UNIVERSITY OF FORT HARE

University of Fort Hare
Together in Excellence

PHY 115F

May/June EXAMINATIONS

DATE	:	*May/June 2023*
TIME	:	*2 hours*
SUBJECT	:	*PHYSICS 115F (Foundation Elementary Mechanics)*
MARKS	:	*100*

EXAMINERS

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INSTRUCTIONS TO CANDIDATES:

*Answer **All** Questions.*

Useful Information:

1. Gravitational acceleration, $g = 10m/s^2$
2. $s = ut + \frac{1}{2}at^2$
3. $v = u + at$
4. $v^2 = u^2 + 2as$

Question 1 [25]

(a) Calculate the speed of growth of a 20-year old person who is 1.52m in m/s.

(1 month = 30 days) (5)

(b) Consider the equation, $a = zx^2t^3$. The variables ***x, t,*** and ***a*** have the dimensions of *[L], [T]* and *[L]/[T]*^{2}, respectively . What must be the dimensions of the variable *z*, such that both sides of the equation have the same dimensions? Show how you determined your answer. (5)

(c) Define a Scalar and a Vector quantity. Give *3 examples* of each. (10)

(d) A force vector points at an angle of 40^0 below the +*x* axis. The magnitude of the *x-component* is *1300N.*

Find **(i)** the magnitude and

(ii) the *y-component* of the force vector. (5)

Question 2 [25]

(a) The volume of liquid flowing per second is called the volume flow rate ***Q*** and has the dimensions of **[L]^3/[T]**. The flow rate of a liquid through a hypodermic needle during an injection can be estimated with the following equation:

$$Q = \frac{\pi R^n (P_2 - P_1)}{8\eta L}$$

The length and radius of the needle are *L* and *R*, respectively, both of which have the dimension **[L]**.

The pressures at opposite ends of the needle are P_2 and P_1, both of which have the dimensions of **[M]/{[L] [T]^2}**.

The symbol ή represents the viscosity of the liquid and has the dimensions of **[M]/{[L][T]}**.

The symbol π stands for *pi* and, like the number 8 and the exponent ***n***, has no dimensions.

Using dimensional analysis, determine the *value* of ***n*** in the expression for ***Q***. (12)

(b) What is the magnitude and direction of the force, ***D,*** that must be added to the following three forces, so that the resultant of the four forces is zero.

(Due east is the +x direction and due north is the +y direction.)

A = 200N, 55^o west of south; ***B = 200N, 55^o*** south of east; ***C = 200N, 55^o*** east of north.

(13)

Question 3 [25]

(a) A frog hops four times:- *twice* forward, *once* to the right, and *twice* forward again. Each hop covers a distance of *28 cm*. What is the *magnitude* and *direction* of the frog's displacement? (7)

(b) An observer, whose eyes are *1.60 m* above the ground, is standing *35.0 m* away from a tree. The ground is level, and the tree is growing perpendicular to it. The observer's line of sight with the treetop makes an angle of *25.0°* above the horizontal. How tall is the tree? (8)

(c) The object oscillates up and down, and the time T required for one complete up- and-down oscillation is given by the equation; $T = 2\pi\sqrt{\frac{m}{k}}$, where k is known as the spring constant and m is the mass. What must be the dimension of k for this equation to be dimensionally correct? (5)

(d) Convert $0.617 g/cm^3$ to kg/m^3. (5)

Question 4 (25)

Instructions: On occasion, the notation $\vec{\mathbf{A}} = [A, \theta]$ will be a shorthand notation for

$$\vec{\mathbf{A}} = A\cos\theta\hat{\mathbf{i}} + A\sin\theta\hat{\mathbf{j}}. \qquad \vec{A} = A_x\hat{i} + A_y\hat{j}$$

(a) A vector, $\vec{\mathbf{B}}$, when added to the vector $\vec{\mathbf{C}} = 3\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$ yields a resultant vector which is in the positive y direction and has a magnitude equal to that of $\vec{\mathbf{C}}$.
What is the magnitude of $\vec{\mathbf{B}}$? (5)

(b) If $\vec{\mathbf{C}} = [15\text{ m}, 30°]$ and $\vec{\mathbf{D}} = [25\text{ m}, 130°]$, what is the *magnitude* and *direction* of the sum of these two vectors? (5)

(c) A ball is thrown downwards with an initial speed of *8 m/s*, from a height of *30 m* before it hits the ground. After what time does it strike the ground? (5)

(d) A ball is thrown straight upward and rises to a maximum height of *30 m* above its launch point. At what height above its launch point has the speed of the ball decreased to *one-third* of its initial value? (10)

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The strongest of all warriors are these two – Time and Patience!