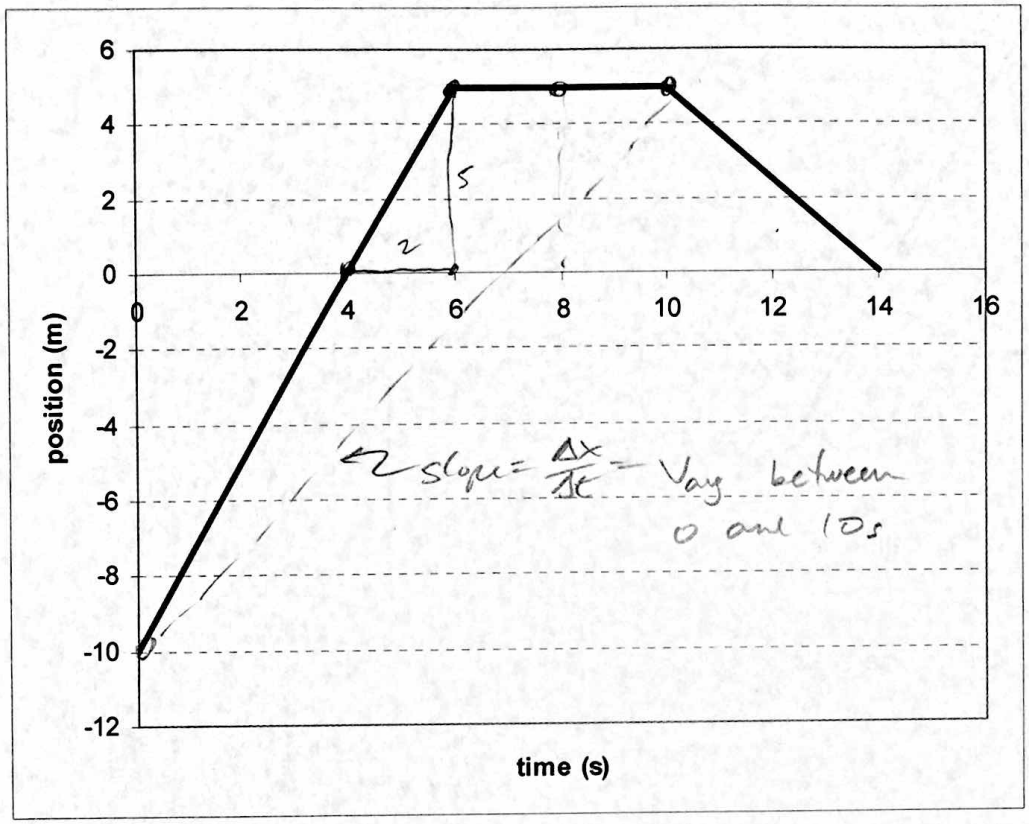
Name: STANFORD Date: _____ Block: _____

NV College Physics PQuiz: chapter 2 part 2-graphs and free-fall

Section A: Graphs. (40 pts.) Each of the following questions refers to the graph preceding it. Answer each question in the space provided. Show your work.

This is a position vs. time graph for the motion of a car.



1) What is the velocity of the car at a time t= 4s?

$v = \frac{\Delta x}{t}$ = slope @ t=4: $v = \frac{5m}{2s} = 2.5 m/s$

1) 2.5 m/s

2) What is the position of the car at time t = 8s?

x=5m, just read from graph!

2) 5m

3) What is the velocity of the car at time t = 7s?

$v = \frac{\Delta x}{t}$ = slope = 0 @ t=7s

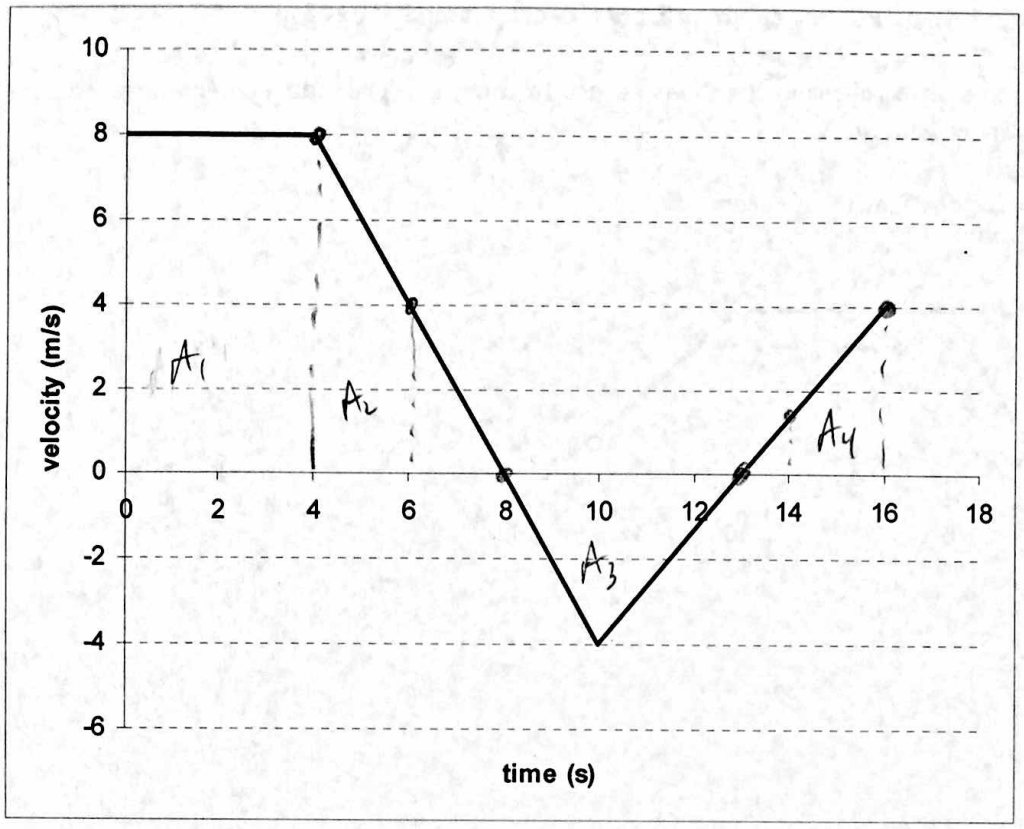
3) 0

4) What is the **average** velocity of the car between t = 0 and t= 10s?

$v_{avg} = \frac{\Delta x}{t} = \frac{5-(-10)}{10} = \frac{15m}{10s} = 1.5 m/s$

4) 1.5 m/s

This is a velocity vs. time graph for the motion of a train on a straight track.



5) What is the velocity of the train at time t= 2s?

Read from graph!

5) 8 m/s

6) What is the acceleration of the train at t= 6s?

$a = \frac{\Delta v}{t} = \text{slope @ } t=6 = \frac{0-8}{8-4} = -2\ m/s^2$

6) $-2\ m/s^2$

7) What is the acceleration of the train at t = 14s?

$a = \text{slope @ } t=14 = \frac{4-0}{16-13} = \frac{4}{3}\ m/s^2$

7) $1.33\ m/s^2$

8) What is the total displacement of the train between t=0 and t=16s?

Area "under" graph $= A_1 + A_2 + A_3 + A_4$

$= \underbrace{8 \cdot 4}_{A_1} + \underbrace{\frac{1}{2}(8 \cdot 4)}_{A_2} + \underbrace{\frac{1}{2}(5)(-4)}_{A_3} + \frac{1}{2}(3)(4)$

$= 32 + 16 - 10 + 6 = 44\ m$

8) 44m

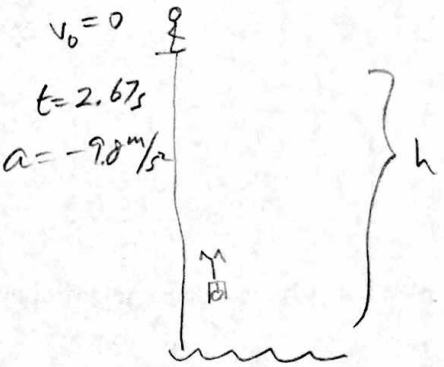
Section B: Free-Fall. For each problem find the requested quantity. Define your variables, show all your work and circle or box your answer. IGNORE THE EFFECTS OF AIR RESISTANCE ON FREE-FALL MOTION.

1) The cliff divers of Acapulco make dives from the top of a high cliff and land in the Pacific Ocean. A diver typically jumps off the top of the cliff and hits the water 2.67s later.

a) How fast is the diver going when he strikes the water? Assume he starts with zero initial velocity.

$v = \cancel{v_0}^{0} + at = 0 - 9.8(2.67) = -26.2\ m/s$

Speed = 26.2 m/s



b) How high is the cliff?

$\Delta x = \cancel{v_0 t}^{0} + \frac{1}{2}at^2 = \frac{1}{2}(-9.8)(2.67)^2$

$= -34.9m$, $h = 34.9m$

2) A student drops a pumpkin (initial velocity zero) from a rooftop that is 40m high.

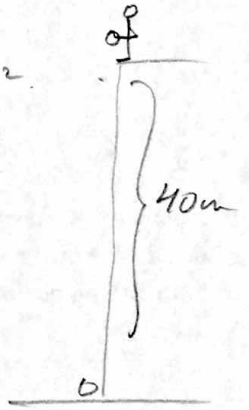
a) How long is the pumpkin in the air?

$\Delta y = \cancel{v_0 t}^{0} + \frac{1}{2}at^2$

$-40 = \frac{1}{2}(-9.8)t^2$

$t = 2.86s$

$\Delta y = -40m$
$a = -9.8\ m/s^2$
$v_0 = 0$



b) What is its velocity as it reaches the ground?

$v^2 = \cancel{v_0^2}^{0} + 2a(\Delta y)$

$v^2 = 2(-9.8)(-40) = 784$

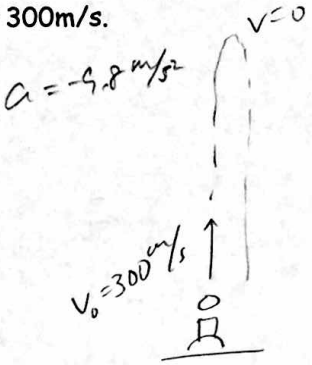
v = 28 m/s down

3) A cannonball is shot straight up into the air with an initial velocity of 300m/s.

a) What maximum height does it reach?

$v^2 = v_0^2 + 2a\Delta y$

$\Delta y = \frac{\cancel{v^2}^{0} - v_0^2}{2a} = \frac{-(300)^2}{2(-9.8)} = 4592m$



b) how long is it in the air?

going up: $v_0 = 300\ m/s$, $v = 0$, $a = -9.8\ m/s^2$

$v = v_0 + a t_{up}$

$0 = 300 + (-9.8)t_{up}$

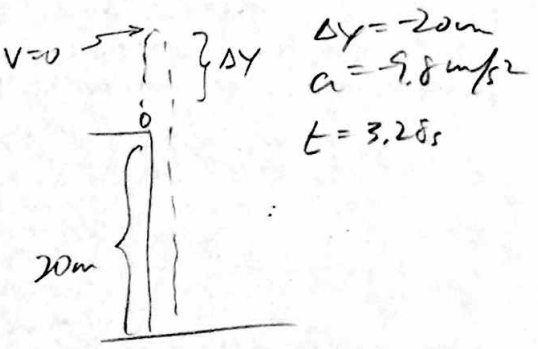
$t_{up} = 30.61s = t_{down}$

total time $= t_{up} + t_{down}$

$= 61.2s$

4) A trick-or-treater throws and apple upward from the edge of a rooftop that is 20m above the ground. The apple comes back down and just misses the edge of the rooftop as it falls all the way to the ground. It is in the air for 3.28s between the time that is thrown upward and the time it lands on the ground below.

a) What was the initial velocity of the apple?



$\Delta y = v_0 t + \frac{1}{2} a t^2$

$-20 = v_0(3.28) + \frac{1}{2}(-9.8)(3.28)^2$

$\boxed{v_0 = 9.97 \text{ m/s up}}$

b) What is its maximum height above the ground?

At max height: $v = 0$, $a = -9.8 \text{ m/s}^2$

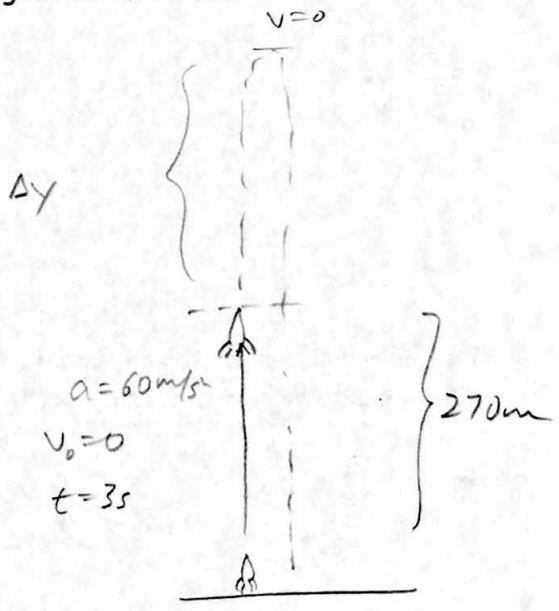
$v^2 = v_0^2 + 2a(\Delta y)$

$\Delta y = \frac{v^2 - v_0^2}{2a} = \frac{-(9.97)^2}{2(-9.8)} = 5.07\text{m}$

$h = \Delta y + 20\text{m} = \boxed{25.07\text{m}}$

5) A rocket is initially at rest on the ground. It is launched straight up into the air with an acceleration of 60m/s2. After three seconds the engine runs out of fuel and the rocket goes into free-fall.

a) Find the height of the rocket at three seconds



$\Delta y = v_0 t + \frac{1}{2} a t^2$

$\Delta y = \frac{1}{2}(60)3^2 = \boxed{270\text{m}}$

V @ 3s : $v = v_0 + at = 0 + 60(3) = 180 \text{ m/s}$

b) What maximum height does it reach?

$v^2 = v_0^2 + 2a(\Delta y)$

$\Delta y = \frac{v^2 - v_0^2}{2a} =$

In free fall going up:
$v_0 = 180 \text{ m/s}$
$v = 0$, $a = -9.8 \text{ m/s}^2$

$\Delta y = \frac{0 - 180^2}{2(-9.8)} = \boxed{1653\text{m}}$

c) How long is the rocket in the air from launch to landing?

t = time in free-fall:

$v_0 = 180 \text{ m/s}$

$\Delta y = -270\text{m}$

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

$\Delta y = v_0 t + \frac{1}{2} a t^2$

$-270 = 180t - 4.9t^2$

or

$4.9t^2 - 180t - 270 = 0$

by quadratic formula:

$t = 38.2\text{s}$ or ~~-1.44s~~

$+ 3\text{s}$

$\boxed{41.2\text{s}}$ = total time in air