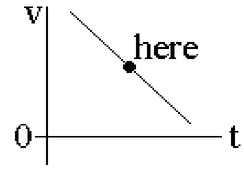
Phy 131 – Assignment 1

A. 1. Yes. For example, a ball which is moving upward has a downward acceleration.

At the point indicated, v is positive. Acceleration, which is the line's slope, is negative since the line runs downhill.



2. Calling up positive,

a) given: $\Delta x = -18.0\text{ m}$, $\Delta t = 2.86\text{ s}$, $a = -g = -9.8\text{ m/s}^2$

find: v_i

$$\Delta x = v_i t + \tfrac{1}{2} a t^2$$
$$-18 = v_i(2.86) + \tfrac{1}{2}(-9.8)(2.86^2)$$
$$-18 = 2.86 v_i - 40.08$$
$$22.08 = 2.86 v_i$$
$$v_i = \frac{22.08}{2.86} = \boxed{7.72\text{ m/s}}$$

Now, instead of considering the whole trip from your hand to the ground, consider just the part from your hand to the maximum height.

b) given: $v_i = 7.72\text{ m/s}$, $v_f = 0$, $a = -9.8\text{ m/s}^2$

find: Δx

$$v_f^2 = v_i^2 + 2a\Delta x$$
$$0^2 = 7.72^2 + 2(-9.8)\Delta x$$
$$0 = 59.6 - 19.6\Delta x$$
$$19.6\Delta x = 59.6$$
$$\Delta x = \frac{59.6}{19.6} = 3.04\text{ m}$$

This is its maximum height above where it was thrown, but the question asks for the maximum height above the ground 18 m below. So,

$$18 + 3.04 = 21.04 \approx \boxed{21.0\ m}$$

B. 1. <u>Yes.</u> Acceleration depends on the rate the velocity is <u>changing</u>, not on v itself. A velocity of zero can be in the process of changing into something else, just like any other velocity can. Or if you prefer, you could explain by giving an example: When a ball going straight up is at the top of its path, it has a velocity of zero at that moment, and an acceleration of 9.8 m/s^2 down.

2.

a) given: $\Delta X = 2.10\ m$ $\quad v_i = 7.40\ m/s$

$a = -g = -9.8\ m/s^2$

find: v_f

$$v_f^2 = v_i^2 + 2a\Delta X$$
$$= 7.4^2 + 2(-9.8)(2.1)$$
$$= 54.76 - 41.16 = 13.6$$
$$v_f = \sqrt{13.6} = 3.69\ m/s$$
$$\Delta v = v_f - v_i = 3.69 - 7.40 = \boxed{-3.71\ m/s}$$

b)

$$v_f^2 = v_i^2 + 2a\Delta X$$
$$= (-7.4)^2 + 2(-9.8)(-2.1)$$
$$= 54.76 + 41.16 = 95.92$$
$$v_f = \sqrt{95.92} = \pm 9.79$$

Select the negative square root because the rock is moving down.

$$\Delta v = v_f - v_i = -9.79 - (-7.40) = \boxed{-2.39\ m/s}$$

C.

$$x = 5.5 + 3.5t - t^3$$
$$v = \frac{dx}{dt} = 0 + 3.5(1) - 3t^2 = 3.5 - 3t^2$$
$$a = \frac{dv}{dt} = 0 + 0 - 3(2t^1) = -6t$$

Evaluate these at t = 2.00 s.

$$x = 5.5 + 3.5(2) - (2)^3 = 5.5 + 7 - 8 = \boxed{4.5\,m}$$

$$v = 3.5 - 3(2)^2 = 3.5 - 12 = \boxed{-8.5\,m/s}$$

$$a = {}^{-}6(2) = \boxed{-12\,m/s^2}$$

D. I did this with down positive because there are fewer minus signs to handle that way. That makes the answers 96.3 ft/s and – 3.09 x 10^3 ft/s^2. On the syllabus, I gave the answers as – 96.3 ft/s & 3.09 x 10^3 ft/s^2 because I thought more people probably did it with up positive. Either way is correct. On a quiz, all that would matter is that your answers have opposite signs from each other.

a. While falling,

$v_i = 0$, $a = g = 32\ ft/s^2$ $\Delta X = 144\ ft$

find: v_f

$v_f^2 = v_i^2 + 2a\Delta X$

$v_f^2 = 0^2 + 2(32\ ft/s^2)(144\ ft)$

$v_f^2 = 9216$

ANS $\boxed{v_f = 96.0\ ft/s}$

b. While crushing box,

$v_i = 96\ ft/s$ (from a)

$\Delta X = 1.5\ ft$ (= 18 in.)

$v_f = 0$ (ends up at rest)

find: a

$$v_f^2 = v_i^2 + 2a\Delta X$$

$$0 = 96^2 + 2a(1.5\ ft)$$

$$0 = 9216 + 3a$$

$$-9216 = 3a$$

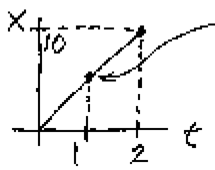
$$a = \frac{-9216}{3} = -3072\ \frac{ft}{s}$$

Rounding to 3 significant figures, a = $\boxed{-3.07\text{x}10^3\ ft/s^2}$

E. 1. The equation $v_f^2 = v_i^2 + 2a\Delta x$ fails because it is derived by assuming a constant acceleration. That assumption is false in this case, so the equation is false too.

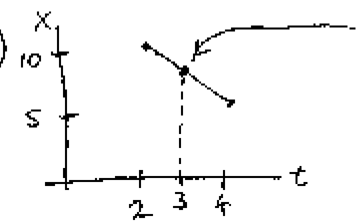
2. Velocity is the slope of an x vs. t graph.

a)



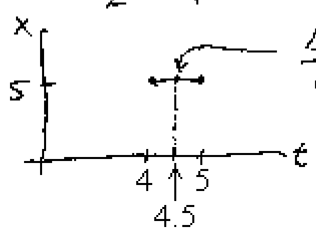
Slope at this point = slope of line segment which contains it = $\frac{\Delta x}{\Delta t} = \frac{10\text{ m}}{2\text{ s}} = \boxed{5\text{ m/s}}$

b)



At t = 3 (like any other point between 2 and 4), $\frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_o} = \frac{5-10}{4-2} = \frac{-5}{2} = \boxed{-2.5\text{ m/s}}$

c)



$\frac{\Delta x}{\Delta t} = \frac{0\text{ m}}{1\text{ s}} = \boxed{0\text{ m/s}}$

F. Apply $\Delta x = v_i t + \frac{1}{2} a t^2$ to the bag's trip from the helicopter to the ground.

$\Delta x = -24$ m (given in question)

$a = -9.8$ m/s^2 (The bag is freely falling.)

If you had the bag's v_i, then t would be the only unknown in that equation. The bag's v_i is the same as the helicopter's velocity at the moment the bag is released.

$v = \frac{dx}{dt} = 3(3t^2) = 9t^2 = 9(2\text{ sec})^2 = 9(4) = \underline{36\text{ m/s}}$ (up)

$$\Delta x = v_i t + \tfrac{1}{2} a t^2$$

$$-24_m = (36\ ^m/_s)t + \tfrac{1}{2}(-9.8\ ^m/_{s^2})t^2$$

$$4.9t^2 - 36t - 24 = 0$$

Quadratic formula:

$$t = \frac{36 \pm \sqrt{36^2 - 4(4.9)(-24)}}{2(4.9)}$$

$$= \frac{36 \pm \sqrt{1296 + 470.4}}{9.8} \leftarrow \sqrt{1766.4} = 42.03$$

36 – 42.03 gives a negative time which would mean the bag hit the ground before it was released. So, the correct answer comes from using the + sign.

$$\frac{36 + 42.03}{9.8} = \boxed{7.96\ s}\ \text{ANS}$$