EF 151 Exam #2, Spring, 2010

1. (14 pts) Dean throws a rock horizontally off a bridge with a speed of 15 m/s. The height of the bridge is 30 m above the water. What is the speed of the rock when it hits the water? (Ignore air resistance)

\[ \frac{29.5 \text{ m/s}}{29.5 \text{ m/s}} \]

\[ 15 \text{ m/s} \]

\[ s_0 = s_1 + v_0 t + \frac{1}{2} a t^2 \]

\[ 0 = s_0 + \frac{1}{2} (-9.81) t^2 \to t = 2.47 \text{ sec} \]

\[ v_y = v_{y0} - gt \to v_y = 0 - 9.81 \cdot 2.47 = 24.26 \text{ m/s} \]

\[ \text{Speed: } \sqrt{v_x^2 + v_y^2} = \sqrt{(15 \text{ m/s})^2 + (24.26 \text{ m/s})^2} = 29.5 \text{ m/s} \]

2. (14 pts) Boats A and B start sailing from the same location. Boat A is moving with a velocity of 12 mph 30° North of East with respect to the ground and with a velocity of 10 mph due North with respect to boat B. How far has boat B traveled after 2 hours?

\[ \frac{33.41 \text{ miles}}{33.41 \text{ miles}} \]

\[ \text{Given: } \text{given} \]

\[ \left| V_b/g \right| = 11.13 \text{ mph} \]

\[ \text{Speed of } V_b \]

\[ \text{distance: } 11.13 \text{ mph} \cdot 3 \text{ hours} = 33.41 \text{ miles} \]
3. (14 pts) A car driving in a circular path and increases speed at a constant rate of 1.5 ft/s². The diameter of the circular path is 180 ft. If its initial speed is 8 ft/s, what is the magnitude of its total acceleration after 10 seconds?

$$a_t = 1.5 \text{ ft/s}^2, R = \frac{180}{2} = 90 \text{ ft}$$

$$\frac{a_n}{R} = \frac{V_f^2}{2} = \frac{8^2}{2} = 32 \text{ ft}^2/\text{s}^2$$

$$V_f = 23 \text{ ft/s}$$

$$a_n = \frac{(23 \text{ ft/s})^2}{90 \text{ ft}} = 5.88 \text{ ft/s}^2$$

$$a_t = \sqrt{a_n^2 + a_t^2} = \sqrt{(5.88 \text{ ft/s}^2)^2 + (1.5 \text{ ft/s}^2)^2} = 6.05 \text{ ft/s}^2$$

4. (14 pts) A 145 lb snowboarder slides down a 20° slope. The coefficient of kinetic friction, $\mu_k$, is 0.14. What is the snowboarder’s acceleration? (FBD=KD required)

$$y: N - W \cos \alpha = 0$$

$$\Rightarrow N = W \cos \alpha$$

$$x: W \sin \alpha - f = ma$$

$$W \sin \alpha - \mu_k N = ma \quad (F = Ma)$$

$$= \dot{a} = \frac{W \sin \alpha - \mu_k W \cos \alpha}{m}$$

$$= 32.2 \text{ ft/s}^2 - 0.14 \times 32.2 \cos 20°$$

$$= 32.2 \text{ ft/s}^2 - 0.14 \times 32.2 \times 0.94$$

$$= 32.2 \text{ ft/s}^2 - 2.9$$

$$= 29.3 \text{ ft/s}^2$$

5. (14 pts) Dr. Arel is pulling with a force of 25 lb on a box filled with toy trucks. Three is a constant friction force of 20 lb. The box is sliding down a slope at a rate of 24 ft/s². If each toy truck weighs 2 lb, and the weight of the box is 6 lb, how many toy trucks are in the box? (FBD=KD required)

6. (14 pts) A rider in a “barrel of fun” finds herself stuck with her back to the wall. She is not sliding up or down the barrel. The angular speed of the barrel, $\omega$, is 2 rad/sec. The mass of the woman is 4 slugs and the coefficient of static friction, $\mu_s$, is 0.9. What is the radius of the barrel? (FBD=KD required)

$$F - W = 0 \Rightarrow F = W, F = \frac{mg}{\mu_s}$$

$$F = W \Rightarrow W = \frac{9.81 \text{ slugs}}{0.9 \text{ rad/s}} = 10.9 \text{ slugs}$$

$$\Rightarrow R = \frac{g}{\omega^2} = \frac{9.81 \text{ slugs} \cdot \text{sec}^2}{(2 \text{ rad/sec})^2} = 2.45 \text{ slugs} / \text{sec}^2$$

$$\Rightarrow R = 2.45 \text{ ft}$$
7. (8 pts) A moving sidewalk at an airport terminal moves at 0.8 m/s relative to the ground, and is 35 meters long. If Dean steps on the sidewalk at one end and walks at 1.5 m/s relative to the moving sidewalk in the opposite direction to which the sidewalk is moving. How much time is required for him to reach the opposite?

\[ v_{Dg} = v_{D/s} + v_{s/g} = -1.5 \text{ m/s} + 0.8 \text{ m/s} = -0.7 \text{ m/s} \]

\[ |v_{Dg}| = \text{speed} = 0.7 \text{ m/s} \]

\[ \text{time} = \frac{\text{Distance}}{\text{speed}} = \frac{35 \text{ m}}{0.7 \text{ m/s}} = 50 \text{ sec} \]

8. (4 pts) Dr. Bennett is standing on a bridge. He is holding 2 rocks. Rock A weighs 2 lbs and rock B weighs 4 lbs. Dr. Bennett decides to throw both rocks at the same time with the same initial velocity. Ignoring air resistance, which rock will hit the bottom ground first?

a) Rock A
b) Rock B
c) Not enough information
d) Both will hit the ground at the same time.

9. (4 pts) Ryan throws two balls with the same initial speed \( v_0 \). Ball 1 is thrown at an angle of 45° below the horizontal. Ball 2 is thrown at an angle of 45° above the horizontal. Upon reaching the ground,

a) Ball 1 will have the greater speed
b) Ball 2 will have the greater speed
c) Not enough information
d) Both balls will have the same speed