

SPRING 2005 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).

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

1. (1 pt.) The physical quantity $R = 6.400 \times 10^6 \text{ m}$ has how many **significant figures**?
A. 2 D. 5
B. 3 E. 6
C. 4 F. 7

2. (2 pts.) Your friend has 850 music files on her computer, each of which has an average size of 3.0 Mb (b = byte). She wants to buy a new hard drive that's **just large enough** to store all of her songs, but not much larger. If the computer store sells only the following sizes, which hard drive should your friend buy?
A. 300 kb C. 3 Gb E. 0.3 Tb
B. 0.3 Gb D. 30 Gb F. 3 Tb

3. (1 pt.) If object B has **twice the mass** of object A, then which one of the following is TRUE?
A. Object B has the same weight as A.
B. Object B has more inertia than A.
C. Object B is easier to accelerate than A.

4. (2 pts.) If an object's **acceleration** is non-zero and constant, then which one of the following is TRUE?
A. Its position must be positive.
B. Its velocity must be non-zero.
C. Its velocity must be positive.
D. Its velocity must change over time.

5. (2 pts.) If all forces acting on an object **sum to zero**, then which one of the following is TRUE?
A. The object must be at rest.
B. The object's weight must be zero.
C. There must be no tension forces acting on the object.
D. The object must have a constant velocity.

6. (1 pt.) When hit, a 45-g golf ball is in contact with a golf club for approx. 5 ms, during which time an average force of 400 N is exerted by the club on the ball, and the ball is accelerated. At the same time, what is the average **force exerted by the ball on the club**?
A. virtually zero, since the ball has so little mass compared to the club
B. something less than 400 N, since the ball accelerates away from the club
C. greater than 400 N, since the ball slows down the club
D. 400 N

7. (2 pts.) A particular displacement vector \mathbf{D} can be written in component notation as $(-2.08 \text{ m}, 9.78 \text{ m})$. What is its **direction**, $\theta_{\mathbf{D}}$ (measured in the usual “trigonometric” manner, counterclockwise from the $+x$ -axis)?

- A. 34° D. 131°
 B. 78° E. 156°
 C. 102° F. 219°

8. The graph at right shows the **POSITION** along the x -axis of two cars, A and B, as a function of time. The cars move along the x -axis on parallel but separate tracks, so that they can pass each other's position without colliding.

a. (2 pts.) At which instant(s) in time is one car **passing** the other? *Circle ONE or MORE:*

- A. t_1 B. t_2 C. t_3 D. t_4

b. (1 pt.) At time t_3 , which car is moving **faster**?

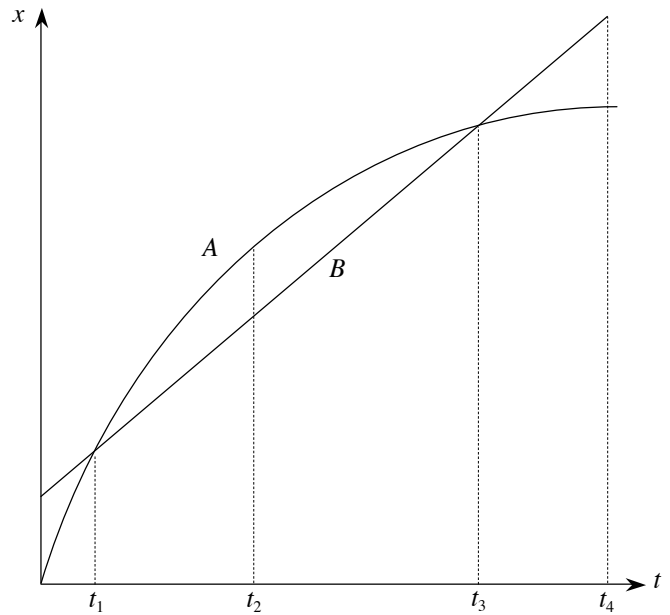
- A. car A B. car B

c. (2 pts.) At which instant(s) do the two cars have the **same velocity**? *Circle ONE or MORE:*

- A. t_1 B. t_2 C. t_3 D. t_4

d. (1 pt.) Which one of the following best describes the motion of **car A** as shown on the graph?

- A. speeding up
 B. constant velocity
 C. slowing down
 D. first speeding up, then slowing down



SPRING 2005 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.

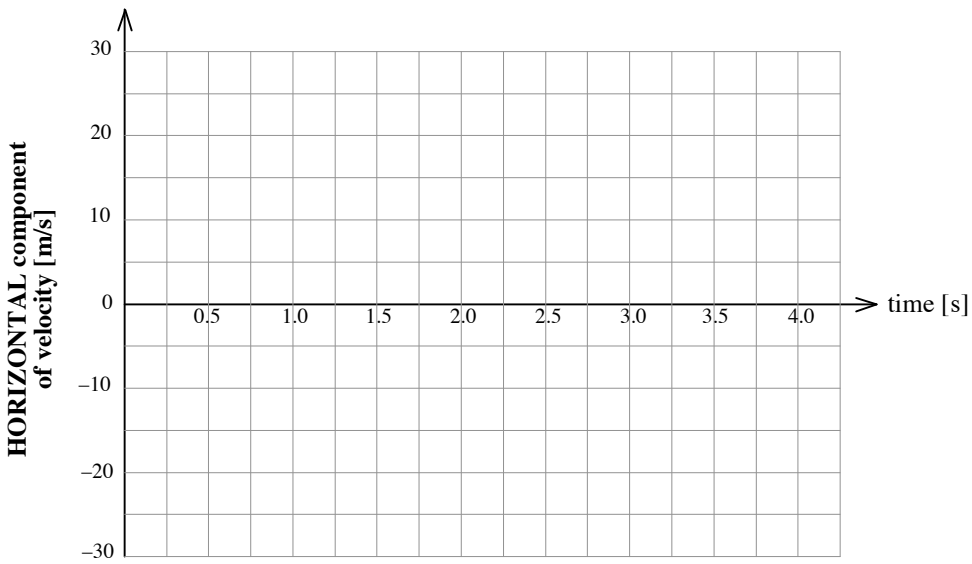
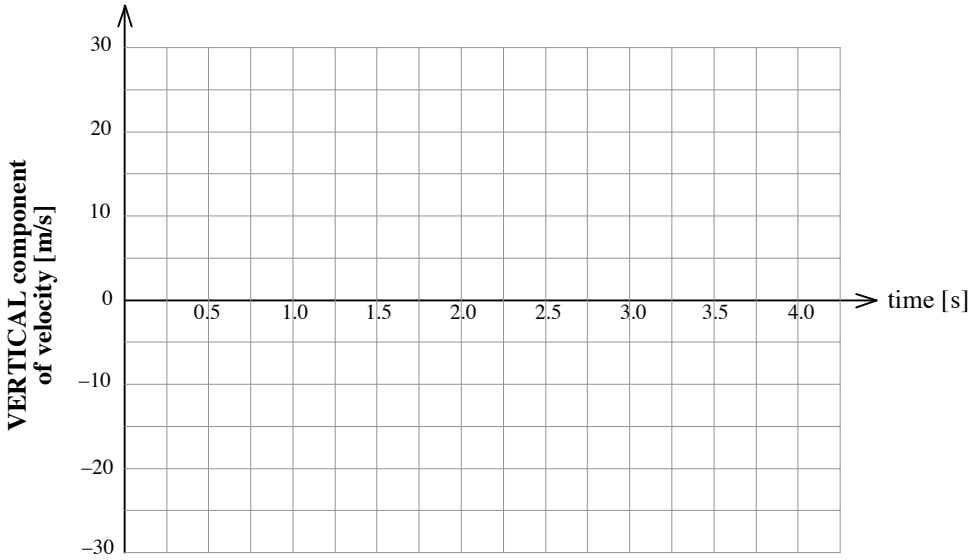
1. A soccer ball on a *level field* is kicked with an initial velocity $v_0 = 25.0$ m/s at 36.9° above the horizontal. (Ignore air resistance throughout the problem.)

a. (5 pts.) Calculate the **vertical and horizontal components, v_{0x} and v_{0y} , of the initial velocity** of the ball. Show your work.

b. (4 pts.) Calculate the **total time of flight** of the ball.

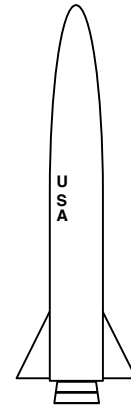
1. continued:

c. (6 pts.) On the axes provided, carefully graph the **vertical component** and **horizontal component of the ball's velocity** as functions of time, from kick to landing. (You do NOT need to show calculations.)



2. A huge 2.8×10^6 -kg rocket rises away from its launch pad vertically by firing its main engine, which provides a constant upward force on the rocket. Assume that both the value of g and the mass of the rocket remain constant during ascent. Ignore air resistance throughout this problem.

a. (3 pts.) Using the diagram of the rocket at right as a **free-body diagram**, sketch **all force vectors** acting on the rocket *after the rocket has left the ground*. Be sure to **label** each vector clearly.



b. (5 pts.) Calculate the magnitude of the upward **force** of the rocket engine (in newtons) needed to cause a constant upward acceleration of the rocket of 1.9 m/s^2 . Show your work.

Assume that the rocket's acceleration remains constant at 1.9 m/s^2 as the rocket ascends.

c. (4 pts.) How much **time** does it take for the rocket to reach a height of 100. *kilometers* above its starting point, if it starts from rest?

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2. continued:

d. (4 pts.) What is the rocket's **velocity** when it reaches a height of 100. *kilometers*, if it starts from rest?

Consider questions (e) and (f) separately and independently from each other.

e. (1 pt.) In real life, the rocket consumes fuel as it rises, causing its *mass to decrease* over time. Suppose that the upward force supplied by the engine (that you calculated in part (b)) remains constant during ascent. Then the actual real-life **velocity** of the rocket at a height of 100 km should be _____ your answer to part (d).

A. less than

B. the same as

C. greater than

f. (1 pt.) In real life, gravitational acceleration decreases as distance from the center of the Earth increases, causing the *value of g to decrease* over time as the rocket rises. Again, suppose that the upward force supplied by the engine (that you calculated in part (b)) remains constant during ascent. Then the actual real-life **velocity** of the rocket at a height of 100 km should be _____ your answer to part (d).

A. less than

B. the same as

C. greater than