Physics 161 - First Midterm Exam  
Prof. Kloet  
October 19, 2017

Your name with exam code 

Your signature 

Turn off and put away cell phones now!

1. The exam will last from 10:00 PM to 11:20 PM. 
2. Use a # 2 pencil to make entries in the circles at the bottom of the cover sheet. 
3. During the exam, you may use pencils, a calculator, and one handwritten 8.5 x 11 inch sheet with formulas and notes, without attachments.

4. 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. 
5. At the end of the exam, hand in only the cover sheet. Retain the question sheets for future reference and study. 
6. 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.

Good Luck!

Natural Constants 
\( G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2 \)  
\( g = 9.8 \text{ m/s}^2 \)  
\( m_{\text{earth}} = 5.98 \times 10^{24} \text{ kg} \)  
\( R_{\text{earth}} = 6.38 \times 10^6 \text{ m} \)  
\( \rho_{\text{water}} = 1000 \text{ kg/m}^3 \)  
\( 1 \text{ m}^3 = 1000 \text{ liter} \)
1. A bullet of mass 5 g leaves the muzzle of a rifle with speed of 410 m/s. What constant force is exerted on the bullet while traveling down the 0.78 m barrel of the rifle?
   a) 3120 N
   b) 215 N
   c) 256 N
   d) 539 N
   e) 312 N

2. A 80 kg man stands on a scale in an elevator. The scale reads 675 N. The acceleration of the elevator is
   a) 1.36 m/s² up
   b) 1.36 m/s² down
   c) 0.73 m/s² down
   d) 1.56 m/s² up
   e) 1.56 m/s² down

3. Three blocks of respectively $M_4 = 4 kg$, $M_2 = 2 kg$, $M_1 = 1 kg$, are stacked on a frictionless horizontal floor as shown in the figure. A force $F$ of 8 N is pushing at the 4 kg block. Find the force on the 2 kg block, exerted by the 1 kg block.
   a) 1.14 N to the left
   b) 0.875 N to the left
   c) 1.14 N to the right
   d) 0.875 N to the right
   e) 8 N to the right

4. Three blocks of respectively $M_4 = 4 kg$, $M_2 = 2 kg$, $M_1 = 1 kg$, are stacked on a frictionless horizontal floor as shown in the figure, in front of a solid wall. A force $F$ of 8 N is pushing the 4 kg block. Find the force on the 2 kg block, exerted by the 1 kg block.
   a) 1.14 N to the left
   b) 0.875 N to the left
   c) 1.14 N to the right
   d) 0.875 N to the right
   e) 8 N to the right

5. A block starts at the bottom of an incline. Its initial speed is $v_i$ up along the incline. It comes to rest momentarily at the top of the incline. There is no friction. The top of the incline is at a height $h$. At which height was the speed of the block equal to $v_i/2$?
   a) $h/4$
   b) $h/2$
   c) $h/\sqrt{2}$
   d) $3h/4$
   e) $2h/3$
6. Two football players of opposite teams collide in a perfectly inelastic collision. One of the players is 100 kg and runs West at 3 m/s. The second player of 110 kg runs East at 4 m/s. What is the loss of total kinetic energy?

\[
\begin{align*}
- \text{a)} & \quad 1283 J \quad m_1v_1 + m_2v_2 = (m_1 + m_2)v \\
& \Rightarrow v = 0.667 m/s \\
- \text{b)} & \quad 856 J \quad -300 + 440 = 210 v \\
& \Rightarrow v = 0.667 m/s \\
- \text{c)} & \quad 47 J \quad KE = 450 + 280 = 1330 J \\
- \text{d)} & \quad KE = \frac{210}{2} 0.667^2 = 47 J \\
- \text{e)} & \quad 450 J \quad KE = \frac{210}{2} - 1330 = -1283 J \quad (loss = 1283 J)
\end{align*}
\]

7. A water bottle is dropped from a balloon that is at a height of 95 m and at that instant rising at 6 m/s. How long does it take for the bottle to fall to the ground?

\[
\begin{align*}
- \text{a)} & \quad 5.01 s \\
- \text{b)} & \quad 5.06 s \\
- \text{c)} & \quad 3.78 s \\
- \text{d)} & \quad 3.83 s \\
- \text{e)} & \quad 4.17 s
\end{align*}
\]

8. Two pucks lie on a frictionless table. Puck A has a mass M and puck B has a mass 4M. Starting from rest the pucks are pushed across the table by two equal forces F to the finish line. The time for puck A is t_A. The time for puck B is t_B.

\[
\begin{align*}
- \text{a)} & \quad t_B = t_A \\
- \text{b)} & \quad t_B = 2t_A \\
- \text{c)} & \quad t_B = 3t_A \\
- \text{d)} & \quad t_B = 4t_A \\
- \text{e)} & \quad t_B = 8t_A
\end{align*}
\]

9. A mass of 12 kg, attached to a spring with spring constant k = 80 N/m, is extended 6 cm out of equilibrium and then released. What is the speed when the object passes the equilibrium position x = 0 cm?

\[
\begin{align*}
- \text{a)} & \quad 0 \text{ cm/s} \quad \frac{1}{2}lx^2 + \frac{1}{2}lu^2 = \cos \omega t \\
- \text{b)} & \quad 97 \text{ cm/s} \quad \frac{1}{2}lx^2 + 0 = 0 + \frac{1}{2}lu^2 \\
- \text{c)} & \quad 40 \text{ cm/s} \quad \frac{1}{2}lx^2 + 0 = 0 + \frac{1}{2}lu^2 \\
- \text{d)} & \quad 6 \text{ cm/s} \quad u^2 = 0.024 \\
- \text{e)} & \quad 15 \text{ cm/s} \quad u = 0.155 \text{ cm/s} = 15.5 \text{ cm/s}
\end{align*}
\]

10. Two identical spherical masses each with diameter 2R are separated by a distance 6R, as measured from the surface of each mass. When the two masses are brought in contact with each other, the gravitational potential between them

\[
\begin{align*}
- \text{a)} & \quad \text{has changed by a factor of 8} \\
- \text{b)} & \quad \text{has changed by a factor of 25} \\
- \text{c)} & \quad \text{has changed by a factor of 4} \\
- \text{d)} & \quad \text{has changed by a factor of 16} \\
- \text{e)} & \quad \text{has changed by a factor of 36}
\end{align*}
\]

11. The driver of a 1500 kg automobile without brakes, coasts his car down a hill 45 m high, starting from rest. The road is 500 m long. There is an average retarding force due to friction of 88.5 N directed up along the slope as the car coasts down. What is the speed of the car at the bottom?

\[
\begin{align*}
- \text{a)} & \quad 14 \text{ m/s} \\
- \text{b)} & \quad 19 \text{ m/s} \\
- \text{c)} & \quad 29 \text{ m/s} \\
- \text{d)} & \quad 39 \text{ m/s} \\
- \text{e)} & \quad 49 \text{ m/s}
\end{align*}
\]

\[
\begin{align*}
\frac{1}{2}lu^2 + 0 &= 0 + 661,750 - 44,750 \\
v^2 &= \frac{2}{1500} 617,250 = 823 \\
v &= 28.7 \frac{u}{s}
\end{align*}
\]
12. See figure. A block of mass 2 kg is released from rest at point A (height h of 10 m). It slides without friction down a track to point B (height of 0 m). From point B it slides horizontally on a rough track to point C, a distance of 20 m, where it stops. What is the coefficient of kinetic friction between points B and C?
   a) 0.02
   b) 0.20
   c) 0.25
   d) 0.50
   e) 0.75

14. For the first 6.7 s of a 100 m race, a sprinter accelerates uniformly from rest at 1.8 m/s², at which point he reaches his maximum speed. He maintains his maximum speed for the rest of the race. How long does it take for the sprinter to complete the race?
   a) 9.58 s
   b) 10.05 s
   c) 10.49 s
   d) 11.64 s
   e) 12.16 s

15. A ship of mass 4 x 10⁷ kg has to slow down from a speed of 11 m/s to 2 m/s. It has to do this over a distance of 2 km. What is the force required to do this?
   a) 1.01 x 10⁶ N
   b) 1.09 x 10⁶ N
   c) 1.14 x 10⁶ N
   d) 1.17 x 10⁶ N
   e) 1.21 x 10⁶ N

13. A boy on the top of a cliff at the edge of a river throws away a stone in horizontal direction with a speed of 25 m/s. The stone hits the water below after 3 seconds. How high is the cliff above the water?
   a) 29 m
   b) 44 m
   c) 75 m
   d) 88 m
   e) 119 m