

THE COPPERBELT UNIVERSITY
IN ASSOCIATION WITH
THE TECHNICAL AND VOCATIONAL TEACHERS' COLLEGE
BACHELOR OF SCIENCE IN MATHEMATICS AND SCIENCE WITH
EDUCATION

FIRST YEAR - ODL

INTRODUCTION TO PHYSICS (PHY 120)

DECEMBER 2022 PROMOTIONAL EXAMINATION

TOTAL MARKS – 100%

TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. All questions carry equal marks.
2. The marks are shown in brackets.
3. This paper contains seven questions. Answer **any five** questions of your choice.
4. Show clearly all the necessary calculations.
5. Marks will be awarded for neat and well-drawn diagrams.
6. Clearly indicate on the answer booklet cover page which questions you have attempted.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

WHEREVER NECESSARY USE:

$$g = 9.81 m/s^2$$

$$P_A = 1.01 \times 10^5 Pa$$

$$1 cal = 4.184 J$$

$$G = 6.67 \times 10^{-11} Nm^2/kg^2$$

$$1 Ci = 3.7 \times 10^{10} Bq$$

$$\mu_0 = 4\pi \times 10^{-7} Tm/A$$

$$\varepsilon_0 = 8.85 \times 10^{-12} F/m$$

$$m_e = 9.11 \times 10^{-31} kg$$

$$k_e = 8.99 \times 10^9 Nm^2/C^2$$

$$e = 1.60 \times 10^{-19} C$$

$$\hbar = 1.05 \times 10^{-34} Js$$

$$R_H = 1.097 \times 10^7 m^{-1}$$

$$\sigma = 5.669 \times 10^{-8} W/m^2 K^4$$

$$h = 6.626 \times 10^{-34} Js$$

Question One

- a. What is a physical quantity? [2 marks]
- b. A unit is often expressed with a prefix. For example, the gram may be written with the prefix 'kilo' as the kilogram. The prefix represents a power-of-ten. In this case the power-of-ten is 10^3 . Complete the table below to show each prefix with its symbol and power-of-ten.

prefix	symbol	power-of-ten
	μ	10^{-6}
nano	n	
centi		10^{-2}
	M	10^6
	T	10^{12}
giga	G	
pico	p	
	m	10^{-3}
femto	f	
	d	10^{-1}

[10 marks]

- c. What are the dimensions of the following quantities?
- i. Density [2 marks]
- ii. Force [2 marks]
- d. The period of a simple pendulum, defined as the time necessary for one complete oscillation, is measured in time units and is given by

$$T = 2\pi \sqrt{\frac{l}{g}}$$

where, l is the length of the pendulum and g is the acceleration due to gravity, in units of length divided by time squared. Use dimensional analysis to show that this equation is dimensionally consistent. [4 marks]

Question Two

- a. Define the following terms;
- i. Projectile [2 marks]
- ii. Trajectory [2 marks]
- iii. Range [2 marks]

- b. A rescue plane drops a package of emergency rations to stranded hikers as shown in Figure 2.1. The plane is travelling horizontally at 40.0 m/s at a height of 100 m above the ground.

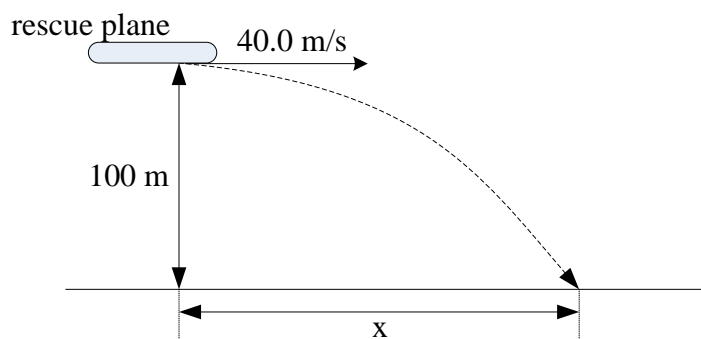


Figure 2.1

- i. Where does the package strike the ground relative to the point at which it was released? (Hint: find x) [4 marks]
 - ii. What are the horizontal and vertical components of the velocity of the package just before it hits the ground? [3 marks]
 - iii. Find the angle on impact. [2 marks]
- c. The maximum height is attained when the vertical component of a projectile's velocity is zero. Show that this maximum height is given by;

$$H = \frac{u^2 \sin^2 \theta}{2g}$$

[5 marks]

Question Three

- a. State what is meant by a scalar quantity and by a vector quantity. [2 marks]
- b. Complete the table below by indicating whether each of the quantities is a vector or a scalar.

Quantity	Vector or scalar
Temperature	
Momentum	
Kinetic energy	
Acceleration	

[4 marks]

- c. Perform graphically the following vector additions and subtractions, where **A**, **B** and **C** are the vectors shown in the Fig. 3.1 below. [3 marks]

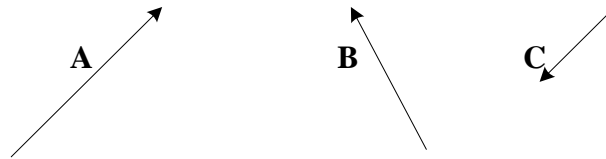


Fig. 3.1

- i. $\mathbf{A} + \mathbf{B} + \mathbf{C}$
- ii. $\mathbf{A} - \mathbf{B}$
- iii. $\mathbf{A} + \mathbf{B} - \mathbf{C}$

- d. Given three vectors $\mathbf{A}=20\text{N}$, $\mathbf{B}=15\text{N}$ and $\mathbf{C}=12\text{N}$ as shown in Fig. 3.2. Find the magnitude and direction of the resultant vector. [11 marks]

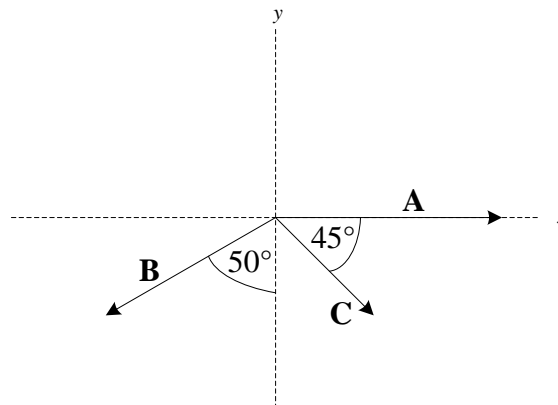


Fig. 3.2

Question Four

- a. In a test run, a certain car accelerates uniformly from zero to 24m/s in 2.95 s .
 - i. What is the magnitude of the car's acceleration? [2 marks]
 - ii. How long does it take the car to change its speed from 10m/s to 20m/s ? [2 marks]
- b. A ball is thrown vertically down towards the ground with an initial velocity of 4.23m/s . The ball falls for a time of 1.51 s before hitting the ground. Air resistance is negligible.
 - i. Show that the downwards velocity of the ball when it hits the ground is 19.0m/s . [2 marks]
 - ii. Calculate the distance the ball falls to the ground. [3 marks]
- c. A stone is thrown straight upward with a speed of 20m/s . It is caught on its way down at a point 5.0m above where it was thrown as shown in Fig. 4.1.

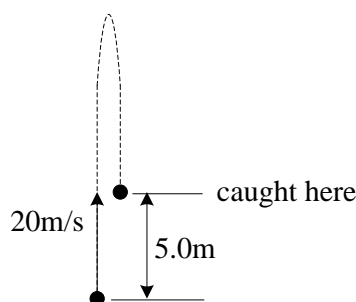


Fig. 4.1

- i. How fast was it going when it was caught? [3 marks]
 - ii. How long did the trip take? [2 marks]
- d. Imagine an object travelling with velocity u m/s. If the object experiences an unbalanced force, this will cause the object to accelerate a m/s². After t seconds, the object has final velocity v m/s. Show that v is given by [3 marks]
- $$v = u + at$$
- Also show that the displacement s covered by the object in time t is given by [3 marks]
- $$s = ut + \frac{1}{2}at^2$$

Question Five

- a. Give four examples of vector quantities. [4 marks]
- b. A force A is added to another force that has x and y components equal to -10 N and 8 N respectively. The resultant of the forces is in the positive x-direction and has a magnitude of 12 N. Find the x and y components of the force A. [7 marks]
- c. An object undergoes three successive displacements in a plane as follows: 200m due south, 250m due west, and 150m at 30° east of north. Choose the y-axis pointing north and the x-axis pointing east and find;
 - i. The components of each displacement. [3 marks]
 - ii. The components of the resultant displacement. [2 marks]
 - iii. The magnitude and direction of the resultant displacement. [4 marks]

Question Six

- a. The kilogram, metre and second are SI base units. State two other base units. [2 marks]
- b. Determine the SI base units of;
 - i. Energy [2 marks]
 - ii. Force [2 marks]
- c. Write the following numbers in the form of the indicated prefix.
 - i. 40000m in kilometres [1 mark]
 - ii. 0.001g in milligrams [1 mark]
 - iii. 2500000N in meganewtons [1 mark]
 - iv. 250000A in kiloamperes [1 mark]
 - v. 0.000000075s in nanoseconds [1 mark]

- d. Suppose that the acceleration a of a particle moving with uniform speed v in a circle of radius r is proportional to some power of r , say r^n , and some power of v , say v^m . Determine the values of n and m and write the simplest form of an equation for the acceleration. [9 marks]

Question Seven

- a. State the two conditions for an object to be in equilibrium. [2 marks]
- b. For the situation in Fig.7.1, find the values of T_1 and T_2 if the objects weight is 600 N.

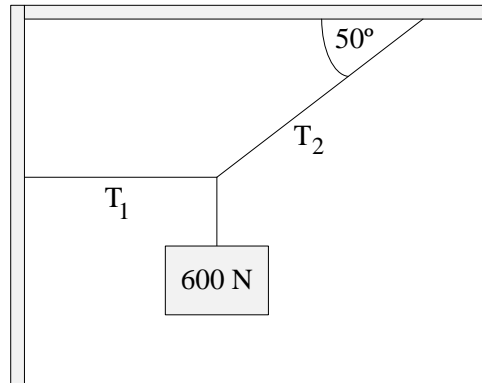


Fig. 7.1

[8 marks]

- c. The object in Fig. 7.2 below weighs 400N and hangs at rest. Find the tensions in the three cords that hold it.

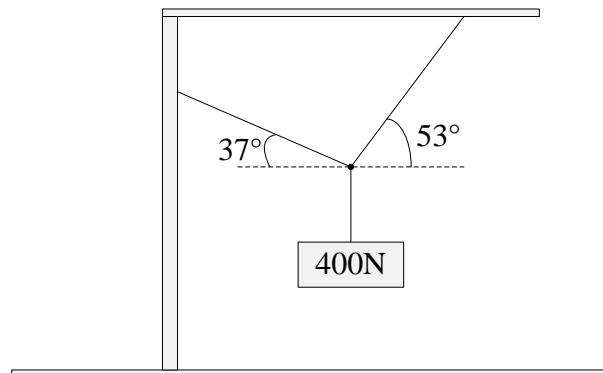


Fig. 7.2

[10 marks]

END OF EXAMINATION