Student Name: _____ Date: _____

Lab 7: Gravity Pitch

Start-up Instructions

1. Go to https://www.explorelearning.com
2. If you already created an account using my class code got to step 6.
3. Click on the "Enroll in a Class" button in the upper right hand corner of the web page.
4. Type in the class code: **CWBJQF.**
5. Create an account, all you need is your name and mail.
6. Select the **Gravity Pitch** Gizmo simulation.

_____

Gizmo Warm-up: Which way does gravity pull?

1. Use the slider to set the **Velocity** to 0.0 km/s (kilometers per second). **Velocity** is basically the same thing as speed, but has direction as well. In this case the pitcher is simply dropping the ball. Click **Play** ( ).

   A. What direction does the ball go? _____

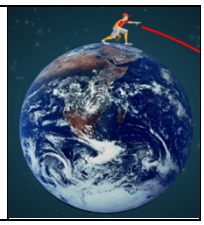
   B. Sketch the pitcher and the trajectory of the ball on the diagram.

2. Click **Reset** ( ) and drag the pitcher to several new positions. Click **Play** and watch him drop the ball each time. Sketch the pitcher and the trajectory of each ball on the diagram.

   A. What do you notice? _____

   B. The ball is pulled by a force called **gravity**. In what direction does gravity always pull the ball?

   _____

Activity A: **How far does it go?**	Get the Gizmo ready: • Click **Reset**. • Drag the pitcher back to the top. • Set the **Velocity** to 1.0 km/s (2,232 miles per hour).	

Question: Why do objects go around, or orbit, other objects?

1. Observe: Click **Play** and observe the ball's trajectory. (Note: The pitcher is very tall – about 1500 km (930 miles) tall!)

2. Predict: How would the trajectory of the ball change as the pitcher throws it harder and harder? Explain below, and draw several predicted trajectories on the diagram.

_____

_____

3. Collect data: Throw the ball at velocities of 3, 5, and 7 km/s. If necessary, use the **Fast forward** button (⏩) to speed things up and the "–" zoom control to see a larger area. For each throw, sketch and label the trajectory and record the **Distance traveled** in the table below.

Velocity	Distance traveled
3 km/s	
5 km/s	
7 km/s	

4. Analyze: What happens? _____

_____

_____

5. Draw conclusions: What force causes objects to stay in orbit? _____

6. Run Gizmo: Test 8 km/s and 9 km/s. (If you have a lot of spare time, try 10 km/s as well.) Use the "–" zoom control. What happens?

_____

Activity B: **Comparing planets**	Get the Gizmo ready: • Click **Reset**. • On the **Planet** menu, choose **Venus**. • Set the **Velocity** to 1 km/s.	

Question: How would the gravity of other planets affect a pitched ball?

1. Observe: Look at the **Planet mass** and **Planet radius** of Venus. The **mass** of a planet is how much matter it contains. The **radius** of a planet is the distance from the center to the surface. Compared to Earth, what are the mass and radius of Venus?

Venus mass: _____ × Earth's mass Venus radius: _____ × Earth's radius

2. Predict: Will the pitcher have to throw the ball faster or not as fast to send a ball into orbit around Venus? _____ Why? _____

3. Run Gizmo: **Orbital velocity** is the velocity needed to make a circular orbit. Use the Gizmo to find the orbital velocity of the ball on Venus. Make the orbit as circular as you can.
   A. What is the orbital velocity on Venus? _____
   B. Do the same on Earth. What is the orbital velocity on Earth? _____
   C. Based on this, which planet do you think has stronger gravity, Venus or Earth? Explain.

      _____

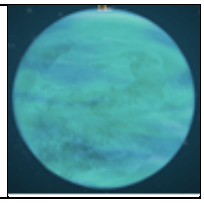
4. Predict: Select **Mars**. Estimate what the orbital velocity will be on Mars: _____

   Why did you choose that value? _____

5. Run Gizmo: Adjust the **Velocity** until you create a circular orbit on Mars.
   A. What is the orbital velocity on Mars? _____
   B. How does gravity on Mars compare to Earth and Venus? _____

6. Extend your thinking: The **escape velocity** is the smallest velocity needed for the baseball to escape from the planet's gravity and fly off into space, never to return. When the ball reaches escape velocity, the **Distance traveled** will read "infinity."
   A. Which planet do you think has the lowest escape velocity? _____

   Use the Gizmo to test your prediction. Were you correct? _____

Activity C: **Design a planet**	Get the Gizmo ready: • Click **Reset**. • On the **Planet** menu, select **Custom**. • Set the **Velocity** to 7.0 km/s.	

Question: How does a planet's mass and radius affect a pitched ball?

1. Observe: Using the sliders, try a variety of values for **Planet mass** and **Planet radius** for your custom planet. Observe the trajectory of the ball each time.

2. Form hypotheses: Fill in the blanks below:

   As its mass increases, the strength of a planet's gravity _____.

   As its radius increases, the strength of a planet's gravity _____.

3. Run Gizmo: Set **Planet mass** to 0.0 of Earth (no mass), **Planet radius** to 1.0 of Earth (equal to Earth). Press **Play** and record results. Repeat for **masses** of 1.0 (equal to Earth) and 2.0.

Planet mass	Planet radius	Velocity	What happened?
0.0	1.0	7.0 km/s	
1.0	1.0	7.0 km/s	
2.0	1.0	7.0 km/s	

4. Analyze: How does increasing the mass affect the gravity of the planet? How do you know?

   _____

   _____

5. Experiment: Do the same kind of experiment, but now keep the **Planet mass** at 1.0 and change the **Planet radius**. Record results in a notebook or on a separate sheet of paper.

   A. What do you notice? _____

   B. How does changing the radius affect the strength of a planet's gravity? _____

      _____

6. Apply: Using what you have learned, create a planet with the strongest possible gravity. What are the mass and radius of this planet? _____