f_1 - f_2$$

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

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

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

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

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

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

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

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

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

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

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

$$v = f \times \lambda$$

$$R_T = R_1 + R_2 + R_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

V = IR

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

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

$v = f8$

$8 = d \sin$ □

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

$W = VI$

$W = pV$

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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	□ = 5, 67 × 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 ºC) T = 0.0589 N/m (100 ºC)
Surface tension of glycerine	T = 0.0631 N/m (20 ºC)
Surface tension of mercury	T = 0.4 N/m (0 ºC) T = 0.465 N/m (20 ºC)
Surface tension of kerosene	T = 0.026 N/m (20 ºC)
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

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