Midterm Exam No. 01 (2014 Summer)

PHYS 203A: College Physics

Date: 2014 Jun 20

Solution

(Name) (Signature)

1. **(10 points.)** Convert $10^6\,\text{mm}^2$ to μm^2.

2. **(10 points.)** You are driving into St. Louis, Missouri, and in the distance you see the famous Gateway-to-the-West arch. This monument rises to a height of 192 m. You estimate your line of sight with the top of the arch to be 5.0° above the horizontal. Approximately how far are you from the base of the arch?

3. **(10 points.)** A dog searching for a bone walks 5.00 m at an angle 45° North of East, then 10.0 m at an angle 30° North of West. What is the magnitude and direction of the dog's resultant displacement vector?

4. **(10 points.)** An Australian emu is running along a straight line at a speed of 17.3 m/s. It slows down uniformly to a speed of 14.3 m/s in 7.0 s. How much distance does the emu cover in this time?

5. **(10 points.)** A ball thrown vertically up takes 2.0 s to reach its highest point. How high does the ball rise?

6. **(10 points.)** An airplane flying horizontally at a constant speed of 350 km/h over level ground releases a bundle of food supplies. Ignore the effect of air on the bundle.

   (a) What is the bundle's initial vertical component of velocity?

   (b) What is the bundle's initial horizontal component of velocity?

   (c) What is the bundle's horizontal component of velocity just before hitting the ground?

   (d) If the airplane's speed were, instead 450 m/s, would the time of fall be larger, smaller, or the same?

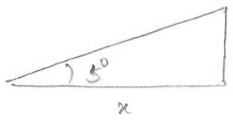
7. **(10 points.)** A ball is projected horizontally from the edge of a table that is 2.00 m high, and it strikes the floor at a point 3.00 m from the base of the table. What is the initial speed of the ball?

8. **(10 points.)** Figure 1 shows three paths for a football kicked from ground level. Ignore the effects of air. Rank the paths according to initial vertical velocity component.

Midterm 1, Prob 1

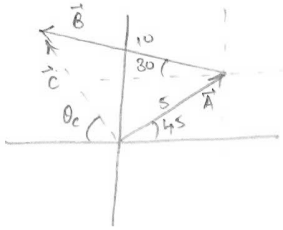
$$10^6\ mm^2 \times \frac{10^3\ \mu m}{1\ mm} \times \frac{10^3\ \mu m}{1\ mm} = 10^{12}\ \mu m^2$$

Midterm 1, Prob 2



$$\tan(15) = \frac{192}{x} \Rightarrow x = \frac{192\ m}{\tan(15)} = 2195\ m$$

Midterm 1, Prob 3



$$\vec{A} = 5\cos 45\,\hat{i} + 5\sin 45\,\hat{j}$$
$$= 3.54\,\hat{i} + 3.54\,\hat{j}$$

$$\vec{B} = -10\cos 30\,\hat{i} + 10\sin 30\,\hat{j}$$
$$= -8.66\,\hat{i} + 5\,\hat{j}$$

$$\vec{C} = \vec{A} + \vec{B} = -5.12\,\hat{i} + 8.54\,\hat{j}$$

$$|\vec{C}| = \sqrt{(-5.12)^2 + (8.54)^2} = 9.96\ m$$

$$\theta_c = \tan^{-1}\left(\frac{8.54}{5.12}\right) = 59.1^\circ \text{ N of West}$$

Midterm 1, Prob 4

$\Delta x =$?

$\Delta t = 7$ sec

$V_i = 17.3$ m/s

$V_f = 14.3$ m/s

$a =$

$$\frac{\Delta x}{\Delta t} = \frac{V_f + V_i}{2}$$

$$\Delta x = \frac{17.3 + 14.3}{2} \times 7. = 110.6\ m$$

Midterm 1, Prob. 5

$\Delta y =$ $\quad V_i =$ $\quad a = -9.8\ m/s^2$.

$\Delta t = 2$ sec. $\quad V_f = 0$

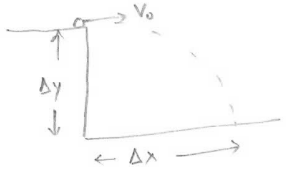
$$\Delta y = V_f \Delta t - \frac{1}{2} a \Delta t^2$$
$$= 0 - \frac{1}{2}(-9.8)\, 2^2 = 19.6\ m.$$

Midterm 1, Prob 6

(a) 0 (b) 350 $\frac{km}{h}$ (c) 350 $\frac{km}{h}$

(d) Same. $\Delta y = \frac{1}{2} g \Delta t^2 \Rightarrow$ Δt is independent of the initial horizontal velocity.

Midterm 1, Prob 7



$\Delta x = V_0 \Delta t$.

$\Delta y = \frac{1}{2} g \Delta t^2$.

$$\Rightarrow V_0 = \frac{\Delta x}{\sqrt{\frac{2\Delta y}{g}}} = \frac{3}{\sqrt{\frac{2\times 2}{9.8}}} = 4.7\ m/s$$

Midterm 1, Prob 8

V_{yi} = initial vertical component of velocity.

H = maximum height. (same for all paths).

$$H = \frac{V_{yi}^2}{2g}$$

$$V_{yi}^2 = 2gH$$

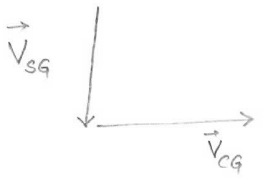
$\Rightarrow$ All paths, a, b & c, have the same vertical component of velocity.

Midterm 1, Prob 9

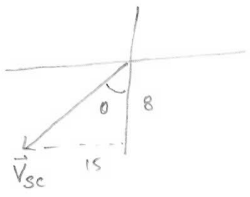
S - Snow
C - Car
G - Ground.

$\vec{V}_{SG} = 0\,\hat{i} - 8\,\hat{j}$

$\vec{V}_{CG} = 15\,\hat{i} - 0\,\hat{j}$



$$\vec{V}_{SC} = \vec{V}_{SG} + \vec{V}_{GC}$$
$$= \vec{V}_{SG} - \vec{V}_{CG}$$
$$= -15\,\hat{i} - 8\,\hat{j}$$



$\theta = \tan^{-1}\left(\frac{15}{8}\right) = 61.93$, West of South

Midterm 1, Prob 10

$$t = t_{downstream} + t_{upstream}$$
$$= \frac{3000\,m}{(20+5)\,m/s} + \frac{3000\,m}{(20-5)\,m/s}$$
$$= \frac{3000}{25} + \frac{3000}{15}$$
$$= 120 + 200$$
$$= 320\,sec.$$