10 Sep 2015

Physics 1307 Examination 1

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Please PRINT your name so that we can read it.

Name: Solutions

BOX your final answers.

SHOW work for maximum credit.

Be Brilliant!

Q1 2 pts A swimmer is swimming laps in the SMU pool. She swims in a single lane, back and forth at a constant *speed* of 2.5 m/s. The lane runs in the North-South direction. What is her average *velocity*? Circle the one best answer.

a) Her average velocity is zero.

b) her average velocity is 10 m/s North.

c) her average velocity is 10 m/s South.

d) None of the above answers is correct.

Q2 2 pts You toss a ball directly upwards with some initial velocity. The ball reaches some height and then falls back to the ground. What can you say about the acceleration of the ball after it has left your hand and just before it strikes the ground? Circle the single best answer.

a) The acceleration is constant throughout the flight.

b) The acceleration is constant in magnitude but changes direction when the ball starts downward.

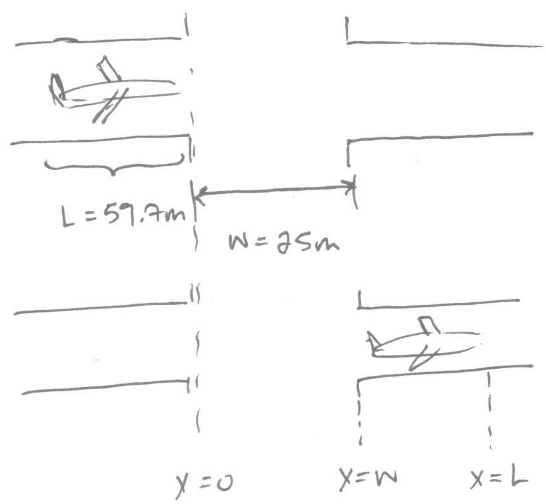
c) The acceleration direction is constant but changes in magnitude during the ball's flight.

d) None of the above answers is correct.

Q3 15 pts A Boeing 747 "Jumbo Jet" has a length $L = 59.7\,\text{m}$. The runway on which the plane lands intersects another runway. The width w of the intersection is $w = 25.0\,\text{m}$. The plane decelerates through the intersection at a rate of $a = -5.70\,\text{m/s}^2$ and clears it with a final speed of $45.0\,\text{m/s}$. (By clear, I mean the tail end of the plane has passed through the intersection, not just the nose.) How much time t is needed for the plane to clear the intersection? Box that answer.

initial:

final:



$\longrightarrow$ $\Delta x = L + W = 59.7\,\text{m} + 25\,\text{m}$

$a = -5.7\,\text{m/s}^2$

$v_i = ?$

$v_f = 45\,\text{m/s}$

$t = ?$

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

$$v_i^2 = v_f^2 - 2a\Delta x$$

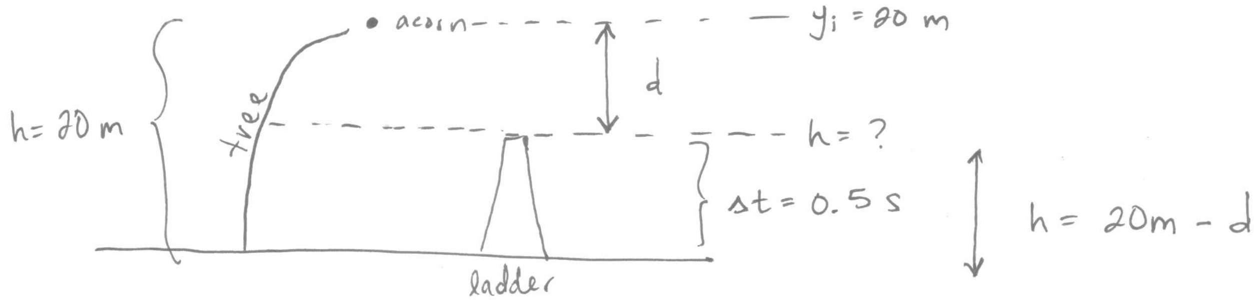
$$v_i = \sqrt{(45\,\text{m/s})^2 - 2(-5.7\,\text{m/s}^2)(59.7\,\text{m} + 25\,\text{m})}$$

$$= 54.69\,\text{m/s}$$

then $v_f = v_i + at \longrightarrow t = \dfrac{v_f - v_i}{a} = \dfrac{45\,\text{m/s} - 54.69\,\text{m/s}}{-5.7\,\text{m/s}^2}$

$$\boxed{t = 1.7\,\text{s}}$$

Q4 10 pts From atop a ladder of unknown height h you see a squirrel in a walnut tree 20 m above the ground eating walnuts. The little guy occasionally drops one from rest from its tiny paws. When this happens, you notice, alert observer that you are, that a walnut takes $t_p = 0.5$ sec to pass by your ladder on the way to the ground. What is the height h of your ladder? To make calculations easier, you can round the value of the gravitational acceleration g to have the value $g = 10\,\text{m/s}^2$, even though the more accurate value is $g = 9.8\,\text{m/s}^2$. Box your answer.



time to fall all the way to the ground:

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

$$20\text{ m} = \frac{1}{2}(10\text{ m/s}^2)t^2 \longrightarrow t_{total} = \sqrt{\frac{2 \cdot 20\text{m}}{10\text{ m/s}^2}} = 2\text{ s}$$

$\longrightarrow$ time to fall from tree to ladder $= 2\text{s} - 0.5\text{s} = 1.5\text{ s}$

distance from top of tree to top of ladder:

$$d = \Delta y = \cancel{v_0 t}^{\,0} + \frac{1}{2}at^2 = \frac{1}{2}(10\text{ m/s}^2)(1.5\text{ s})^2 = 11.25\text{m}$$

height of ladder $h = 20\text{m} - d = 20\text{ m} - 11.25\text{m}$

$$\boxed{h = 8.75\text{ m}}$$

Q5 10 pts The left ventricle of the heart accelerates blood from rest to a velocity of +26 cm/sec. You can assume for this question that the blood travels in a straight line. I recommend you do your calculation using centimeters. This is a rare case where we will not use meters for lengths and displacements in a calculation.

a) 5 pts If the displacement of the blood during the acceleration is +2.0 cm, determine its acceleration $\vec{a}$ (in cm/sec^2).

$|\vec{v}_i| = 0 \text{ cm/s}$

$|\vec{v}_f| = +26 \text{ cm/s}$

$\Delta x = +2 \text{ cm/s}$

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

$v_f^2 - v_i^2 = 2a\Delta x$

$$a = \frac{v_f^2 - v_i^2}{2\Delta x} = \frac{(26 \text{ cm/s})^2}{2(2 \text{ cm})}$$

$$\boxed{|\vec{a}| = +169 \text{ cm/s}^2}$$

b) 5 pts How much time t does it take for the blood to reach its final velocity?

$$V_f = V_i + at$$

$$t = \frac{V_f - V_i}{a} = \frac{26\ cm/s}{169\ cm/s^2}$$

$$\boxed{t = 0.15\ s}$$

Extra credit. 1 pt. Identify the author of the following definitions.

Distance, *n.* The only thing that the rich are willing for the poor to call theirs and keep.

Kill, *v.t.* To create a vacancy without nominating a successor.

Plan, *v.t.* To bother about the best method of accomplishing an accidental result.

- Mark Twain;
- Benjamin Franklin;
- Sarah Palin;
- William Shakespeare;
- Ambrose Bierce;
- Hillary Clinton.