Name: _____ **Class:** _____ **Date:** _____ **ID: A**

Conceptual Physics Circular Motion and Gravitation Practice Exam 2010-2011

Multiple Choice (1 point each)
Identify the choice that best completes the statement or answers the question.

____ 1. Which has more rotational inertia, a girl running with her legs bent or the same girl running with her legs straight?
   a. With straight legs.
   b. With bent legs.
   c. Both have the same rotational inertia.

____ 2. Which objects roll down an incline with the greatest acceleration?
   a. Objects with large rotational inertia.
   b. Objects with small rotational inertia.
   c. Acceleration is independent of rotational inertia in this case.

Essay Please write a short paragraph for each question. Be sure to include equations supporting your ideas.

3. Discuss the difference between linear speed and rotational speed. Where does a ladybug sitting on a rotating record have the greatest linear speed? The greatest rotational speed? What kind of speed would she have at the center? (3 points possible)

4. Explain what a centripetal force is and give some examples. Are centripetal forces real? (3 points possible)

5. Which has more rotational inertia, a solid sphere of mass 100 kg and radius 50 cm or a solid cylinder of the same mass and radius? Explain why. (3 points)

6. Define angular momentum. Discuss how conservation of angular momentum is applied to a gymnast starting from a standing position and turning a somersault in the air. Consider the change in his or her rotational inertia. (3 points)

Problems Each is worth 4 points. Always show equations used, all work, and correct units. Be neat and thorough.

7. The tangential speed at the outer rim of a Ferris wheel is 10 m/s. What is the tangential speed of a position half way from the center to the outer rim? Show all work and units.

8. You sit at the outer rim of a Ferris wheel that rotates at 4 revolutions per minute (RPM). What would your rotational speed be if you were instead clinging to a position halfway from the center to the outer rim? Show all work and units.

9. A vertical pole standing against a wall topples to the ground and the center of the pole has a speed of 12 m/s as it hits. With what speed does the far end of the pole hit the ground?
Show all work and units.

10. At the outer edge of a rotating space habitat, 50 m from its center, the rotational acceleration is *g*. What is the rotational acceleration at a distance of 25 m from the center of the habitat?
    Show all work and units.

11. A ball at the end of a long rope is swung in a horizontal circular path. The rope is then pulled in so that the radius of the path is $\frac{1}{3}$ as big. How does the tangential speed of the ball change?

12. What would a person who weighs 650 N on Earth weigh on a planet that has the same mass as Earth but half its radius?

13. Imagine you are standing atop a ladder so tall that you are 2 Earth radii from Earth's center. What is your weight at the top of the ladder, relative to your weight on the ground?

14. A woman whose mass is 70 kg on Earth's surface is in a spacecraft at a height of twice Earth's radius (that is, 4 Earth radii) above Earth's surface. What is her mass (not weight) there?

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Answer Section

MULTIPLE CHOICE

1. ANS: A PTS: 1 DIF: L2 OBJ: 12.1 Rotational Inertia
   STA: Ph.1.l KEY: rotational | inertia BLM: comprehension
2. ANS: B PTS: 1 DIF: L2 OBJ: 12.1 Rotational Inertia
   STA: Ph.1.l KEY: incline | acceleration BLM: comprehension

ESSAY

3. ANS:
   Linear speed is distance an object moves per unit time, whereas rotational speed is angle an object rotates per unit time. The ladybug will have the greatest linear speed at the edge of the record, but its rotational speed will be the same anywhere on the record. At the center of the record the ladybug has no linear speed, only rotational speed, as she rotates about her own and the record's axis.

   PTS: 1 DIF: L2 OBJ: 10.2 Rotational Speed
   STA: Ph.1.l KEY: speed | linear | rotational BLM: comprehension
4. ANS:
   A centripetal force is any force that makes an object move in a curved path. The gravitational force holding Earth in orbit about the sun is centripetal force. The electrical force holding an electron in orbit about the atomic nucleus is also centripetal force. The string tension that holds a rock whirling in a circular path at the end of a string is also a centripetal force. Centripetal forces are real forces because they are part of an interaction between two things.

   PTS: 1 DIF: L2 OBJ: 10.3 Centripetal Force
   STA: Ph.1.f | Ph.1.g KEY: centripetal BLM: analysis
5. ANS:
   The cylinder rotating about its center axis has more rotational inertia, because more of its mass is at the edges away from its central axis. (See the formulas on page 152). The rotational inertia of the sphere is $\frac{2}{5}mr^2 = 10$ kg·m^2, whereas the rotational inertia of the cylinder is $\frac{1}{2}mr^2 = 12.5$ kg·m^2.

   PTS: 1 DIF: L2 OBJ: 12.1 Rotational Inertia
   STA: Ph.1.l KEY: rotation | inertia | cylinder BLM: application

6. ANS:
Angular momentum is the product of an object's moment of inertia and its angular velocity. A gymnast jumping into the air pushes off with a slight rotational speed so as to have some angular momentum. The speed increases greatly when the gymnast reduces rotational inertia by tucking into a small ball shape. Before landing, the gymnast increases his or her rotational inertia by straightening out. This reduces his or her rotational speed. Throughout the jump, the product of rotational inertia and rotational speed remains constant.

PTS: 1 DIF: L2 OBJ: 12.3 Rotational Inertia and Rolling
STA: Ph.2.f KEY: angular | momentum BLM: application

PROBLEM

7. ANS:
5 m/s

PTS: 1 DIF: L2 OBJ: 10.2 Rotational Speed
STA: Ph.1.l KEY: tangent | speed BLM: application

8. ANS:
4 RPM

PTS: 1 DIF: L2 OBJ: 10.2 Rotational Speed
STA: Ph.1.l KEY: rotate | speed BLM: application

9. ANS:
24 m/s

PTS: 1 DIF: L2 OBJ: 10.2 Rotational Speed
STA: Ph.1.l KEY: speed BLM: application

10. ANS:
$\frac{1}{2}\,g$

PTS: 1 DIF: L2 OBJ: 10.4 Centripetal and Centrifugal Forces
STA: Ph.1.l KEY: rotate | acceleration BLM: application

11. ANS:
increases by a factor of 3

PTS: 1 DIF: L2 OBJ: 12.1 Rotational Inertia
STA: Ph.1.l KEY: circular | tangent | speed BLM: application

12. ANS:
2600 N

PTS: 1 DIF: L2 OBJ: 13.5 Gravity and Distance:The Inverse-Square Law
STA: Ph.1.e | Ph.1.m KEY: Earth | radius | weight
BLM: application

13. ANS:
$\frac{1}{4}$ as much

PTS: 1 DIF: L2 OBJ: 13.5 Gravity and Distance:The Inverse-Square Law
STA: Ph.1.e | Ph.1.m KEY: radius | weight
BLM: application

14. ANS:
70 kg

PTS: 1 DIF: L2 OBJ: 13.5 Gravity and Distance:The Inverse-Square Law
STA: Ph.1.e | Ph.1.m KEY: mass | Earth | height
BLM: application