

## PH2100 Exam II

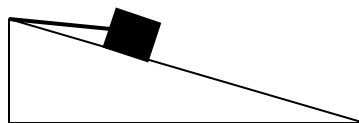
SPRING 2005

### INSTRUCTIONS

1. Remove the answer sheet (General Purpose Data Sheet I) from the exam booklet.
2. Using a #2 pencil, write your first and last name neatly in the NAME box.
3. Under the green box labeled "ID NUMBER", write in your MTU student I.D. number (without dashes) and carefully fill in the appropriate circles corresponding to your ID number. Most of you have your Social Security number as your student I.D. number. If your M number is your student I.D. number, please replace the leading M with a zero. Again, do not include dashes. Leave the "SPECIAL CODES" boxes blank.
4. Be sure to fill in the circles completely and avoid stray marks on the form.
5. This a ninety minute exam.
6. Please cover your Score Sheet at all times.
7. This is a closed book exam. You may use the PH2100 Formula Sheet that is attached to this exam, and you may find it convenient to rip the formula sheet from the exam booklet.
8. Equations may not be stored in calculators, nor may calculators be exchanged.
9. Assume all numerical data supplied with the problems have three significant figure accuracy, unless explicitly identified otherwise.
10. This exam consists of a total of 31 questions on six following pages: each question is worth five points. Problem 31 is a five-point bonus question. The total number of points available on the exam is 155, out of which 5 points can be considered bonus points.
11. If you have any questions during the exam, please raise your hand and wait for assistance.
12. Please turn in only your answer sheet. You may keep the exam booklet and formula sheet.

1. An object is moving with constant velocity. Which of the following statements must be true?
- (A) The net force on the object is zero.
  - (B) A small net force must be acting in the direction of the velocity.
  - (C) There are no forces acting on the object.
  - (D) There can be forces on the object but no friction.
2. While flying horizontally in an airplane, you notice that a string dangling from the luggage compartment hangs at rest, relative to the airplane, at 15 degrees away from the vertical. From this observation, you can conclude that:
- (A) The airplane must be an inertial reference frame.
  - (B) The airplane must be moving with a constant speed.
  - (C) The airplane must be moving with an acceleration of constant magnitude.
  - (D) The airplane must be moving with a constant velocity.
3. A rope is tied to a box and is holding it at rest on an inclined plane. Ignoring friction, how many forces are acting on the box?

- (A) 0
- (B) 1
- (C) 2
- (D) 3
- (E) 4



4. A constant net force is applied to an object of mass 1.50 kg in order to make it accelerate  $4.50 \text{ m/s}^2$ . What net force is necessary to accelerate the same object at  $9.00 \text{ m/s}^2$ ?

- (A) 6.00 N
- (B) 9.00 N
- (C) 13.5 N
- (D) 17.0 N
- (E) 21.2 N

The following information relates to the next two questions: A truck is moving with constant acceleration on a horizontal surface. A wooden crate of mass 20.4 kg is at rest with respect to the truck in the middle of the flatbed, shown below. The coefficient of static friction is 0.30 between the crate and the flatbed.

5. If the truck accelerates at  $0.55 \text{ m/s}^2$  what is the magnitude of the force of static friction acting on the crate?

- (A) 0.0 N
- (B) 3.3 N
- (C) 11 N
- (D) 60 N
- (E) 120 N



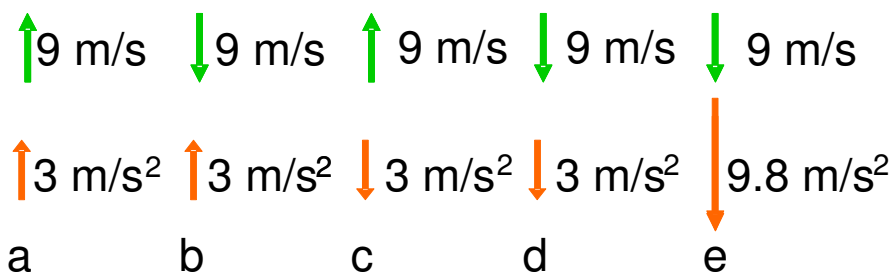
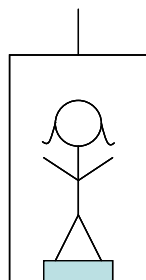
6. What is the maximum acceleration that the truck could have and the crate not slip off of the back of the truck?

- (A)  $0.30 \text{ m/s}^2$
- (B)  $0.55 \text{ m/s}^2$
- (C)  $1.25 \text{ m/s}^2$
- (D)  $2.00 \text{ m/s}^2$
- (E)  $2.94 \text{ m/s}^2$

7. An astronaut on the space shuttle has zero apparent weight because she is so far from the earth that the force of gravity is negligible.

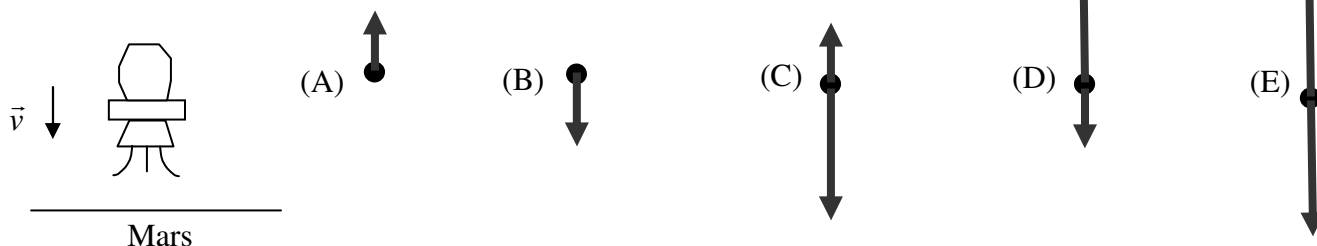
- (A) True  
(B) False

8. Rank-order the apparent weights of generic woman from highest to lowest for each of the following five cases:



- (A)  $a = b > c = d < e$   
(B)  $a > b = c > d > e$   
(C)  $a > b = c > d < e$   
(D)  $a = b < c = d > e$   
(E)  $a = b > c = d > e$

9. A Martian lander is approaching the surface of the planet. It is slowing its descent by firing its rocket motor. Which is the correct free body diagram for the lander?



10. A rocket is launched from rest with a constant thrust force at 45 degrees up from the horizontal. You may ignore air drag. What shape will the rocket's trajectory have?

- (A) A straight line.  
(B) A parabola.  
(C) A smooth curve that is not a parabola.

11. Two rubber bands stretched to the standard length cause an object to accelerate at  $2 \text{ m/s}^2$ . Suppose another object with twice the mass of the first object is pulled by four rubber bands stretched to the standard length. The acceleration of the second object is:

- (A)  $1 \text{ m/s}^2$   
(B)  $2 \text{ m/s}^2$   
(C)  $4 \text{ m/s}^2$   
(D)  $8 \text{ m/s}^2$   
(E)  $16 \text{ m/s}^2$

The following information pertains to the next three questions:

A hiker kicks a rock off of a 8.50 m high vertical cliff into the lake below. If the rock has an initial velocity at the edge of the cliff of 6.00 m/s directed perfectly horizontally,

12. How much time did it take the rock to travel from the edge of the cliff to the water?

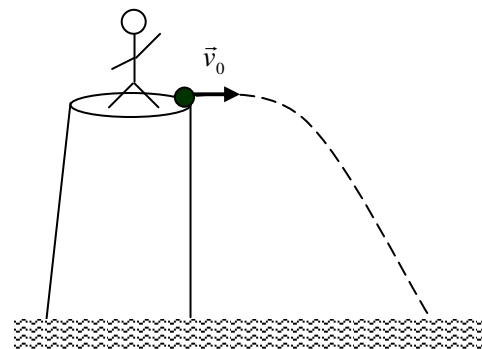
- (A) 1.32 s
- (B) 2.62 s
- (C) 7.88s
- (D) 9.87 s
- (E) 133. s

13. How far from the base of the cliff does the rock hit the water?

- (A) 0.556 m
- (B) 3.20 m
- (C) 7.90 m
- (D) 15.1 m
- (E) 21.3 m

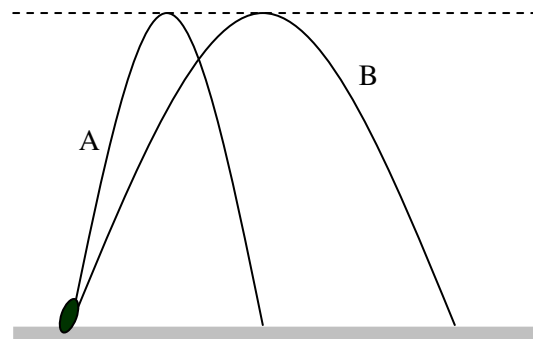
14. What is the speed of the rock just before it hits the water?

- (A) 6.0 m/s
- (B) 7.8 m/s
- (C) 10.5 m/s
- (D) 13.0 m/s
- (E) 14.3 m/s



15. A goal kicker is practicing for the big game. The trajectory for the football in two practice kicks is shown at the right. In both cases, the football makes it to the same maximum height. What can you conclude about the hang time  $t_A$  and  $t_B$  and the initial speeds of the football  $v_{oA}$  and  $v_{oB}$  for both kicks?

- (A)  $t_A = t_B$  and  $v_{oA} = v_{oB}$
- (B)  $t_A > t_B$  and  $v_{oA} > v_{oB}$
- (C)  $t_A < t_B$  and  $v_{oA} < v_{oB}$
- (D)  $t_A = t_B$  and  $v_{oA} < v_{oB}$
- (E)  $t_A = t_B$  and  $v_{oA} > v_{oB}$



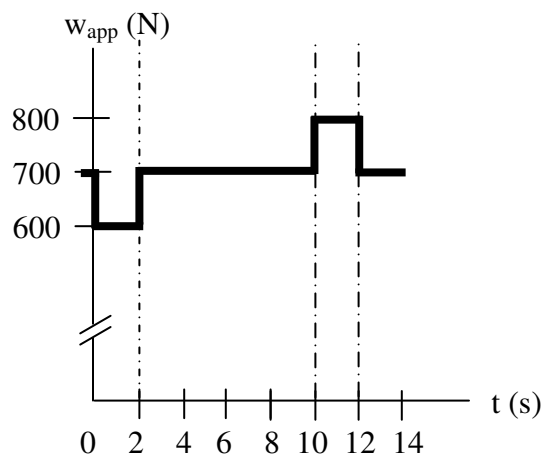
16. If you swing a ball in a vertical circle using a thin string, the string will be most likely to break at

- (A) the top of the circle
- (B) the bottom of the circle

The following information pertains to the next three questions:

Mary gets into an elevator in a tall building, and starting from rest, travels between floors for 12 s. Mary's apparent weight is shown over the 12-second ride in the graph at the right.

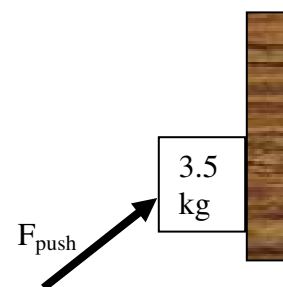
17. During the first 2.00 s, is Mary moving up or down?  
 (A) Up  
 (B) Down
18. What is Mary's mass?  
 (A) 98.0 kg  
 (B) 71.4 kg  
 (C) 62.1 kg  
 (D) 56.6 kg  
 (E) 30.6 kg
19. How far did Mary travel over the first 2.00 s of the ride?  
 (A) 0.565 m  
 (B) 1.24 m  
 (C) 1.95 m  
 (D) 2.80 m  
 (E) 14.6 m



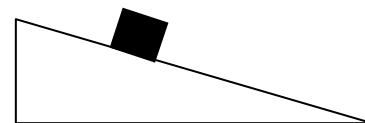
The following information pertains to the next two questions:

A 3.50-kg block of cement is to be held at rest against a wooden wall by a pushing force inclined by 45 degrees with respect to the horizontal, as shown in the figure at the right. The coefficient of static friction is 0.250 and the coefficient of kinetic friction is 0.200 between the block and the wall.

20. How many forces are acting on the block of cement?  
 (A) 1  
 (B) 2  
 (C) 3  
 (D) 4  
 (E) 5
21. What is the magnitude of the minimum pushing force that can be exerted without the block slipping downward?  
 (A) 10.6 N  
 (B) 38.8 N  
 (C) 55.1 N  
 (D) 69.0 N  
 (E) 81.2 N



22. A box of mass  $m$  is moving with constant speed down an inclined surface. What can you conclude about the forces acting on the box?



- (A) The normal force is less than  $mg$  in magnitude; a force of friction acts uphill  
 (B) The normal force equals  $mg$  in magnitude; a force of friction acts uphill  
 (C) The normal force is greater than  $mg$  in magnitude; a force of friction acts uphill  
 (D) The normal force is less than  $mg$  in magnitude; a force of friction acts downhill  
 (E) The normal force equals  $mg$  in magnitude; there is no friction

The next four questions relate to the following information:

A spacetraveller on Planet Carbonium kicks a ball at time  $t = 0$ , from the origin, and it follows the trajectory illustrated at the right. At time  $t = 2.0$  s, the velocity is given by  $\vec{v} = (3.0\hat{i} + 4.0\hat{j})\text{m/s}$ .

23. At time  $t = 0\text{s}$ , what is  $v_x$ ?

- (A)  $-4.0\text{ m/s}$
- (B)  $-3.0\text{ m/s}$
- (C)  $0.0\text{ m/s}$
- (D)  $3.0\text{ m/s}$
- (E)  $4.0\text{ m/s}$

24. At time  $t = 6.0$  s, what is  $v_y$ ?

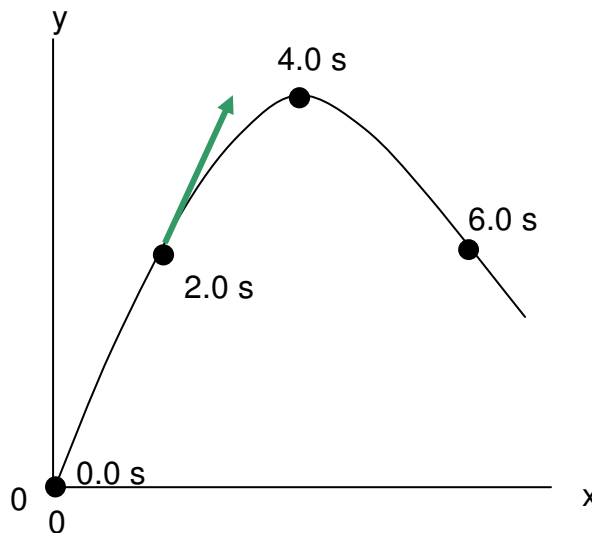
- (A)  $-4.0\text{ m/s}$
- (B)  $-3.0\text{ m/s}$
- (C)  $0.0\text{ m/s}$
- (D)  $3.0\text{ m/s}$
- (E)  $4.0\text{ m/s}$

25. What is the value of  $g$  on Planet Carbonium?

- (A)  $0.0\text{ m/s}^2$
- (B)  $1.0\text{ m/s}^2$
- (C)  $1.5\text{ m/s}^2$
- (D)  $2.0\text{ m/s}^2$
- (E)  $4.0\text{ m/s}^2$

26. What is the displacement of the particle from the origin at time  $t = 6.0$  s?

- (A)  $(18\hat{i} + 4.0\hat{j})\text{m}$
- (B)  $(6.0\hat{i} + 4.0\hat{j})\text{m}$
- (C)  $(6.0\hat{i} + 16\hat{j})\text{m}$
- (D)  $(6.0\hat{i} + 6.0\hat{j})\text{m}$
- (E)  $(18\hat{i} + 12\hat{j})\text{m}$



27. A softball player hits a fly ball that, in the absence of air resistance, follows a parabolic trajectory. Where along its trajectory is the ball's acceleration zero?

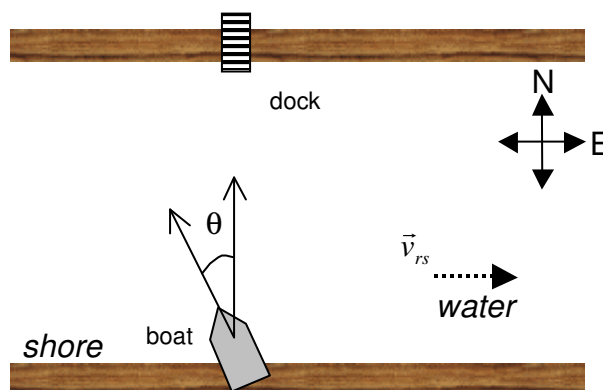
- (A) at the initial point, immediately after the ball is hit with the bat
- (B) at the peak of the trajectory
- (C) Nowhere. The ball is always accelerating
- (D) at the instant immediately before the ball is caught by the outfielder

The following information pertains to the next two questions:

A boat is trying to cross a wide river to reach the dock. As shown in the figure, the dock is directly north of the initial starting position of the boat. The river is moving with a uniform speed of  $v_{rs} = 4.00$  km/h due east relative to the shore. The boat travels with a speed  $v_{br} = 9.50$  km/h relative to the water.

28. What direction should the boat be heading in order that it travel due north and make it to the dock?

- (A)  $25^\circ$
- (B)  $30^\circ$
- (C)  $37^\circ$
- (D)  $39^\circ$
- (E)  $47^\circ$



29. If the river is 0.700 km wide, how long does it take the boat to reach the dock if it succeeds in traveling due north.

- (A) 0.035 h
- (B) 0.081 h
- (C) 0.250 h
- (D) 0.505 h
- (E) 1.22 h

30. A famous baseball player is standing in the back of a truck in a parade through Houghton. The truck is moving at a constant speed 2.50 m/s. The baseball player throws a ball out at 5.40 m/s in the direction exactly opposite to the direction that the truck is moving. What is the speed of the ball relative to some one standing in the crowd?

- (A) 7.90 m/s
- (B) 6.25 m/s
- (C) 5.40 m/s
- (D) 3.95 m/s
- (E) 2.90 m/s

31. **BONUS.** The pilot of an airplane notes that the compass indicates a heading due west. The airplane's speed relative to the air is 175 m/s. The velocity of the airplane relative to the ground is 195 m/s at  $15.0^\circ$  north of west. What is the velocity of the wind?

- (A) (50.5 North, 13.4 West) m/s
- (B) (50.5 North, 112 West) m/s
- (C) (50.5 North, 165 West) m/s
- (D) (73.2 North, 13.4 West) m/s
- (E) (73.2 North, 112 West) m/s