November 27, 2021

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.

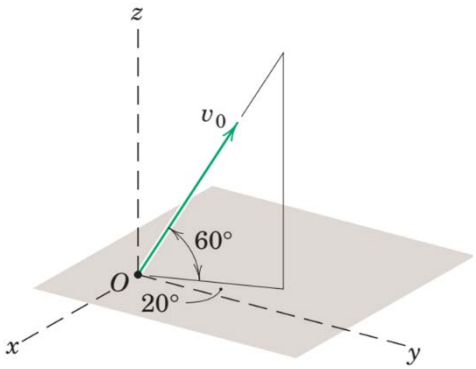


Fig. 1

(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. A pulley is being pulled upward with a force $\vec{F}$ on the axle directly. Two objects of masses m_1 = 1.3 kg and m_2 = 1.8 kg are attached to the opposite ends of a massless string, which passes over the massless and frictionless pulley as shown in Fig. 2. The object m_2 is in contact with the floor. Consider g = 9.81 m/s^2

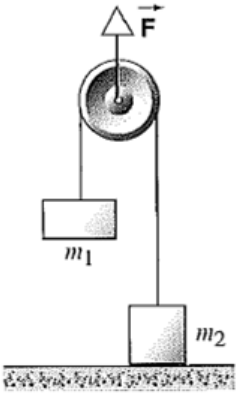


Fig. 2

(a) (*4 marks*) What is the largest value, the force $\vec{F}$ may have so that m_2 will remain at rest on the floor?

(b) (*2 marks*) What is the tension in the string if the upward force F is 108 N?

(c) (*4 marks*) With the tension determined in part (b), what are the accelerations of the masses m_1 and m_2?

1) a

Ans: to: que: no: 1

2) a) ~~The time takes~~

2] a] Given that, $V_0 = 600 \text{ ft s}^{-1}$

$\theta = 60^\circ$

$g = 32 \text{ ft s}^{-2}$

The flight time is $T = \frac{2V_0 \sin\theta}{g}$

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

$= 32.47 \text{ sec}$

(Ans)

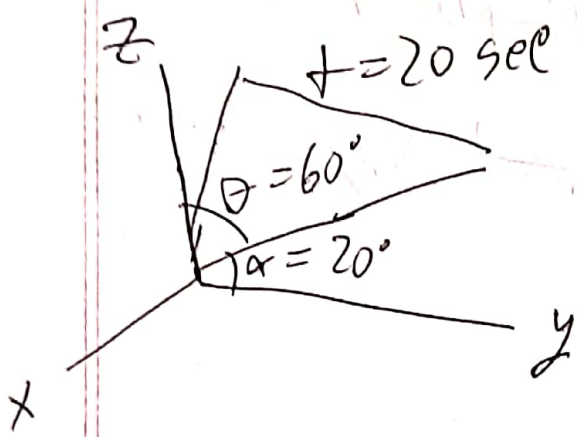
Given

b) $V_0 = 600\ ft\ s^{-1}$

$g = 3$

b] Given, $V_0 = 600\ ft\ s^{-1}$

$g = 32\ ft\ s^{-2}$



For x,

$V_x = V_0 \cos 60^\circ (-\sin 20^\circ)$ in x direction

$V_y = V_0 \cos 60^\circ \cos 20^\circ$ in y direction

$V_z = V_0 \sin 60^\circ$ in z direction.

$\therefore V_x = -102.60\ ft\ s^{-1}$

$V_y = 281.90\ ft\ s^{-1}$

$V_z = 519.61 \text{ ft s}^{-1}$

Given $T = 20 \text{ sec}$

towards x,

$x = -102.60 \times 20$

$= -2052 \text{ ft}$

towards y,

$y = 281.9 \times 20$

$= 5638 \text{ ft}$

towards z,

we know,

$V_z^2 = u_z^2 - 2gh$

$V_z = u_z - gt$

$= -120.39 \text{ ft s}^{-1}$

$$v_z^2 = u_z^2 = 2gh$$

$$\therefore h = \frac{-v_z^2 + u_z^2}{2g}$$

$$= 3992.2 \text{ ft}$$

$$\therefore h = -2052 \text{ ft}$$

$$y = 5638 \text{ ft}$$

$$z = 3992.2 \text{ ft}$$

(Ans)

(b) (c) We know,

Velocity towards xy-axis

$$V_{xy} = V_0 \cos\theta$$

$$= 600 \cos(60^\circ)$$

$$= 300 \text{ fts}^{-1}$$

velocity towards z axis

$$V_z = V_0 \sin\theta - gt$$

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

$$= -120.3847 \text{ fts}^{-1}$$

$$V = \sqrt{(V_{xy})^2 + (-120.3847)^2}$$

$$V = \sqrt{(V_{xy})^2 + (V_z)^2}$$

$$= \sqrt{(300)^2 + (-120.3847)^2}$$

$$= 323.252 \text{ fts}^{-1}$$

The velocity after 20 seconds is $323.292 ft s^{-1}$

d) we get total flight time from question

(a) that 32.47 sec

From question (c) we get ~~displacement~~ velocity towards ny ~~$300 ms^{-1}$~~ $V_{ny} = 300 ms^{-1}$

$\therefore$ Displacement $= V_{ny} \times T$

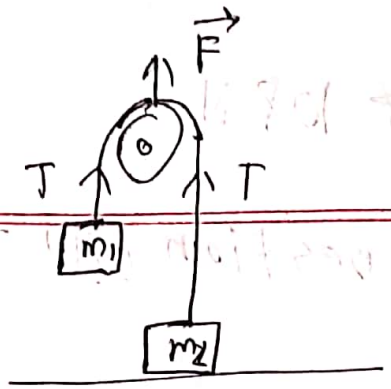
$= 300 \times 32.47$

$= 9741 ft$

The displacent when it hits the ground is 9741 ft.

(Ans)

2) a]



Ans: to :que: no: 2

The force $\vec{F}$ will ~~fell~~ feel will be the twice the tension on the string.

$$F = 2T$$

As we are told to use the value of m_2

$$\therefore T = m_2 g$$

$$\therefore F = 2 m_2 g$$

$$= 2 \times 1.8 \times 9.81$$

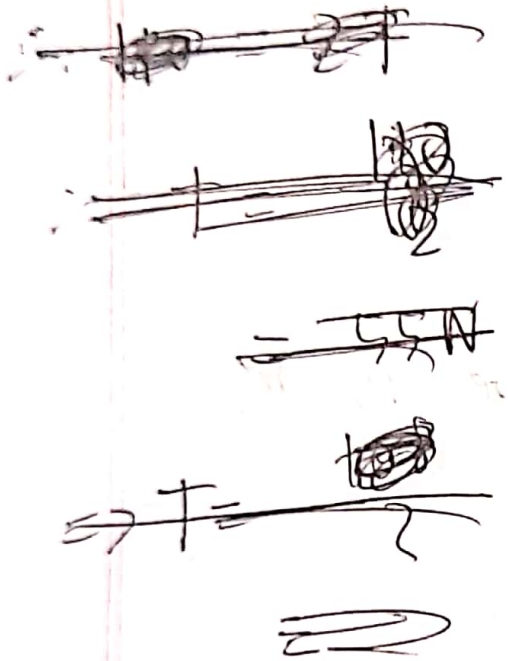
$$= 35.316 \text{ N}$$

For value of $F = 35.316$ N m_2 will remain remain rest on the floor.

b] Given that F = ~~H.cN~~ 108 N

We know ~~that~~ from question (a) that

$F = 2T$



$\therefore 2T = F$

$\Rightarrow T = \frac{F}{2}$

$= \frac{108}{2}$

$= 54\,N$

c] For m_1 block

$$T - m_1 g = m_1 a_1$$

$$\Rightarrow 54 - 1.3 \times 9.81 = 1.3 a_1$$

$$\therefore a_1 = 31.728 \, ms^{-2}$$

For, m_2 block,

~~$T - m_2 g =$~~

$$m_2 g - T = m_2 a_2$$

$$a_2 = \frac{m_2 g - T}{m_2}$$

$$= -20.2 \, ms^{-2}$$

$\therefore$ m_1 acceleration $31.728 \, ms^{-2}$

m_2 acceleration $-20.2 \, ms^{-2}$