UNIVERSITY
OF
JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING MATHEMATICS

NATIONAL DIPLOMA IN ANALYTICAL CHEMISTRY
FOOD TECHNOLOGY

MODULE PHYSICS PHYXTA2 and PHYXTA2
PHYSICS PHY1AE3

CAMPUS **DFC**

JUNE EXAMINATION

DATE 05 /31/2018 **SESSION: 12:30 – 15:30**

ASSESSOR **MR. T.E NEMAKHAVHANI**
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INTERNAL MODERATOR **MR. J MVELASE**

DURATION 3 HOURS **MARKS 120**

NUMBER OF PAGES: 8 PAGES, INCLUDING 2 INFORMATION SHEETS

INSTRUCTIONS: CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT)

REQUIREMENTS: ANSWER BOOK

ANSWER ALL QUESTIONS IN THE ANSWER BOOK PROVIDED

QUESTION 1

1.1. Define *pressure*. (2)

1.2. State the correct formula used to calculate pressure. Name all the terms used in the formula. (2)

1.3. State the following for pressure:

1.3.1. The *correct unit* obtained from the formula (2)

1.3.2. The *correct single name* of the above unit. (2)

1.3.3. The abbreviation for your answer to Question 1.3.2 (2)

(10)

QUESTION 2

2.1. A cylinder is filled with water so that the force at its circular base is **F** N. If the pressure measures **P** kPa, show that the radius of the cylinder's base is given by

$$r = \sqrt{\frac{F}{\pi P}}$$ (5)

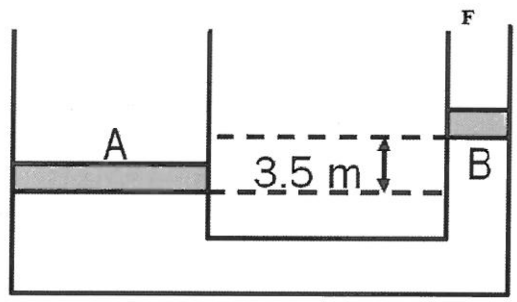
2.2. A skateboarder lands on all four wheels after riding a railing. If the skateboarder has a weight of 900×10^{-3} kN and the area on the bottom of a single wheel is 1×10^{3} mm^{2}, what pressure does the skateboard put on the ground? (5)

(10)

QUESTION 3

3.1. With the aid of a diagram, show that the pressure due to a liquid is given by $\mathbf{P = g\rho_{\ell}h}$. (4)

3.2. In the sketch below, the cylinder **A** has a mass of 13 kg and cross-sectional area of 2 m^2. The piston **B** has a cross-sectional area of 15000 mm^2 and negligible weight. If the apparatus is filled with oil (ρ = 780 kg/m^3), with the aid of a complete diagram calculate the force **F** required for equilibrium. (6)



(10)

QUESTION 4

4.1. A rod 3000 mm long expanded 0.3 cm when heated through a temperature of 100 °C. Calculate the coefficient of linear expansion. (3)

4.2. A copper rod is 250 cm long at 15 °C. Calculate its length when heated to 35 °C. (4)

4.3. A rectangular copper sheet has area 80 mm^2 at 20 °C. Calculate the area at 100 °C. (4)

4.4. Calculate the temperature change required to increase the volume of brass plate by 5%. (5)

4.5. A steel cube has a volume of 10 cm × 10 cm × 10 cm at 10 °C. Calculate the volume of the cube at 120 °C. (4)

(20)

QUESTION 5

5.1. With the aid of graphs, state the following laws and name all the terms used:

5.1.1. Boyles's law. (4)

5.1.2. Gay Lussac's law. (4)

5.2. An enclosed gas has a volume of 10 mm × 10 mm × 10 mm at 17 °C. The temperature drops, and the new volume of the gas is 7.5 mm^3. Calculate the new temperature if the pressure remains constant. (4)

5.3. An enclosed gas has a pressure of 1000 kPa at 40 °C. Calculate the pressure at 120 °C if the volume remains constant. (3)

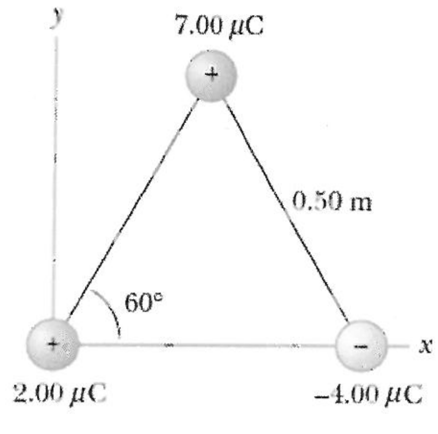
(15)

QUESTION 6

6.1. Calculate the number of electrons in a small, electrically neutral silver pin that has a mass of 10.0 g. Silver has 47 electrons per atom, and its molar mass is 107.87 g/mol. (2)

6.2. Electrons are added to the pin until the net negative charge is 1.00 nC. How many electrons are added for every 10^9 electrons already present? (2)

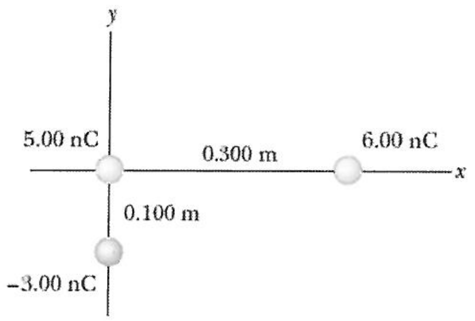
6.3. Three point charges are located at the corners of an equilateral triangle as shown in the figure below. Calculate the resultant electric force on the 7.00 μC charge. (8)



6.4. Three point charges are arranged as shown in the figure below. Determine

6.4.1. The vector electric field that the 6.00 nC and -3 nC charges together create at the origin. (4)

6.4.2. The vector force on the 5.00 nC charge. (4)



(20)

QUESTION 7

7.1. Define

7.1.1. Ohm's law. (3)

7.1.2. Electric current. (2)

7.1.3. Resistance. (3)

7.2. If 6 J of work is needed to move a charge of 0.002 C from point A to point B in an electrical field, calculate the potential difference between point A and B. (3)

7.3. Calculate the work done by a battery to drive a current of 5×10^{-3} A through a conductor for 1 minute, if the potential difference across the conductor is 10 V. (4)

(15)

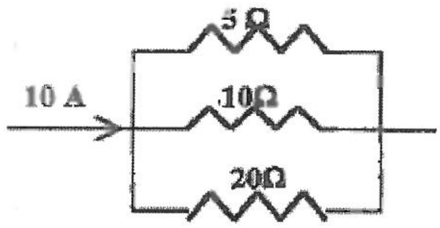
QUESTION 8

8.1. With the aid of a free body diagram derive the expression for the effective resistance of resistors in series. (10)

8.2. For the diagram shown below, calculate:

8.2.1. The effective resistance. (5)

8.2.2. The current through the 20 Ω resistor. (5)



(20)

Total Marks [120]

University of Johannesburg

PHYSICS INFORMATION SHEET

OPTICS

1. $f = \frac{R}{2}$
2. $m = \frac{v}{u}$
3. $m = \frac{v}{f} - 1$
4. $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
5. ${}_1n_2 = \frac{\sin i_1}{\sin i_2}$
6. $n = \frac{c}{v}$
7. $n = \frac{\text{real depth}}{\text{apparent depth}}$
8. $\sin c = \frac{n_1}{n_2}$
9. $n_1 \sin i_1 = n_2 \sin i_2$
10. ${}_1n_2 = \frac{n_2}{n_1}$
11. $A = r_1 + r_2$
12. $\sin i_1 = n \sin r_1$
13. $\sin i_2 = n \sin r_2$
14. $D = (i_1 + i_2) - A$
15. $n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\frac{A}{2}}$
16. $P = \frac{1}{f}$
17. $n\lambda = d \sin\theta$
18. $d = t\left(1 - \frac{1}{n}\right)$

MECHANICS

1. $v = u + at$
2. $v^2 = u^2 + 2as$
3. $s = ut + \frac{1}{2}at^2$
4. $s = vt - \frac{1}{2}at^2$
5. $s = \left(\frac{u+v}{2}\right)t$
6. $F = ma$
7. $F_f = \mu N$
8. $W = mg$
9. $W = F \times s$
10. $E_p = mgh$
11. $E_k = \frac{1}{2}mv^2$
12. $p = m \times v$

FLUIDS

1. $P = \rho gh$
2. $W = \rho gV$

$$RD = \frac{\rho_{subs\tan ce}}{\rho_{water}} = \frac{m_{subs\tan ce}}{m_{water}}$$

4. $P_1V_1 = P_2V_2$
5. $W_{loss} = \rho_l g V_b$
6. $RDs = \frac{W \text{ in air}}{W \text{ in air} - W \text{ in water}}$
7. $RDl = \frac{W \text{ in air} - W \text{ in liquid}}{W \text{ in air} - W \text{ in water}}$
8. $W = \rho gV$
9. $P = F / A$

HEAT

1. $\alpha = \frac{\Delta l}{l_1 \Delta t}$
2. $V_2 = V_1[1 + 3\alpha\Delta t]$
3. $\beta = 2\alpha$
4. $\gamma = 3\alpha$
5. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

6. $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

7. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

8. $Q = mc\Delta t$

9. $T = t + 273$

10. $Q = m\ell$

ELECTRICITY

1. $V = IR$
2. $R = \frac{\rho\ell}{A}$
3. $R_t = R_o(1+\alpha\Delta t)$
4. $emf = I(R+r)$
5. $W = VIt$
6. $P = VI$
7. $P = \frac{W}{t}$

SOUND

1. $v = f\lambda$

CONSTANTS

1. $g = 9{,}8\ ms^{-2}$
2. $c = 3\times10^{8}\ ms^{-1}$
3. $e^{-} = 1{,}6\times10^{-19}\ C$

4. LINEAR EXPANSIVITIES (in °C^{-1} or K^{-1})

Aluminium	= $2{,}2 \times 10^{-5}$
Brass	= $1{,}9 \times 10^{-5}$
Brick	= $9{,}5 \times 10^{-6}$
Concrete	= $1{,}2 \times 10^{-5}$
Copper	= $1{,}7 \times 10^{-5}$
Glass	= $8{,}5 \times 10^{-6}$
Iron	= $1{,}2 \times 10^{-5}$
Pine	= $3{,}4 \times 10^{-7}$
Pyrex glass	= $3{,}9 \times 10^{-4}$
Steel	= $1{,}1 \times 10^{-5}$

5. SPECIFIC HEAT CAPACITIES (in Jkg^{-1} °C^{-1})

Aluminium	= 910
Copper	= 380
Glass	= 700
Glycerine	= 2 500
Ice	= 2 100
Pyrex glass	= 837
Rubber	= 1 700
Steam	= 1 800
Steel	= 460
Stone	= 900
Water	= 4 200
Wood	= 1 700

6. SPECIFIC LATENT HEAT (in Jkg^{-1})

Ice	= $3{,}35 \times 10^{5}$
Steam	= $2{,}26 \times 10^{6}$

7. RELATIVE DENSITIES

Alcohol	= 0,8
Copper	= 9
Glycerine	= 1,26
Gold	= 19,3
Lead	= 11,3
Mercury	= 13,6
Plastic	= 1,43
Tin	= 7,3
Water	= 1

8. STANDARD PRESSURE

101,3 kPa = 76 cmHg

9. STANDARD TEMPERATURE

273 K = 0 °C