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# SPH 4U Lab: Projectile Motion

**Background:**

1. Define or explain the meaning of the term Projectile.
2. Which lands first – a stone thrown horizontally or one dropped from the same height?

**Purpose:**

To study projectile motion.

**Materials:**

Tilted air table, puck & timer, paper

**Method:**

1. Tilt the air table, so that each group of 2 or 3 has a slightly different angle.
2. As demonstrated in class, project a puck up and across the tilted air.
3. Set the timer to a frequency of your choice.
4. Consider the dot recording of a two-dimensional motion to be two simple one-dimension motions. Draw horizontal and vertical grid lines through each dot.
5. Measure the horizontal motion of the puck, and record your measurements in the standard "ticker timer table".
6. Repeat the measurements for the vertical motion of the puck. Record your measurements in another table.

**Results:**

Completed tables as per the procedure.

**Discussion:**

1. Within limits of experimental error approximately what type of motion is displayed by:
   a) The puck's horizontal motion? (Do a % deviation for velocity)
   b) The puck's vertical motion? (Do a % deviation for acceleration)

2. Knowing that $a_g = 9.804\ m/s^2$, calculate the angle of tilt of the air table.

Vertical

| Time (s) | Position $\vec{d}$ (cm) [F] | Change in Position $\Delta\vec{d}$ (cm) [F] | Velocity $\vec{v}$ (cm/s) [F] | Acceleration $\vec{a}$ (cm/s$^2$) [F] |
|---|---|---|---|---|
| 0.00 | 0.00 | | | |
| | | 0.40 | 4.00 | |
| 0.10 | 0.40 | | | 60 |
| | | 1.00 | 10.0 | |
| 0.20 | 1.40 | | | 50 |
| | | 1.50 | 15.0 | |
| 0.30 | 2.90 | | | 50 |
| | | 2.00 | 20.0 | |
| 0.40 | 4.90 | | | 30 |
| | | 2.30 | 23.0 | |
| 0.50 | 7.20 | | | 70 |
| | | 3.00 | 30.0 | |
| 0.60 | 10.3 | | | 40 |
| | | 3.40 | 34.0 | |
| 0.70 | 13.7 | | | 50 |
| | | 3.90 | 39.0 | |
| 0.80 | 17.6 | | | 40 |
| | | 4.30 | 43.0 | |
| 0.90 | 21.9 | | | 60 |
| | | 4.90 | 49.0 | |
| 1.00 | 26.8 | | | 50 |
| | | 5.40 | 54.0 | |
| 1.10 | 32.2 | | | |
| | | | | |
| 1.20 | | | | |
| | | | | |
| 1.30 | | | | |
| | | | | |
| 1.40 | | | | |
| | | | | |
| 1.50 | | | | |
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| 1.60 | | | | |
| | | | | |
| 1.70 | | | | |
| | | | | |
| 1.80 | | | | |
| | | | | |
| 1.90 | | | | |
| | | | | |
| 2.00 | | | | |
| | | | | |
| 2.10 | | | | |
| | | | | |
| 2.20 | | | | |
| | | | | |

Horizontal

| Time (s) | Position $\vec{d}$ (cm) [F] | Change in Position $\Delta\vec{d}$ (cm) [F] | Velocity $\vec{v}$ (cm/s) [F] | Acceleration $\vec{a}$ (cm/s$^2$) [F] |
|---|---|---|---|---|
| 0.00 | 0.0 | | | |
| | | 2.3 | 23 | |
| 0.10 | 2.3 | | | 20 |
| | | 2.5 | 25 | |
| 0.20 | 4.8 | | | -20 |
| | | 2.3 | 23 | |
| 0.30 | 7.1 | | | 0 |
| | | 2.3 | 23 | |
| 0.40 | 9.4 | | | 20 |
| | | 2.5 | 25 | |
| 0.50 | 11.9 | | | -20 |
| | | 2.3 | 23 | |
| 0.60 | 14.2 | | | 10 |
| | | 2.4 | 24 | |
| 0.70 | 16.6 | | | -10 |
| | | 2.3 | 23 | |
| 0.80 | 18.9 | | | 0 |
| | | 2.3 | 23 | |
| 0.90 | 21.2 | | | 0 |
| | | 2.3 | 23 | |
| 1.00 | 23.5 | | | 0 |
| | | 2.3 | 23 | |
| 1.10 | 26.0 | | | |
| | | | | |
| 1.20 | | | | |
| | | | | |
| 1.30 | | | | |
| | | | | |
| 1.40 | | | | |
| | | | | |
| 1.50 | | | | |
| | | | | |
| 1.60 | | | | |
| | | | | |
| 1.70 | | | | |
| | | | | |
| 1.80 | | | | |
| | | | | |
| 1.90 | | | | |
| | | | | |
| 2.00 | | | | |
| | | | | |
| 2.10 | | | | |
| | | | | |
| 2.20 | | | | |
| | | | | |

# SPH4U Lab: Projectile Motion

**Background:**

1. A projectile is an object that moves along a curved trajectory without a propulsion system, usually with constant velocity in one direction and constant acceleration in another direction.
2. They both land at the same time because of gravity.

**Discussion:**

1. a) Horizontal motion:

| $\vec{v}$ (cm/s) | $\lvert\vec{v} - \vec{v}_{avg}\rvert$ |
|---|---|
| 23 | 0.5 |
| 25 | 1.5 |
| 23 | 0.5 |
| 23 | 0.5 |
| 25 | 1.5 |
| 23 | 0.5 |
| 24 | 0.5 |
| 23 | 0.5 |
| 23 | 0.5 |
| 23 | 0.5 |
| 23 | 0.5 |
| $\Sigma$ 258 | 7.5 |

$\vec{v}_{Avg} = \frac{258}{11}$
$= 23.5$

Mean Deviation $= \frac{7.5}{11}$
$= 0.682$

% Deviation $= \frac{0.682}{23.5} \times 100$
$= 2.90\%$

b) Vertical motion:

| $\vec{a}$ (cm/s²) | $\lvert\vec{a} - \vec{a}_{avg}\rvert$ |
|---|---|
| 60 | 10 |
| 50 | 0 |
| 50 | 0 |
| 30 | 20 |
| 70 | 20 |
| 40 | 10 |
| 50 | 0 |
| 40 | 10 |
| 60 | 10 |
| 50 | 0 |
| $\Sigma$ 500 | 80 |

$\vec{a}_{avg} = \frac{500}{10}$
$= 50$

Mean deviation $= \frac{80}{10}$
$= 8.0$

% Deviation $= \frac{8.0}{50} \times 100$
$= 16\%$

Horizontal motion is uniform motion.

Vertical motion is approximately uniform acceleration.

2.


$F_g = 9.804\ m/s^2 \times m$
$F_{gx} = 0.50\ m/s^2 \times m$

$\sin\theta = \frac{0.50\ m}{9.804\ m}$
$\theta = 2.9^\circ$

$\therefore$ The table was tilted at 2.9°