Physics 123 - Analytical Physics
SECOND COMMON HOUR EXAM
Monday, November 7, 2011
Professor R.A. Bartynski

SIGN HERE:
1. The exam will last from 9:40 - 11:00 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 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 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 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 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. 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. 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. If needed, the acceleration due to gravity on earth may be take as $g = 9.81 \text{ m/s}^2$.

Circle your choice to the question starting with “Mia shoots a pebble...”:
(a) (b) (c) (d) (e)

Explain your reasoning below.
1. An automobile skids to a complete stop by a constant force of friction on a wet road in a distance of 44 m. If the road is level and the coefficient of friction is 0.55, what was its initial speed?

   a) \( 29 \text{ m/s} \)
   b) \( 22 \text{ m/s} \)
   c) \( 9.4 \text{ m/s} \)
   d) \( 40 \text{ m/s} \)
   e) \( 13 \text{ m/s} \)

   \[ \eta_s = \sqrt{2 \mu \eta_s \frac{g}{s}} \]

2. In the figure, a block of mass \( M = 1.5 \text{ kg} \) hangs in equilibrium. The rope that is fastened to the right wall is horizontal. The rope attached to the ceiling makes an angle \( \theta = 30^\circ \) as shown. The tension (in N) in the horizontal rope is closest to:

\[ T_3 = \frac{Mg}{2} \]

\[ T_3 = \frac{1.5 \times 9.8}{2} = 7.35 \text{ N} \]

3. 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) \( 90 \text{ J} \)
   b) \( 120 \text{ J} \)
   c) \( 6.0 \text{ J} \)
   d) \( 240 \text{ J} \)
   e) \( 5.25 \text{ J} \)

\[ u = \frac{v}{1 + \cos(30^\circ)} \]

At max elevation, \( u = 0 \)

\[ K_h = \frac{1}{2} m v_h^2 \]

\[ K_h = \frac{1}{2} \left( \frac{1}{2} \right)(0.15)(40)^2 = 90 \text{ J} \]

4. A 12-kg projectile is launched vertically upward with an initial speed of 20 m/s. It rises to a maximum height of 18 m above the launch point. How much work is done by the dissipative (air) resistive force on the projectile during this ascent?

   a) \( -0.40 \text{ kJ} \)
   b) \( -0.28 \text{ kJ} \)
   c) \( +0.76 \text{ kJ} \)
   d) \( +0.28 \text{ kJ} \)
   e) \( -0.52 \text{ kJ} \)

\( W_{\text{air}} = \frac{1}{2} (12)(20)^2 - (12)(18)(4.8) = -0.83 \text{ kJ} \)

5. A river flows with a constant speed of 1.00 mi/h. A rower leaves from a point on the river bank and he rows a boat 1.00 mi directly upstream and returns to the starting point. The speed of the rower as seen from the river bank is 1.00 mi/h during the trip going upstream. The speed of the rower relative to still water remains constant throughout the travel. The total travel time for the rower is

   a) 0.67 h
   b) 1.15 h
   c) 2.00 h
   d) 1.33 h
   e) 1.00 h

\( v_{\text{w}} = v_{\text{up}} + v_{\text{r}} \)

\( v_{\text{up}} = 2 \text{ mph} \)

\( v_{\text{down}} = -3 \text{ mph} \)

\( t = \frac{1}{2} \text{ hr} \)

6. A book is placed on a chair which is standing on the floor. A video-cassette is placed on the book. The floor exerts a normal force:

   a) upwards on the chair and downwards on the book.
   b) only on the book.
   c) only on the objects that you have defined to be part of the system.
   d) on all three.
   e) only on the chair.
7. A system comprising blocks, a light frictionless pulley, a frictionless incline, and connecting ropes is shown. The 9.0 kg block accelerates downward when the system is released from rest. The tension (in N) in the rope connecting the 4.0 and 6.0 kg blocks is closest to:

8. Mia shoots a pebble horizontally with her slingshot from a window that is at a height H and it lands a distance D away from the building. She then shoots a pebble from a different window with the same initial velocity, but this time the pebble lands a distance D/2 away. How high is the window from which Mia takes her second shot?

**Important:** Fill in your choice on the scantron answer sheet. The choice on the answer sheet will be counted in your total score. And, in the box shown on the cover sheet, circle your choice and explain your reasoning. Full credit will be given for correct choice and possibly incorrect reasoning but you must explain your reasoning on the cover sheet.

9. Two boxes are next to each other on a horizontal frictionless floor. A person exerts a horizontal 100 N push on the lighter 5.00 kg box, as shown in the figure. Both boxes accelerate together. The magnitude of force exerted by the 20.0 kg box onto the 5.00 kg box is closest to:

10. What angle does the vector \( \vec{A} = 3\hat{i} - 4\hat{j} + 5\hat{k} \) make with the positive z axis?

\[
\Theta = \cos^{-1}\left(\frac{A_z}{r}\right) = \cos^{-1}\left(\frac{5}{\sqrt{34}}\right) = 70.7^\circ
\]
11. Two masses undergo uniform circular motion in concentric horizontal circles. Mass $m$ is connected to the center by rope 1 of length $R$, and attached to mass $2m$ by rope 2 which is also of length $R$. Each rope can withstand a maximum tension $T_{1\text{max}}$ and $T_{2\text{max}}$, respectively. The masses orbit the center with the same period so that the ropes remain aligned radially as shown in the diagram. It is found that as the masses rotate, there is a minimum common period at which both ropes break simultaneously. From this it is deduced that:

1. \[ T_1 - T_2 = m a = m \left( \frac{\omega_m^2}{R} - \frac{\omega_m^2}{R} \right) = \frac{2 \pi m}{T_1^2} - \frac{2 \pi m}{T_2^2} \]

2. \[ T_1 = 2 m a = \left( \frac{2 \pi}{T_1^2 - T_2^2} \right) 2 m a = 4 \left( \frac{2 \pi m}{T_1^2} \right) \]

So \[ T_1 = \left( \frac{4 \pi m}{T_1^2} \right) \]

12. In order for you to jump off the floor, the floor must exert a force on you

- a) opposite to and equal to your weight.
- b) in the direction of and less than your weight.
- c) opposite to and greater than your weight.
- d) opposite to and less than your weight.
- e) in the direction of and equal to your weight.

You accelerate upward so

\[ n > m g \]

13. In the figure shown, the coefficient of kinetic friction between the block and the incline is 0.29. What is the magnitude of the acceleration of the suspended block as it falls? Disregard any pulley mass or friction in the pulley.

\[ \begin{align*}
T &= \text{mass} \times \text{acceleration} \\
T &= M \times \text{acceleration} \\
T &= M \times \text{acceleration}
\end{align*} \]

a) 4.9 m/s$^2$

14. A 5.0 kg mass is suspended by a string from the ceiling of an elevator that is moving upward with a speed which is decreasing at a constant rate of 2.0 m/s in each second. What is the tension in the string supporting the mass?

- a) 59 N
- b) 42 N
- c) 49 N
- d) 39 N
- e) 10 N

15. A 0.50 kg mass attached to the end of a string swings in a vertical circle (radius = 2.0 m). When the mass is at the highest point of the circle the speed of the mass is 8.0 m/s. What is the magnitude of the force of the string on the mass at this position?

- a) 26 N
- b) 21 N
- c) 36 N
- d) 11 N
- e) 16 N