higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N5

(15070115)

5 August 2019 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and a formula sheet of 2 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. Sketches must be large, neat and fully labelled.
5. Keep subsections of questions together.
6. Start each question with the formula and substituted values.
7. Round off each final answer to THREE decimal numbers.
8. Write neatly and legibly.

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QUESTION 1

1.1 Give ONE term for each of the following descriptions. Write only the term next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Diffusion that takes place in only one direction

1.1.2 Line to which a tangent at any point gives the direction of magnetic field density at any specific point

1.1.3 Amount of refraction a ray undergoes differs from one optical medium to another

1.1.4 Total radiation energy emitted per unit area per unit time by a body is proportional to the fourth power of the absolute temperature

1.1.5 Deformation of a solid due to stress

(5 × 1) (5)

1.2 Give ONE use of each of the following:

1.2.1 Leslie's cube

1.2.2 Polarimeter

1.2.3 Magnetometer

1.2.4 Wattmeter

1.2.5 Oscilloscope

(5 × 1) (5)

1.3 State Graham's law of diffusion. (2)

1.4 The following results could have been obtained during an experiment to investigate Charles's law:

Volume in m^3	0,4	1,2	B
Temperature in K	200	A	800

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

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

1.4.3 Draw a graph which best describes Charles's law. (3)

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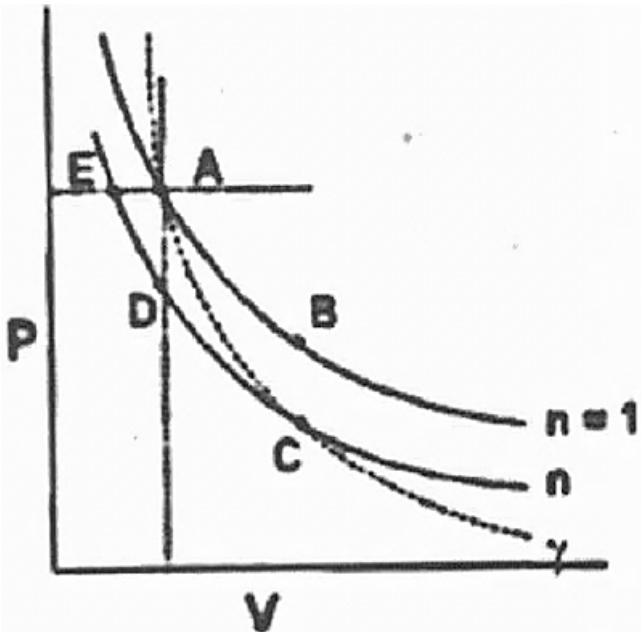
1.5 Study the diagram about gases below.



Name the process represented by each of the following:

1.5.1 $A \rightarrow C$

1.5.2 $E \rightarrow C$

1.5.3 $A \rightarrow B$

1.5.4 $A \rightarrow E$

1.5.5 $A \rightarrow D$

(5 × 1) (5)

[25]

QUESTION 2

2.1 Given: $E = e\delta T^4 At$

2.1.1 What is this formula used for? (2)

2.1.2 Give the meaning of each of the following in the formula:

- E
- e
- δ
- T
- A
- t

(6 × 1) (6)

2.2 A chemical plant has a copper cylinder filled with water. The cylinder has a height of 1 500 cm, a radius of 0,4 m and emissivity of 0,2 at a temperature of 30 °C.

Given: Area of the cylinder is $2\pi r^2 + 2\pi rh$

Calculate the:

2.2.1 Area of the cylinder (2)

2.2.2 Heat radiated in 2 minutes (3)

2.3 Give TWO suitable examples of each of the following statements:

2.3.1 Object that produces seldom pure tone and overtones

2.3.2 Artificial source of light

2.3.3 Sound will resonate in an open tube

(3 × 2) (6)

2.4 Briefly discuss THREE factors that affect the strength of an electromotive force. (3 × 2) (6)

[25]

QUESTION 3

3.1 Name TWO experimental means that can be used to test the tensile strength of an object. (2)

3.2 Draw the diagram that illustrates osmotic pressure by using a sugar solution and semipermeable membrane. (3)

3.3 Calculate the surface tension of a liquid that requires a force of 0,0058 N to hold a wire frame 200 mm wide in equilibrium. (2)

3.4 A vessel with a volume of 0,6 m^3 contains chlorine gas at 1,013 bar and 15 °C. If 0,4 kg of chlorine gas is now pumped into the vessel the molecular weight of the chlorine gas is 75 and it may be assumed to be a perfect gas.

Calculate the new pressure when the vessel has returned to its initial temperature. (5)

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3.5 A cylinder contains 0,68 ℓ gas at a pressure of 2,55 kPa and a temperature of 40 °C. The gas is compressed adiabatically to one third of the original volume.

If the gas has a C_p = 360 J/kg.K and a C_v = 240 J/kg.K calculate the:

3.5.1 Gas constant R for this gas (1)

3.5.2 Value of the compression coefficient (1)

3.5.3 Original volume of the gas (3)

3.5.4 Final pressure of the gas (3)

3.5.5 Final temperature in °C (2)

3.5.6 Root mean square velocity of the gas molecules at the final condition (3)

[25]

QUESTION 4

4.1 Explain the law of refraction. (3)

4.2 List THREE materials used to test polarised light. (3)

4.3 Name TWO media through which sound is transmitted and give a suitable example of each. (2)

4.4 What is meant by the concept *intensity of sound*? (3)

4.5 Six possible image formations can occur in a convex lens.

Write down how an object can be placed in each of the following:

4.5.1 Telescope

4.5.2 Camera

4.5.3 Copying machine

4.5.4 Magnifying glass

4.5.5 Lens of a motorcar light

4.5.6 Microscope

(6 × 1) (6)

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4.6 Calculate the illumination intensity of a light of 95 cd at a point 500 mm away. (2)

4.7 Determine the velocity of a sound wave emitted at a frequency of 60 Hz with a wavelength of 4,8 m. (2)

4.8 The index of refraction of a glass prism is 1,5 and the angle at the apex of the prism is 45°.

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

[25]

TOTAL: 100

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FORMULA SHEET

Any applicable formula may be used.

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

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

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

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

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

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

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

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

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

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

$$\text{emf} = BLv$$

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

$$F = BIL\sin\theta$$

$$f = nz$$

$$f = f_1 - f_2$$

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

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

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

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

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

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

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

$$p = \rho g h$$

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

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

$$pV = nR_0 T$$

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

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

$$Q = u + w$$

$$Q = mc\Delta t$$

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

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

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

$$R = c_p - c_v$$

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

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

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

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

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

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

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

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

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

$$v = f8$$

$$8 = d \sin 2$$

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

$$W = VI$$

$$W = pV$$

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 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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