Physics 151 Roster No.:______________________

Score:______22 pts. possible___________

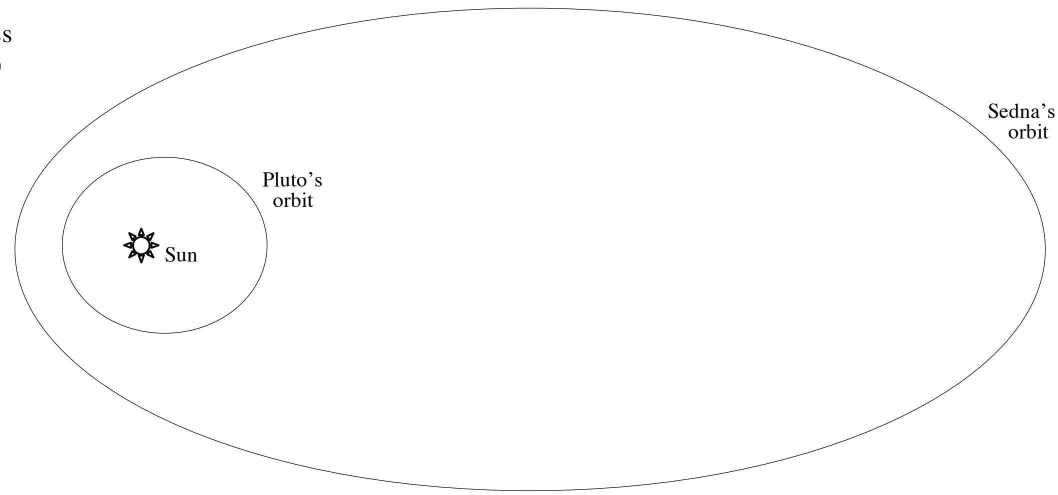
SPRING 2004 Midterm Exam #2, Part A

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: $G = 6.67 \times 10^{-11}$ N·m²/kg² 1 year = 3.156×10^7 s

masses	*radii*	*orbital distances*	*orbital periods*
$M_{Sun} = 1.99 \times 10^{30}$ kg	$R_{Sun} = 6.96 \times 10^8$ m		
$M_{Earth} = 5.97 \times 10^{24}$ kg	$R_{Earth} = 6.38 \times 10^6$ m	$r_{Earth\text{-}Sun} = 1.50 \times 10^{11}$ m	$T_{Earth} = 1.00$ year
$M_{Moon} = 7.35 \times 10^{22}$ kg	$R_{Moon} = 1.74 \times 10^6$ m	$r_{Earth\text{-}Moon} = 3.84 \times 10^8$ m	$T_{Moon} = 27.4$ days

(1 pt. each, unless otherwise stated)



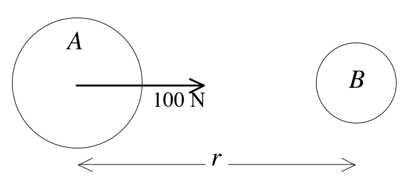
1. In March 2004, there was some excitement in astronomy (and in the general news) about the discovery of a "10th planet," tentatively named Sedna. Pluto is the 9th planet from the Sun, and is 30% larger than Sedna in physical diameter. The above diagram schematically shows their relative orbits about the Sun. (*Note:* The diagram above is not exactly to scale.) Pluto's average orbital distance from the Sun is 39.5 times that of Earth, while Sedna's is a whopping 480 times that of Earth.

a. Name the **mathematical curve** that describes the shape of the orbits of both Pluto and Sedna: ________________

b. (2 pts.) **Label** the points on Sedna's orbit (above) where its linear speed along its orbit is at its **fastest** and its **slowest**.

c. Which of the two planets has the **longer period**? ________________

2. Consider two spherical masses, *A* and *B*, as shown. *A* has a greater mass than *B*. The gravitational force acting on mass *A* is 100 N to the right.



a. The **magnitude** of the **gravitational force on B** is:

A. less than 100 N
B. 100 N
C. greater than 100 N
D. cannot be determined from information given

b. The **direction** of the **gravitational force on B** is:

A. to the right
B. to the left
C. in a direction neither right nor left
D. cannot be determined from information given

c. (2 pts.) Let *r* be the distance from the center of mass *A* to the center of mass *B*. To *decrease* the gravitational force on mass *A* to just 10 N, the centers of the two masses should be separated to a new **distance** of:

A. 2.5 *r*
B. (√10) *r*
C. 4 *r*
D. 5 *r*
E. 10 *r*
F. 100 *r*

3. a. (2 pts.) A stadium "wave" takes 11 seconds to complete one cycle around UH's Stan Sheriff sports arena. Assuming that the arena is a circle with an average radius of 31 m, what is the **linear speed** of the "wave"?

A. 5.5 m/s
B. 8.7 m/s
C. 12 m/s
D. 15 m/s
E. 18 m/s
F. 22 m/s

b. (2 pts.) What is the **angular speed, ω,** of the "wave"?

A. 0.57 rad/s
B. 0.83 rad/s
C. 1.1 rad/s
D. 3.1 rad/s
E. 5.7 rad/s
F. 8.9 rad/s

4. A Salad Spinner™ is a plastic cylinder-shaped centrifuge with many small holes designed to drain wet vegetables. The entire bowl and contents are spun at high speed, thereby forcing any water through the holes, just as the "spin" cycle of a washing machine does.

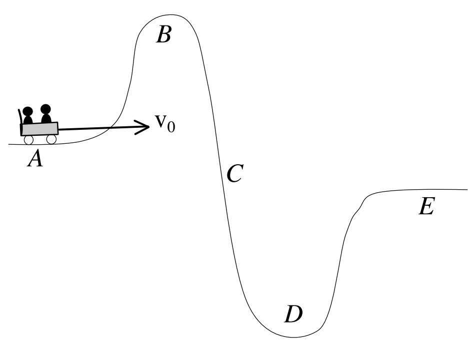
a. (2 pts.) If a Salad Spinner™ has a radius of 15 cm and is spinning 4.0 cycles per second, what is the **centripetal acceleration** felt by vegetables at the very edge of the bowl? (1 "gee" = 9.80 m/s^2)

A. 0.080 gee
B. 0.15 gee
C. 0.45 gee
D. 0.75 gee
E. 1.5 gees
F. 9.7 gees

b. Which force provides the centripetal force on the vegetables?

A. weight
B. friction
C. normal force
D. tension
E. centrifugal force
F. the Jedi force

5. Consider the roller coaster car and *frictionless* track as shown. The car has just enough initial velocity v_0 at *A* to be able to barely pass over hill *B* with virtually zero speed. At point *D*, the car's PE = 0 and KE = 30,000 J.



a. At **point *B***, what is the car's **PE**? __________

b. At **point *C***, what is the car's **KE + PE =** ? __________

c. At **which point** is the car's **speed greatest**? __________

d. If **point *E*** is at a *lower elevation* than point *A*, which **one** of the following is **TRUE**?

A. The car's *speed* at point *E* is less than at point *A*.
B. The car's *KE* at point *E* is less than at point *A*.
C. The car's *PE* at point *E* is less than at point *A*.
D. The car's *total energy* at point *E* is less than at point *A*.
E. None of the above.

e. (2 pts.) If the car's mass is 250 kg, and its PE = 18,000 J at point *A*, what is $\mathbf{v_0}$?

A. 5.0 m/s
B. 7.5 m/s
C. 9.8 m/s
D. 10.5 m/s
E. 12 m/s
F. 15 m/s

6. Which one of the following does **NOT** have **units of joules** (or equivalent)?

A. work
B. heat
C. power
D. elastic potential energy
E. gravitational potential energy
F. kinetic energy

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Score: **28 pts. possible**

SPRING 2004 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. Astronomers estimate that our Sun takes 225 million years to complete one orbit about the center of our Milky Way Galaxy, and that the distance from the Sun to the center of the Galaxy is 2.5×10^{20} m.

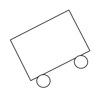
a. (5 pts.) Assuming that our Sun is in uniform circular motion about the center of the Milky Way, calculate the **tangential (linear) speed** of the Sun in its orbit. Convert your answer to **[kilometers/second]**. (For comparison, the Earth's speed in its orbit around the Sun is 30 km/s; your answer here should be a few *hundred* km/s.)

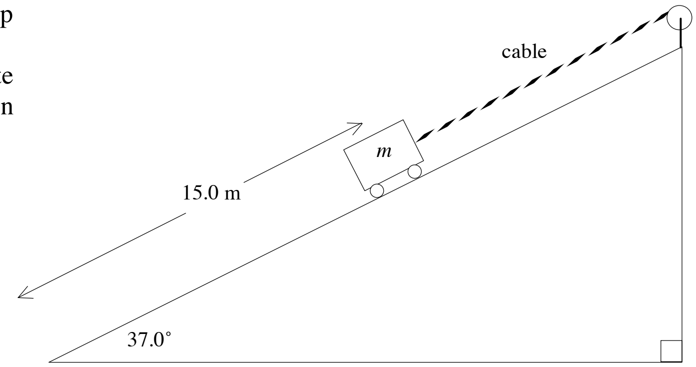
b. (5 pts.) For simplicity, imagine that all of the mass of the Milky Way Galaxy were packed into a single object at the center of the Galaxy, and pretend that the Sun's orbit is a simple circular orbit about this huge, hypothetical central mass. Calculate this **mass, in kilograms**.

c. (2 pts.) Estimate the **number of stars** in the Milky Way by dividing your answer to part (b) by the mass of our Sun: $M_{Sun} = 1.99 \times 10^{30}$ kg (This assumes that our Sun is an average-mass star, which turns out to be true.) **How many billion stars** is your answer?

2. While being loaded onto a cargo ship, a 925-kg crate on *frictionless* wheels is pulled up a 37.0˚ ramp by a cable. The crate is presently at rest.

a. (3 pts.) On the free-body diagram of the crate below, **draw and name all force vectors** acting on the crate:





b. (6 pts.) Calculate the magnitude of the **force of tension** in the cable while the crate is at rest. Show your work.

c. (1 pt.) If, instead of being at rest, the crate were being pulled uphill at *constant speed*, your **answer to part (b)** would become:

A. greater B. less C. unchanged

d. (6 pts.) The crate is at rest, 15.0 meters along the ramp. If the cable suddenly breaks and the crate rolls down frictionlessly, what will be its **final speed** at the bottom of the ramp? (You may solve this either using conservation of energy, or using force and kinematics. In either case, show all steps in your work.)