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**THE COPPERBELT UNIVERSITY**

**SCHOOL OF MATHEMATICS AND NATURAL SCIENCES**

**DEPARTMENT OF PHYSICS**

**PH 110 TEST 1**, 30 MARCH 2023

***INSTRUCTIONS:*** ***DURATION: 2.0 HRS 30 MINUTE*** ($2\frac{1}{2}hrs$)

***ANSWER ALL questions*** . *Each question carries 25 marks. You may tackle the questions in any order provided they are correctly and clearly numbered. Essential working must be shown to avoid loss of marks. Clearly write your* **full names, computer number** *and* **lecture group**.

***Whenever necessary, use the following constants:*** $g = 9.8\ \text{m/s}^2$, 2.54 cm = 1 inch, 1 ft = 30.48 cm, 1 mile=1609 m =1.609 km, 1 ton = 1000 kg

**QUESTION ONE.**

(a) When taking measurements in an experiment, the results are expected to be both accurate and precise. Distinguish between **accuracy** and **precision**. **[3]**

(b) If the length and width of a rectangular plate are measured to be $(17.30 \pm 0.05)$ cm and $(13.30 \pm 0.05)$ cm, respectively, find the area of the plate and the approximate uncertainty in the calculated area. **[4]**

(c) A solid cube is 350 g and each edge has length of 5.35 cm. Determine the density $\rho$ of the cube in SI units. **[4]**

(d) The speed $v$ of an object is given by the equation $v = At^3 - Bt$, where $t$ refers to time. What are the dimensions of $A$ and $B$? **[4]**

(e) (i) Write down the dimensions of **velocity, force and density** **[4]**

(ii) A Toyota Harrier moving with velocity $v$ experiences a force $F$ due to air resistance given by the express;

$$F = \tfrac{1}{5}C\rho^x v^y A^z$$

where $C$ is a dimensionless constant called the drag coefficient, $\rho$ is the density of the air and $A$ is the cross section area of the vehicle. Use dimensional analysis to find the values of the powers of $x, y$ and $z$. **[6]**

## QUESTION TWO

(a) State **three** methods used to graphically add vectors. **[3]**

(b) Define the terms listed below and give **two** examples in each case:
i) Scalar quantities, and ii) Vector quantities. **[4]**

(c) You find yourself, in a deep thought about a physics problem. First you walk 3.5 meters due south. Then, you walk 8.2 meters due northeast. Then you doze off and find yourself 15.0 meters due west. Determine how far you walked while you were lost in the deep thought. **[5]**

(d) Define a unit vector **[2]**

(e) Let a force $\boldsymbol{F} = (5\hat{\imath} + A_y\hat{\jmath} + 4\hat{k})$N act on an object over a displacement $\boldsymbol{R} = (3\hat{\imath} - \hat{\jmath} + 2\hat{k})$ m. Given that the force $\boldsymbol{F}$ has a magnitude of $\sqrt{90}$. Determine or otherwise as indicated,

(i) the value of $A_y$ **[2]**
(ii) the unit vector of $\boldsymbol{F}$ **[2]**
(iii) the **dot** product of $\boldsymbol{F}$ and $\boldsymbol{R}$. **[3]**
(iv) a vector perpendicular to $\boldsymbol{F}$ and $\boldsymbol{R}$ **[2]**

(f) Find the magnitude of the **cross product** for a force given by $F = (2\hat{\imath} + \hat{\jmath} + 2\hat{k})N$ acting at 30° angel to the radius $\boldsymbol{R} = (\hat{\imath} + \hat{\jmath} + \hat{k})\ m$. **[2]**

$v^2 = u^2 + 2as$

## QUESTION THREE

(a) Define (i) Uniform motion (ii) Acceleration. **[2, 2]**

(b) A stone is dropped from a balloon that is 72.5 m above the ground and rising vertically. The stone reaches the ground in 5 s. What was the velocity of the balloon just at an instant the stone was dropped? **[3]**

(c) Police officers in a parked patrol car hidden at the intersection, observes a bus that ignores a stop sign, crosses the intersection, and continue moving at constant velocity. 2 seconds after the bus has crossed the intersection, the patrol car starts off in pursuit in the same direction as the bus, accelerating uniformly until it catches the bus with velocity of 48 m/s. At that instant, the bus is 240 m from the intersection. How fast was the bus travelling? **[6]**

(d) At a funfair, a prize is awarded when a coin is tossed into a small dish. The dish is mounted on a shelf above the ground as shown in **Fig.3.1**.

$+2as$ $+\frac{1}{2}at^2$

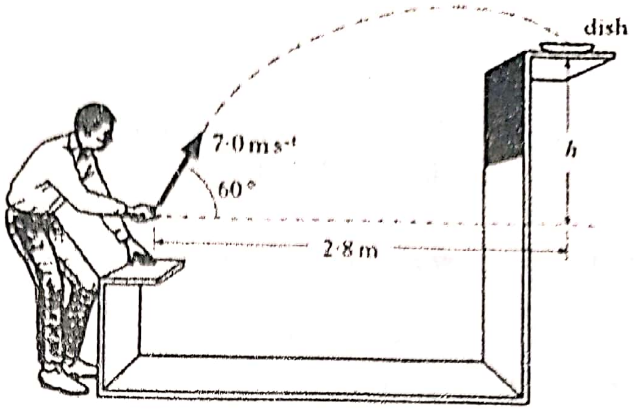


**Fig.3.1**

A contestant projects the coin with a speed of 7 $ms^{-1}$ at an angle of $60^o$ to the horizontal. When the coin leaves his hand, the horizontal distance between the coin and the dish is 2.8 m. The coin lands in the dish. The effect of air friction may be neglected.

(i) Calculate the horizontal and vertical components of initial velocity of the coin. [2]

(ii) Show that the time taken for the coin to reach the dish is 0.8 s. [2]

(iii) What is the height, $h$, of the shelf above the point where the coin leaves the contestant's hands? [3]

(iv) What is the velocity of the coin when it enters the dish compare with the velocity of the coin just as it leaves the contestant's hands? [5]

**QUESTION FOUR**

In **Fig. 4.1**, a 1 kg mass on a rough horizontal surface is joined to a 2 kg mass by a light, inextensible string running over a frictionless pulley. The coefficient of kinetic friction between the 1 kg mass and the surface is 0.13.

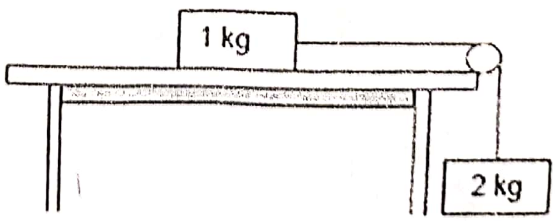


**Fig.4.1**

(a) State Newton's second law of motion in words [2]

(b) Calculate the magnitude of the:

(i) Kinetic frictional force acting on the 1 kg mass. [3]



F = ma

(ii) Acceleration of the system. [6]
(iii) Tension in the string. [2]

(c) (i) State **two** conditions for static equilibrium. [2]

(ii) A 20.0kg floodlight in a park is supported at the end of a horizontal beam of negligible mass that is hinged to a pole as shown in Figure 4.2. A cable at an angle of 30.0° with the beam helps to support the light. Sketch a free-body diagram of the system and determine the tension in the cable. [4]

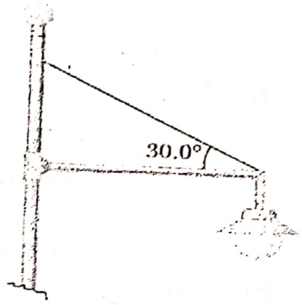


**Fig 4.2**

(e) A uniform ladder of length $6.0\,m$ and weight $300N$ rests against a slipping vertical wall as shown in **Fig**4.3. The inclination angle between the ladder and the rough floor is 37°.Using your sketched free-body diagram; determine the **reaction forces from the floor** and **from the wall on the ladder** and the **static friction coefficient** at the interface of the ladder with the floor that prevents the ladder from slipping. [6]

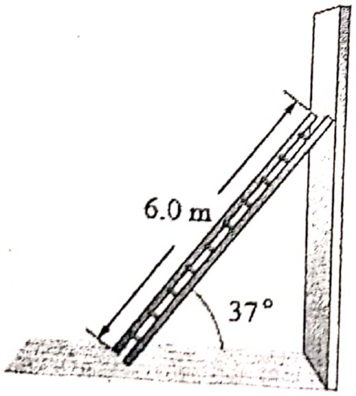


**Fig 4.3**