1 Physics Club Handout: Motion

For all these problems, assume acceleration due to gravity is 9.81 m/s^2.

Beginner problems:

1. An automobile traveling at 10 m/s accelerates to 20 m/s in 10 seconds. How far does the automobile travel during that time?

2. A roller-coaster car moves 200 ft horizontally and then rises 135 ft at an angle of 30.0° above the horizontal. It next travels 135 ft at an angle of 40.0° downward. What is its displacement from its starting point?

3. A projectile is fired such that the maximum height it reaches is three times the distance it travels before it lands. Find the angle of projection.

4. A bullet is fired from a gun on the surface of the earth (radius 6340 km) at velocity v. Find v such that the bullet will enter a stable orbit around the moon at its inital height.

Intermediate problems:

5. A projectile is launched at an angle θ to the horizontal. It rises to a height h and lands a distance d away. Find the ratio h/d in terms of θ.

6. For the vector $\vec{R} = 2\,\hat{i} + \hat{j} + 3\,\hat{k}$, find the magnitude of $\vec{R}$, and the angles between $\vec{R}$ and the x, y, and z axes.

7. A dive-bomber has a velocity of 280 m/s at an angle θ below the horizontal. It releases a bomb at an altitude of 2.15 km, which initially has the same velocity as the aircraft. The displacement from the point of release (not just horizontal displacement) is 4 km. Find θ.

Advanced problems:

8. The speed of a projectile at its greatest height is $\sqrt{\frac{6}{7}}$ of its speed when it is at half of its greatest height. Find the angle of projection.

9. The speed of a projectile at its greatest height h is m times its speed when it is at a height $n \cdot h$, where $n < 1$. Find the angle of projection in terms of m and n.

10. A ski jumper jumps off a ramp at angle θ to land on a hill that slopes downward and makes an angle ψ with the horizontal. Find θ such that the ski jumper's distance is maximized.

11. A ball is kicked off a hemispherical rock of radius R with horizontal velocity v. Assume no friction between the rock and the ball. Find the distance away from the center of the rock the ball lands in terms of R and v.