higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T600**(E)**(A4)T

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N5

(15070115)

4 April 2019 (X-Paper)
09:00–12:00

This question paper consists of 7 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. 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 When different substances are placed next to each other, the movement of their molecules may cause them to form one homogeneous mixture.

1.1.2 The amount of light radiated by a black container with a surface area of 100 mm^2 filled with liquid platinum allowed to set at 2 500 °C

1.1.3 The intensity of an internal force acting at a point in an object

1.1.4 When a wave does not move forward through a medium but is reflected just as much as it is transmitted so that the total movement of the wave is zero

1.1.5 Any process during which pressure remains constant

(5 × 1) (5)

1.2 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 If the elasticity limit of a metal is exceeded, the metal will return to its original shape when the load is removed.

1.2.2 Adiabatic compression takes place so rapidly that heat cannot be transferred to its surroundings and the temperature of the system will decrease.

1.2.3 When incident light rays pass through a lens which causes them to become parallel, the rays will no longer overlap after dispersion and the colour spectrum obtained will be much purer because the colours will be separated. This phenomenon is called spectrometer.

1.2.4 In an alternating-current generator the current continuously changes direction with each 180° that the conductor turns.

1.2.5 The lateral force of attraction between molecules of gases that are on the surface of a liquid causes the liquid to behave as if it was covered with a membrane. This concept is known as liquid-surface tension.

(5 × 1) (5)

1.3 Name TWO ways to measure the surface tension of a liquid. (2)

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1.4 The following results were obtained during an experiment to investigate Boyle's law:

Volume in m^3	0,15	0,25	B
Pressure in kPa	10	A	5

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

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

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

1.5 Determine the force with which two masses of 20 kg and 50 kg respectively attract one another when they are 225 cm apart. (2)

1.6 Complete the following sentences by writing the missing word or words next to the question number (1.6.1–1.6.3) in the ANSWER BOOK.

1.6.1 The … of a sound depends on the amplitude of the wave.

1.6.2 One part red to two parts peacock blue will produce … light.

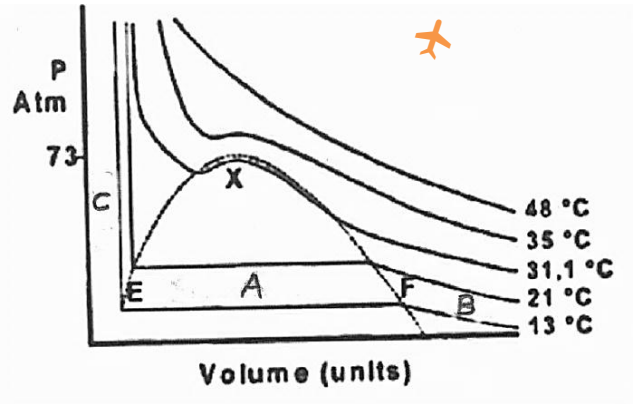
1.6.3 The distance taken to complete one oscillation is called …

(3 × 1) (3)

[25]

QUESTION 2

2.1 Carbon dioxide is compressed at different temperatures during the liquefaction of a gas as shown in the graph below.



Use the graph to explain the:

2.1.1 13 °C line at point F when meniscus is formed

2.1.2 21 °C line

2.1.3 31,1 °C line

2.1.4 35 °C line

2.1.5 48 °C line

2.1.6 State of matter of B and C

(6 × 2) (12)

2.2 Give TWO examples of a semipermeable membrane. (2)

2.3 15 g of gas is a by-product at a water-purification plant in Tzaneen. The gas has a volume of 0,0042 m^3 at a pressure of 5 bar and a temperature of 128 °C. The gas is allowed to expand to 0,14 bar when the volume is 0,035 m^3. The c_v = 1,53 kJ/kg.K.

Calculate the:

2.3.1 Gas constant for this gas (3)

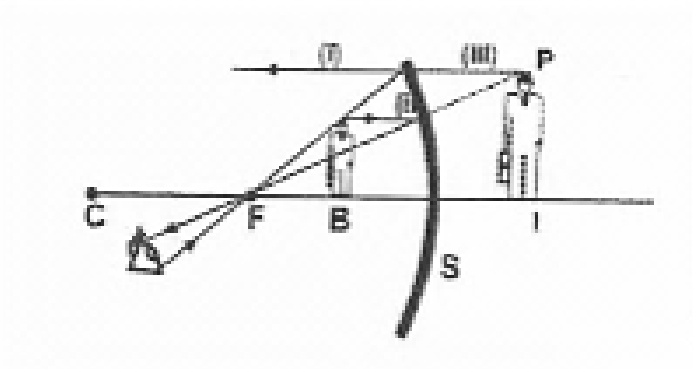
2.3.2 Change in internal energy (5)

2.3.3 Work done by the gas while expanding (3)

[25]

QUESTION 3

3.1 Study the diagram of the image formation in a concave-curved mirror below.



Use the diagram to answer the following questions:

3.1.1 List the meaning of B, C, F, I and S. (5)

3.1.2 Briefly explain what happens to the object between F and S. (4)

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

Determine the:

3.2.1 Position of the image (2)

3.2.2 Nature of the image (2)

3.2.3 Size of the image formed if the height of the object is 40 mm (3)

3.3 A combination of two lenses in contact is built up of lenses with radii of curvature of 1,6 m and 1 m and the index of refraction n = 1,8.

Determine the power of the combination if the lenses are convex-concave. (3)

3.4 In a diffraction grating the lines are 500/mm, the two spectra are 180 mm apart and the screen is 240 mm from the grating.

Calculate the:

3.4.1 Angle θ by which red light deviated

3.4.2 Wavelength of the red light used

(2 × 2) (4)

3.5 Explain the term *short-sighted person*. (2)

[25]

QUESTION 4

4.1 A string is 4 m long and has a mass of 8,5 g. One end of the string hangs over a drum and is fastened to a copper mass of 16 kg. The density of the copper is 8 500 kg/m^3.

Calculate the:

4.1.1 Tension exerted on the string (1)

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

4.1.3 Wavelength of the waves emitted if the note has a frequency of 150 Hz (2)

4.1.4 Young's modulus of elasticity for the copper metal (2)

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4.2 4 m^3 of a gas at a pressure of 2,3 kPa and 30 °C is compressed adiabatically in accordance with the formula $P.V^{1,4}$ = constant until the pressure is 5 kPa.

Calculate the:

4.2.1 New volume of the gas (3)

4.2.2 Mass of the gas if the gas constant R = 0,17 kJ/kg.K (2)

4.2.3 Density of the gas (2)

4.3 Briefly explain the difference between:

4.3.1 Cohesive force and adhesive force

4.3.2 Transverse wave and longitudinal wave

(2 × 2) (4)

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

4.4.1 What is this formula used for? (1)

4.4.2 Give the meaning of each of the following components of the formula:

(a) H

(b) T

(c) R

(d) I

(e) μ_0

(f) θ

(6 × 1) (6)

[25]

TOTAL: 100

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FORMULA SHEET

Any applicable formula may be used.

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

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

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

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

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

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

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

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

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

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

$$\text{emf} = BLv$$

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

$$F = BIL\sin\theta$$

$$f = nz$$

$$f = f_1 - f_2$$

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

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

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

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

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

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

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

$$p = \rho gh$$

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

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

$$pV = nR_0T$$

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

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

$$Q = u + w$$

$$Q = mc\Delta t$$

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

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

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

$$R = c_p - c_v$$

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

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

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

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

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

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

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

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

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

$$v = f8$$

$$8 = d \sin 2$$

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

$$W = VI$$

$$W = pV$$

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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	$\Phi = 5{,}67 \times 10^{-8}$ 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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