General Physics I **Exam 1 - Chs. 1,2,3 - Units, Motion, Vectors** **Sep. 15, 2010**

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show formulas used, essential steps, and results with correct units and significant figures. Partial credit is available if your work is clear. Points shown in parenthesis. For TF and MC, choose the *best* answer.

1. (3) Which is NOT TRUE of a scientific theory?

a. It's based on ideas, philosophy, and creative imagination.
b. Once developed, it never changes.
c. It makes predictions tested by experiments and observations.
d. All of the above.

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

a) 4.70 μg b) 150 Tm

3. (10) Ann has a cord and measures its length using a meter stick to be 4.80 m $\pm$ 0.05 m.

a) (4) Calculate the percent uncertainty in the length of the cord.

b) (6) Ann uses the cord to draw a circle of radius 4.80 m $\pm$ 0.05 m in a field. Calculate the area of the circle drawn, giving the answer as $A \pm \Delta A$ (area with uncertainty).

4. (8) Nick buys a farm in Mexico, and he is told that the area is 745 hectares. A hectare is 10^4 m^2 (exactly).

a) (3) How large is the area of the farm, in square meters?

b) (5) How large is the area of the farm, in square miles?

5. (8) A light-year is the distance light travels in one year. The speed of light is exactly 299792458 m/s.

a) (5) Express one light-year in meters, using scientific notation (powers of ten), and 3 significant figures.

b) (3) Express one light-year in petameters, using 3 significant figures.

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6. (8) Make an order of magnitude estimate of the time it would take for an adult to walk from New York City to Manhattan, Kansas. Do not include the time for resting.

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7. (3) **T F** A car with an eastward acceleration must be moving towards the east.

8. (3) **T F** The average velocity of an object is always one-half of the sum of its initial and final velocities.

9. (3) **T F** A car moving down an incline must have an acceleration down along the incline.

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10. (16) A car is initially moving at 88 km/h along a straight highway. To pass another car, it speeds up to 128 km/h in 6.80 seconds at a constant acceleration.

a) (6) How large was the acceleration in m/s^2?

b) (4) How large was the acceleration, in units of $g = 9.80\ m/s^2$?

c) (6) How far down the highway did the car travel in the 6.80 seconds?

11. (14) An automobile goes east at 64 km/h for 0.75 hour, and then turns on a road heading 30.0° west of north at 88 km/h for 0.50 hour.

a) (8) Calculate the net displacement of the automobile from the starting position. Give the result in terms of its (x, y) components, where the x-axis is east and the y-axis is north.

b) (6) Calculate the magnitude and direction of the automobile's net displacement. Give its magnitude in km and its direction using points of the compass, like "25° south of east".

12. (16) A baseball is thrown straight up so that it reaches a peak height above the launch point in 2.56 seconds, before falling back down.

a) (8) With what initial speed was the ball launched?

b) (8) What maximum height above the launch point did the ball achieve?

13. (14) A river 420 m wide flows at a uniform 2.5 m/s east. Amy can row her boat at a constant speed of 3.5 m/s relative to the moving water. She wants to row her boat due north directly across the river.

a) (6) Make a sketch to the right, showing and labeling the vectors for the velocities of: the water relative to the shore $\vec{v}_{WS}$, the boat relative to the shore $\vec{v}_{BS}$, and the boat relative to the water $\vec{v}_{BW}$.

b) (8) Calculate the direction that Amy should head the boat. Express the result using points of the compass and an angle.

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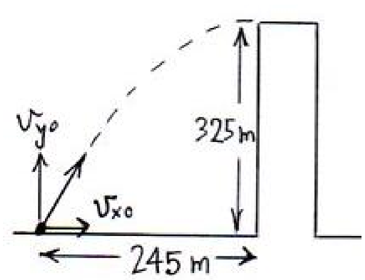
14. (16) In physics lab students are to launch a projectile from a point 245 m in front of a building 325 meters high. The projectile is to just barely land on the top near corner of the building. Its launch velocity has unknown components (v_{x0}, v_{y0}). Ignore air resistance.



a) (8) What minimum vertical component of initial velocity (v_{y0}) is needed to just reach the top of the building?

b) (8) What horizontal component of initial velocity is needed to go along with your result from part (a)?

Score = ___________/130.

Prefixes

a=10^{-18}, f=10^{-15}, 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}, P=10^{15}

Physical Constants

$g = 9.80$ m/s^2 (gravitational acceleration)
$M_E = 5.98 \times 10^{24}$ kg (mass of Earth)
$m_e = 9.11 \times 10^{-31}$ kg (electron mass)
$c = 299792458$ m/s (speed of light)
$G = 6.67 \times 10^{-11}$ N·m^2/kg^2 (Gravitational constant)
$R_E = 6380$ km (mean radius of Earth)
$m_p = 1.67 \times 10^{-27}$ kg (proton mass)

Units and Conversions

1 inch = 1 in = 2.54 cm (exactly)
1 mile = 5280 ft
1 m/s = 3.6 km/hour
1 acre = 43560 ft^2 = (1 mile)^2/640
1 foot = 1 ft = 12 in = 30.48 cm (exactly)
1 mile = 1609.344 m = 1.609344 km
1 ft/s = 0.6818 mile/hour
1 hectare = 10^4 m^2

Chapter 1 Equations

Percent error:

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

Chapter 2 Equations

Motion:

$\bar{v} = \frac{\Delta x}{\Delta t}$, $\Delta x = x - x_0$, slope of $x(t)$ curve $= v(t)$.
$\bar{a} = \frac{\Delta v}{\Delta t}$, $\Delta v = v - v_0$, slope of $v(t)$ curve $= a(t)$.

For constant acceleration in one-dimension:

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

For free fall on Earth, using an upward y-axis, with $g = 9.80$ m/s^2 downward:

$\bar{v}_y = \frac{1}{2}(v_{y0} + v_y)$, $v_y = v_{y0} - gt$, $y = y_0 + v_{y0}t - \frac{1}{2}gt^2$, $v_y^2 = v_{y0}^2 - 2g\Delta y$.

Chapter 3 Equations

Vectors

Written $\vec{V}$ or **V**, described by magnitude=V, direction=θ or by components (V_x, V_y).
$V_x = V\cos\theta$, $V_y = V\sin\theta$,
$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = \frac{V_y}{V_x}$. 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 **B** reversed.

Projectiles

$a_x = 0$, $v_x = v_{x0}$, $x = x_0 + v_{x0}t$. For a horizontal x-axis.
$a_y = -g$, $v_y = v_{y0} - gt$, $y = y_0 + v_{y0}t - \frac{1}{2}gt^2$. 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

$\sin\theta = \frac{\text{(opp)}}{\text{(hyp)}}$, $\cos\theta = \frac{\text{(adj)}}{\text{(hyp)}}$, $\tan\theta = \frac{\text{(opp)}}{\text{(adj)}}$, $(\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2$.
$\sin\theta = \sin(180^\circ - \theta)$, $\cos\theta = \cos(-\theta)$, $\tan\theta = \tan(180^\circ + \theta)$, $\sin^2\theta + \cos^2\theta = 1$.