PHYSICS 103

Final exam

TIME: 120 minutes

Jan. 28, 2008

DO NOT OPEN THIS EXAM BEFORE YOU ARE TOLD TO BEGIN

NAME_____

ID Number _____

Grading

A	
B	
C	
TOTAL	

Score:_____

☐ Check if solution is continued on the back.

Part A (18%):

1.(3%) State the general Newton's first law of motion.

2. (3%) State the general Newton's second law of motion.

3. (3%) Define the centripetal acceleration and write down its expression as a function of the translational velocity and radius.

Score:_____

☐ Check if solution is continued on the back.

4. (3%) What are the equivalent equations in angular motion of

(a) $x_f = x_i + v_i t + at^2/2$ .....

(b) $p=mv$ .....

(c) $KE=1/2mv^2$ .....

5. (3%) a) What are the conserved dynamic quantities during elastic collisions and

b) What are the conserved dynamic quantities during inelastic collisions

6. (3%) Write down the expression of the gravitational force and the corresponding gravitational potential energy.

Score:_____

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Part B (36%):

1. (3%) A constant net torque is applied to an object. Which one of the following will *not* be constant?

a. angular acceleration,
b. angular velocity,
c. moment of inertia
d. center of gravity.

2. (3%) Which statement is true about the unit vectors **i**, **j**?

a. They are used in a Cartesian coordinate system.
b. The angle between any two is 90 degrees.
c. Each has a length of 1.
d. If **i** is directed east then **j** is directed south.
e. All of the above.

3. (3%) A constant force F is applied to a body of mass m that initially is headed east at velocity v_0 until its velocity becomes $-v_0$. The total time of travel is $2t$. The total distance the body travels in that time is

a. $Ft^2/2m$
b. Ft^2/m
c. $v_0t - Ft^2/2m$
d. $v_0t + Ft^2/2m$
e. $2(v_0t + Ft^2/2m)$

4. (3%) A toy rocket, launched from the ground, rises vertically with an acceleration of 20 m/s^2 for 6.0 s until its motor stops. Disregarding any air resistance, what maximum height above the ground will the rocket achieve?

a. 1.1 km
b. 0.73 km
c. 1.9 km
d. 0.39 km
e. 1.5 km

5. (3%) A small sports car collides head-on with a massive truck. The greater impact force (in magnitude) acts on

(a) the car,
(b) the truck,
(c) neither, the force is the same on both.

Which vehicle undergoes the greater magnitude acceleration?

(d) the car,
(e) the truck,
(f) the accelerations are the same.

Score:_____

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6. (3%) An object of mass m moves to the right with a speed v. It collides head-on with an object of mass $3m$ moving with speed $v/3$ in the opposite direction. If the two objects stick together, what is the speed of the combined object, of mass $4m$, after the collision?

a. 0
b. $v/2$
c. v
d. $2v$
e. $-v/2$

7. (3%) The same constant force is used to accelerate two carts of the same mass, initially at rest, on horizontal frictionless tracks. The force is applied to cart A for twice as long a time as it is applied to cart B. The work the force does on A is WA; that on B is WB. Which statement is correct?

a. WA = WB.
b. WA = 2 WB.
c. WA = 2 WB.
d. WA = 4 WB.
e. WB = 2WA.

8. (3%) A 30 kg child sitting 5.0 m from the center of a merry-go-round has a constant speed of 5.0 m/s. While she remains seated in the same spot and travels in a circle, the work the seat performs on her in one complete rotation is

a. 0 J.
b. 150 J.
c. 1500 J.
d. 4700 J.
e. 46,000 J.

9. (3%) A ball falls to the ground from height h and bounces to height h'. Momentum is conserved in the ball-earth system

a. no matter what height h' it reaches.
b. only if $h' < h$.
c. only if $h' = h$.
d. only if $h' > h$.
e. only if $h' \geq h$.

10. (3%) The angular speed of the minute hand of a clock, in rad/s, is

a. $\pi/1800$.
b. $\pi/60$.
c. $\pi/30$.
d. π.
e. 120π.

Score:_____

☐ Check if solution is continued on the back.

11. (3%) Stars originate as large bodies of slowly rotating gas. Because of gravity, these clumps of gas slowly decrease in size. The angular velocity of a star increases as it shrinks because of

a. conservation of angular momentum
b. conservation of linear momentum
c. conservation of energy
d. the law of universal gravitation
e. conservation of mass

12. **(3%)** A car of mass 1000 kg moves with a speed of 50 m/s on a circular track of radius 100 m. What is the magnitude of its angular momentum (in kg m^2/s) relative to the center of the race track?

a. 5.0×10^2
b. 5.0×10^6
c. 2.5×10^4
d. 2.5×10^6
e. 5.0×10^3

Score:_____

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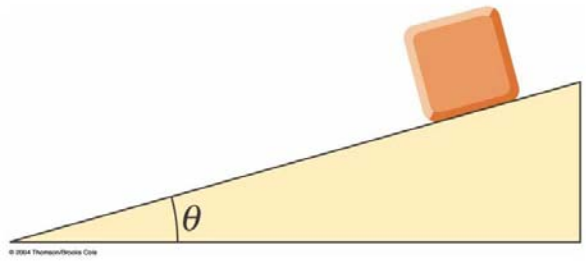
Part C (46%)

1. **(16%)** A block starts from rest at the top of a frictionless plane. The inclination is $\theta = 15.0°$ and the length of the inclined surface is 2.00 m.



(a) **(3%)** Draw a free-body diagram of the block.

(b) **(3%)** Find the acceleration of the block

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(c) **(3%)** Find its speed when it reaches the bottom of the incline.

(d) **(3%)** Assume that the plane is no longer frictionless but has a kinematic friction of μ_k=0.4. Re-determine the acceleration of the block.

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(e) **(4%)** How much work did the block as it slides the whole surface.

2. (10%) A bug is on the rim of a 25 cm radius disk. The disk moves from rest to an angular speed of 78 rev/min in 3.0 s.

(a) (3%) What is the angular acceleration of the bug?

(b) (3%) When the disk is at its final speed, what is the angular velocity of the bug?

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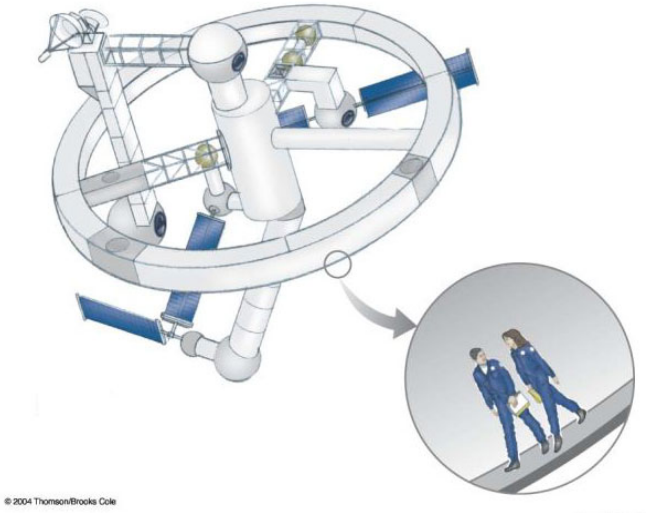
(c) (4%) One second **after** the bug starts from rest, what are its angular acceleration, centripetal acceleration, and total acceleration?

3. (14%) A space station is constructed in the shape of a hollow ring of mass 5.00×10^4 kg with radius 100 m. The moment of inertia for the ring is MR^2 and other parts have negligible mass.



At rest when constructed, the ring is rotated about its axis so that the people inside experience an effective free-fall acceleration equal to 1g.

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(a) (3%) assuming that this artificial gravitation is caused only by centripetal acceleration, determine the angular velocity necessary to achieve 1g.

(b) (3%) The rotation is achieved by firing **two** small rockets attached tangentially to opposite points on the outside of the ring. Initially the ring was at rest, what angular momentum does the space station acquire?

(c) (4%) How long must the rockets be fired if each exerts a thrust of 125 N?

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(d) (4%) Assume that the total mass of the ring includes the mass of one hundred crew member each weighing 65.0 kg. If all the crew members move to the center, determine the angular speed change at the rim of the space station.

4. (6%) Determine the expression of the minimum velocity needed for an object to be launched with from the surface of the earth so as it soars into space.

Score:_____

☐ Check if solution is continued on the back.

Score:_____

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SCRATCH PAPER

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Score:_____

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