PHY 115 - Spring 2014

QUIZ 2 KEY

(With worked out solutions)

Part 1 – Multiple choice problems. Choose 2 out of 3, or do all 3 problems.

1. A helicopter is moving straight upward with a constant, non-zero acceleration. The vertical position versus time graph of this helicopter is

a. A vertical straight line.

b. A horizontal straight line.

c. A straight line making an angle with the time axis.

d. A sinusoidal curve.

e. A parabolic curve.

Answer: e

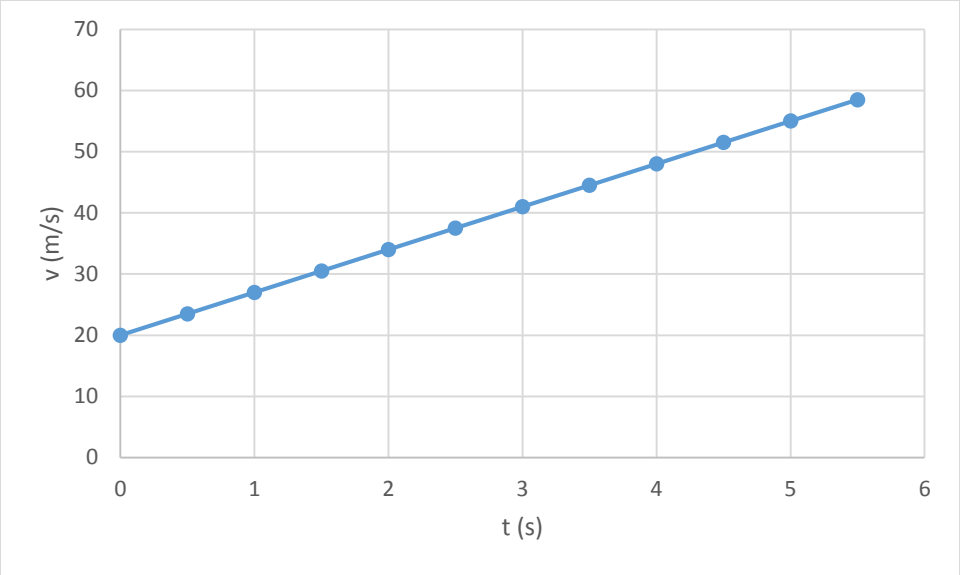
Solution:

Let's say the helicopter is accelerating at +7.0 m/s^2 , and y is positive upwards. We can assume any initial velocity. I will assume $\overrightarrow{v_0} = 20\frac{m}{s}$. We can also assume any initial position. I will assume y_0 = 0 m.

Then the corresponding velocity versus time and position versus time equations and graphs are:

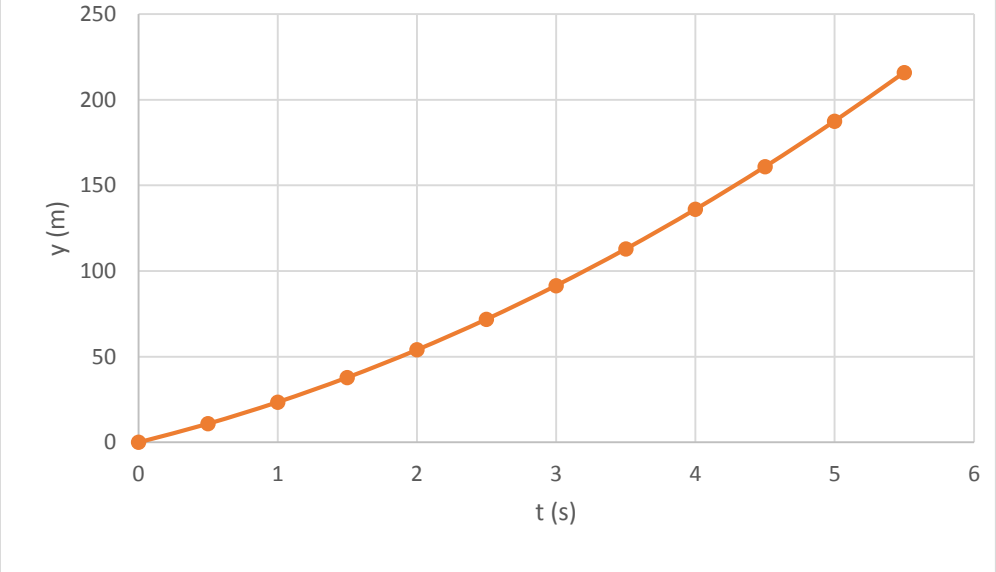
Velocity versus time:

$\vec{v} = \vec{v}_0 + \vec{a}t$



Position versus time:

$$\vec{y} = \overrightarrow{y_0} + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$



This is a parabolic curve.

2. In a demonstration, an engineer drops two smartphones from the Tokyo Skytree. The smartphones are dropped at an interval of 1.0 s apart. As the smartphones fall, the difference in their speeds

a. increases.

b. remains constant.

c. decreases.

d. nothing can be said about the difference in their speeds, because the height of the Tokyo Skytree was not provided.

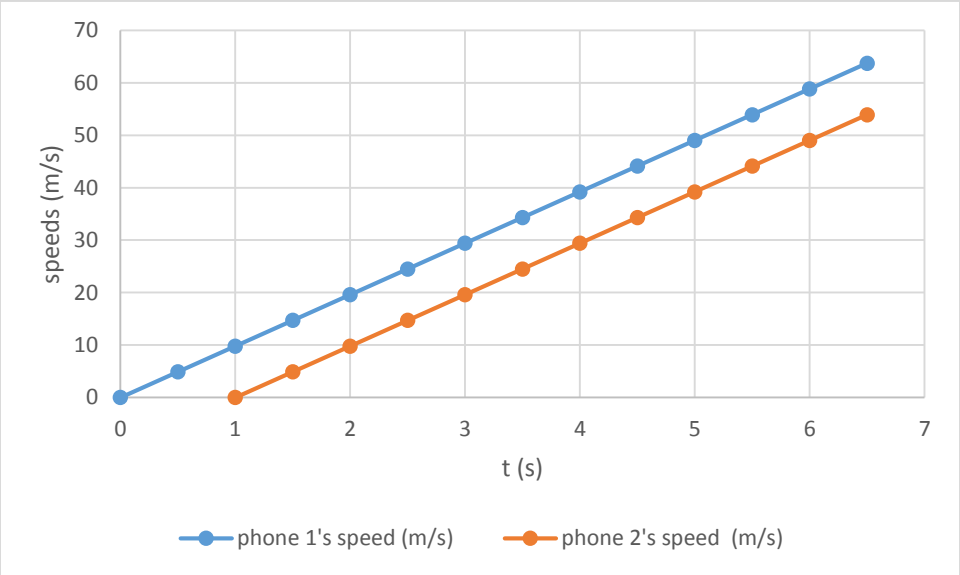
e. increases at first, but then remains constant.

Answer: b

Explanation: both initial velocities are equal to zero, since both smartphones are dropped. After they start falling, their speeds will increase at the constant rate of 9.8 meters per second every second. Therefore the difference between the speeds is constant.

Note: it should be always assumed that what is happening when an object falls is free fall, unless a drag force is provided.

Speed versus time graphs:



3. A beginner ice skater is moving in a straight path due north at a constant speed of 5.0 m/s. After traveling 20 m from his initial position, he hits a wall, and, feeling dizzy, stays at the same position (by the wall) for 0.50 minutes. He then moves due south at a constant speed of 2.0 m/s, returning to his initial position. What is the ice skater's average speed?

a. 0.00 m/s.

b. 0.91 m/s

c. 1.2 m/s

d. 2.9 m/s

e. 1.2×10^{-1} m/s

Answer: b

The average speed is: $avg.speed = \frac{total\ distance\ traveled}{total\ time\ elapsed}$

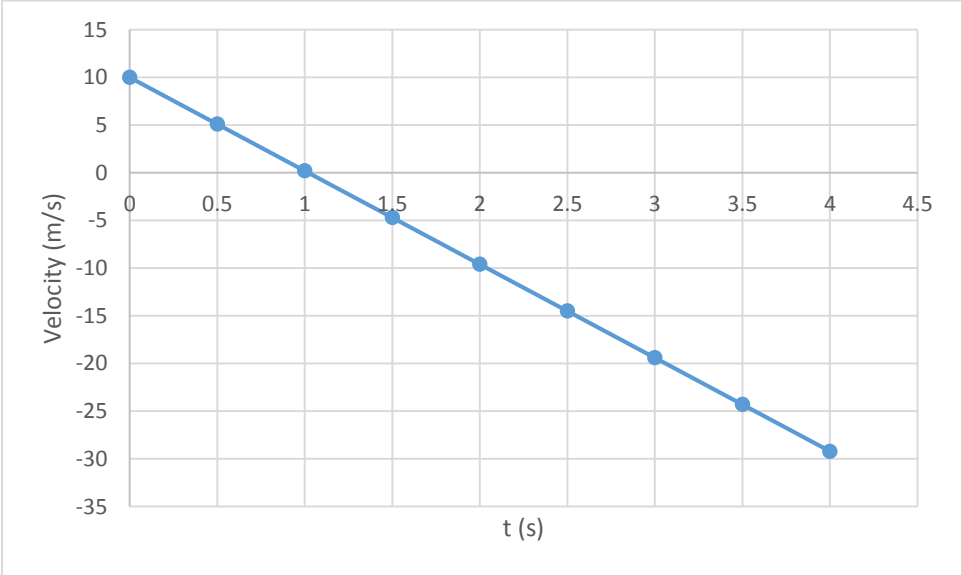
The total time is: $t = \frac{20\ m}{5.0\frac{m}{s}}$ + 30 s + $\frac{20\ m}{2.0\ m/s}$ = 44 s

The total distance is: $d = 20\ m + 0 + 20\ m = 40\ m$

So the average speed is: : $avg.speed = \frac{40\ m}{44s} \approx$ $0.91\frac{m}{s}$ $(rounded\ to\ two\ sig.figs.)$

4. Part 2 – This problem is mandatory

The coordinate system above, where y is positive upwards, is used in the graph below. The graph represents the 1-D motion of a basketball being thrown directly upwards from a building.



What is the total displacement (*reminder:* displacement is a vector) of this basketball? You must show your work for this question.

Solution:

The total displacement can by calculated using the area under the curve of the graph above.

$$\Delta\vec{y} \approx \frac{10\,\frac{m}{s} * 1.0\ s}{2} - \frac{28\left(\frac{m}{s}\right) * (4.0\ s - 1.0\ s)}{2} = 5.0\ m - 42\ m = \boxed{-38\ m}$$

Note that approximate values were used for the quantities that were graphed. Using the final velocity as -30 m/s, for example, is acceptable, therefore a displacement of -40 m is also an acceptable answer.

OR you can use the equation:

$$\Delta\vec{y} = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2 = 10\,\frac{m}{s} * 4.0s + 0.5 * \left(-9.8\,\frac{m}{s^2}\right) * 16\ s^2 = \text{-38.4 m} \approx \boxed{-38\ m}$$