

VICTOR PHIRI  
GROUP C  
N. Q



THE COPPERBELT UNIVERSITY  
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES  
DEPARTMENT OF PHYSICS

TEST ONE  
PH110: PHYSICS

25 JUNE, 2013

**DURATION: 2.0 HRS**

**INSTRUCTIONS**

*Attempt ALL questions. Each question carries 25 marks. The marks are shown against each question in square brackets. Essential working must be shown to avoid loss of marks. Write very clearly your name, computer number, lecture group and name of your lecturer on each page of your answer script.*

*Leave a reasonable margin on both ends of a page.*

*Where necessary sketch diagrams and label them very clearly.*

**IMPORTANT:** Notwithstanding what is written above, Groups A, B, C and D will answer Questions 1, 2 and 3. Group E will answer Questions 1, 2 and 4.

### Question One

- a) (i) The height of a horse is sometimes given in units of "hands". Why is this method a poor standard of length? (3 marks)
- (ii) Suppose that two quantities  $G$  and  $F$  have different dimensions. Determine which of the following operations could be physically meaningful: (2 marks)
1.  $G+F$  2.  $G/F$  3.  $F-G$  4.  $GF$

- b) The square of the speed of an object undergoing a uniform acceleration  $a$  is some function of  $a$  and the displacement  $s$ , according to the expression given by:

$$v^2 = ka^m s^n$$

What dimensions should  $k$  have in order for the expression to be dimensionally consistent? (6 marks)

- c) Army engineers in 1946 determined the distance from the earth to the moon by using radar. The time from which a signal was sent out from their radar to the time at which it was received back was 2.56 s
- (i) Name two assumptions that must be made about the earth and the moon in this question? (6 marks)
- (ii) What is the distance from the earth to the moon? (The speed of radar waves is  $3.00 \times 10^8$  m/s.) (8 marks)

### Question Two

- a) The Cartesian coordinates of a point are  $x = 4.0$  and  $y = 7.0$ . What are the polar coordinates of the point? (4 marks)
- b) Vector  $\mathbf{B}$  has  $x$ ,  $y$ , and  $z$  components 4, 6, and 3, respectively.
- (i) Calculate the magnitude of  $\mathbf{B}$  and the angles that  $\mathbf{B}$  makes with the axes of the coordinate system. (6 marks)
- (ii) What are the vectors that result after carrying out cross products of  $\mathbf{B}$  with each of the axes? (6 marks)
- c) (i) Can the magnitude of a particle's displacement be greater than the distance travelled? Explain. (3 marks)
- (iii) If the component of vector  $\mathbf{A}$  along the direction of vector  $\mathbf{B}$  is zero, what can you conclude about the two vectors? Illustrate. (4 marks)
- (iv) If Bwalya adds a constant to a vector, what should Sibongile tell Bwalya? (2 marks)

Question Three (To be answered by Groups A, B, C, D)

- a) A body moving with uniform acceleration has a velocity of 12 m/s when its coordinate is 3 cm. The x coordinate of the particle 2 s later is -5 cm. (4 marks)
- What is the magnitude of its acceleration? (6 marks)
  - Find the instantaneous velocity for this particle at time  $t = 3s$ . (6 marks)
- b) A car makes a 300-km trip at an average speed of 60 km/h. A second car starting 2 h later arrives at their mutual destination at the same time. (5 marks)
- What was the average speed of the second car for the period that it was in motion? (7 marks)
  - Comment on the time that the second car takes in relation to the general speed limit of 100 km/h in Zambia. Assume the journey started in Kafue and ending in Kapiri Mposhi. (3 marks)
- c) If the car is travelling eastwards, can its acceleration be westwards? (3 marks)

Question Four (To be answered by Group E ONLY)

- a) Obtain a unit vector perpendicular to the vectors:

$$\mathbf{A} = 3\hat{i} + 2\hat{j} + 4\hat{k}$$

$$\mathbf{B} = 2\hat{i} - 2\hat{j} + 4\hat{k}$$

(8 marks)

- b) Investigate the validity of the following by carrying out dimensional analysis;

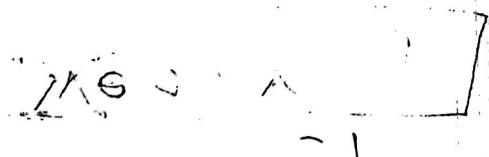
$$x \propto a^n t^m$$

where  $a$  represents acceleration and  $t$  represents time.

(6 marks)

- c) Estimate the number of atoms in  $1\text{cm}^3$  of a solid. (8 marks)

- d) The volume of water in a cup is estimated to be 30 ml. Express this volume in cubic inches. (3 marks)



$$\begin{aligned}
 & 30 \times 10^{-3} \quad \frac{30}{1000} = 0.03 \\
 & 1 \text{ litre} \rightarrow 1000 \text{ cm}^3 \\
 & 30 \text{ ml} \rightarrow 30 \text{ cm}^3 \quad (1 \text{ m} \rightarrow 100 \text{ cm}) \\
 & \quad \quad \quad (1 \text{ m})^3 \rightarrow (100 \text{ cm})^3
 \end{aligned}$$

## FORMULA SHEET

$$v = v_0 + at; \quad y - y_0 = \frac{1}{2}(v + v_0)t; \quad y - y_0 = v_0 t + \frac{1}{2}at^2; \quad v_y^2 - v_{y0}^2 = 2a_y(y - y_0)$$

## USEFUL CONSTANTS

$g = 3.00 \times 10^8 \text{ m/s}^2$ ; Approximate atom size in diameter =  $1 \times 10^{-10} \text{ m}$ ;  $2.54 \text{ cm} = 1 \text{ in.}$   $1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$ ;  $N_A = 6.02 \times 10^{23} (\text{g mol})^{-1}$