7. An astronaut on a strange planet finds that she can jump a *maximum* horizontal distance of 30 m if her initial speed is 9 m/s. What is the acceleration of gravity on the planet?

$X = \frac{V_0^2 \sin(2\theta)}{g}$ $a = 2.7 \ m/s^2$

$g = \frac{V_0^2 \sin(2\theta)}{X} = \frac{9^2 \sin(2.45)}{30}$

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8. It has been said that in his youth George Washington threw a silver dollar across a river. Assuming that the river was 300 m wide, (a) what *minimum initial* speed was necessary to get the coin across the river and (b) how long was the coin in flight?

$X = \frac{V_0^2 \sin(2\theta)}{9.81}$ $V_0 = 54.25 \ m/s$

$V_0 = \sqrt{\frac{9.81(X)}{\sin(2\theta)}} \rightarrow \sqrt{\frac{9.81(300)}{\sin(2.45)}}$

$t = \frac{2V_0 \sin\theta}{9.81} = \frac{2(54.25)\sin 45}{9.81}$

$= 7.82 \ s$

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9. A rifle is aimed horizontally through its bore at the center of a large target 150 m away. The initial velocity of the bullet is 450 m/s. (a) Where does the bullet strike the target? (b) To hit the center of the target the barrel must be at an angle above the line of sight. Find the angle of elevation of the barrel.

V_0

$X = V_{0x}(t)$ $-y = \frac{1}{2}(-9.81)t^2$

$t = \frac{X}{V_{0x}} = .33 \ s$ $y = -.54 \ m$

$X = \frac{V_0^2 \sin(2\theta)}{9.81}$

$\theta = \frac{\sin^{-1}\left(\frac{9.81(X)}{V_0^2}\right)}{2}$ $\theta = .21^\circ$

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10. A ball is thrown horizontally from the top of a building 35 m high. The ball strikes the ground at a point 80 m from the base of the building. Find (a) the time the ball is in flight, (b) its initial velocity, and (c) the x and y components of velocity just before the ball strikes the ground.

$-y = \frac{1}{2}(-9.81)(t^2)$ $X = V_{0x}(t)$

$t = \sqrt{\frac{2y}{9.81}}$ $V_{0x} = \frac{X}{t}$

$= 2.67 \ s$ $29.96 \ m/s$

$V_x = V_{0x} = 29.96 \ m/s$

$V_y = -9.81(t)$

$= -26.2 \ m/s$

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11. A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. What is the angle of projection?

$X = 3h$

Formula

$\frac{V_0^2 \sin(2\theta)}{9.81} = 3\left(\frac{(V_0 \sin\theta)^2}{2(9.81)}\right)$ $\tan\theta = \frac{4}{N}$

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12. Show that the horizontal range of a projectile with a fixed initial speed will be the same for any two complementary angles, such as 30° and 60°.

$X = \frac{V_0^2 \sin(2\theta)}{9.81}$

$\theta = 30$ $\sin(2 \cdot 30) = .866$

$\theta = 60$ $\sin(2 \cdot 60) = .866$

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13. The initial speed of a cannon ball is 200 m/s. If it is fired at a target that is at a horizontal distance of 2 km from the cannon, find (a) the two projected angles that will result in a hit and (b) the total time of flight for each of the two trajectories found in (a).

$$X = \frac{V_0^2 \sin(2\theta)}{9.81}$$

$$\theta = \frac{\sin^{-1}\left(\frac{9.81(X)}{V_0^2}\right)}{2}$$

$\theta_1 = 14.2°$

$\theta_2 = 75.8°$

$$t_1 = \frac{2V_0 \sin\theta}{9.81} = \boxed{10\ s}$$

$t_2 = 39\ s$

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