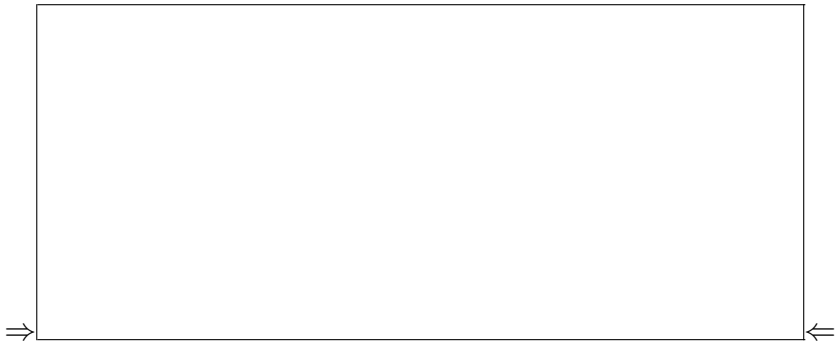
Physics 123 - Analytical Physics – FINAL EXAM

Tuesday, December 18, 2007

Professor Madey and Mr. Lucido



Your name sticker with **exam code. SIGN HERE:**

1. The exam will last from 4:00 p.m to 7:00 p.m. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
2. In the section labelled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial. DO NOT fill in blanks after your middle initial
3. Under STUDENT # enter your RU ID #
4. Enter 123 under COURSE, and your section number (see label above) under SEC.
5. Under CODE enter the exam code given above.
6. During the exam, you may use pencils, a calculator, and two 8.5 x 11 inch sheet (both sides) with formulas and notes.
7. There are 30 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. **At the end of the exam, hand in the answer sheet and the cover page.** Make sure that the cover page is signed where indicated. Retain this question paper for future reference and study.
8. When you are asked to open the exam, make sure that your copy contains all 30 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.
10. Some possibly useful information

Moments of Inertia about the Axis of Symmetry Through the Center of Mass

Solid Sphere	$\frac{2}{5}MR^2$
Solid Cylinder	$\frac{1}{2}MR^2$
Thin Walled Hollow Cylinder	MR^2
Slender Rod, Perpendicular To Rod	$\frac{1}{12}ML^2$

$g = 9.80\ m/s^2$

1. Taking the acceleration due to gravity to be 9.8 m/s^2, which of the following four statements is false for a body falling freely from rest near the surface of the earth? If none of the four statements is false, choose "None". (Ignore air resistance.)

   a) after 1 second, the body has fallen 9.8 meters.
   b) after 3 seconds, its speed is 29.4 meters per second.
   c) during each time interval of 1 second, its speed changes by 9.8 meters per second.
   d) after 2 seconds, the body has fallen 19.6 meters.
   e) None of these are false.

2. A point is located in a polar coordinate system by the coordinates $r = 2.5$ m and $\theta = 35°$. Find the x and y coordinates of this point, assuming the two coordinate systems have the same origin and the x axis is along $\theta = 0$.

   a) 1.43 m, -2.05 m
   b) 2.50 m, 2.50 m
   c) 2.50 m, 0.00 m
   d) 1.50 m, 1.35 m
   e) 2.05 m, 1.43 m

3. A student can throw a football a maximum range of 60 meters. How far could he throw it if the earth's gravity were reduced to 1/6 of its normal value, similar to the moon's gravity?

   a) 1.66 m
   b) 10 m
   c) 60 m
   d) 360 m
   e) 2160 m

4. A block of mass 3.0 kg is pulled up a frictionless 30° incline by an applied force of 25 N. What is the magnitude of the resulting acceleration of the block?

   a) 4.6 m/s^2
   b) 2.3 m/s^2
   c) 4.9 m/s^2
   d) 2.9 m/s^2
   e) 3.4 m/s^2

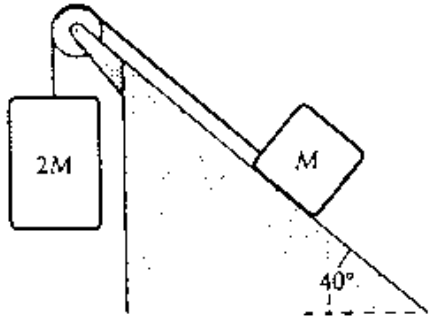
5. A cylindrically shaped space station with a radius of 40 m is turning about its axis at a constant rate. If the acceleration of the outer rim of the station is 2.5 m/s^2, how long does it take for the space station to complete one revolution?

   a) 22 s
   b) 19 s
   c) 28 s
   d) 40 s
   e) 25 s

6. You throw a ball up in the air and hold your hand under it to catch it when it comes down. The reason why the ball stops is:

   a) your hand is there; your hand exerts no force on the ball.
   b) your hand exerts a force on the ball perpendicular to its velocity.
   c) your hand exerts a force on the ball in the direction of its velocity.
   d) your hand exerts a force on the ball in the direction opposite to its velocity.
   e) your hand and the ball exert forces in the same direction on each other.

7. In the figure shown, the coefficient of kinetic friction between the block of mass M and the incline is 0.40. What is the magnitude of the acceleration of the suspended block (of mass 2M) as it falls? Disregard the mass of the pulley and any friction in the pulley.



a) 3.4 m/s^2
b) 4.7 m/s^2
c) 4.2 m/s^2
d) 3.9 m/s^2
e) 5.4 m/s^2

8. A 0.20-km wide river has a uniform flow speed of 3.0 m/s toward the east. A boat with a speed of 8.0 m/s relative to the water leaves the south bank and heads in such a way that it crosses to a point directly north of its departure point. How long does it take the boat to reach the other side of the river?

a) 29 s
b) 23 s
c) 25 s
d) 27 s
e) 17 s

9. When a car goes around a circular curve on a level road without slipping,

a) no friction force is needed because the car simply follows the road.
b) the frictional force of the road on the car increases when the car's speed decreases.
c) the frictional force of the road on the car increases when the car's speed increases.
d) the frictional force of the road on the car increases when the car moves to the outside of the curve while keeping its speed constant.
e) there is no net frictional force because the road and the car exert equal and opposite forces on each other.

10. How much work is done by a person lifting a 2.0-kg object from the bottom of a well at a constant speed of 2.0 m/s for 5.0 s?

a) 0.15 kJ
b) 0.20 kJ
c) 0.25 kJ
d) 0.30 kJ
e) 0.35 kJ

11. A baseball outfielder throws a baseball of mass 0.15 kg at a speed of 40 m/s and initial angle of 30° above horizontal. What is the kinetic energy of the baseball at the highest point of the trajectory?

a) 6.0 J
b) 240 J
c) 90 J
d) 5.25 J
e) 120 J

12. A 0.75-kg sphere is released from rest and is moving 5.0 m/s after falling 2.0 m in a viscous medium. How much work is done by the viscous force on the block during this descent?

a) -6.1 J
b) -4.6 J
c) -5.3 J
d) -6.8 J
e) -2.7 J

13. The turntable of a record player has an angular velocity of 5.0 rad/s just at the instant it is turned off. The turntable comes to rest 2.0 s later. Through how many radians does the turntable rotate after being turned off? Assume constant angular acceleration.

a) 5.0 rad
b) 4.0 rad
c) 6.0 rad
d) 3.4 rad
e) 8.0 rad

14. A 35-kg girl is standing near and to the left of a 43-kg boy on a frictionless surface of a frozen pond. The boy tosses a 0.75-kg ice ball to the girl with a horizontal speed of 6.2 m/s. What are the velocities of the boy and the girl immediately after the girl catches the ball?

a) Girl: 0.13 m/s, left; Boy: 0.11 m/s, right
b) Girl: 0.81 m/s, left; Boy: 0.67 m/s, right
c) Girl: 0.17 m/s, left; Boy: 0.14 m/s, left
d) Girl: 0.18 m/s, right; Boy: 0.13 m/s, left
e) Girl: 0.42 m/s, left; Boy: 0.49 m/s, right

15. A dumbbell consists of two 15-kg masses on a rod of negligible mass and length 0.50 m. The moment of inertia for rotation of the dumbbell around an axis perpendicular to the rod, passing through the center of mass, is

a) 2.4 kg-m^2
b) 0.26 kg-m^2
c) 0.63 kg-m^2
d) 1.2 kg-m^2
e) 1.9 kg-m^2

16. A 6.0-kg object moving 2.0 m/s in the positive x direction has a one-dimensional elastic collision with a 4.0-kg object moving 3.0 m/s in the opposite direction. What is the total kinetic energy of the two-mass system after the collision?

a) 30 J
b) 62 J
c) 20 J
d) 44 J
e) 24 J

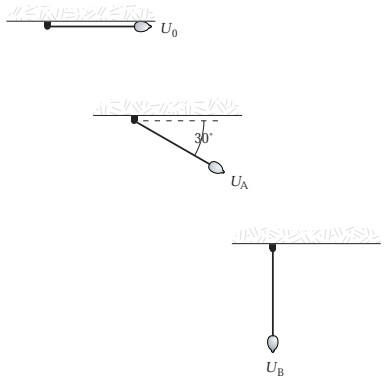
17. An 80-g particle moving with an initial speed of 50 m/s in the positive x direction strikes and sticks to a 60-g particle moving 50 m/s in the positive y direction. How much kinetic energy is lost in this collision?

a) 96 J
b) 89 J
c) 175 J
d) 86 J
e) 110 J

18. Two masses of 1.0 kg and 4.0 kg are attached by a 5.0-m long rod of negligible mass in outer space. This rigid body rotates around an axis perpendicular to the rod, passing through the center of mass, once per second. The rotational energy of the system is

a) $10\pi^2$ J
b) $20\pi^2$ J
c) $40\pi^2$ J
d) $60\pi^2$ J
e) $80\pi^2$ J

19. A pendulum bob has potential energy U_0 when held taut in a horizontal position. The bob falls until it is 30° away from the horizontal position, where it has potential energy U_A. It continues to fall until the string is vertical, where it has potential energy U_B. Compare its potential energies at O, A and B.



a) $U_0 = U_A = U_B$
b) U_A - $U_B = 2U_0$
c) U_A - $U_B = U_0$ - U_A
d) $U_0 = U_B = 2U_A$
e) U_0 - $U_A = 2(U_A$- $U_B)$

20. A rifle is aimed horizontally at the center of a large target 60 m away. The initial speed of the bullet is 240 m/s. What is the distance from the center of the target to the point where the bullet strikes the target?

a) 0.48 m
b) 0.17 m
c) 0.31 m
d) 0.69 m
e) 0.52 m

21. A 2.0-kg projectile moves from its initial position to a point that is displaced 20 m horizontally and 15 m above its initial position. How much work is done by the gravitational force on the projectile?

a) +290 J
b) -290 J
c) +30 J
d) -30 J
e) -50 J

22. A solid, uniform sphere spining about an axis through its center has kinetic energy K. A second sphere has twice the mass, twice the diameter, and twice the angular velocity of the first one. The rotational kinetic energy of the second sphere is

a) 32K
b) 4K
c) 16K
d) 8K
e) 2K

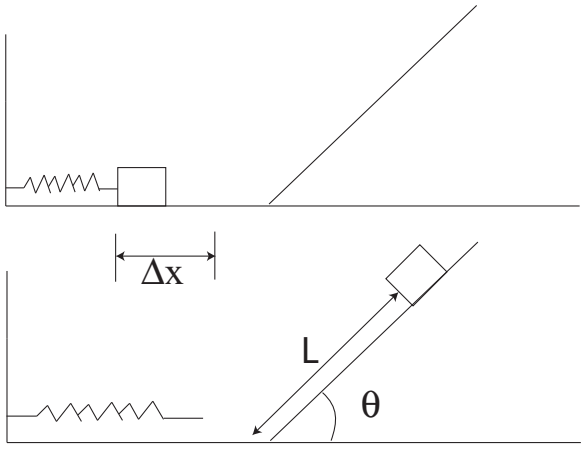
23. A block of mass 2.90 kg, moving on a frictionless surface with initial speed 4.1 m/s makes a perfectly elastic collision with a block of mass M, initially at rest. After the collision, the 2.9 kg block recoils back with a speed of 0.8 m/s, while the block of mass M moves forward with a speed of

a) 3.7 m/s
b) 3.3 m/s
c) 4.1 m/s
d) 4.9 m/s
e) 4.5 m/s

24. You are testing a new car using crash test dummies. Consider three ways to slow the car down from 90 km/h to a complete stop:
(i) You let the car slam into a wall, bringing it to a sudden stop (in 1 second)
(ii) You apply the brakes so that the car comes to a stop in 8 seconds
(iii) You let the car plow into a giant tub of gelatin so that it comes to a gradual halt (stops in 15 seconds)
In which case is there a greater impulse of the net force on the car?

a) in case (i)
b) in case (ii)
c) in case (iii)
d) The impulse is the same in all cases
e) not enough information is given to decide

25. A 4.0 kg block is pushed against a spring with (k=250 N/m), and comressed a distance of $\Delta x = 0.15$ m. The block is released and slides along a frictionless track, which is initially horizontal, then at an incline of $\theta = 30°$, as shown in the figure. What is the distance, L that the block travels along the inclined part of the track?



a) 23 m
b) 17 m
c) 0.98 m
d) 0.14 m
e) 0.071 m

26. We have a solid cylinder that rolls without slipping with a center of mass velocity of 3.50 m/s. It has a total mass of 0.500 kg and a radius of 0.250 m. What is the ratio of the translational kinetic energy to the rotational kinetic energy?

a) 1
b) 2
c) 1.5
d) 0.75
e) 2.5

27. In one minute, a ski lift raises 50 passengers (each of who has a mass of 75 kg each) a height of 0.30 km, at a constant speed. What is the average power required to run the lift?

a) 125 kW
b) 78 kW
c) 3.7 kW
d) 3.1 kW
e) 180 kW

28. There are three vectors given by:
$\mathbf{A} = 3.00\mathbf{i} - 1.50\mathbf{j}$
$\mathbf{B} = -2.50\mathbf{i} + 0.50\mathbf{j}$
$\mathbf{C} = -1.00\mathbf{i} - 1.00\mathbf{j}$.
Find the angle between the vector $\mathbf{D} = \mathbf{A} + \mathbf{B}$ and vector $\mathbf{C}$.

a) 72°
b) 0.0°
c) 76°
d) 45°
e) 66°

29. Consider the two vectors shown in the figure. Notice $\theta = 30°$ while $\phi = 53°$. If the magnitude of $\mathbf{A} = 4.00$ and the magnitude of $\mathbf{B} = 5.00$, what is their sum, $\mathbf{A} + \mathbf{B}$?

a) $6.5\mathbf{i} + 6.0\mathbf{j}$
b) $0.46\mathbf{i} + 2.0\mathbf{j}$
c) $-0.53\mathbf{i} + 1.0\mathbf{j}$
d) $7.5\mathbf{i} + 5.0\mathbf{j}$
e) $1.1\mathbf{i} + 8.9\mathbf{j}$

30. A rock of mass m and a rock of mass $2m$ are both released from rest at the same height, and feel no air resistance as they fall. Which of these statements is true?

a) Both have the same initial gravitational potential energy
b) Both have the same kinetic energy when they reach the ground
c) When they reach the ground, the heavier rock has twice the kinetic energy of the lighter one
d) When they reach the ground, the lighter rock has twice the kinetic energy of the heavier rock
e) When they reach the ground, the lighter rock has twice the velocity of the heavier one