

Last Name: _____ First Name _____ Network-ID _____
Discussion Section: _____ Discussion TA Name: _____

Instructions—

Turn off your cell phone and put it away.

Keep your calculator on your own desk. Calculators cannot be shared.

This is a closed book exam. You have ninety (90) minutes to complete it.

1. Use a #2 pencil; do **not** use a mechanical pencil or a pen. Fill in completely (until there is no white space visible) the circle for each intended input – both on the identification side of your answer sheet and on the side on which you mark your answers. If you decide to change an answer, erase vigorously; the scanner sometimes registers incompletely erased marks as intended answers; this can adversely affect your grade. Light marks or marks extending outside the circle may be read improperly by the scanner.
2. Print your last name in the **YOUR LAST NAME** boxes on your answer sheet and print the first letter of your first name in the **FIRST NAME INI** box. Mark (as described above) the corresponding circle below each of these letters.
3. Print your NetID in the **NETWORK ID** boxes, and then mark the corresponding circle below each of the letters or numerals. Note that there are different circles for the letter “I” and the numeral “1” and for the letter “O” and the numeral “0”. **Do not** mark the hyphen circle at the bottom of any of these columns.
4. **This Exam Booklet is Version A.** Mark the **A** circle in the **TEST FORM** box at the bottom of the front side of your answer sheet.
5. Stop **now** and double-check that you have bubbled-in all the information requested in 2 through 4 above and that your marks meet the criteria in 1 above. Check that you do not have more than one circle marked in any of the columns.
6. Do **not** write in or mark any of the circles in the STUDENT NUMBER or SECTION boxes.
7. On the **SECTION line**, print your **DISCUSSION SECTION**. (You need not fill in the COURSE or INSTRUCTOR lines.)
8. Sign (**DO NOT PRINT**) your name on the **STUDENT SIGNATURE line**.

*Before starting work, check to make sure that your test booklet is complete. You should have 11 **numbered pages** plus two *Formula Sheets*.*

*Academic Integrity—***Giving assistance to or receiving assistance from another student or using unauthorized materials during a University Examination can be grounds for disciplinary action, up to and including dismissal from the University.**

Exam Grading Policy—

The exam is worth a total of **120** points, and is composed of three types of questions:

MC5: *multiple-choice-five-answer questions, each worth 6 points.*

Partial credit will be granted as follows.

- (a) If you mark only one answer and it is the correct answer, you earn **6** points.
- (b) If you mark *two* answers, one of which is the correct answer, you earn **3** points.
- (c) If you mark *three* answers, one of which is the correct answer, you earn **2** points.
- (d) If you mark no answers, or more than *three*, you earn **0** points.

MC3: *multiple-choice-three-answer questions, each worth 3 points.*

No partial credit.

- (a) If you mark only one answer and it is the correct answer, you earn **3** points.
- (b) If you mark a wrong answer or no answers, you earn **0** points.

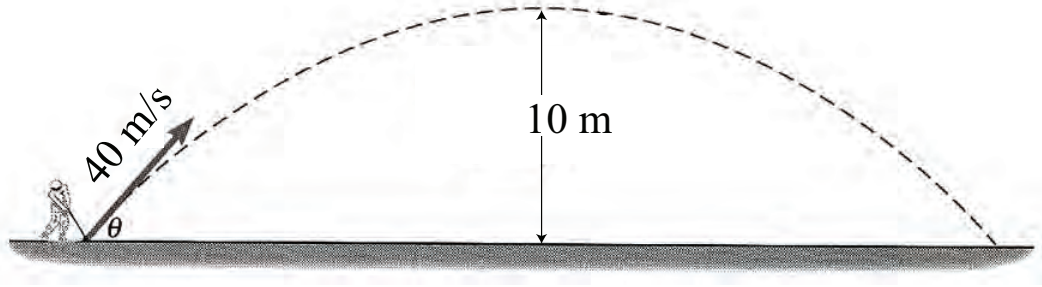
TF: *true-false questions, each worth 2 points.*

No partial credit.

- (a) If you mark only one answer and it is the correct answer, you earn **2** points.
- (b) If you mark the wrong answer or neither answer, you earn **0** points.

Unless told otherwise, you should assume that the acceleration of gravity near the surface of the earth is 9.8 m/s^2 downward and ignore any effects due to air resistance.

The following three problems concern the same physical situation.



A golf ball is hit upward at an angle θ from the horizontal and speed $v = 40$ m/s. It reaches a maximum height of 10 m as illustrated above. Assume the ballistic trajectory starts at ground level and ignore air resistance. Assume the shot is made on a wide, level field.

1. What is the initial angle θ ?
 - a. $\theta = 20.5$ deg
 - b. $\theta = 46.4$ deg
 - c. $\theta = 57.3$ deg
 - d. $\theta = 70.2$ deg
 - e. $\theta = 81.1$ deg

2. How long is the ball in the air?
 - a. 1.15 s
 - b. 2.86 s
 - c. 3.12 s
 - d. 3.37 s
 - e. 3.59 s

3. Suppose we are free to vary the angle θ ($0 < \theta \leq 90$ deg), but everything else remains the same. The ball will have the highest speed when it hits the ground if
 - a. $\theta = 90$ deg
 - b. $\theta = 45$ deg
 - c. All angles hit at the same speed.

4. Which of the following most nearly is in free fall? Allow for air resistance.
- A feather dropped from the top of Loomis Lab.
 - A bowling ball dropped from a height of 1 m.
 - A bungee jumper suspended from a taut bungee cord at the lowest point on her trajectory.
5. A man of mass 80 kg is in an elevator in the Burj Khalifa in Dubai (now the tallest building in the world). The elevator has a cruising speed of 8 m/s and reaches this speed at $t = 4$ s after starting from rest at $t = 0$ s. What is the man's apparent weight while the elevator is accelerating upward? Assume constant acceleration.
- 660 N
 - 770 N
 - 940 N
 - 1010 N
 - not enough information given.
6. Two boats A and B are moving on the surface of Lake Michigan. We will describe their motion using x and y coordinates; assume that x is to the east and y is to the north. Boat A has velocity $v_x = 5$ m/s, $v_y = -1$ m/s. Boat B has velocity $v_x = 4$ m/s, $v_y = 1$ m/s. What is their relative speed?
- 2.0 m/s
 - 2.2 m/s
 - 4.1 m/s
 - 5.0 m/s
 - 25 m/s

The following two problems concern the same physical situation.

7. Two astronauts with masses $m_1 = 50$ kg and $m_2 = 70$ kg are floating freely in orbit, watching the sun set. The little one pushes the big one. During the push, which astronaut experiences the larger force?
- The little one.
 - The big one.
 - They're the same.
8. Which astronaut experiences the larger acceleration?
- The little one.
 - The big one.
 - They're the same.

9. Which of the following must be moving at constant velocity?
- A car moving down a straight road at constant speed.
 - A car moving around a circular race track at constant speed.
 - A car moving on a circular race track at varying speed.

The following three problems concern the same physical situation.

10. A 30 kg boy is attached by a taut, ideal rope to a pole in the middle of an ice skating rink. The boy circles the pole at a speed $v = 2.1$ m/s and distance 3 m. What is the tension in the rope?

- 9 N
- 11 N
- 22 N
- 33 N
- 44 N

11. What is the boy's angular speed?

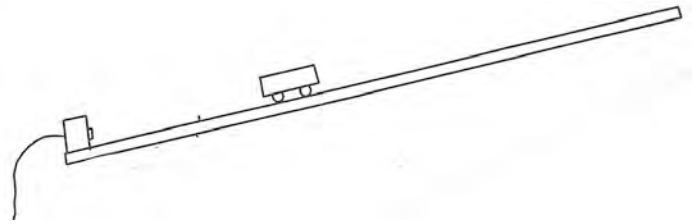
- 0.7 rad/s
- 0.9 rad/s
- 1.1 rad/s
- 1.3 rad/s
- 1.5 rad/s

12. Suppose that the boy is actually moving with angular speed 0.5 rad/s, and begins to slow down at a rate of 0.01 rad/s². How many times does he go around the pole before stopping?

- once.
- twice.
- three times.

13. You give the cart a push up a ramp, as shown in the following figure. The cart rolls up and then rolls back down the ramp. When the cart reaches the top, its acceleration is:

- a. zero
- b. downward
- c. upward

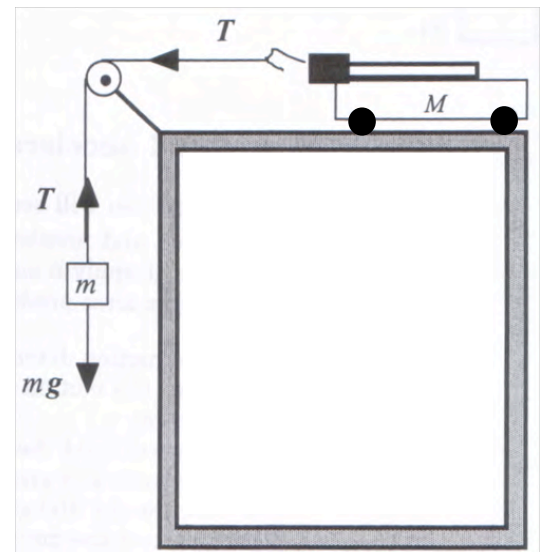


14. A block is sliding up an incline, turns around, and slides back down. There is friction between the block and the incline. Which of the following is true?

- a. The magnitude of the acceleration is larger going up than going down.
- b. The magnitude of the acceleration is larger going down than going up.
- c. The magnitude of the acceleration is the same going up and going down.

The following two problems concern the same physical situation.

A cart of mass M is on the frictionless horizontal table, and is connected to a mass m with an ideal string through a massless and frictionless pulley as shown in the figure at right.



15. When m is very large compared to M , what is the acceleration, a , of the cart?

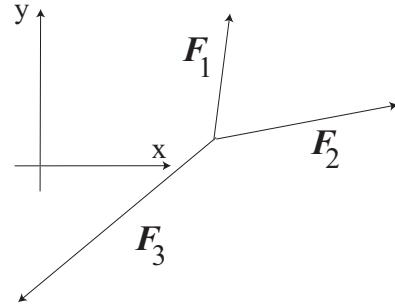
- a. $a = 0$
- b. a is very large compared to g .
- c. a is close to g .

16. When $m = M$, what is the acceleration, a , of the cart?

- a. $a = 0$
- b. $a = g/2$
- c. $a = g$

17. There are three forces \mathbf{F}_1 , \mathbf{F}_2 , and \mathbf{F}_3 acting on the same mass, as illustrated below. The mass has zero acceleration. Using the coordinates shown in the figure, the force vectors in components read $\mathbf{F}_1 = (0.2, 2.1)$ and $\mathbf{F}_3 = (-4.1, -3.8)$ (in N). Find the magnitude of \mathbf{F}_2 .

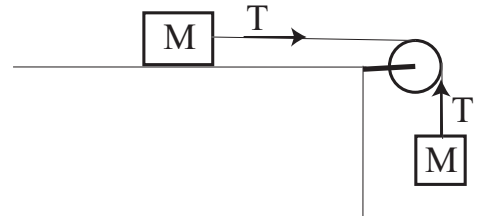
- a. 2.8 N
- b. 3.3 N
- c. 3.8 N
- d. 4.3 N
- e. 4.7 N



18. Consider the two blocks connected with an ideal string through a massless and frictionless pulley as shown in the figure. There is kinetic friction between the table and the block. The coefficient of kinetic friction between the block on the table and the table is μ_k .

Let “a” be the acceleration of block on the table to the right. The masses of the blocks are both equal to M . The tension in the string is T . Newton’s second law tells us the following two equations.

$$\begin{aligned} Ma &= T - \mu_k Mg \\ -Ma &= T - Mg \end{aligned}$$

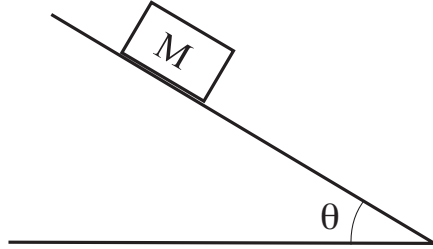


Solving these simultaneous equations, obtain the acceleration a .

- a. $a = (1 - \mu_k)g/2$
- b. $a = (1 + \mu_k)g/2$
- c. $a = (1 - \mu_k)g$
- d. $a = (1 + \mu_k)g$
- e. $a = \mu_k g$

The following 2 questions concern the same physical situation:

There is a block of mass M on the slope that makes an angle $\theta = 30^\circ$ to the horizontal. The coefficient of static friction is 0.7.



19. The block is stationary on the slope. What is the magnitude of the friction force?

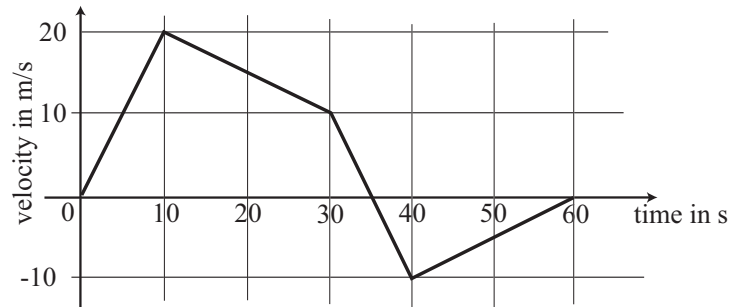
- a. $Mg \cos 30^\circ$
- b. $0.7 Mg \cos 30^\circ$
- c. $Mg \sin 30^\circ$

20. How large can the angle θ be before the block starts to slip?

- a. $\theta = 25 \text{ deg}$
- b. $\theta = 35 \text{ deg}$
- c. $\theta = 47 \text{ deg}$
- d. $\theta = 55 \text{ deg}$
- e. $\theta = 63 \text{ deg}$

The following 2 questions concern the same physical situation:

A block of mass 23 kg is under various forces and moves along the x-axis. The x-component of its velocity is plotted as a function of time as follows.



21. What is the largest magnitude of the net force acting on the block before 60 s?

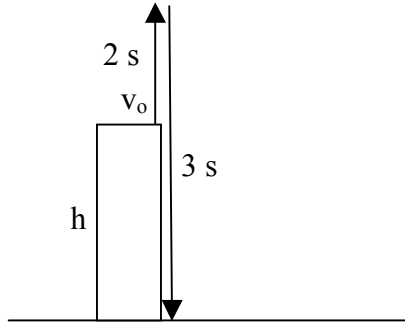
- a. 23 N
- b. 30 N
- c. 39 N
- d. 46 N
- e. 52 N

22. What is the average velocity of the block during 60 s?

- a. 3.3 m/s
- b. 5.0 m/s
- c. 6.7 m/s
- d. 8.3 m/s
- e. 10 m/s

The following 2 questions concern the same physical situation:

A ball is thrown upward with a certain initial velocity v_0 from the top of a tower of height h at time $t = 0$. It reaches the highest point at time $t = 2$ seconds, and the ground at time $t = 5$ seconds.



23. What is the height of the tower?

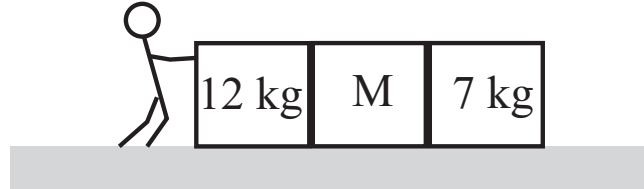
- a. 7.5 m
- b. 11.5 m
- c. 16.5 m
- d. 20.5 m
- e. 24.5 m

24. Suppose the mass of the ball is doubled and the same experiment is repeated from the same tower with exactly the same initial velocity. How long does it take for the ball to reach the ground?

- a. 2 s
- b. 5 s
- c. 10 s

The following 2 questions concern the same physical situation:

There are three boxes on a horizontal surface as illustrated in the following figure. The masses of two of the boxes are known, as shown in the figure. A person pushes the leftmost box to the right with a force of 320 N. The boxes accelerate to the right at 8 m/s^2 .



25. What is the mass M of the middle box?

- a. 7 kg
- b. 9 kg
- c. 13 kg
- d. 17 kg
- e. 21 kg

26. What is the force exerted by the middle box on the leftmost box?

- a. 153 N
- b. 167 N
- c. 224 N
- d. 253 N
- e. 289 N

**Check to make sure you bubbled in all your answers.
Did you bubble in your name, exam version and network-ID?**