General Physics I **Exam 1 - Chs. 1,2,3 - Units, Motion** **Sep. 16, 2009**

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show the formulas you use, the essential steps, and results with correct units and correct number of significant figures. Partial credit is available if your work is clear. Point values are given in parenthesis. Use g = 9.80 m/s^2. Exact conversions: 1 inch = 2.54 cm, 1 ft = 12 in., 1 mile = 5280 ft. Prefixes: p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^3, M=10^6, G=10^9, T=10^{12}.

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1. (2) Which of the following is NOT an SI unit?

   a. meter b. kilogram c. second d. mile

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2. (6) Write these values as full decimal numbers (not using scientific notation), in standard SI units without any prefixes, preserving the number of significant figures.

   a) 630 μs b) 42400 km

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3. (6) What is the product of 9.0 ns and 4.24×10^5 km/s? Give the result in SI units, with a prefix if convenient, to the correct number of significant figures.

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4. (6) George says his height is 6 feet 2.0 inches. But in many countries, height is given in centimeters. Find George's height in centimeters, to the correct number of significant figures.

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5. (8) A U.S. gallon is a volume of 3.78 liters, where 1000 liters = 1000 L = 1 m^3. If a water tank holds 350 gallons, how much is that in m^3?

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6. (8) A square mile is equivalent to 640 acres (exactly). Show how to find the exact number of square feet in an acre.

7. (6) Some architecture students measure the height of Cardwell Hall to be 13 m $\pm$ 0.5 m. What is the percent error in their measurement?

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8. (10) Make an order of magnitude estimate of the volume of air you will breathe in (equal to what you breathe out) during one hour of vigorous excercise like running.

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9. (2) **T** **F** A car can have an eastward velocity and a westward acceleration at the same time.

10. (2) **T** **F** If the average velocty of an object is zero during some time interval Δt, the object did not move during that time interval.

11. (2) **T** **F** A car moving up along an incline must have an acceleration up along the incline.

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12. (18) A football wide receiver starts from rest and runs straight forward 24.0 meters in 2.80 seconds at a constant acceleration.

a) (6) How large was his average velocity?

b) (6) How large was his acceleration, in m/s^2?

c) (6) How long did it take for the wide receiver to travel the first 12.0 meters?

13. (14) A cat walks slowly north at 0.45 m/s for 4.0 s, and then spots a mouse behind her and runs back south at 3.2 m/s for 1.0 s.

a) (8) Calculate the net displacement of the cat from her starting position. Give its magnitude and direction.

b) (6) Calculate the cat's average velocity. Give its magnitude and direction.

14. (14) Lisa can throw a baseball straight up so that is reaches a peak height of 25.0 meters above the launch point before falling back down.

a) (6) At the instant the ball is at its peak height, what are the ball's velocity and acceleration? Give their magnitudes and directions.

b) (8) After being thrown, how long does it take for the ball to return to the launch point?

Exam 1 Score: _____

15. (14) A plane intends to fly from Denver going due east towards Manhattan. The plane's airspeed is 380 km/h, but a wind of 120 km/h is blowing towards due south.

a) (6) To the right, make a sketch for this situation, showing and labeling the vectors for the plane's airspeed $\vec{A}$, groundspeed $\vec{G}$, and the wind velocity $\vec{W}$.

b) (8) Use your sketch to figure out the direction that the plane should head (direction of its airspeed). Give the answer using points of the compass and an angle.

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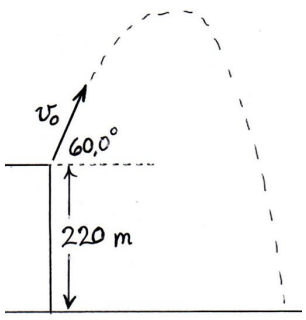
16. (14) A projectile is launched with an initial speed $v_0 = 88$ m/s at 60.0° above horizontal from the top of a 220 meter high building. Ignore any air resistance during its flight.



a) (8) How long after launch does the projectile land on the level ground below?

b) (6) How far out from the building does the projectile land?

Chapter 1 Equations

Percent error:

If a measurement = value ± error, the percent error $= \frac{\text{error}}{\text{value}} \times 100\ \%$.

Chapter 2 Equations

Motion:

$\bar{v} = \frac{\Delta x}{\Delta t}, \quad \Delta x = x - x_0, \quad$ slope of $x(t) = v(t)$.

$\bar{a} = \frac{\Delta v}{\Delta t}, \quad \Delta v = v - v_0, \quad$ slope of $v(t) = a(t)$.

For constant acceleration in one-dimension:

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

For free fall on earth:

$g = 9.80$ m/s^2 downward.

$v_y = v_{y0} - gt, \quad y = y_0 + v_{y0}t - \frac{1}{2}gt^2.$ Using an upward y-axis.

Chapter 3 Equations

Vectors

Written $\vec{V}$ or $\mathbf{V}$, described by magnitude=V, direction=θ or by components (V_x, V_y).

$V_x = V\cos\theta, \quad V_y = V\sin\theta,$

$V = \sqrt{V_x^2 + V_y^2}, \quad \tan\theta = \frac{V_y}{V_x}.$ θ is the angle from $\vec{V}$ to x-axis.

Addition: $\mathbf{A} + \mathbf{B}$, head to tail. Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is $\mathbf{B}$ reversed.

Projectiles

$a_x = 0, \quad v_x = v_{x0}, \quad x = x_0 + v_{x0}t.$ For a horizontal x-axis.

$a_y = -g, \quad v_y = v_{y0} - gt, \quad y = y_0 + v_{y0}t - \frac{1}{2}gt^2.$ For an upward y-axis.

$R = \frac{v_0^2}{g}\sin 2\theta_0,$ (For level ground only.)

Relative Motion

$\vec{V}_{\text{BS}} = \vec{V}_{\text{BW}} + \vec{V}_{\text{WS}},$ B=Boat, S=Shore, W=Water.

BS means "boat relative to shore", etc.

Must be applied as a vector equation!

Trig summary

$\sin\theta = \frac{(\text{opp})}{(\text{hyp})}, \quad \cos\theta = \frac{(\text{adj})}{(\text{hyp})}, \quad \tan\theta = \frac{(\text{opp})}{(\text{adj})}, \quad (\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2.$

$\sin\theta = \sin(180^\circ - \theta), \quad \cos\theta = \cos(-\theta), \quad \tan\theta = \tan(180^\circ + \theta), \quad \sin^2\theta + \cos^2\theta = 1.$