PHYS 101  

MIDTERM EXAM 1  
(Closed Book)  

Fall 2010  

KEY: Yellow  

SFSU ID# ____________________ NAME (Print Clearly): ____________________  
(First/Given) (Last/Family)  

I have not received any aid in taking this examination.  

Student Signature: ____________________  

INSTRUCTIONS  

1. Print name and sign above. Your exam will not be graded if you have not signed.  

2. DO NOT OPEN THE EXAM UNTIL TOLD TO DO SO. Once you have opened the exam, you may not leave the room until you turn in the exam.  

3. This is a closed book and closed notes exam. An equation sheet is provided as the last page of the exam package. You may not use any notes, books, or electronic devices other than a calculator.  

4. You may use a calculator, but not a cell-phone or computer-based calculator.  

5. For the free response problems, write clearly and neatly and be sure to show your work. Put the final answer on the line provided, be sure to use proper units and to give directions for vectors. (For vertical motion, take “up” to be the positive direction.) Give answers to at least two significant figures.  

6. Use $g = 10 \text{ m/s}^2 = 10 \text{ N/kg}$ in your calculations.  

| QUESTIONS | 52 |  
| PROBLEMS | 48 |  
| TOTAL SCORE | 100 |  

Version B
MULTIPLE-CHOICE QUESTIONS. CIRCLE THE BEST ANSWER (4 Pts. each):

1) A car increases its forward speed from zero to 20 m/s in 10 seconds. What is the size of its acceleration?
   A) 200 m/s²
   B) 20 m/s²
   C) 10 m/s²
   D) 2 m/s²
   E) 1 m/s²  **(Correct Answer)**

2) An apple falls from a tree and hits the ground 4 seconds later. How far did it fall?
   A) 160 m
   B) 40 m
   C) 20 m
   D) 80 m
   E) 10 m  **(Correct Answer)**

3) An airplane is flying at 40 m/s due East relative to the air. The air is moving at 30 m/s due North and carries the plane with it. How fast is the plane moving relative to the ground?
   a) 70 m/s
   b) 50 m/s
   c) 40 m/s
   d) 30 m/s
   e) 10 m/s  **(Correct Answer)**

4) Suppose the circumference of a bicycle wheel is 2 meters. If it rotates at 3 revolutions per second when you are riding the bicycle, then your speed will be
   A) 9.4 m/s
   B) 6 m/s
   C) 2 m/s
   D) 1 m/s
   E) 1 m/s  **(Correct Answer)**

5) A boy of mass 100 kg and a girl of mass 50 kg sit on a balanced seesaw. If the girl sits 2m from the axis, where does the boy sit?
   A) 4.0 m from the axis
   B) 3.0 m from the axis
   C) 2.0 m from the axis
   D) 1.0 m from the axis
   E) 0.5 m from the axis  **(Correct Answer)**

6) When rotating clockwise, an ice skater brings her arms inward. If there is no friction on her, her rotational velocity
   A) changes to counterclockwise and decreases in size
   B) changes to counterclockwise and increases in size
   C) remains the same
   D) decreases clockwise
   E) increases clockwise  **(Correct Answer)**
7) A small meteor strikes the Moon. The magnitude of the force of impact is:
   (a) Zero on the Moon
   (b) Zero on the meteor
   (c) The same for both the meteor and the Moon
   (d) Greater on the meteor
   (e) Greater on the Moon

8) A bullet fired horizontally over level ground hits the ground in 1.0 seconds. If it had been fired with twice the speed in the same direction, it would have hit the ground in:
   A) 4.0 s
   B) 2.0 s
   C) 1.0 s
   D) 0.5 s
   E) 0.25 s

9) A 300-kg bear grasping a vertical tree slides down at constant velocity. The size of the friction force between the tree and the bear is:
   A) 3000 N
   B) 1500 N
   C) 300 N
   D) 30 N
   E) Zero

10) A girl of mass 50 kg jumps out of the front of a 200 kg boat that was initially at rest. If her velocity is 10 m/s South, what is the velocity of the boat after she jumps? Assume there is no net external force.
    a) Zero
    b) 2.5 m/s North
    c) 2.5 m/s South
    d) 10 m/s North
    e) 10 m/s South

21) Which one of the following is electrically neutral (has no net electric charge)?
   A) none of these
   B) atomic nucleus
   C) electron
   D) copper atom
   E) proton

12) A scale from which a rock is suspended reads 5.0 N when the rock is out of water and 2.5 N when the rock is fully submerged. The density of the rock is:
    A) 3.0 times the density of water
    B) 2.5 times the density of water
    C) 1.5 times the density of water
    D) equal to the density of water
    E) 0.5 times the density of water

\[ F_B = 5N - 2.5N = 2.5N = \rho_B g \]
\[ W = \rho_B g \Rightarrow V = \frac{2.5N}{\rho_B g} \]
\[ S = \frac{W}{Vg} = \frac{5N \rho_B g}{(2.5N)/(\rho_B g)} = 2S \]
13. Water flows from a larger diameter pipe to a smaller diameter pipe at the same height. Which is true?
   a) Both the water speed and pressure will be smaller in the small tube.
   b) The water speed will be smaller in the small tube, but the pressure will be greater.
   c) The water speed will be smaller in the small tube, but the pressure will be the same.
   d) Both the water speed and pressure will be larger in the small tube.
   e) The water speed will be larger in the small tube, but the pressure will be smaller.
   f) The water speed will be larger in the small tube, but the pressure will be the same.

PROBLEMS. BE SURE TO SHOW YOUR METHOD CLEARLY. (6 points each.)

Problems #1 - #2 refer to the following situation:
A 1 kg water balloon is dropped with zero initial velocity at time t = 0 seconds from a window that is 47 meters above the ground. Three seconds later, the balloon hits the head of a 2 meter tall student.

1. What is the acceleration of the balloon just after it is dropped? (Please give a numerical value with units, and remember that acceleration is a vector quantity.)

   
   \[
   \text{Acceleration} = -9.8 \text{ m/s}^2 \text{ (down)}
   \]

2. What is the speed of the water balloon when it hits the student’s head?

   \[
   V = at
   \]

   \[
   = (10 \text{ m/s}) (3 \text{s}) = 30 \text{ m/s}
   \]

Problems #3 - #4 refer to the following situation:
A 2 kg block of ice and a 4 kg block of ice move with no friction as they are pulled along a horizontal surface. The acceleration of each is 3 m/s² in the forward direction.
3. What is the tension (force) in the rope segment being pulled on by the person?

\[ F = \frac{m}{\alpha} \cdot a = (6 \text{ kg}) \cdot (3 \text{ m/s}^2) = 18 \text{ N} \]

4. What is the tension in the rope segment between the blocks?

\[ F_2 = m_2 \cdot a = (2 \text{ kg}) \cdot (3 \text{ m/s}^2) = 6 \text{ N} \]

5. A 20 kg block with an initial speed of 6 m/s slides on a rough surface. It comes to a complete stop after sliding 20 meters. How much work is done by the frictional force that stops the block? (Note that the work is positive if it increases the object’s energy and negative if it decreases the energy.)

\[ KE_i = \frac{1}{2} mV^2 = \frac{1}{2} (20 \text{ kg}) (6 \text{ m/s})^2 = 360 \text{ J} \]

\[ KE_f = 0 \]

\[ W_{nc} = \Delta E = 0 - 360 \text{ J} = -360 \text{ J} \]

Friction Work = \[ -360 \text{ J} \]

6. A park ranger exerted 10N of force to raise a 0.5 kg flag a distance of 4.0 m up a pole at a constant speed. If she took 5 seconds seconds to do the job, what power did she supply?

\[ P = \frac{W}{\Delta t} = \frac{F \cdot d}{\Delta t} = \frac{(10 \text{ N}) \cdot (4.0 \text{ m})}{5 \text{ s}} = 8 \text{ W} \]

Power = \[ 8 \text{ Watts} \]
7. A person of mass 80 kg stands on one foot, whose area is 0.4 m². What is the resulting pressure exerted by the foot on the floor? (Neglect atmospheric pressure.)

\[ P = \frac{F}{A} = \frac{mg}{A} = \frac{(80 \text{ kg})(10 \text{ N/kg})}{0.4 \text{ m}^2} = 2000 \text{ N/m}^2 \]

Pressure = 2000 Pa

8. A certain dam is holding back fresh water 160 m deep. What is the pressure at the base of the dam due to the water (neglecting atmospheric pressure)? Give the answer in kPa units. (Density of fresh water is 1000 kg/m³).

\[ P = P_{atm} + \rho gh \]

\[ = (1000 \text{ kg/m}^3)(10 \text{ N/kg})(160 \text{ m}) \]

\[ = 1600 \text{ kPa} \]

Pressure = 1600 kPa