

2m

**THE COPPERBELT UNIVERSITY**  
**SCHOOL OF MATHEMATICS & NATURAL SCIENCES**  
**DEPARTMENT OF PHYSICS**  
**PH 110: INTRODUCTORY PHYSICS 2021/2022 TEST 1**  
**DURATION:  $2\frac{1}{2}$  HOURS      TOTAL MARKS: 100 MARKS**

**INSTRUCTIONS:**

1. Write your Names, **Student Identification Number and Lecture Group** on the front page of your answer booklet and possibly your ID on all your scripts.
2. There are four (4) questions in this test; **ANSWER ALL.**
3. The marks for each question are shown in the square brackets [ ], show your working to avoid loss of marks.

**CONSTANTS:**

1. Acceleration due to gravity  $g = 9.81 \text{ m/s}^2$
2. Gravitational constant  $G = 6.673 \times 10^{-11} \text{ N.m}^2.\text{kg}^{-2}$
3. Mass of the Earth  $M_E = 5.98 \times 10^{24} \text{ kg}$

Where necessary, use

1.0 inch = 2.54 cm, 1.609 km = 1.0 miles, 7.48 gallons = 0.0283 m<sup>3</sup>, 1.0 cm<sup>3</sup> = 1.0 ml,  
746 W = 1.0 horsepower, 1000 kg = 1.0 tonnes.

**QUESTION ONE.**

- a) One gallon of paint, that is  $3.78 \times 10^{-3} \text{ m}^3$ , covers an area of  $25 \text{ m}^2$ . What is the thickness of paint on the wall? Give your answer in 5 significant figures. [3]
- b) A plate rectangular in form has a length  $(21.4 \pm 0.3) \text{ cm}$  and a width of  $(8.8 \pm 0.2) \text{ cm}$ . Determine the values of the *best area* of the plate and its *uncertainty*. [4]
- c) A mile is 1760 yards or 1609 meters or 5280 feet, and a fortnight is 14 days. In 1991, the Zambian athlete, Samuel Matete won an Olympic gold med, in Zurich, Switzerland, when he represented Zambia in the 400m hurdles. His average speed was 8.5 meters per second. Give his speed in: (i) kilometers per second; (ii) yards per hour; and (iii) feet per fortnight. [6]

0.0058 km/s

334.72

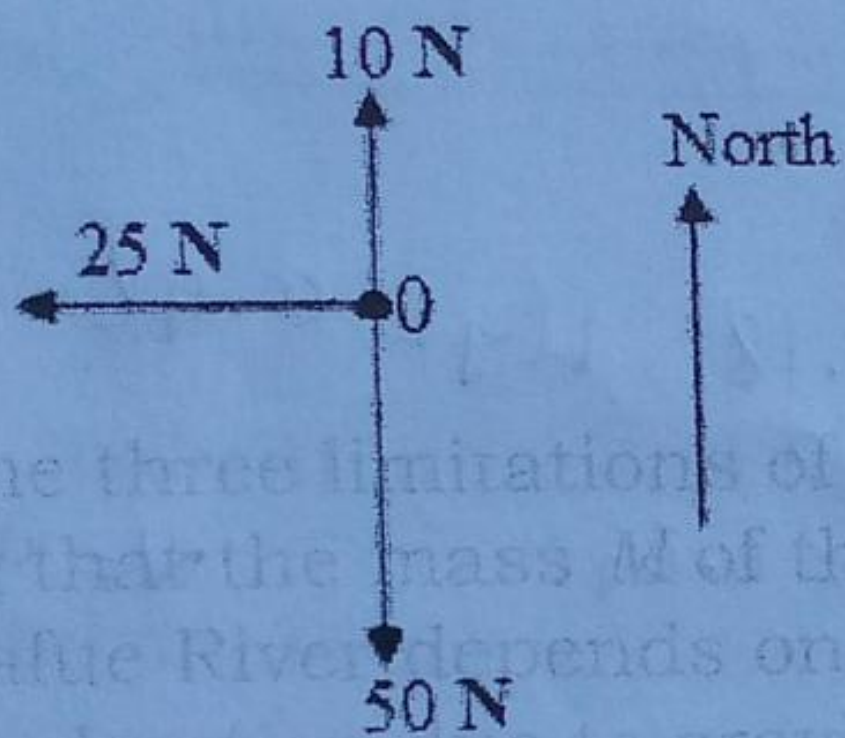
33739495.34



- (d) (i) What are the three limitations of dimensional analysis? [3]  
 (ii) Assuming that the mass  $M$  of the big stone that can be moved by the flowing Kafue River depends on ' $v$ ' the velocity, ' $\rho$ ' the density of water and ' $g$ ', the acceleration due to gravity. Use dimensional analysis to find an expression for  $M$ . [9]

## QUESTION TWO

- (a) Give **two** examples in each case of a  
 (i) scalar quantity [2]  
 (ii) vector quantity [2]  
 (b) Three boys are pulling an object with forces acting in different directions as shown in the diagram to the right:  
 (i) Draw a vector diagram and show the resultant force. [3]  
 (ii) Calculate the magnitude and direction of the resultant [5]



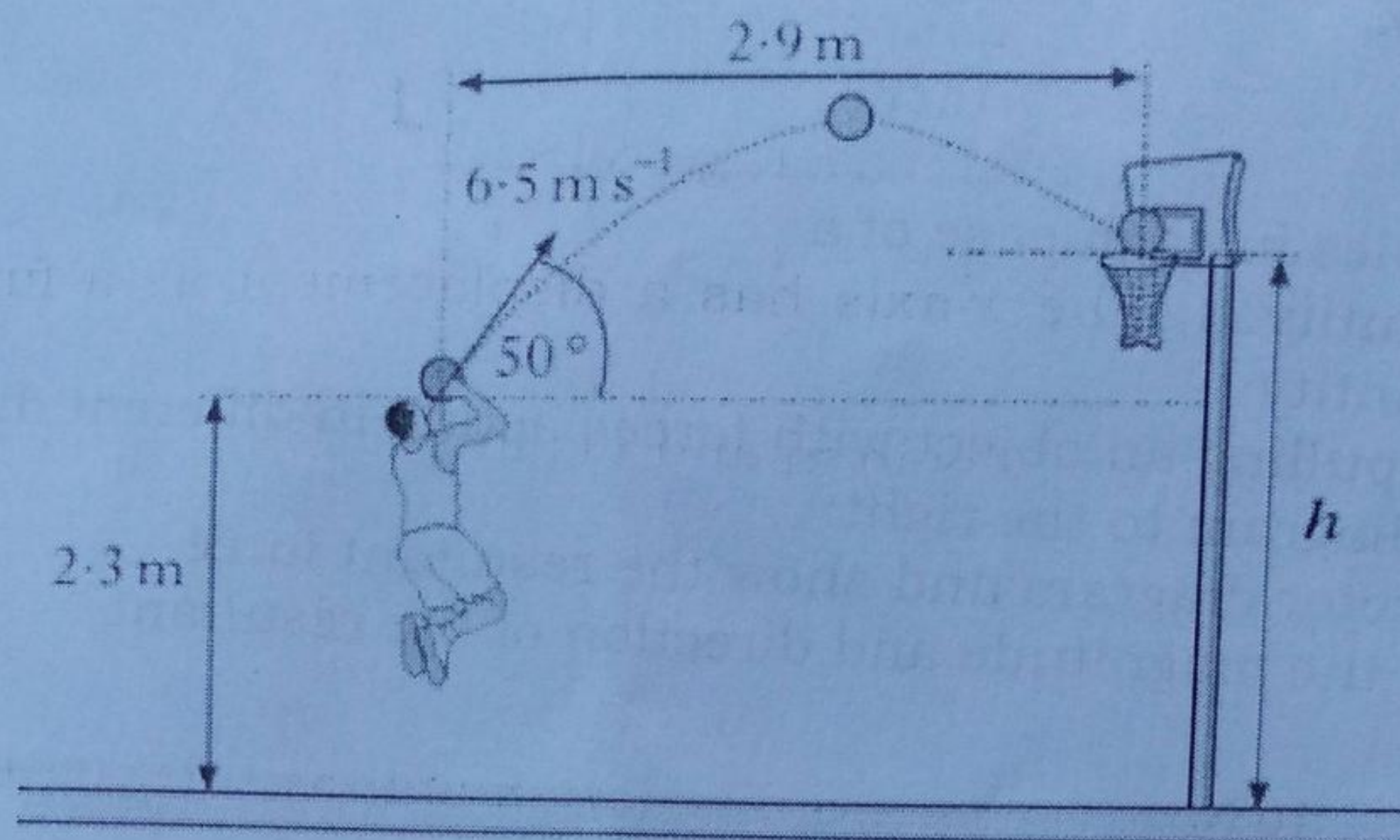
- (c) For what value of  $\lambda$  are the vectors  $2\mathbf{i} - \mathbf{j} + 2\mathbf{k}$  and  $3\mathbf{i} + 2\lambda\mathbf{j}$  perpendicular? [4]  
 (d) If vector  $\mathbf{a} = 2\mathbf{i} + 3\mathbf{j} + 4\mathbf{k}$ , and vector  $\mathbf{b} = \mathbf{i} - \mathbf{j} + \mathbf{k}$ , Find  
 (i)  $\mathbf{a} \times \mathbf{b}$  [3]  
 (ii) the Sine of the angle between these vectors. [3]  
 (iii) the Unit vector perpendicular to each vector. [3]

## QUESTION THREE ✓

- (a) A runner travels 1.5 laps around a circular track in a time of 50 s. The diameter of the track is 45 m and its circumference is 142 m. Find:  
 (i) The average speed of the runner [3]  
 (ii) The magnitude of the runner's average velocity. [4]  
 (b) A particle moving along the  $x$ -axis has a displacement as a function of time given by:  
 $x(t) = 30 + 20t - 15t^2$ , where  $x$  is in m and  $t$  is in s. Find:  
 (i) The velocity at  $t = 0.5$  s.  $v = 5 \text{ m/s}$  [3]  
 (ii) The acceleration at  $t = 3$  s.  $a = -30 \text{ m/s}^2$  [4]



- (c) A basketball player throws a ball with an initial velocity of  $6.5 \text{ m/s}$  at an angle of  $50^\circ$  to the horizontal. The ball is  $2.3 \text{ m}$  above the ground when released, and travels a horizontal distance of  $2.9 \text{ m}$  to reach the top of the basket. See the figure below (Not drawn to scale). The effects of air resistance can be ignored.



Find the

- (i) horizontal and vertical components of the initial velocity of the ball.  $u_x = 4.18, u_y = 4.98$  [2]  
(ii) time taken by the ball to reach the basket.  $t = 0.69 \text{ s}$   $v = 4.55 \text{ m/s}$  [3]  
(iii) magnitude of the velocity of the ball as it reaches the top of the basket. [4]  
(iv) height  $h$  as depicted from the figure.  $h = 3.4 \text{ m}$  [4]

#### QUESTION FOUR

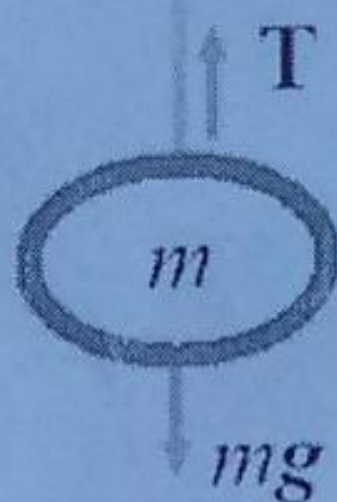
- (a) Let  $35^\circ$  be the critical angle of an inclined plane on which a  $10 \text{ kg}$  block of wood slides down. Taking  $g = 9.81 \text{ m/s}^2$ , determine the:

- (i) Coefficient of static friction  $\mu_s = 0.7$   $f = \mu \vec{n}$  [2]  
(ii) Static frictional force  $f_{\text{fric}} = 56.25 \text{ N}$   $\mu mg \cos 35$  [2]

- (b) Consider the diagram below with a  $12 \text{ kg}$  mass ( $m$ ) vertically hanging on a rope that is attached to an upper platform. If the whole system accelerates upwards at  $5.5 \text{ m/s}^2$ , calculate the tension ( $T$ ) in the rope. Take  $g = 9.81 \text{ m/s}^2$ .

$$T = 183.6 \text{ N} \quad [3]$$

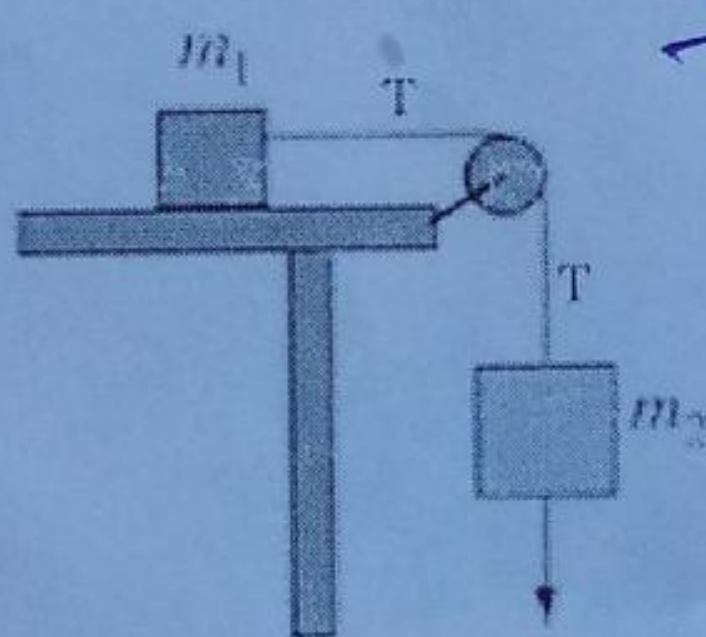




- (c) Two blocks of mass  $m_1 = 4 \text{ kg}$  and  $m_2 = 10 \text{ kg}$  are connected via a cord through the pulley as shown. The coefficient of kinetic friction between  $m_1$  and the table is 0.2. Taking  $g = 9.81 \text{ m/s}^2$ , determine the,
- Acceleration of the system
  - Tension in the cord.

[4]

[2]



$$a = 2.26 \text{ m/s}^2$$

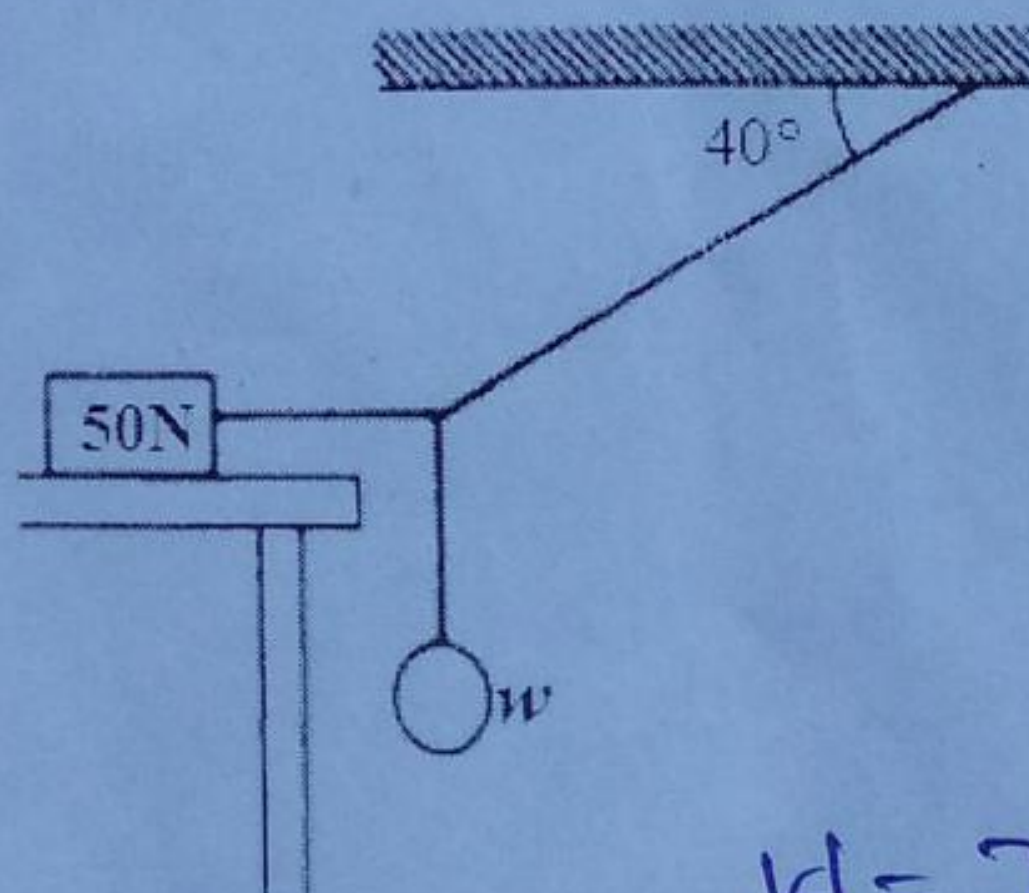
$$T = 75.5 \text{ N}$$

- (d) The system shown in the Figure below is in equilibrium.

- Determine the maximum value of  $w$  if the friction force on the 50 N block cannot exceed 15 N.
- What is the coefficient of static friction between the block and the table top?

[9]

[3]



$$f = \mu n$$

$$f = \mu mg$$

$$\frac{15}{50} = \mu_s$$

$$\mu_s = 0.3$$

$$\mu_s = 0.3$$



- c) Solve for real values of  $x$  given the equation:  $2e^x - 3e^{-x} + 5 = 0$
- d) The three numbers  $a$ ,  $b$  and  $c$  are such that  $a + b + c = 0$  and  $a^2 + b^2 + c^2 = 1$ .