Physics 124 - Analytical Physics
FIRST COMMON HOUR EXAM
Monday, February 24, 2014 10:00 - 11:20 PM

(your name sticker with exam code)

SIGN HERE:

1. The exam will last from 10:00 - 11:20 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 labeled 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.
3. Under STUDENT # enter your 9-digit RUID Number.
4. Enter 124 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 one 8.5 x 11 inch sheet (both sides) with formulas and notes.
7. There are 15 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction 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. 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 15 questions. Raise your hand if this is not the case, and a proctor will help you. Raise your hand 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.

Some possibly helpful numbers: \( G = 6.67 \times 10^{-11} \text{ m}^3/(\text{kg s}^2) \), \( g = 9.8 \text{ m/s}^2 \), radius of Earth \( = 6.4 \times 10^6 \text{ m} \), mass of Earth \( = 6 \times 10^{24} \text{ kg} \), \( \rho_{\text{water}} = 10^3 \text{ kg/m}^3 \), 1 atm \( = 1.01 \times 10^5 \text{ Pa} \), Moments of inertia for uniform density objects: \( I_{\text{disk}} = I_{\text{solidcylinder}} = \frac{1}{2}MR^2 \), \( I_{\text{hollowcylinder}} = MR^2 \), \( I_{\text{solidsphere}} = \frac{2}{5}MR^2 \), \( I_{\text{hollowsphere}} = \frac{2}{3}MR^2 \)
1. Two masses hang from massless ropes attached at different radii to a 1-kg pulley. The left mass, \( m_1 = 5 \text{ kg} \), hangs from a radius of 0.2 m; the right mass, \( m_2 = 10 \text{ kg} \), hangs from a radius of 0.1 m. There is friction between the rope and the pulley. The pulley is supported at its c.m. What is the net torque on the pulley from the forces acting on it?

   - a) 0 N·m
   - b) 4.9 N·m
   - c) 9.8 N·m
   - d) 19.6 N·m
   - e) 196 N·m

2. A machine part has the shape of a solid uniform sphere of mass 0.2 kg and radius 0.03 m. It is spinning about a vertical frictionless axle through its center, but at one point on its equator it is scraping against metal, resulting in a friction force of 0.01 N at that point. Its angular acceleration (in rad/s\(^2\)) is:

   - a) - 1.2
   - b) - 2.3
   - c) - 3.6
   - d) - 4.2
   - e) - 6.6

3. The center of a bowling ball translates at 6 m/s while rolling. The ball has a mass of 8 kg, a diameter of 0.30 m, and recall that the moment of inertia of a solid sphere about its center is \((2/5)MR^2\). Calculate its total kinetic energy.

   - a) 144 J
   - b) 4.84 J
   - c) 201.6 J
   - d) 57.6 J
   - e) 684.9 J

4. A horizontal meter stick supported at the 50-cm mark has a mass of 0.50 kg hanging from it at the 20-cm mark and a 0.30 kg mass hanging from it at the 60-cm mark. Determine the position on the meter stick at which one would hang a third mass of 0.60 kg to keep the meter stick balanced. See figure and note that the third mass is not shown.

   - a) 74 cm
   - b) 70 cm
   - c) 65 cm
   - d) 86 cm
   - e) 62 cm

5. The horizontal boom supporting the sign is of uniform construction and weighs 50 N. If the signs weighs 150 N, the tension in the supporting cable is approximately

   - a) 350 N
   - b) 303 N
   - c) 25 N
   - d) 550 N
   - e) None of these is correct.

6. An object is placed at the left end of a 20-kg, 5-m long beam. The beam is supported at the right end and at a distance 4 m from the right end. How heavy can the object be without the beam tipping over?

   - a) 0 kg
   - b) 13.3 kg
   - c) 20 kg
   - d) 30 kg
   - e) 80 kg
7. A certain wire stretches 1 mm when a force $F$ is applied to it. The same force is applied to a wire of the same material but with twice the diameter and twice the length. The second wire stretches
   a) Need to know Young’s modulus
   b) 0.5 mm
   c) 1 mm
   d) 2 mm
   e) 4 mm

8. The Martian moon Deimos has a diameter of about 12.6 km and a mass of about $2 \times 10^{15}$ kg. Treating it as spherical, how fast do you have to throw a ball so that it circles Deimos, 2 m above the surface, so that you can catch it?
   a) $< 2$ m/s
   b) in the range $2 \rightarrow 4$ m/s
   c) in the range $4 \rightarrow 6$ m/s
   d) in the range $6 \rightarrow 8$ m/s
   e) $> 8$ m/s

9. A satellite in a circular orbit $1.609 \times 10^6$ m above the surface of the earth ($r_e = 6.436 \times 10^6$ m) has an acceleration toward the earth of:
   a) $9.76 \text{ m/s}^2$
   b) $6.25 \text{ m/s}^2$
   c) $7.80 \text{ m/s}^2$
   d) $8.73 \text{ m/s}^2$
   e) zero

10. In a distant galaxy, a planet orbits a sun at a distance of $1.8 \times 10^{12}$ m with a period of $10^8$ s. A second planet orbits the same sun at a distance of $9 \times 10^{11}$ m. What is the period of the second planet?
    a) $5 \times 10^7$ s
    b) $2 \times 10^8$ s
    c) $0.35 \times 10^8$ s
    d) $2.8 \times 10^8$ s
    e) $5 \times 10^8$ s

11. A satellite with a mass of 10 kg was launched into a circular orbit 1000 km above the Earth’s surface. What is the total (kinetic + potential) energy of the satellite? Take the potential energy to be zero when the Earth and satellite are infinitely far apart.
    a) $1.3 \times 10^8$ J
    b) $2.7 \times 10^8$ J
    c) $-2.7 \times 10^8$ J
    d) $5.4 \times 10^8$ J
    e) $-5.4 \times 10^8$ J

12. A tall cylinder is partially filled with water. The cross sectional area of the cylinder is 2 m$^2$, and on top of the water is a lid, tightly sealed against the sides but floating on the water. What is the change in pressure at the bottom of the cylinder when several students (one shown) with total mass 200 kg stand on the lid?
    a) There is no change in pressure.
    b) 100 Pa
    c) 200 Pa
    d) 980 Pa
    e) 1960 Pa

13. In a pipe of radius 0.1 m, the water flow is 2 m/s past a certain point. What is the speed of the water further along the pipe where it expands to a radius of 0.12 m?
    a) 1.4 m/s
    b) 1.7 m/s
    c) 2.0 m/s
    d) 2.4 m/s
    e) 2.9 m/s
14. The apparent weight of a steel sphere immersed in various liquids is measured using a spring scale. The greatest reading is obtained for that liquid:
   a) having the smallest density
   b) having the largest density
   c) subject to the greatest atmospheric pressure
   d) having the greatest volume
   e) in which the sphere was submerged deepest

15. Your professor has put 5 objects near the top of an inclined plane: a uniform density solid sphere, a hollow sphere, a hollow cylinder, a special solid cylinder in which the density is proportional to the radius ($\rho(r) = \alpha r$), and a solid cube. The spheres and cylinders have radius $r$ and will roll down the plane, while the cube has sides of length $2r$ and a frictionless coating, so it will slide down the plane. All objects are released at the same time. Which is the last to get to the bottom of the plane?
   a) solid sphere
   b) hollow sphere
   c) hollow cylinder
   d) solid cylinder
   e) frictionless cube