Physics 151 Roster No.:_____

Score:_____28 pts. possible_____

SPRING 2006 Midterm Exam #1, Part A

Exam time limit: 50 minutes. You may use a calculator and both sides of ONE sheet of notes, *handwritten only*. Closed book; no collaboration. For multiple choice questions, circle the letter of the one best answer (unless more than one answer is asked for).

Physical constants: $g = 9.80\ \text{m/s}^2$

Useful conversions: $1\ \text{y} = 3.156 \times 10^7\ \text{s}$ $1\ \text{Å} = 10^{-10}\ \text{m}$

1. (8 pts.) **Convert** the following quantities into the units specified. Fill in the blanks. (You do NOT need to show your work.) Use *scientific notation* where appropriate (very large or very small values), and express all final values to *2 significant figures*.

a. 630 nm = _____ Å (see conversion factor above)

b. 1.3×10^{-4} g = _____ μg

c. 2200 cm^2 = _____ m^2

d. 2.5 mm/s = _____ km/y (see conversion factor above)

2. a. (1 pt.) How many **significant figures** does the value "0.080900 kg" have?

A. 2 D. 5
B. 3 E. 6
C. 4 F. 7

b. (2 pts.) Write the value "0.080900 kg" in **scientific notation**: _____kg_____
(Write your answer as compactly as possible, i.e., using the fewest digits necessary to write the number.)

3. A bird tries to propel itself through the air at 8.0 m/s due north, but it does so in a crosswind that blows due east at 3.0 m/s. The bird's *total* velocity (relative to the ground) is the vector sum of these two velocities.

a. (2 pts.) What is the **magnitude** of the bird's **total velocity**?

A. 6.8 m/s D. 9.2 m/s
B. 7.4 m/s E. 9.9 m/s
C. 8.5 m/s F. 11 m/s

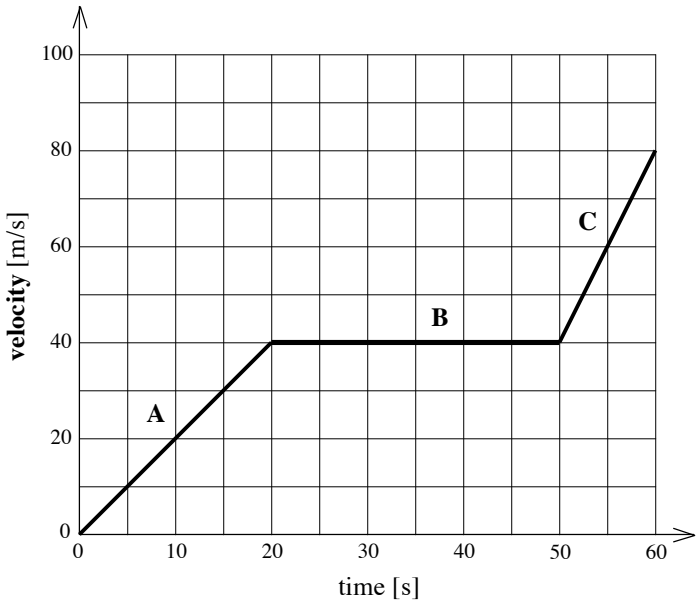
b. (2 pts.) What is the **direction** of the bird's **total velocity**?

A. 21° east of north D. 30.° east of north
B. 24° east of north E. 33° east of north
C. 27° east of north F. 36° east of north

4. (1 pt.) An object's **speed** is equal to:

A. the magnitude of the object's displacement
B. the magnitude of the object's velocity
C. the direction of the object's displacement
D. the direction of the object's velocity

5. A racecar, facing in the +*x*-direction, moves only along the *x*-axis. Its *velocity* as a function of time is described by the graph at right:



a. (6 pts.) What is the car's **acceleration** during each of the three time segments? (You do NOT need to show your work.) Be sure to include *correct units* on your answers.

segment *A*: _____

segment *B*: _____

segment *C*: _____

b. (1 pt.) Which one of the following is TRUE about the car during **segment *B***?

A. The car's position is constant.
B. The car is moving in the +*x*-direction.
C. The car is at rest.
D. The car's speed is increasing.

c. (2 pts.) If the car starts at the origin at $t = 0$, what is its **position** at $t = 30.$ s?

A. 200 m
B. 400 m
C. 600 m
D. 800 m
E. 1000 m
F. 1200 m

6. Suppose that, near the surface of some planet without air resistance, a mass m is released from rest and falls a distance of Δy during the first second.

a. (1 pt.) A **larger mass** $2m$ in the same situation would fall…

A. the same distance Δy during the first second.
B. distance $\sqrt{2}\,\Delta y$ during the first second.
C. distance $2\Delta y$ during the first second.
D. distance $4\Delta y$ during the first second.

b. (2 pts.) What **additional distance** does the original mass m fall during the ***next* second** (i.e., during the time interval from $t = 1.0$ s to $t = 2.0$ s)?

A. Δy
B. $2\Delta y$
C. $3\Delta y$
D. $4\Delta y$

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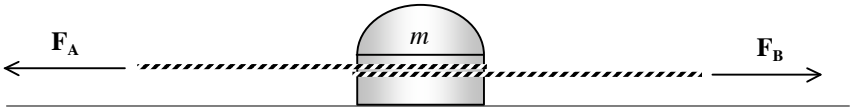
Score: 22 pts. possible (+2 pts. Bonus)

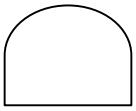
SPRING 2006 Midterm Exam #1, Part B

Show your work on free-response questions. Be sure to use **proper units** and **significant figures** in your final answers.



1. Suppose that an 85.0-kg treasure chest is at the center of a tug-of-war between two ropes: rope *A*, pulled directly to the left with 315 N; and rope *B,* pulled directly to the right with 275 N. The treasure chest sits on frictionless level ground.

a. (2 pts.) At right, draw a **free-body diagram** showing (and **labeling)** ALL forces acting on the chest:



b. (4 pts.) What are the **magnitude and direction** of the chest's **acceleration**?

c. (3 pts.) What are the **magnitude and direction** of the **normal force** acting on the chest?

d. (1 pt.) Suppose that, at some later time, the person pulling on rope *B* changes the strength of $\mathbf{F_B}$ so that the chest slides along the ground at a *constant speed* of 0.250 m/s. ($\mathbf{F_A}$ did not change.) What is the **new magnitude of $\mathbf{F_B}$**?

A. zero
B. 254 N
C. 293 N
D. 296 N
E. 315 N
F. 336 N

2. You have a homemade catapult that launches all objects (of any mass) at an initial velocity of 25.0 m/s, and can only launch at an angle of 35.0° above the horizontal. Ignore air resistance throughout this problem.

a. (4 pts.) Calculate $\mathbf{v_{0x}}$ **and** $\mathbf{v_{0y}}$ (the *x*- and *y*-components of the initial velocity, $\mathbf{v_0}$) for the object as it leaves the catapult. Show your work.

b. (4 pts.) Suppose that you use the catapult to launch an object *on level ground*, so that the object lands at the same height from which it was launched. What is the object's **total time** of flight? Show and clearly explain your work.

c. (4 pts.) Using your catapult, what is the **greatest possible height** that an object can reach (above the level from which it is launched)?

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2. continued:

BONUS (2 pts.): You want to launch a gift from the ground into the middle of your friend's dorm room window, which is located 9.00 m higher than your catapult. **Horizontally, how far** from the building should you position your catapult for success? *Note:* There are TWO solutions! Depending on your approach, you may need the quadratic formula:

$$\text{If: } ax^2 + bx + c = 0, \text{ solutions are: } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$