Homework: http://math.mnrt.net/

Name _____ raw scaled percent

Physics Trimester 1 Exam 1 - In Class Part (200 Points)

One Dimensional Motion

■ **There are 8 questions.**

You have an average of $7\frac{1}{2}$ minutes per question.

Each question counts for 25 points.

■ **For all questions neglect friction, air resistance, etc.**

Take the acceleration of gravity to be 9.81 $\frac{m}{s^2}$ directed toward the earth.

Round answers to 3 digits to the right of the decimal point (e.g. 32.2416 → 32.242).

■ **Handy equations**

1. $x(t) = x_0 + v_0\, t + \frac{1}{2}\, a\, t^2$
2. $v^2 = v_0{}^2 + 2\, a(x - x_0)$

■ **A. Answer the following.**

[1] The displacement as a function of time of an object with initial position x_0, initial velocity v_0 and constant acceleration a is given by the equation $\boldsymbol{x(t) = x_0 + v_0\, t + \frac{1}{2}\, a\, t^2}$. Write the equation for the velocity of this object as a function of time.

$v(t) = v_0 + at$

[2] A good pitcher can throw a baseball 90 mph. The distance from the pitcher's release of the ball to the batter is 60 feet. How long (in seconds) does the ball take to reach the batter? (1 mile = 5280 feet).

$$\left(90 \frac{mi}{h}\right)\left(\frac{h}{3600 s}\right)\left(\frac{5280 f}{mi}\right) = 132 \frac{f}{s}$$

$$\left(132 \frac{f}{s}\right) t = 60 f$$

$$t = \frac{60 f}{132 f}$$

$$\therefore \quad t = 0.455 s$$

[3] A ball is dropped from a height of 30 m. What is its velocity just as it hits the ground?

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

$$= 2\left(-9.81 \tfrac{m}{s^2}\right)(-30\ m)$$

$$= 588.6 \tfrac{m^2}{s^2}$$

$$\therefore \vec{v} = 24.261 \tfrac{m}{s}, \text{ down}$$

[4] A ball released with initial velocity of 20 $\frac{m}{s}$ straight up. How long does it take for the ball to reach its maximum height?

$V_0 = 20 \frac{m}{s}$

Ymat at $V(t) = 0$

$V = 20 \frac{m}{s} - (9.81 \frac{m}{s^2}) t = 0$

$\therefore \quad t = 2.039 \text{ s}$

[5] A bullet is fired from ground level (height = 0) with initial velocity of 400 $\frac{m}{s}$ straight up. How long does it take for the bullet to hit the ground?

time to return to ground is twice time to max hght.

y_{max} when $v(t) = 0 = 400 \frac{m}{s} - (9.81 \frac{m}{s^2})t$

$\Rightarrow t = 40.775$ s

$\therefore$ Takes 81.549 s to return to ground.

[6] The displacement of a certain object is given as a function of time by the equation $x(t) = 16\,t - 2\,t^2$, where x is in meters and t is in seconds. What is the object's average velocity for the portion of its motion that is in the positive direction?

$x(t) = 16t - 2t^2$

$v(t) = 16 - 4t$

$\boxed{t = 4s} \Rightarrow v(t) = 0$ after which object moves in negative direction.

$$v_{Avg} = \frac{\Delta x}{\Delta t}$$

$$x(16s) = \left(16 \tfrac{m}{s}\right)(4\ s) - \left(2 \tfrac{m}{s^2}\right)(16\ s^2)$$

$$= 32\ m$$

then $\frac{32\ m}{4\ s} = v_{Avg} = 8\ \frac{m}{s}$

∴ Avg vel for positive portion is $8\ \frac{m}{s}$

[7] The Porsche 911C4 has a 60 mph – 0 mph stopping distance of 105 feet. This means such a car when brought to a complete stop from a speed of 60 mph ($88 \frac{\text{feet}}{s}$) travels only 105 feet in the process. Assuming that the acceleration is a constant, how long in seconds does it take for the car to come to a complete stop from 60 mph?

$V_0 = 60 \frac{mi}{h} = 88 \frac{f}{s}$

$V_f = 0$

$\Delta x = 105\ f$

$\Delta x = \frac{1}{2}(V_0 + V)t$

$105\ f = \frac{1}{2}\left[88 \frac{f}{s} + 0\right] t$

$\Rightarrow \quad t = \frac{210\ f}{88\ f/s}$

$t = 2.386\ s$

$\therefore$ Takes 2.386 s to bring car to a stop from a speed of 60 mph.

[8] Raindrops fall 1700 m from a cloud to the ground. It is fortunate that they are slowed by air resistance, else it would be painful to be hit by them. If they were not slowed by air resistance, how fast would they be traveling when they hit the ground?

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

$$= 2\left(-9.81 \tfrac{m}{s^2}\right)(-1700\ m)$$

$$= 33354\ m^2/s^2$$

$$\therefore\ v = 182.631\ \tfrac{m}{s}$$