Physics 151
February 16, 2007

Roster No.:_____

Score:_____

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. Ignore friction and air resistance in all problems, unless told otherwise.

Part A: For each question, fill in the letter of the one best answer on your bubble answer sheet.

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

(2 pts. each) **Convert** the following quantities into the given units:

1. 550 nm = _____ m

A. 5.5×10^{-10} m
B. 5.5×10^{-7} m
C. 5.5×10^{8} m
D. 5.5×10^{9} m
E. 5.5×10^{11} m

2. 1.3×10^{-8} kg = _____ μg

A. 1.3×10^{-5} μg
B. 0.013 μg
C. 13 μg
D. 1.3×10^{4} μg
E. 1.3×10^{7} μg

3. 4.4 m^2 = _____ cm^2

A. 4.4×10^{-4} cm^2
B. 0.044 cm^2
C. 440 cm^2
D. 4.4×10^{4} cm^2
E. 4.4×10^{6} cm^2

You know that your friend's car starts at UH Manoa at 1:30 p.m. and finally arrives at Aloha Tower at 2:15 p.m., but you don't know the route that your friend took. (It is not necessarily the shortest or most efficient route, and it may have included stops, detours, or side trips.) The straight-line distance ("as the bird flies") between UH Manoa and Aloha Tower is 4.8 km, but the car's final odometer reading shows that the car traveled a total distance of 8.5 km from start to finish.

4. (2 pts.) What is the magnitude of the car's **average velocity** over the entire trip?

A. 5.5 km/h
B. 6.4 km/h
C. 7.7 km/h
D. 9.1 km/h
E. 11 km/h

5. (2 pts.) What was the car's **average speed** over the entire trip?

A. 5.5 km/h
B. 6.4 km/h
C. 7.7 km/h
D. 9.1 km/h
E. 11 km/h

6. (1 pt.) A **scalar** is a physical quantity which…

A. never has a negative value
B. never has a zero value
C. has only one digit
D. has no units
E. has no direction

7. (1 pt.) Our **3 main equations of kinematics** CANNOT be used for which one of the following cases?

A. An object whose acceleration varies over time
B. An object whose velocity varies over time
C. An object whose acceleration is zero at all times
D. An object with a force acting on it
E. An object in freefall (near the surface of the Earth)

8. (1 pt.) Which one of the following is equal to a **newton**?

A. kg/s^2
B. $kg \cdot m/s$
C. $kg \cdot m/s^2$
D. $kg \cdot m^2/s^2$
E. $kg^2 \cdot m^2/s^2$
F. scrumptious dried fruit with a delightful cookie coating

9. (1 pt.) On Earth, which one of the following statements about **weight** is TRUE?

A. An object's weight always has a magnitude of $m \cdot g$
B. Weight always points perpendicular to the surface of contact.
C. Valid units for weight include pounds (British) and kilograms (MKS system).
D. An object's weight depends on the velocity of the object.

A 2350-kg motorboat is at rest. Standing on a nearby dock, its owner pulls with a constant horizontal force on a rope tied to the boat. As a result, the boat accelerates horizontally at a slow but constant 0.025 m/s^2.

10. (2 pts.) What is the magnitude of the **tension force** in the rope?

A. 41 N
B. 59 N
C. 71 N
D. 89 N
E. 110 N

11. (2 pts.) Starting from rest, how much **time** will it take for the boat to travel 8.0 m?

A. 19 s
B. 22 s
C. 25 s
D. 28 s
E. 31 s

12. (2 pts.) Instead of "normal" force, the supportive force of the water acting upward on the boat is called the "buoyancy" force. If the boat never has any vertical motion, what is the magnitude of the **buoyancy force**?

A. 240 N
B. 9800 N
C. 12,000 N
D. 23,000 N
E. 180,000 N

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Midterm Exam #1, Part B

Part B: **Show your work** on all free-response questions. Be sure to use **proper units** and **significant figures** in your final answers. For any multiple-choice questions, circle the letter of the one best answer (unless more than one answer is asked for).

1. At Mike's old college, the clever (and rascally) students had a pastime called "funnelation": the use of a huge slingshot made from a funnel and rubber tubing to launch water balloons over the roof of one dorm into the courtyard of another.

Suppose that Mike's "funnelator" gives all water balloons an initial velocity v_0 of 40.0 m/s (almost 90 mph!). Mike aims his slingshot at an angle of 60.0° above the horizontal, on *level ground*, and fires one balloon. (Ignore air resistance for this entire problem. Assume that the water balloon is launched from the origin, and that the +*y*-direction is upward.)

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 water balloon. Show your work clearly.

b. (4 pts.) What is the water balloon's total **time** of flight? (*Recall:* The launch and landing take place on *level ground*.) Clearly show your work and/or explain your reasoning.

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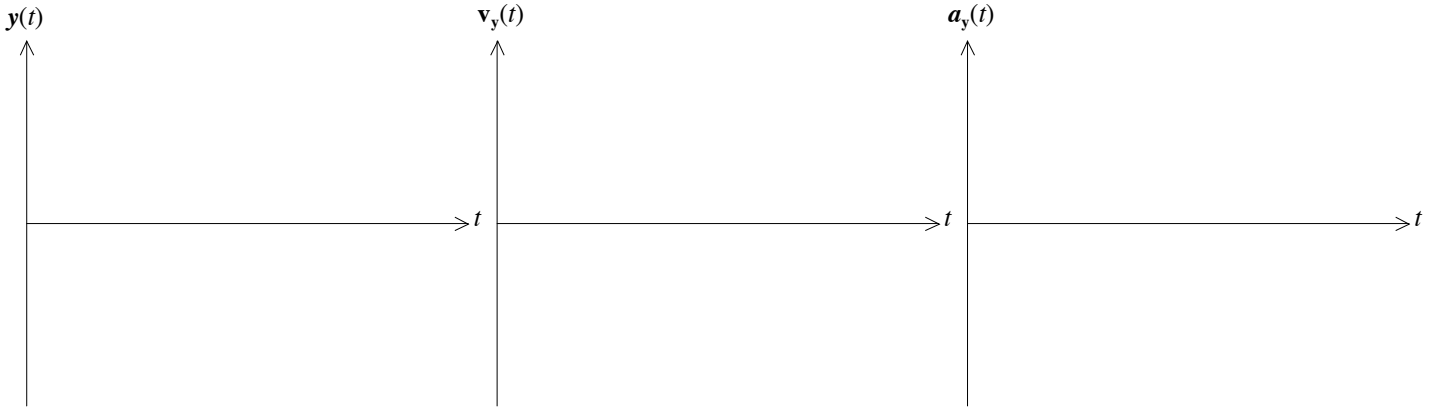
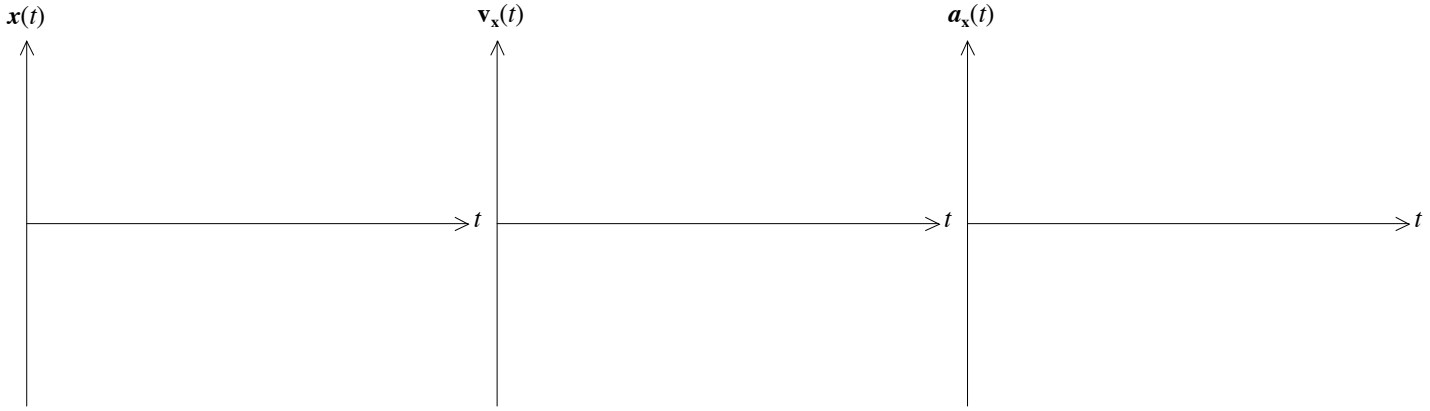
1. *continued:*

c. (4 pts.) What **maximum height** does the water balloon reach?

d. (5 pts.) On the three pairs of axes below, *qualitatively* (without precise numerical values) graph the projectile's **VERTICAL** components of **position**, **velocity**, and **acceleration**, from *launch to landing*:

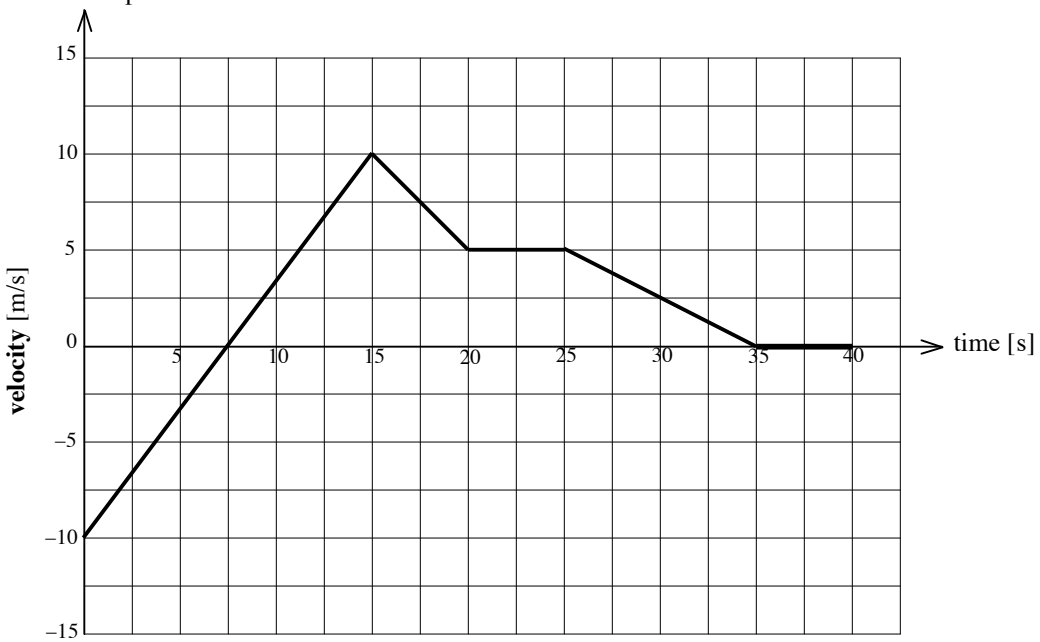


e. (3 pts.) On the three pairs of axes below, *qualitatively* (without precise numerical values) graph the projectile's **HORIZONTAL** components of **position**, **velocity**, and **acceleration**, from *launch to landing*:



2. A small spacecraft is constrained to move only along the x-axis. It faces in the $+x$ direction. The spacecraft has two rocket thrusters that can be used to accelerate it along the x-axis with either constant positive or constant negative acceleration. (Ignore friction/air resistance. Assume that all numerical values have *at least 2 significant figures.*)

The spacecraft's **VELOCITY** as a function of time is shown below:



a. (2 pts.) During which time interval(s) is the spacecraft **at rest**? ***Circle ONE or MORE:***

A. 0 to 7.5 s
B. 7.5 s to 15 s
C. 15 s to 20 s
D. 20 s to 25 s
E. 25 s to 35 s
F. 35 s to 40 s

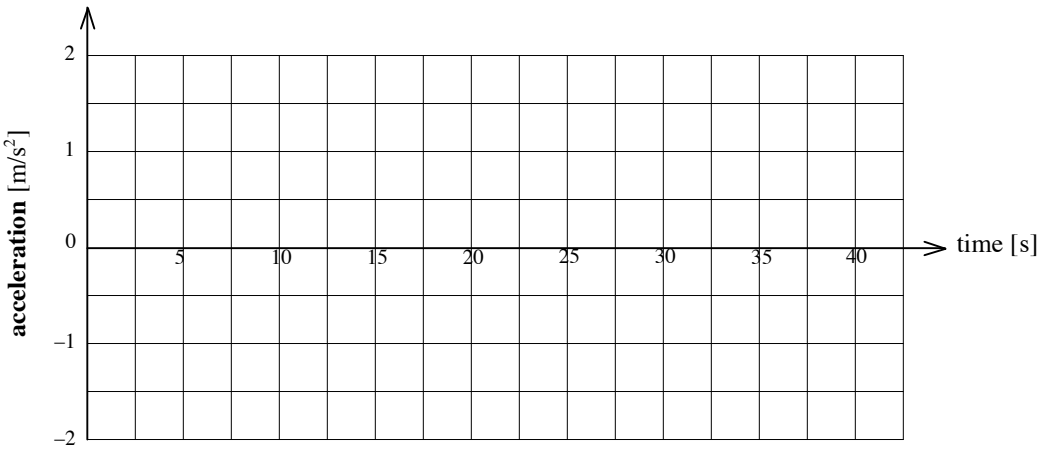
b. (2 pts.) During which interval(s) is the spacecraft **moving backwards** (i.e., "in reverse")? ***Circle ONE or MORE:***

A. 0 to 7.5 s
B. 7.5 s to 15 s
C. 15 s to 20 s
D. 20 s to 25 s
E. 25 s to 35 s
F. 35 s to 40 s

c. (2 pts.) During which interval(s) is the spacecraft **slowing down** (i.e., speed decreasing)? ***Circle ONE or MORE:*** (*Note:* This one can be tricky!)

A. 0 to 7.5 s
B. 7.5 s to 15 s
C. 15 s to 20 s
D. 20 s to 25 s
E. 25 s to 35 s
F. 35 s to 40 s

d. (4 pts.) Carefully and accurately, **graph** the spacecraft's **ACCELERATION** vs. time on the axes provided below. (You do NOT need to show your work.)



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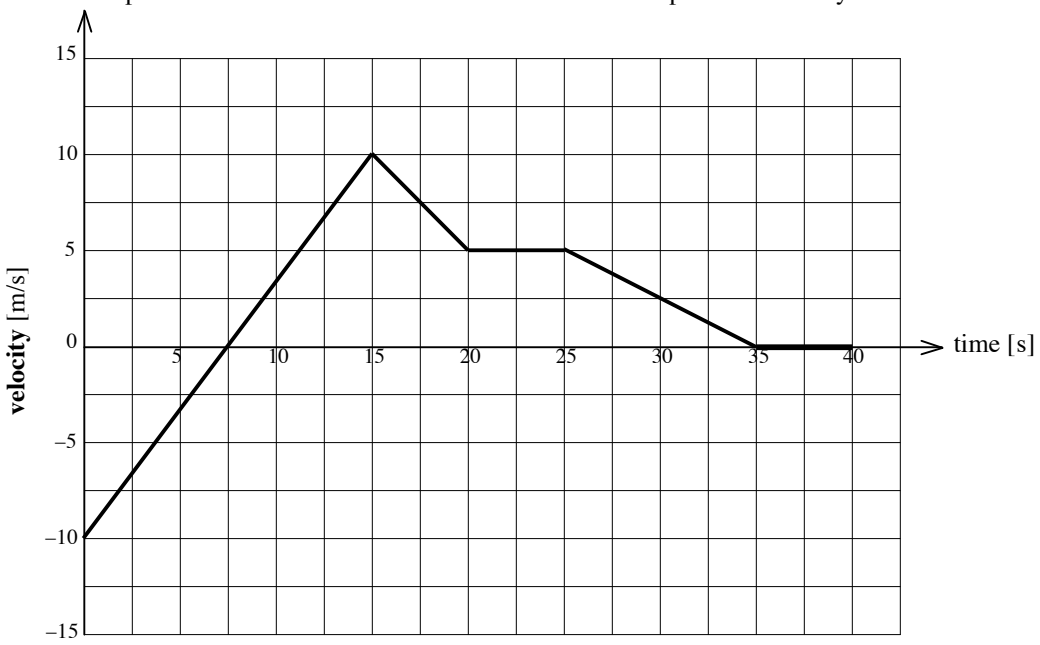
2. *continued:*

The spacecraft's **VELOCITY** as a function of time is repeated here for your reference:



BONUS (2 pts.): Calculate the spacecraft's net **displacement** from its starting position at $t = 40$ s. Show your work completely and/or explain your reasoning: