SOLUTIONS TO
KINEMATICS PROBLEM EXAMPLES #2

① a) $v_i = ?$
$v_f = 0$
$d = 110\,m$
$a = -9.8\,m/s^2$

$d = \frac{v_f^2 - v_i^2}{2a}$

$2ad = v_f^2 - v_i^2$

$\therefore v_i = \sqrt{v_f^2 - 2ad}$

$= \sqrt{0^2 - 2(-9.8\,m/s^2)(110\,m)}$

$= \pm 46\,m/s = \underline{46\,m/s}$

THE NEGATIVE SIGN DOES NOT APPLY IN THIS CASE

b) $t = ?$

$a = \frac{v_f - v_i}{t}$

$\therefore t = \frac{v_f - v_i}{a} = \frac{0 - 46\,m/s}{-9.8\,m/s^2} = \underline{4.7\,s}$

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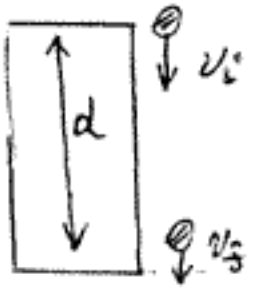
②



a) $v_f = ?$
$v_i = -12\,m/s$
$t = 0.80\,s$
$a = -9.8\,m/s^2$

$a = \frac{v_f - v_i}{t}$

$\therefore v_f = v_i + at$

$= -12\,m/s + (-9.8)(0.8)$

$= \underline{-20\,m/s}$

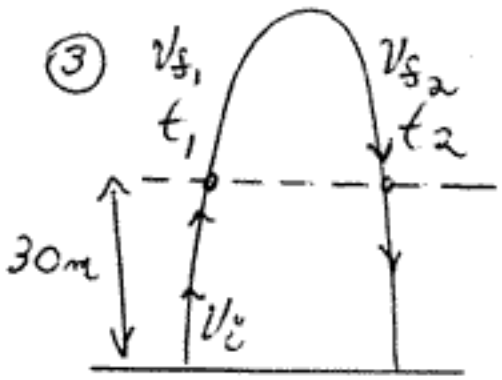
$(-19.8\,m/s)$

b) $d = ?$

$d = \left(\frac{v_i + v_f}{2}\right) t$

$= \left(\frac{-12\,m/s + -19.8\,m/s}{2}\right)(0.80\,s)$

$= \underline{-13\,m}$ (THE HEIGHT IS 13m)



t_1 & t_2 = ?
$d = 30m$ $a = -9.8 m/s^2$
$v_i = 30 m/s$
(THE BALL WILL BE AT 30m ON THE WAY UP & ON THE WAY DOWN.)

METHOD ①

FIND v_f AT t_1 & t_2 FIRST.

$$d = \frac{v_f^2 - v_i^2}{2a}$$

$$\therefore v_f = \sqrt{v_i^2 + 2ad}$$

$$= \sqrt{(30 m/s)^2 + 2(-9.8)(30m)}$$

$$= \pm 17.6 m/s \quad \therefore v_{f_1\,(UP)} = +17.6 m/s$$

$$v_{f_2\,(DOWN)} = -17.6 m/s$$

FROM $a = \frac{v_f - v_i}{t}$

(UP) $t_1 = \frac{v_{f_1} - v_i}{a} = \frac{17.6 m/s - 30 m/s}{-9.8 m/s^2} = 1.26 s$

(DOWN) $t_2 = \frac{v_{f_2} - v_i}{a} = \frac{-17.6 m/s - 30 m/s}{-9.8 m/s^2} = 4.87 s$

The two times are 1.3 s AND 4.9 s. (2 sig. figs)

③ METHOD ②

USE THE QUADRATIC FORMULA

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$d = v_i t + \frac{1}{2} a t^2$$

put this in the quadratic form $ax^2 + bx + c = 0$

$$\frac{1}{2} a t^2 + v_i t - d = 0$$

$$\frac{1}{2}(-9.8)t^2 + 30t - 30 = 0$$

$$-4.9t^2 + 30t - 30 = 0$$

$\therefore$ $a = -4.9$ $\quad b = 30$ $\quad c = -30$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-30 \pm \sqrt{30^2 - 4(-4.9)(-30)}}{2(-4.9)}$$

$\therefore$ $t_1 = \underline{1.26\text{s}}$ & $t_2 = \underline{4.87\text{s}}$

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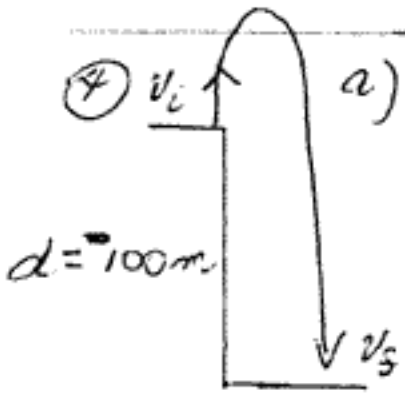
④ 

a) $v_f = ?$

$v_i = 30\text{m/s}$

$a = -9.8\text{m/s}^2$

$d = -100\text{m}$

NOTE THE NEGATIVE

$$d = \frac{v_f^2 - v_i^2}{2a}$$

$$\therefore v_f = \sqrt{v_i^2 + 2ad}$$

$$= \sqrt{30^2 + 2(-9.8)(-100)}$$

$$= \pm 53.5\text{m/s} = \underline{-54\text{m/s}}$$

THE NEGATIVE (DOWN) VALUE IS THE CORRECT ONE

b) $t = ?$

$$a = \frac{v_f - v_i}{t} \quad \therefore \quad t = \frac{v_f - v_i}{a} = \frac{(-54\text{m/s} - 30\text{m/s})}{-9.8\text{m/s}^2}$$

$$= \underline{8.5\text{s}}$$

⑤ a) $\bar{v} = ?$

$v_i = 0 \text{ m/s}$

$v_f = 22 \text{ m/s}$

$t = 40 \text{ s}$

$$\bar{v} = \frac{v_i + v_f}{2}$$

$$= \frac{0 + 22 \text{ m/s}}{2}$$

$$= 11 \text{ m/s}$$

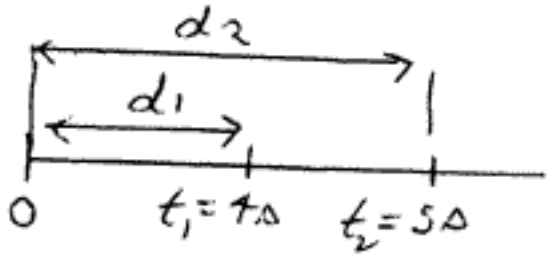
b) $d = ?$

$$d = \left(\frac{v_i + v_f}{2}\right) t$$

$$= \left(\frac{0 + 22}{2}\right) 40 \text{ s}$$

$$= 440 \text{ m}$$

c) $d = ?$



Method one

Find distance after 4.0 s & then distance after 5.0 s. Subtract to find distance during the time interval. You need to find acceleration first.

$$a = \frac{v_f - v_i}{t} = \frac{22 \text{ m/s} - 0}{40 \text{ s}} = \left(\frac{22}{40}\right) \text{m/s}^2$$

$$d_1 = \frac{1}{2} a t_1^2$$

$$= \frac{1}{2} \left(\frac{22}{40} \text{ m/s}^2\right) (4.0)^2$$

$$= 4.4 \text{ m}$$

$$d_2 = \frac{1}{2} a t_2^2$$

$$= \frac{1}{2} \left(\frac{22}{40} \text{ m/s}^2\right) (5.0 \text{ s})^2$$

$$= 6.9 \text{ m}$$

% DISTANCE COVERED IS $\Delta d = d_2 - d_1$

$= 6.9 \text{ m} - 4.4 \text{ m}$

$= 2.5 \text{ m}$