General Physics I **Exam 1 - Chs. 1,2,3 - Units, Motion, Vectors** **Sep. 12, 2012**

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. (2) **T F** A scientific theory can always be proven by performing enough observations and experiments.

2. (2) **T F** A scientific theory can be disproven by one experiment that contradicts it.

3. (6) 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) $m = 27.0$ mg

b) $x = 10.5 \times 10^3$ km

4. (6) Write these using an SI unit with a prefix like n, μ, m, k, M, G, etc. (There is more than one way to do these; just show one way!)

a) $t = 0.0000829$ s

b) $x = 89.2 \times 10^{-11}$ m

5. (8) Convert these quantities to SI units (with a prefix if you like), showing all of the conversion factors with units, that you applied.

a) $x = 27$ feet

b) $A = 1.00$ mile^2

6. (8) Wildman caught a catfish. He says the mass m is about 30 kg.

a) (4) Based on that, how large would you say is the *uncertainty* Δm in the mass?

b) (4) Calculate the *percent uncertainty* in the mass of the catfish.

7. (3) **T F** While a car moving northward is stopping, its acceleration is towards the south.

8. (3) **T F** For each complete lap, the average velocity of a runner on a closed track is zero.

9. (3) **T F** A ball's speed is decreasing if its instantaneous acceleration is the same direction as its velocity.

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10. (16) A car is initially moving at 48 km/h along a straight highway. To pass another car, it speeds up to 128 km/h in 10.8 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 during the 10.8 seconds?

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11. (16) The baseball team is practicing throwing balls vertically upward to test their throwing arms. A player manages to throw a ball that reaches a maximum altitude of 25 m above the launch point, before falling back down. The acceleration due to gravity is 9.80 m/s^2.

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

b) (8) How long did it take for the ball to reach its maximum altitude?

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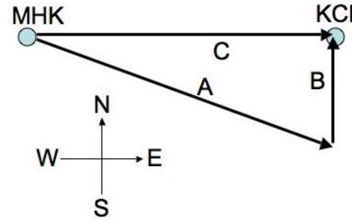
12. (8) Estimate how many times your heart beats during any 24-hour period. Explain in words and show the calculations needed to get your result.

13. (14) An automobile leaves Manhattan, first going due south at 88 km/h for 2.0 hours, and then turns on a road heading 30.0° east of north at 66 km/h for 0.50 hour.

a) (8) Calculate the (x, y) *components* of the net displacement of the automobile from the starting position, 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° east of north".

14. (16) Greg's airplane flies in still air at a speed of 420 km/h. One day, the wind is blowing strongly at 120 km/h towards the north. Greg flies the plane from Manhattan (MHK) to Kansas City (KCI), a due east displacement on the ground. See the diagram, and identify the vectors for:



a) (2) the velocity of the plane relative to the ground? A B C

b) (2) the velocity of the plane relative to the air? A B C

c) (6) Calculate the direction that the airplane should head or point, so that its net motion is towards Kansas City. Express the result using points of the compass and an angle, like 23° *west of north.*

d) (6) How long does it take Greg to fly from MHK to KCI (about 160 km)?

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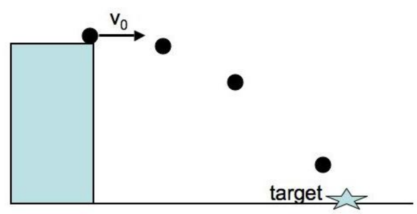
15. (16) In physics class students launch a projectile horizontally off a roof that is 50.0 m above the level ground below. They intend to hit a target on a level area below, out 256 m from the base of the building. Use $g = 9.80\ \mathrm{m/s^2}$ and ignore air resistance.



a) (8) How long will the projectile fly until it hits the ground?

b) (8) What initial horizontal velocity v_0 is needed so that the projectile hits the target?

Score = ____________/127.

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

Units and Conversions

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

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