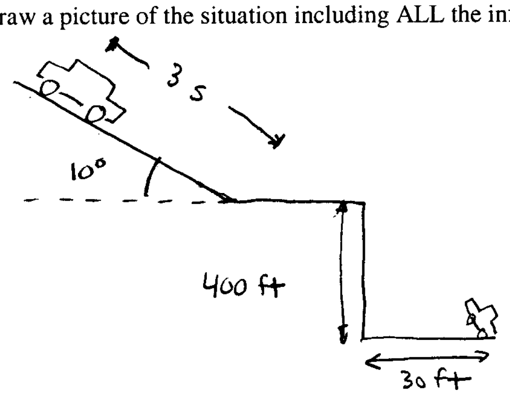
Context-Rich Problems: Solutions Outline

FOCUS the PROBLEM

Draw a picture of the situation including ALL the information given in the problem.



Question(s): What is the problem asking you to find?

What was the acceleration down the hill?

Is this a result of coasting

Approach: Outline the approach you will use.

1) Use projectile motion and kinematic equations to determine velocity when the car left the cliff.

2) Set x axis parallel to the hill and determine average acceleration with one dimensional kinematic equations

DESCRIBE the PHYSICS

Draw physics diagram(s) and define ALL quantities uniquely.

$t_0 = 0$

$V_0 = 0$

$x_0 = 0$

$a = ?$

$t_1 = 3.0s$

$V_x \equiv V_1 = ?$

$x_1 = ?$

Rolling down hill

$t_2 = 0$

$V_{2x} = V_1 \equiv V_x$

$V_{2y} = 0$

$x_2 = 0$ $\quad a_x = 0$

$y_2 = 0$ $\quad a_y = 32\ ft/s^2$

$t_3 = ?$

$V_{3x} = V_x$ $\quad V_{3y} = ?$

$X_3 = 30\ ft$

$y_3 = -400ft$

Going off cliff

Which of your defined quantities is your Target variable(s)? **a**

Quantitative Relationships: Write equations you will use to solve this problem.

$$y_2 - y_1 = V_1 (t_2 - t_1) + \frac{1}{2} a (t_2 - t_1)^2$$

$$V_2^2 = V_1^2 + 2a(x_2 - x_1)$$

$$V_2 = V_1 + a(t_2 - t_1)$$

PLAN the SOLUTION

Construct Specific Equations (Same Number as Unknowns)

UNKNOWNS: V_x, a

$V_1 = V_0 + a(t_1 - t_0)$

$V_1 = a t_1 \quad (v_1 = V_x)$

$V_x = a t_1$

$\boxed{a = V_x / t_1}$ ①

$X_3 - X_2 = V_x (t_3 - t_2)$

$x_3 = V_x t_3$ ② $\quad \boxed{t_3}$

$y_3 - y_2^{\,0} = V_{2y}^{\,0}(t_3 - t_2) - \frac{1}{2} g (t_3 - t_2)^2$

$y_3 = -\frac{1}{2} g t_3^2$ ③

From ③ $\quad t_3 = \sqrt{2 y_3 / g}$ Ⓐ

Plug Ⓐ into ②

$V_x = \frac{x_3}{t_3} = X_3 \sqrt{\frac{g}{2 y_3}}$ Ⓑ

Plug Ⓑ into ①

$$\boxed{a = \frac{X_3}{t_1} \sqrt{\frac{g}{2 y_3}}}$$

Check Units

$\frac{[L]}{[T]^2} = \frac{[L]}{[T]} \left\{ \frac{[L]/[T]^2}{[L]} \right\}^{1/2} = \frac{[L]}{[T]^2}$ ok

EXECUTE the PLAN

Calculate Target Quantity(ies)

$a = \frac{30\,ft}{3\,s} \sqrt{\frac{32\ ft/s^2}{2(400\,ft)}} = 2.0\ ft/s^2$

EVALUATE the ANSWER

Is Answer Properly Stated?

Yes in ft/s^2

Is Answer Unreasonable?

No, it is much less than the acceleration of gravity $32\ ft/s^2$

Is Answer Complete?

No, this is much less than g, and the slope is only 10°. It is a reasonable coasting acceleration on a 10° slope, so this seems like an accident.

(extra space if needed) No foul play seems involved.