Name: _____
Date: _____

Landing Speed / Circular Motion

Follow the policy for using the solutions as outlined on your syllabus, and be sure to correct your work.

1.(*Solution posted*) Jim and Sara stand at the edge of a cliff of height h on the earth. Jim extends his arm over the cliff edge and throws a ball straight up with an initial speed of v_o. Sara throws an identical ball with the same initial speed, but she throws the ball at an angle of θ above the horizontal. We want to find out if both balls land with the same speed or not.

a. Make a sketch with a coordinate system for Jim's throw. List the variables and derive an expression for the speed of the ball at landing in terms of v_o, h, and fundamental constants.
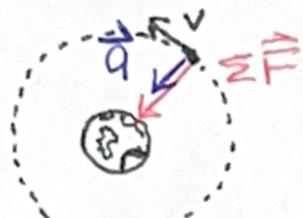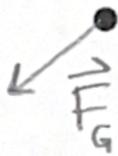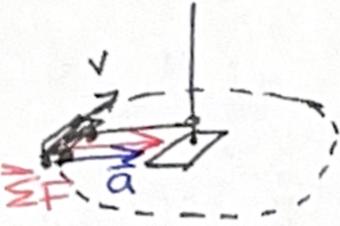

$$\Delta y = -h$$
$$V_{iy} = V_o$$
$$V_{fy} = ?$$
$$a_y = -g$$
$$\Delta t =$$
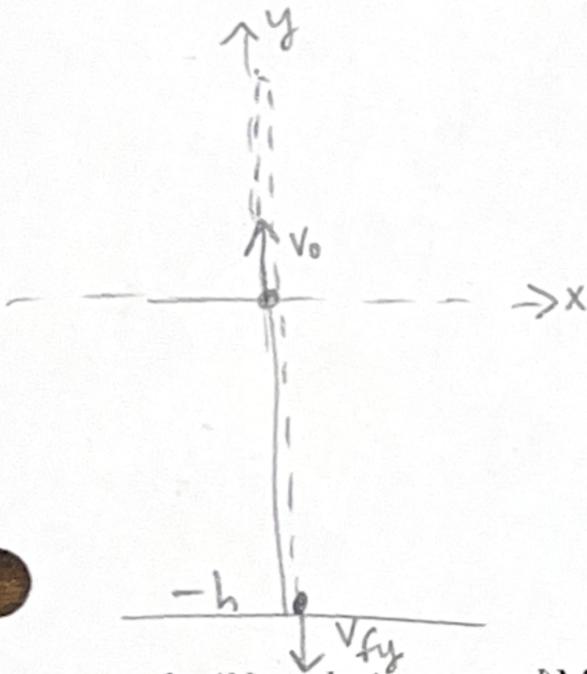
$$V_{fy}^2 = V_{iy}^2 + 2a_y \Delta y$$

$$V_{fy} = \sqrt{V_o^2 + 2(-g)(-h)}$$

$$V_{fy} = \pm\sqrt{V_o^2 + 2gh}$$
$$= -\sqrt{V_o^2 + 2gh}$$

The speed at landing is all vertical, and it is the magnitude of V_{fy}, so it is $V = {}^+\sqrt{V_o^2 + 2gh}$

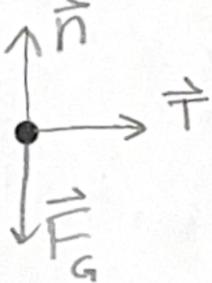b. (*No solution posted*)Make a sketch with a coordinate system for Sara's throw. List the variables and derive an expression for the speed of the ball at landing in terms of v_o, h, and fundamental constants. There will be no θ in the answer.

2a. (*Solution posted*) Complete the chart. Assume constant speed for all motions described.

Situation (The system is the object in bold type)	1. Draw a labeled vector showing $\Sigma \vec{F}_{on\,S}$ at the moment shown in one color. 2. Draw a labeled vector showing the acceleration in another color.	3. Draw a labeled force diagram showing all the forces exerted on the system at the exact time shown in the picture.	4. Write N2L for the radial direction $(a_r = \frac{\Sigma F_{on\,S\,r}}{m_S})$, expressing $\Sigma F_{on\,S\,r}$ in terms of the force(s) in the radial direction on your force diagram.	
1. The **moon** is revolving around the earth.			$a_r = \dfrac{\Sigma F_{on\,S}\,r}{m_S}$ $a_r = \dfrac{+F_G}{m_S}$	✓
2. A toy **car** is attached to a string and moving in a circle on the floor (side view)			$a_r = \dfrac{\Sigma F_{on\,S}\,r}{m_S}$ $a_r = \dfrac{+T}{m_S}$	✓
3. A **car** rounds a flat curve (side view)			$a_r = \dfrac{\Sigma F_{on\,S}\,r}{m_S}$ $a_r = \dfrac{+f_S}{m_S}$	✓
4. **Bucket** attached to a rope, whirled in vertical circle (side view) a. For a point at the top		we can't know which force is greater here.	$a_r = \dfrac{\Sigma F_{on\,S}\,r}{m_S}$ $a_r = \dfrac{+F_G + T}{m_S}$	✓
b. For a point at the bottom		$T > F_G$ b/c I need the sum to point up.	$a_r = \dfrac{\Sigma F_{on\,S}\,r}{m_S}$ $a_r = \dfrac{+T + (-F_G)}{m_S}$	✓
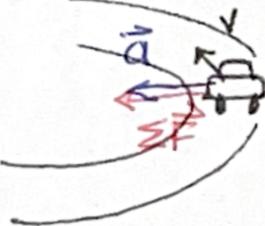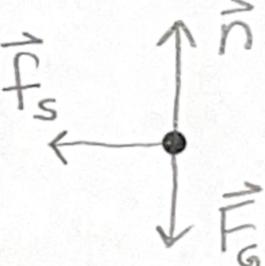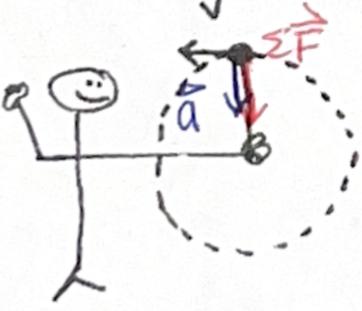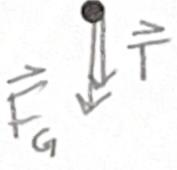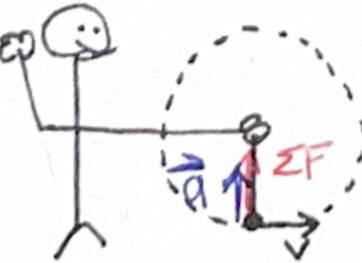
2b. For each situation, look at the direction of the sum of the forces according to your force diagram and compare it with the direction of the sum of the forces you drew on the picture in the first column. Do they match? If yes, put a ✓ at the right end of the row. If no, find and fix your mistake!