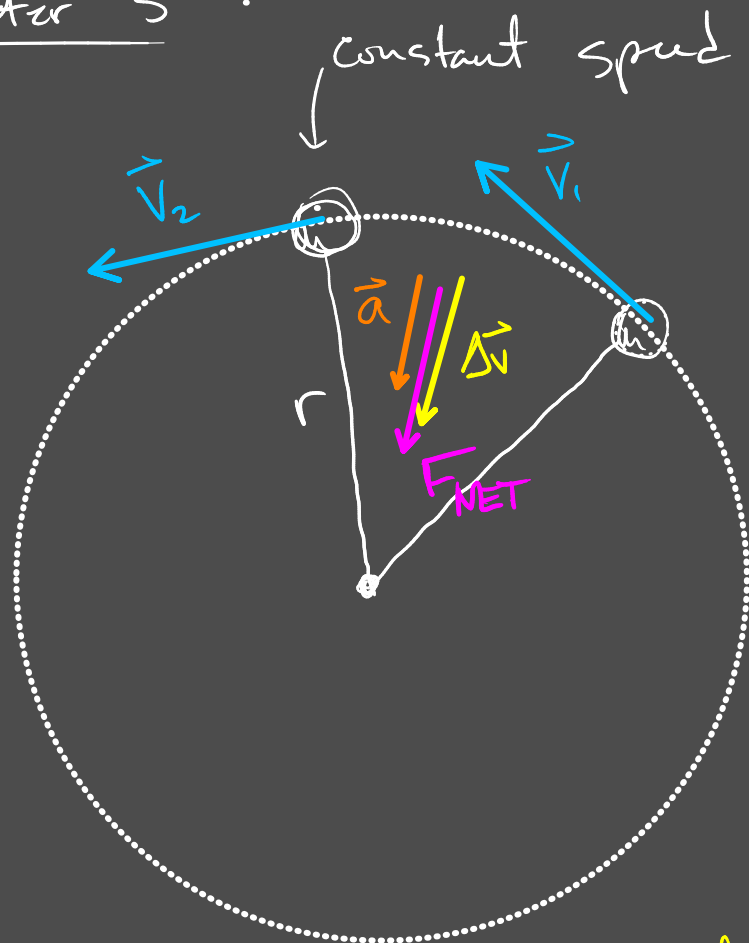


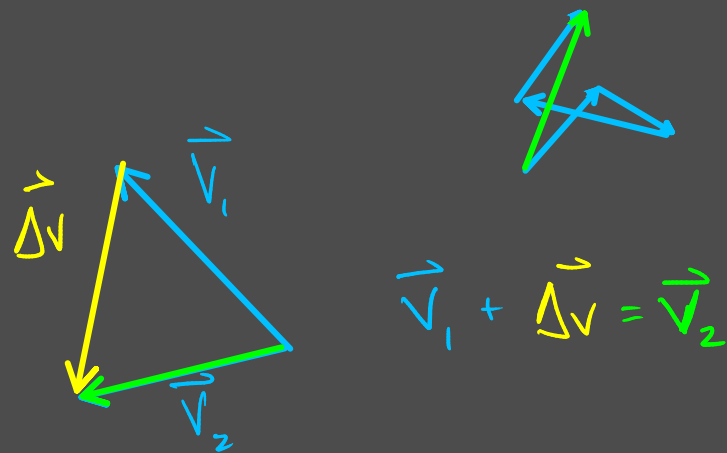
## Chapter 5



centripetal acceleration

$$a_c = \frac{\text{speed}^2}{\text{radius}}$$

$$a_c = \frac{v^2}{r}$$



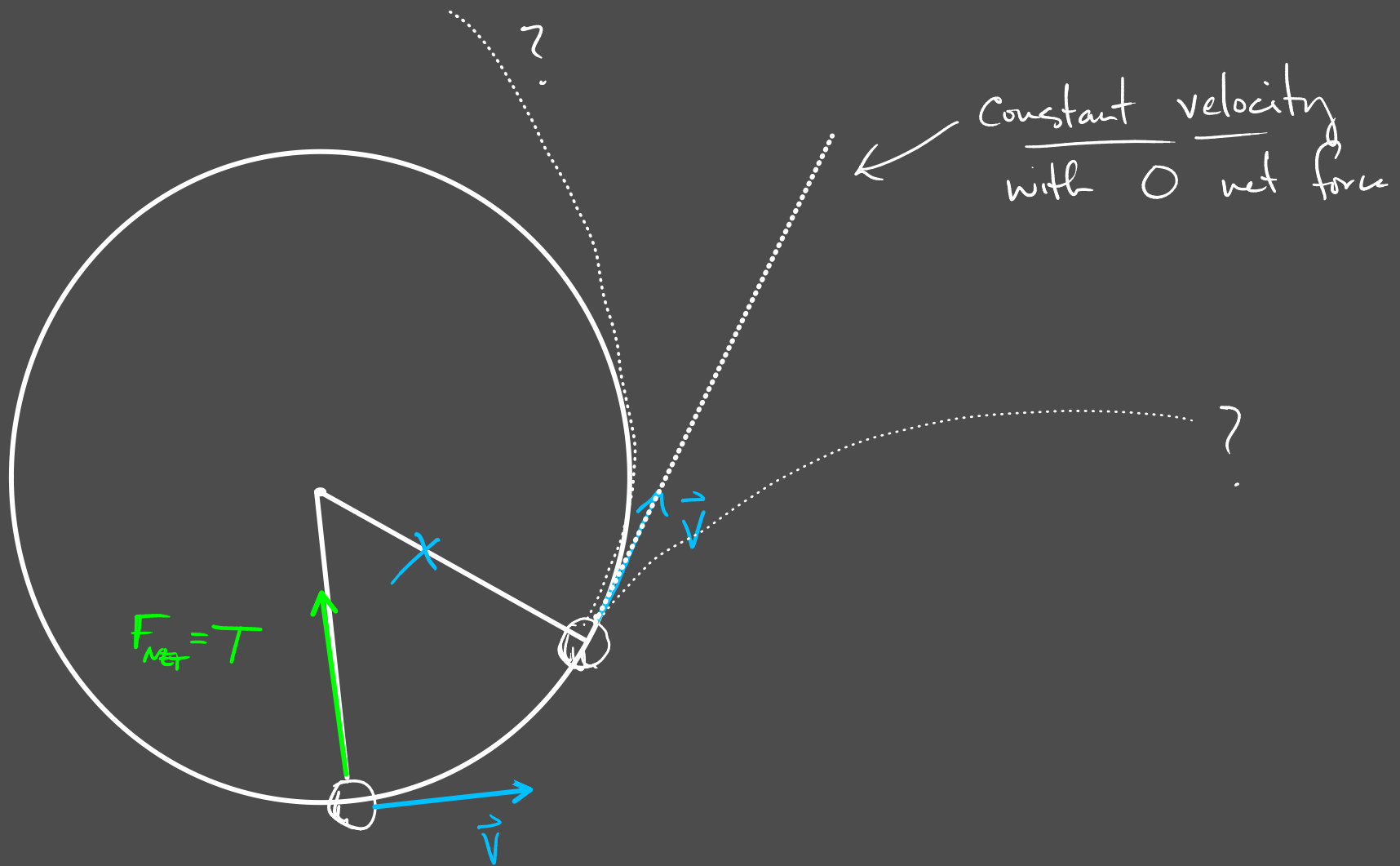
$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

$$\vec{F}_{NET} = m\vec{a}$$

provided by tension  
centripetal net force

$$F_c = ma_c$$

$$F_c = m \frac{v^2}{r}$$



$$m = 0.1 \text{ kg}$$

$$r = 1 \text{ m}$$

$$t = 0.5 \text{ s} \rightarrow \text{one complete revolution}$$

$$v = ?$$

$$C = 2\pi r$$

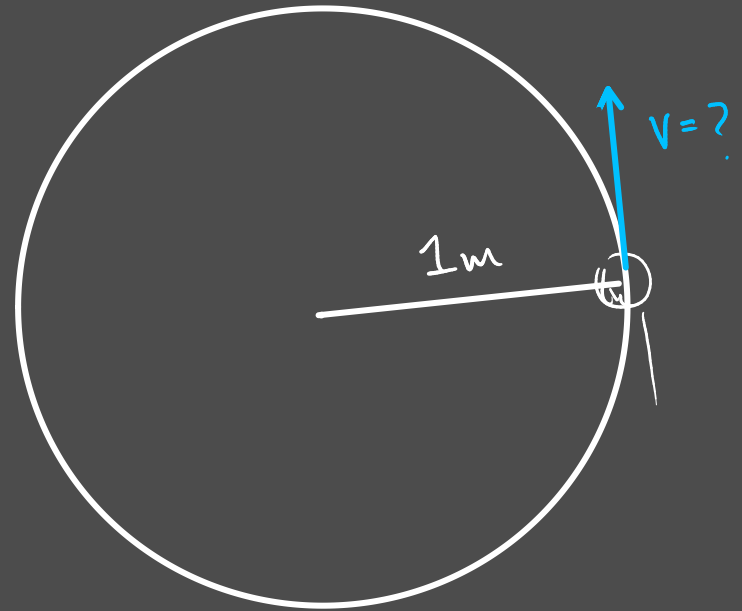
$$C = 2\pi (1 \text{ m})$$

$$C = 6.28 \text{ m}$$

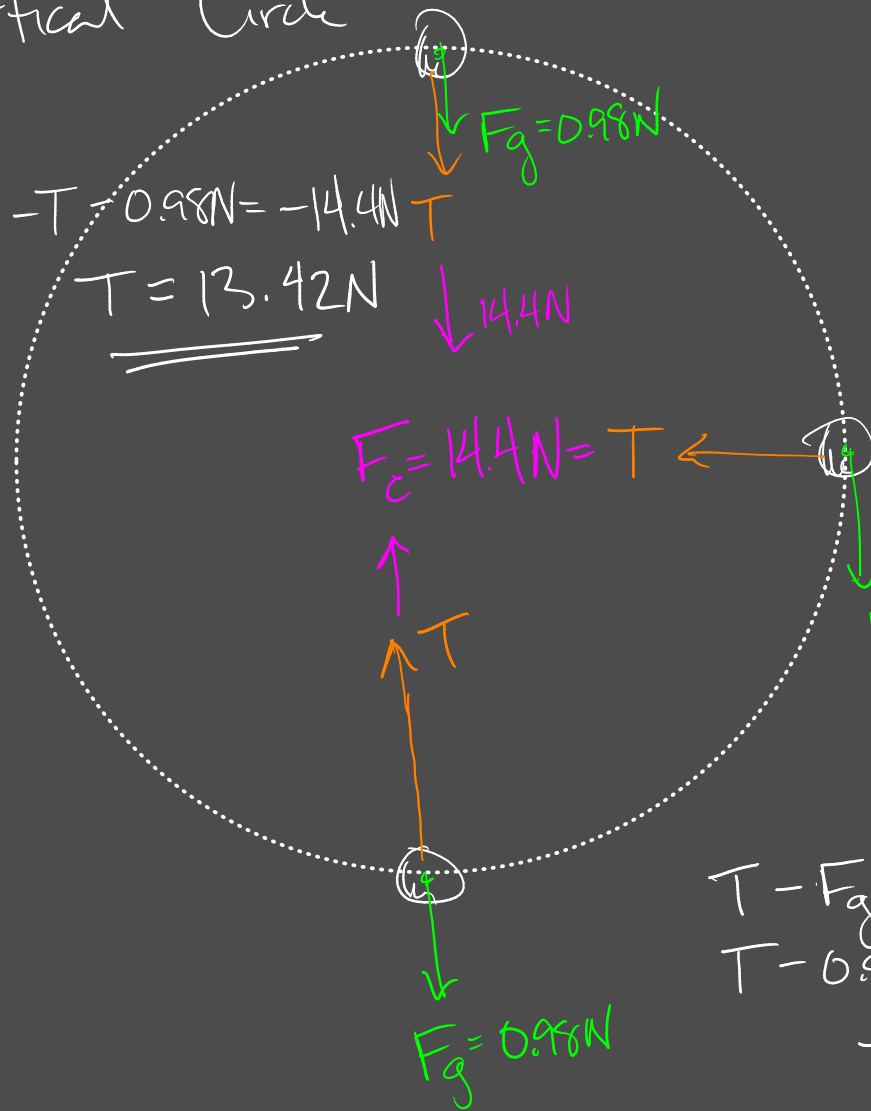
$$v = \frac{d}{t} = \frac{6.28 \text{ m}}{0.5 \text{ s}} = 12.56 \text{ m/s}$$

$$F_c = ma_c = \frac{mv^2}{r} = \frac{0.1 \text{ kg} \cdot (12.56 \text{ m/s})^2}{1 \text{ m}} = 15.8 \text{ N}$$

$$T = F_{\text{net}} = 15.8 \text{ N}$$



# Vertical Circle



$$m = 0.1\text{ kg}$$

$$r = 1\text{ m}$$

$$v = 12\text{ m/s}$$

$$F_c = ma_c$$

$$F_c = \frac{mv^2}{r} = \frac{0.1\text{ kg} \cdot (12\text{ m/s})^2}{1\text{ m}}$$

$$F_c = 14.4\text{ N}$$

$$T - F_g = +14.4\text{ N}$$

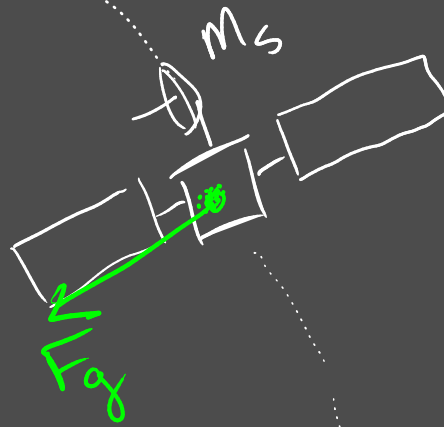
$$T - 0.98\text{ N} = 14.4\text{ N}$$

$$T = 15.38\text{ N}$$



$$m_e = 5.97 \times 10^{24} \text{ kg}$$

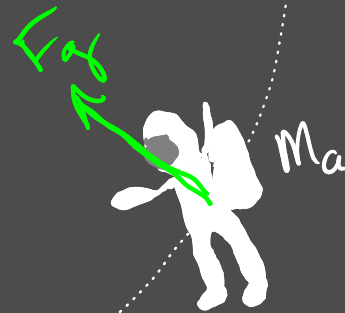
$$\begin{aligned} \text{radius of earth} &= 6,370 \text{ km} \\ &= 6,370,000 \text{ m} \end{aligned}$$



Newton's Law of Universal Gravitation

$$\rightarrow F_g = \frac{G m_1 m_2}{r^2}$$

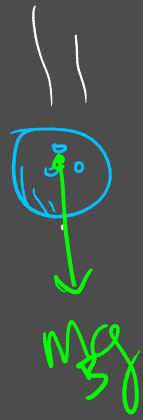
$$G = 6.67 \cdot 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$$



$$F_g = m \cdot 9.8$$

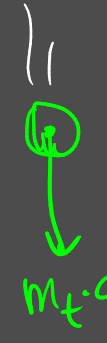
$$F_g = \frac{6.67 \cdot 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2} \cdot 5.97 \cdot 10^{24} \text{ kg} \cdot 70 \text{ kg}}{(6,370,000 \text{ m})^2}$$

$$g = 9.8 \frac{\text{N}}{\text{kg}} = 9.8 \text{ m/s}^2$$



$$F_{\text{net}} = ma$$
$$mg = ma$$

$$g = 9.8 \text{ m/s}^2 = a$$

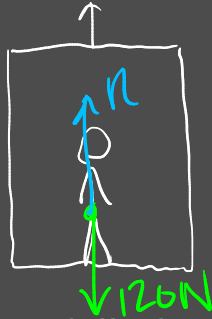


A free-body diagram showing a mass hanging from a string. The mass is represented by a green circle with a dot in the center. A green arrow points downwards from the mass, labeled  $m_t \cdot g$ . Above the mass, two vertical lines represent the string.

$$\cancel{m_t} \cdot g = \cancel{m_t} \cdot a$$

A child's weight is 120 N. Suppose she is standing on a scale in an elevator moving up with a constant speed of 4 m/s. What would be the reading on the scale?

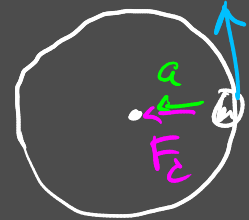
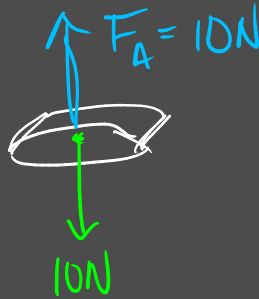
- A. 480 N
- B. 120 N
- C. 70 N
- D. 30 N
- E. 0 N



$$N - 120\text{N} = 0$$
$$N = 120\text{N}$$

A 10 N sack of potatoes falls from an airplane. As the velocity of the falling sack increases, so does the air resistance on it. When the air resistance equals 10 N, the acceleration of the sack will be

- A. 100 ft/s<sup>2</sup>
- B. 9.8 m/s.
- C. 9.8 m/s<sup>2</sup>.
- D. zero.

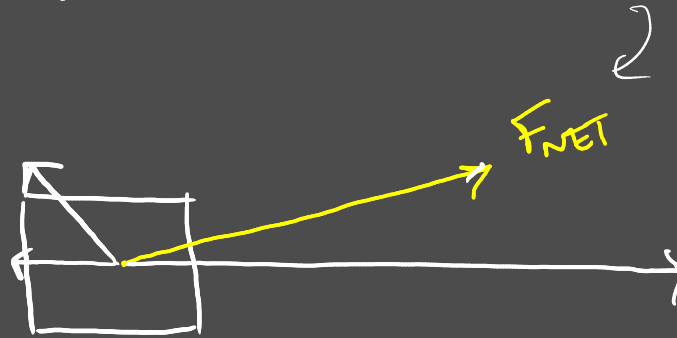


An object undergoes uniform circular motion. Which pair of vectors is perpendicular?

- A. Its centripetal acceleration and the centripetal force
- B. Its centripetal acceleration and velocity vectors
- C. All three vectors are mutually perpendicular: centripetal acceleration, centripetal force, and velocity.

Three forces act on the object in the sketch. In what direction will the object move?

- A. Upward
- B. To the left
- C. To the left and up
- D. To the right
- ☒ E. To the right and up



A 10.0 kg block on a smooth horizontal surface is acted upon by two forces: a horizontal force of 70 N acting to the left and a horizontal force of 30 N to the right. The acceleration of the block will be

- A. 2.3 m/s<sup>2</sup> to the right.
- B. 4.0 m/s<sup>2</sup> to the right.
- C. 10.0 m/s<sup>2</sup> to the left.
- ☒ D. 4.0 m/s<sup>2</sup> to the left.



$$70 - 30 = 40\text{N to the left}$$

$$F_{\text{net}} = ma$$

$$40\text{N} = 10\text{kg} \cdot a$$

$$a = 4\text{m/s}^2 \text{ to the left}$$

An object weighs 30 newtons on Earth. What is its approximate mass?

- A. 640 kg
- B. 30 g
- C. 12 kg
- ☒ D. 3 kg
- E. 294 k

$$F_g = mg$$

$$30\text{N} = m \cdot 9.8\text{m/s}^2$$

$$m = 3\text{kg}$$



A child, whose weight is 150 newtons, lifts a pumpkin from the ground with a force of 50 newtons. The force the pumpkin exerts on the child is

A. more than 50 newtons.

B. 50 newtons.

C. greater than zero but less than 50 newtons.

D. zero.

Newton's 3<sup>rd</sup> law

Force of the child on the pumpkin = Force of the pumpkin on child



~~Your weight is 120 lb. Suppose you are standing on a scale in an elevator moving up with a constant speed of 4 m/s. What would be the reading on the scale?~~

~~A. 480 lb~~

~~B. 120 lb~~

~~C. 70 lb~~

~~D. 30 lb~~

~~E. 0~~

If a ball at the end of a string is whirled in a vertical circle at constant speed, the tension will be

A. the same throughout the motion.

B. greatest at the highest point in the motion.

C. greatest at the lowest point in the motion.

D. greatest at a point where the string is instantaneously parallel to the ground.