Roster No.:

Score: 22 pts. possible

SPRING 2003 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).

<u>Constants & Useful Data:</u>			
$G = 6.67 \times 10^{-11} \mathrm{N \cdot m^2/kg^2}$	<u>radii</u>	<u>orbital distances</u>	<u>orbital periods</u>
$M_{\rm Sun} = 1.99 \times 10^{30} \rm kg$	$R_{\rm Sun} = 6.96 \times 10^8 {\rm m}$		
$M_{\rm Earth} = 5.97 \times 10^{24} \rm kg$	$R_{\text{Earth}} = 6.38 \times 10^6 \text{ m}$	$r_{\text{Earth-Sun}} = 1.50 \times 10^{11} \text{ m}$	$T_{\text{Earth}} = 1.00 \text{ year}$
$M_{\rm Moon} = 7.35 \times 10^{22} \rm kg$	$R_{\rm Moon} = 1.74 \times 10^6 \mathrm{m}$	$r_{\text{Earth-Moon}} = 3.84 \times 10^8 \text{ m}$	$T_{\text{Moon}} = 27.4 \text{ days}$

(1 point each, unless otherwise specified)

1. A 15-kg block sits *at rest* on a horizontal surface. The coefficients of friction between the block and the surface are $\mu_s = 0.50$ and $\mu_k = 0.35$.

a. The magnitude of the **friction force** on the block is currently:

A. zero	D. 51 N
B. 7.5 N	E. 74 N
C. 22 N	F. 150 N

b. A force of 60. N to the right is applied to the block. The **friction force** acting on the block becomes:

A. 7.5 N to the left	D. 51 N to the left
B. 8.6 N to the left	E. 60. N to the left
C. 13.5 N to the left	F. 74 N to the left

c. (2 pts.) Instead, a force of 80. N to the right is applied to the block. The **friction force** acting on the block becomes:

A. zero	D. 51 N to the left
B. 6.5 N to the left	E. 74 N to the left
C. 29 N to the left	F. 80. N to the left

2. (2 pts.) Suppose a car engine has a frequency of 1500 revolutions/minute (rpm). What is its period?

A. 0.11 ms	D. 25 ms
B. 0.67 ms	E. 40. ms
C. 6.4 ms	F. 0.16 s

3. A huge, wheel-shaped space station with a radius of 250 m spins about its center in order to simulate a sense of artificial gravity for people walking on its inside edge. (See sketch.) People feel an apparent "gravity" equal to the magnitude of the centripetal acceleration at their location.

a. (2 pts.) What must be the space station's **period of rotation** if people just inside its edge experience "one gee," or 9.80 m/s^2 ?

A. 9.8 s	D. 96 s
B. 32 s	E. 650 s
C. 49 s	F. 2450 s

b. As a space station visitor moves along one of the spokes from the wheel's edge to the center, what happens to the **magnitude** of his/her artificial "gravity"?

- A. constant at *g* the entire way
- B. constant at g, until dropping suddenly to zero at center
- C. diminishing from g at edge to g/2 at center
- D. diminishing from g at edge to zero at center
- E. increasing from g at edge to 2g at center
- F. increasing from g at edge to ∞ at center



4. If two masses are both tripled in mass AND are moved to 3 times their original separation, the gravitational force of one mass on the other will become:

- A. unchanged
- D. 3 times greater E. $3\sqrt{3}$ times greater
- B. 3 times weakerC. 9 times weaker F. 9 times greater

5. If two large identical masses are placed at rest on a frictionless surface and released, gravitational force would eventually cause them to...

- A. orbit each other
- B. accelerate directly toward each other
- C. move toward each other at constant speed
- D. do nothing; they would remain at rest forever

- 6. Which one of the following is **TRUE**?
- A. The only gravitational force acting on you right now is the Earth's.
- B. The gravitational force of the Earth on you is much greater than the gravitational force of you on the Earth.
- C. The gravitational force of the Earth on you is also known as your "weight."
- D. If the Earth's mass or radius were to change, your weight would still be the same number of newtons.

7. You are in an elevator in a tall building when the elevator cable suddenly snaps. As a physics student, your horror is immediately eclipsed by your realization that you are in freefall. As you study the situation, you realize which one of the following is TRUE?

A. Your acceleration is zero.

- B. Your weight is zero.
- C. The sum of all forces acting on you is zero.
- D. If you were to stand on a bathroom scale, its reading would be zero.
- 8. Mercury is the planet that orbits *closest* to the Sun; Pluto is the *farthest*. Which of the two has...

a.	the greater mass ?			
	A. Mercury	C.	both planets are equal	
	B. Pluto	D.	can't determine from the information given	
b.	the longer orbital period?			
	A. Mercury	C.	both planets are equal	
	B. Pluto	D.	can't determine from the information given	
c.	the greater average linear (tangential) ve	locity?	
	A. Mercury	C.	both planets are equal	
	B. Pluto	D.	can't determine from the information given	
d. the greater average angular speed (frequency) ?				
	A. Mercury	C.	both planets are equal	
	B. Pluto	D.	can't determine from the information given	
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9. If the speed of an object is increased to 4 *times* its original value, its **kinetic energy** becomes:

- D. 8 times greater A. 2 times greater
- E. 16 times greater B. $2\sqrt{2}$ times greater
- C. 4 times greater F. 64 times greater

10. a. (2 pts.) Suppose that Aloha Moving Company uses a rope to hoist 350-kg grand piano up to a high window, 13 m above the ground. How much mechanical work do the movers perform in raising the piano?

A. 130 J D. 4600 J B. 210 J E. 22,000 J C. 3400 J F. 45,000 J

b. If the movers lift the piano the entire distance in 1.0 minute, what is their average **power**?

A. 58 W	D. 2.2 kW
B. 160 W	E. 5.8 kW
C. 740 W	F. 21 kW

c. In part (a), suppose the movers use an arrangement of nested pulleys so that they only need to pull on the rope with a force of 290 N to raise the piano at constant speed. What is the mechanical advantage of their system of pulleys?

A.	2	D.	8
B.	4	E.	12
C.	6	F.	150

10000011000

Score: <u>18 pts. possible</u>

SPRING 2003 Midterm Exam #2, Part B

Exam time limit: 50 minutes. You may use calculators and both sides of 1 page of notes, *handwritten only*. Closed book; no collaboration. Show your work on free-response questions. Be sure to use proper units and significant figures in your final answers.

1. A century or so from now, humans may well land on Europa, one of Jupiter's four largest moons and which intriguingly appears to be covered with H_2O ice.

a. (4 pts.) Suppose that Europa has exactly *one-fourth the radius* of Earth, and exactly *one-hundredth the mass* of Earth. What is the **gravitational acceleration** that astronauts will experience on the **surface** of Europa? Express your answer in terms of the surface gravity on Earth, g_{Earth} .

b. (4 pts.) Information for Jupiter and its four largest moons is summarized in the table below:

Name of	Mass	Orbital Period	Average Orbital Distance
Object	[kg]	[Earth days]	from Jupiter [km]
Jupiter	$1.90 \times 10^{27} \text{ kg}$	_	_
Io	$8.90 \times 10^{22} \text{kg}$	1.77 days	422,000 km
Europa	$4.90 \times 10^{22} \text{ kg}$	3.55 days	???
Ganymede	$1.50 \times 10^{23} \text{ kg}$	7.16 days	1,070,000 km
Callisto	$1.10 \times 10^{23} \text{ kg}$	16.7 days	1,883,000 km

Use Kepler's Third Law in whatever way you wish to determine **Europa's average orbital distance** from Jupiter, the missing value in the table above. (You will only need to use one or two pieces of data from the table, *not* the whole thing.) Show your work.

2. A block with mass m = 5.00 kg is at the top of an inclined plane of angle $\alpha = 20.0^{\circ}$ and height 1.50 m. The block starts from rest.



b. (4 pts.) Suppose that the incline above is *frictionless*. Find the block's **final velocity** at the bottom of the incline. (You may solve this either using conservation of energy, or using force and kinematics. In either case, show all steps in your work.)

 c. Imagine three blocks, of *unknown* masses, released from rest at the same starting height of 1.50 meters: Block A is on the 20.0° frictionless incline above; Block B is on a 55.0° frictionless incline; and Block C is allowed to fall freely straight down.

i. (1 pt.) Which of the three blocks will have the greatest final velocity at the bottom?

- A. Block A C. Block C E. Cannot determine from the information given
- B. Block B D. All three will have same final velocity

ii. (1 pt.) Which of the three blocks will reach the bottom in the shortest time?

- A. Block A C. Block C E. Cannot determine from the information given
- B. Block B D. All three will have same time of descent