November 27, 2021

BRAC UNIVERSITY
Inspiring Excellence

Department of Mathematics and Natural Sciences

PHY111 - Principles of Physics-I

Midterm Assessment, Fall 2021

Time: 1 Hour (5:40 pm to 6:40 pm)

Total Marks: 20

Answer all questions.

1. A projectile is launched in air from point O with an initial velocity of magnitude $v_0 = 600$ ft /s, directed upward as shown in Fig. 1. Neglect the air friction and consider that the magnitude of gravitational acceleration $g = 32$ ft/s^2 for the following calculations.

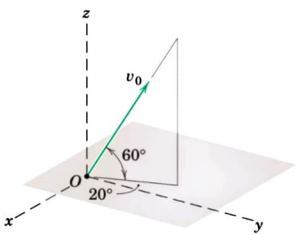


Fig. 1

(a) (*2 marks*) Calculate the time of flight of the projectile.

(b) (*3 marks*) Compute the x-, y-, and z-components of position of the projectile 20 seconds after launch.

(c) (*3 marks*) Calculate the velocity of the projectile 20 seconds after launch.

(d) (*2 marks*) Calculate the displacement of the projectile when it strikes the ground.

2. Consider the system as shown in Fig. 2. The pulley is massless and the whole system is frictionless. Also consider the ropes to be ideal. Here, $m_1 = 2$ kg, $m_2 = 4$ kg, and $M = 8$ kg. The tension in the rope with which the pulley is attached to the ceiling is T, the tension in the rope connecting M and m_1 is T_1 and the tension in the rope connecting m_1 and m_2 is T_2. Consider $g = 9.81$ m/s^2.

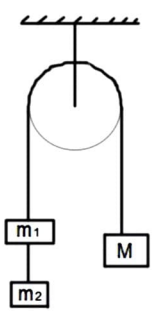


Fig. 2

(a) (*3 marks*) Draw the free body diagrams of all the blocks and the pulley.

(b) (*4 marks*) Find the acceleration of each of the three blocks.

(c) (*3 marks*) Calculate the magnitude of T, T_1 and T_2.

1/(a) Solution:

Given, $V_0 = 600$ ft/s

$g = 32$ ft/s^2, $\theta = 60^\circ$

We know.

The time of flight of the projectile is,

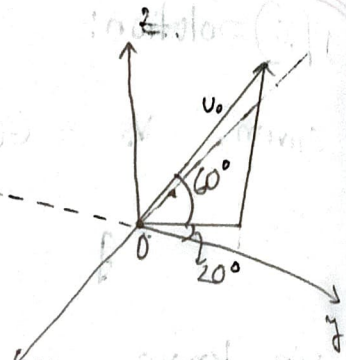
$$T = \frac{2V_0 \sin\theta}{g}$$

$$= \frac{2 \times 600 \times \sin 60^\circ}{32}$$

$$= 32.48 \text{ s}$$

Ans

(6) Solution:



Given, $\theta_0 = 60°$

$\theta = 20°$

$x = (V_0 \cos\theta_0) \cos\theta$

$y = (V_0 \cos\theta_0) \cos\theta$

$z = V_0 \sin\theta_0$

So, $x = 600 \cos 60° \cdot \sin 20°$

$= 102.61$ ft

$y = 600 \cos 60° \cdot \cos 20°$

$= 281.91$ ft

$z = 600 \cdot \sin 60°$

$= 519.62$ ft

(c) Solution:

~~$V_x - V_{x0} = V_0$~~

$V_z = V_0 \sin\theta_0 - gt$

$= 600 \times \sin 60^\circ - 32 \times 20$

~~$= 33253.75$~~

$= 519.615 - 640$

$= -120.38$ ~~ft~~ s^{-1}

Ans

(d)

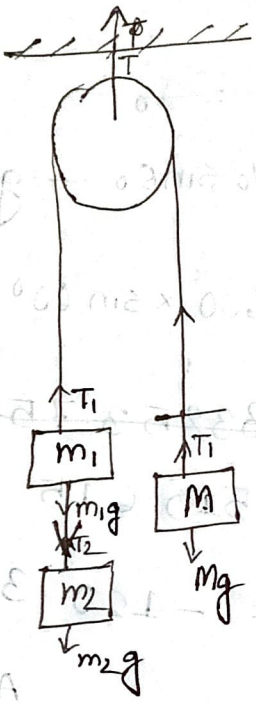
$S = V_0 \cos 60^\circ \times$ ~~220~~ 32.48

$= 600 \times \cos 60^\circ \times 32.48$

$= 9744$ ~~ft~~

Ans

2 (a)



(b) For M,

$$F = Ma = Mg - T_1$$

$$\Rightarrow a = g - \frac{T_1}{M} \quad \text{---- (i)}$$

(c) For m_1,

$$F = m_1 a = m_1 g + T_2 - T_1 \quad \text{---- (ii)}$$

For m_2,

$$F = m_2 a = m_2 g - T_2 \quad \text{---- (iii)}$$

(II) + (III),

$$(m_1 + m_2)a = g(m_1 + m_2) - T_1$$

$$\Rightarrow T_1 = (m_1 + m_2)(g - a)$$

Applying the value of T_1 in (I),

$$m_1 a = m_1 g + T_2 - (m_1 + m_2)(g - a)$$

$$\Rightarrow T_2 = m_1 a + m_2 g - (m_1 + m_2) a$$

$$\therefore T_2 = m_2 (g - a)$$

$$T = T_1 + T_2$$

$$= (m_1 + m_2)(g - a) + m_2 (g - a)$$

$$= m_1 g - m_1 a + m_2 g - m_2 a + m_2 g - m_2 a$$