Physics 151
March 18, 2005

Roster No.:_____

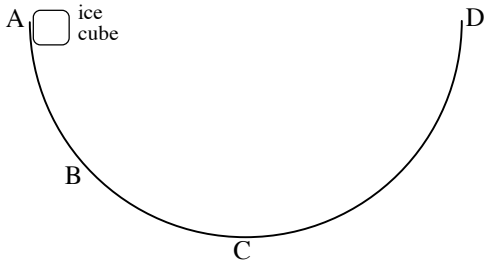
Score:_____

Midterm Exam #2, Part A

Exam time limit: 50 minutes. You may use calculators and both sides of 1 page of notes, *handwritten only*. Closed book; no collaboration. For multiple choice questions, circle the one best answer or letter (unless more than one answer is asked for).

Constants & Useful Data: $g = 9.81$ m/s^2 $G = 6.67 \times 10^{-11}$ N·m^2/kg^2 1 year $= 3.156 \times 10^7$ s

(1 pt. each, unless otherwise specified)



1. An ice cube is released from rest at the rim of a *frictionless* bowl and allowed to slide repeatedly back and forth. At point *C*, assume that the ice cube's $U_{gr} = 0$ J and $K = 0.50$ J.

a. At **point *D***, what is the ice cube's $\boldsymbol{U_{gr}}$? _____

b. At **point *B***, what is the ice cube's ($\boldsymbol{U_{gr} + K}$) = ? _____

c. At **which point(s)** in its path is the ice cube's $\boldsymbol{K = 0}$? _____

d. (2 pts.) If the ice cube's mass is 65 g (constant, assuming no melting), what is its **maximum speed**?

A. 0.45 m/s
B. 1.1 m/s
C. 1.7 m/s
D. 2.8 m/s
E. 3.9 m/s
F. 5.0 m/s

2. (2 pts) You know that your true mass is 60. kg, but as you stand on a bathroom scale in an elevator, it briefly reads that your mass is 45 kg. At that moment, what is the **acceleration** of the elevator, and in which **direction**?

A. 0.25 times *g*, upward
B. 0.25 times *g*, downward
C. 0.33 times *g*, upward
D. 0.33 times *g*, downward

3. **a**. (2 pts.) As part of his workout, a football player runs up the steps in Aloha Stadium, bringing his 95-kg body to a final height of 75 m above his starting point. How much mechanical **work** did he do to raise his body to that height?

A. none
B. 75 J
C. 735 J
D. 930 J
E. 7100 J
F. 70,000 J

b. (2 pts.) If it took the athlete 55 seconds to get there, what was his **power** output?

A. zero
B. 180 W
C. 340 W
D. 1.3 kW
E. 5.2 kW
F. 3.8 MW

c. Another 95-kg athlete runs 75 m along the flat track that encircles the playing field. How much mechanical **work** does he do on his body?

A. none
B. 75 J
C. 735 J
D. 930 J
E. 7100 J
F. 70,000 J

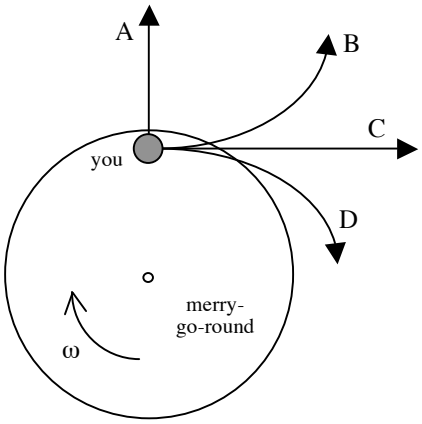
4. (2 pts.) In order for you to push a big 130-kg wooden crate along a level concrete floor at a constant speed, you find that you must apply a constant horizontal force of 700 N to the crate. What is the **coefficient of kinetic friction** between the crate and the floor?

A. 0.48
B. 0.55
C. 0.62
D. 0.70
E. 0.77
F. 0.85

5. Which one of the following is **NOT** one of the **4 Fundamental Forces** of physics?

A. Electromagnetism
B. Gravitation
C. Newtonian Force
D. Nuclear Strong Force

6. You are riding near the edge of a merry-go-round, spinning at a constant angular speed ω, when a big playground bully suddenly stops it. **As you fly off** the merry-go-round through the air (but ignoring air resistance), your body follows which one of the paths shown? ***(Circle the correct letter on the diagram at right.)***



7. a. (2 pts.) The centrifuge machines used for tiny Eppendorf test tubes in the UH Biology labs are capable of a maximum of 14,000 revolutions per minute. At full speed, how much **time** is needed for just one revolution of the centrifuge?

A. 430 ms
B. 43 ms
C. 4.3 ms
D. 430 μs
E. 43 μs
F. 4.3 μs

b. (2 pts.) At full speed, what is the apparent **acceleration** experienced by the test tube contents at the outer edge of the centrifuge, at a distance of 5.0 cm from the spin axis? (*Hint:* This is the same as the *centripetal acceleration* at that location.)

A. 6.3 times *g*
B. 41 times *g*
C. 260 times *g*
D. 510 times *g*
E. 8100 times *g*
F. 11,000 times *g*

Physics 151
March 18, 2005

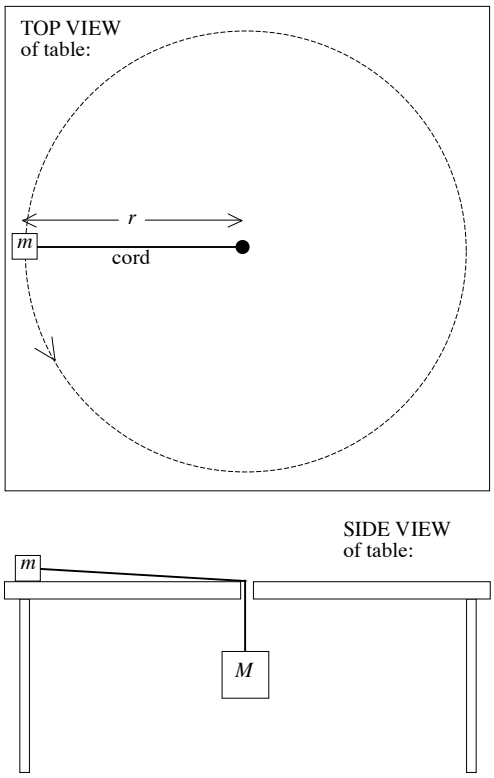
Roster No.:_____

Score:_____

Midterm Exam #2, Part B

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

1. A small mass (m = 0.20 kg) moves in a circle of radius r = 50. cm on a frictionless table. The mass moves with constant speed, completing one revolution every 0.90 s. The small mass m is fastened to the end of a very light cord, which hangs through a hole at the center of the table and suspends a larger mass M below the table (see diagram). The system is exactly "balanced," so that M does not move up or down.

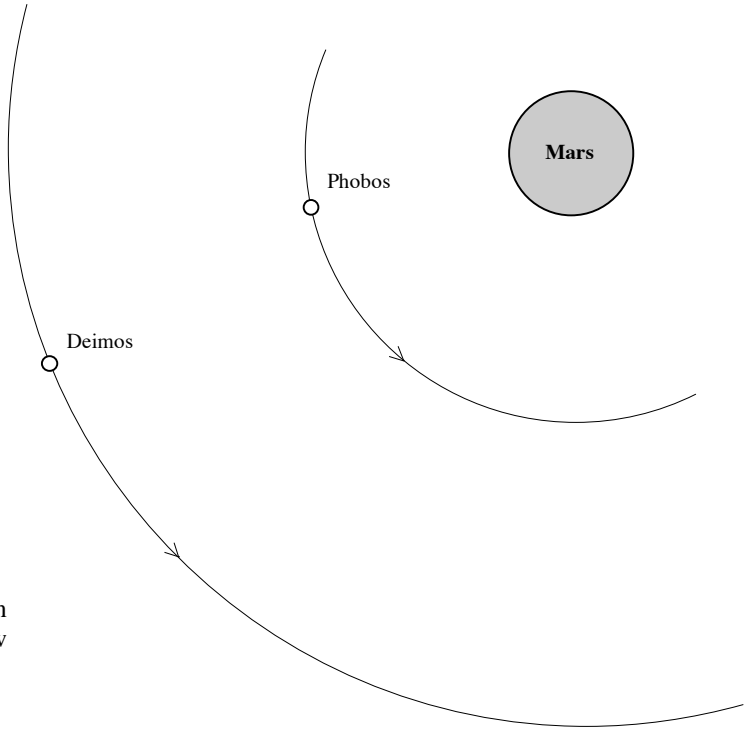


a. (4 pts.) Find the **linear speed** of the small mass m, in [m/s].

b. (2 pts.) How much **work** is done on the small mass m by the tension force in the cord during one complete revolution? **Explain** how you arrived at your answer.

c. (6 pts.) Calculate the **larger mass *M***, in kilograms. Show your work clearly.

2. The planet Mars has two moons, Phobos and Deimos, as shown in the diagram at right. Physical data for Mars and both of its moons are listed in the table below. (***Note:*** There is more information in the table than you will need to answer all of the questions. Pick and choose the necessary data.) For this entire problem, assume that both moons have circular orbits.



a. (1 pt.) Which moon has the **shorter orbital period**?

A. Phobos B. Deimos

b. (1 pt.) Which moon has the **greater linear speed** along its orbit?

A. Phobos B. Deimos

c. (6 pts.) Calculate the **orbital period** of **Phobos**, in **hours**. (Use whatever method you wish, but show your work clearly.)

Name of Object	**Mass** [kg]	**Ave. Radius of object** [km]	**Orbital Period** [hours & minutes]	**Average Orbital Distance from Mars** [km]
Mars	6.42×10^{23} kg	3394 km	—	—
Phobos	1.08×10^{16} kg	22 km	**???**	9377 km
Deimos	1.8×10^{15} kg	13 km	30 h 18 min	23,436 km

(2 . cont'd.)

d. (10 pts.) Suppose that Martian culture develops a system of astrological beliefs which claims that societal and personal events are affected by the positions of Phobos and Deimos in the sky. Calculate the following:

- **i.** the **gravitational force** of Phobos on a 100.-kg Martian standing directly below on the surface of Mars (so that Phobos appears to the Martian to be directly overhead)
- **ii.** the **gravitational force** of one 100.-kg Martian on another 100.-kg Martian standing 1.00 meter away

Very briefly **discuss**: Which of the two forces is greater? *Practically* speaking, does Phobos have any significant gravitational influence on the activities of creatures on the surface of Mars? Does it exert more or less gravitational force than, say, a crowd of other Martians standing nearby?