

Physics 10154 - Exam #1a

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A car drives in a straight line, due East, with a constant speed of 75 miles/hour. During the trip, the driver makes a 17 minute rest stop. The average velocity for the entire trip, including the rest stop, is 66 miles/hour. What is the total distance covered during the trip, in miles?

<u>Part 1</u>	<u>Part 2</u>	<u>Total</u>
$\Delta x_1 = ?$	$\Delta x_2 = 0$	$\Delta x_T = ?$
$v_1 = 75 \text{ mi/hr}$	$v_2 = 0$	$v_T = 66 \text{ mi/hr}$
$t_1 = ?$	$t_2 = 0.283 \text{ hr}$	$t_T = ?$

$$v_T = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2} = \frac{v_1 t_1 + 0}{t_1 + t_2}$$

$$66 = \frac{75 t_1}{t_1 + 0.283}$$

$$66 t_1 + 18.7 = 75 t_1$$

$$9 t_1 = 18.7$$

$$t_1 = 2.08 \text{ hr}$$

$$\Delta x_1 = \Delta x_T = v_1 t_1 = (75)(2.08) = \boxed{160 \text{ miles}}$$

2. (30 pts) A parachutist is descending at a constant speed of 18 miles/hour. When he is at an altitude of 250 meters above the ground, he drops his camera.

How long does it take for the camera to hit the ground, and with what speed (in meters/sec) does the camera hit the ground?

$$\Delta y = 250$$

$$v_{0y} = 18 \text{ mi/hr} = 8.045 \text{ m/s}$$

$$v_y = ?$$

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

$$t = ?$$

$$v_y^2 = v_{0y}^2 + 2a_y \Delta y$$

$$= 8.045^2 + 2(9.8)(250)$$

$$= 4964.7$$

$$v_y = 70.46 = \boxed{70 \text{ m/s}}$$

$$v_y = v_{0y} + a_y t$$

$$70.46 = 8.045 + 9.8t$$

$$t = \frac{62.416}{9.8} = \boxed{6.4 \text{ s}}$$

3. (40 pts) A motorcyclist starts from rest at ground level and accelerates up a 22° ramp for 4.0 seconds at a rate of 14 m/s^2 .

a) What maximum height above ground level does the motorcycle reach (be sure to include the ramp height in your calculations)?

b) What is the motorcycle's speed at maximum height?

c) How far does the motorcycle travel before landing, in horizontal distance, from the point at ground level just below takeoff point?

On ramp

$$\Delta s = ?$$

$$v_0 = 0$$

$$v = ?$$

$$a = 14.0$$

$$t = 4.0$$

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

$$= 0 + \frac{1}{2} (14)(16) = 112$$

$$\Delta x = \Delta s \cos 22^\circ = 103.8 \text{ m}$$

$$\Delta y = \Delta s \sin 22^\circ = 41.96 \text{ m}$$

$$v = v_0 + a t = 56 \text{ m/s}$$

$$v_{0x} = 56 \cos 22^\circ = 51.92 \text{ m/s}$$

$$v_{0y} = 56 \sin 22^\circ = 20.98 \text{ m/s}$$

Free fall to max ht.

$$\Delta y = ?$$

$$v_{0y} = 20.98$$

$$v_y = 0$$

$$a_y = -9.8$$

$$t = ?$$

$$v_y^2 = v_{0y}^2 + 2a_y \Delta y$$

$$0 = 20.98^2 + 2(-9.8)\Delta y$$

$$\Delta y = 22.46$$

$$\Delta y_{\text{tot}} = 41.96 + 22.46 = \boxed{64 \text{ m}}$$

At max ht $v_y = 0$ $v_x = v_{0x} = \boxed{52 \text{ m/s}}$

Free fall to landing $-41.96 = 20.98t - 4.9t^2$

$$\Delta y = -41.96$$

$$v_{0y} = 20.98$$

$$v_y = ?$$

$$a_y = -9.8$$

$$t = ?$$

$$4.9t^2 - 20.98t - 41.96 = 0$$

$$t = \frac{20.98 \pm \sqrt{(20.98)^2 - 4(4.9)(-41.96)}}{9.8}$$

$$= 2.14 \pm 3.63 = 5.77$$

$$\Delta x = v_{0x} t = (51.92)(5.77)$$

$$\boxed{300 \text{ m}}$$

Alternate solution

Free fall to max ht

$$V_y = v_{0y} + a_y t$$

$$0 = 20.98 - 9.8t \quad t = 2.14 \text{ s}$$

$$\Delta x = v_{0x} t = 111.15 \text{ m}$$

Max ht to ground

$$\Delta y = -64 \quad -64 = 0 - 4.9t^2$$

$$v_{0y} = 0$$

$$t = \sqrt{\frac{64}{4.9}} = 3.63$$

$$v_y = ?$$

$$a_y = -9.8$$

$$\Delta x = v_{0x} t = 188.47$$

$$t = ?$$

$$\Delta x_{\text{TOT}} = 111.15 + 188.47 = \boxed{300 \text{ m}}$$