ISP209 Exam 3B **Calculator and Pencil only.** Name:_______________________

November 20, 2003 **No books or notes.** ID: _______________________

<u>Hooke's law</u>: $F=kx$; <u>Weight</u>: $W = F_G = mg$, $g = 9.81\,\mathrm{N/kg}$ (on Earth);

<u>Work</u>: $w = \langle \mathbf{F} \rangle \cdot \mathbf{s}$; <u>Potential Energy</u>: $PE_S = \frac{1}{2}kx^2$ (spring), $PE_G = mgh$ (gravity on Earth);

<u>Kinetic Energy</u>: $KE = \frac{1}{2}mv^2$; <u>Energy Conservation</u>: $KE + PE = KE_0 + PE_0 + w_{NC}$;

<u>Motion Eq. (**a** const.)</u>: $\mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$; $\mathbf{v}^2 = \mathbf{v}_0^2 + 2\mathbf{a}\cdot\mathbf{s}$; $\mathbf{s} = \frac{1}{2}(\mathbf{v}+\mathbf{v}_0)t$; $\mathbf{s} = \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$

<u>Newton's 2nd law</u>: $\mathbf{F} = m\mathbf{a}$.

5. For what observed motion(s) of an object must the forces acting on it be *balanced*?
   - a) Only if the object is at rest.
   - b) Only if the object is moving with a constant non-zero velocity.
   - c) Only if the object is moving with a constant acceleration.
   - d) If the object is moving in a constant direction.
   - <u>e) If the object is at rest or moving with a constant velocity.</u>

6. Consider two springs with a spring constant k. Which spring or spring combination below will store the most energy for a <u>given applied force</u>, F?
   - a) A single spring.
   - <u>b) The two springs connected in series (stretches the most for given F)</u>
   - c) The two springs connected in parallel.
   - d) Each spring above (a, b, or c) stores the same energy.
   - e) The series and parallel connected springs above (b or c) store more energy than the single spring (a).

7. A person stands on an accurate scale in a moving elevator. The scale reads 20 percent larger than the same measurement made in the gym. Which statement below is true?
   - <u>a) The elevator could be moving downward with a decreasing speed.</u>
   - b) The elevator could be moving upward with a decreasing speed. (smaller)
   - c) The elevator could be moving downward with an increasing speed. (smaller)
   - d) The elevator could be moving upward with a constant speed. (same)
   - e) The elevator could be moving downward with a constant speed. (same)

8. A satellite with mass, m = 10,000 kg, is moving in a circular orbit 500 kilometers above the surface of the earth (above the atmosphere). What force is responsible for maintaining that orbit?

   a) friction b) rockets <u>c) gravity</u> d) no force is needed e) its momentum

9. A measurement is made of the time for a mass to drop to the ground from the top of the physics building (not high enough for air friction to affect the motion). The mass is then split into two equal pieces and dropped again. Compare the time of fall in the two cases.
   - a) The fall time of the full mass is just a little less than that of the split masses.
   - b) The fall time of the full mass is just a little more than that of the split mass.
   - c) The fall time of the full mass is twice that of the split mass.
   - d) The fall time of the full mass is half that of the split mass.
   - <u>e) The fall time is the same for the full mass and the split masses.</u> ($\mathbf{a} = -g$ for all m)

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10. A mass m = 100 kg, thrown straight upward from the ground, reaches a maximum displacement, $\mathbf{s} = +100$ m. At the highest point in its flight, what is the <u>magnitude</u> of the net force, **F**, acting on the mass?

$$\text{magnitude of } \mathbf{F}_G \text{ is } mg = (100\text{ kg})(10\text{ N/kg}) = 1000\text{ N}$$

a) zero b) –10 N <u>c) 1000 N</u> d) $-g$ e) 100 N

11. What net force will accelerate 100 kg from zero to 100 m/s in 500 m of travel (hint: first obtain the acceleration).

a) 1 b) 10 N c) 100 N <u>d) 1,000 N</u> e) 10,000 N

$$v^2 = v_0^2 + 2\mathbf{a}\cdot\mathbf{s}; \quad \mathbf{a} = \frac{v^2 - v_0^2}{2\mathbf{s}} = \frac{10{,}000 - 0}{2(500)}\text{ m/s}^2 = 10\text{ m/s}^2$$

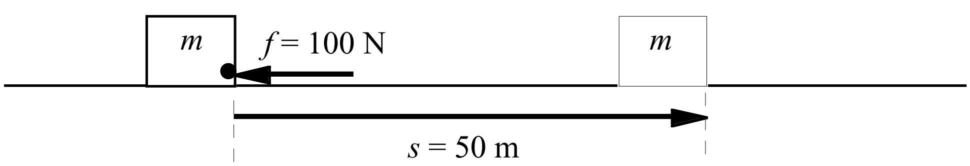
$$\mathbf{F} = m\mathbf{a} = (100\text{ kg})(10\text{ m/s}^2) = 1{,}000\text{ N}$$

12. An object is initially at rest against an ideal spring storing 200 J of energy. The object is fired off the spring with a speed of 5 m/s. Ignoring air friction, what is the mass of this object? (Use Energy Conservation)

a) 200 kg b) 25 kg <u>c) 16 kg</u> d) 50 kg e) 800 kg

$$PE + KE = PE_0 + KE_0; \quad PE = KE_0 = 0$$

$$0 + \tfrac{1}{2}mv^2 = PE_0 + 0; \quad m = \frac{2PE_0}{v^2} = \frac{2(200\text{ J})}{25\text{ m}^2/\text{s}^2} = \frac{400}{25}\frac{\text{kg}\cdot\text{m}^2/\text{s}^2}{\text{m}^2/\text{s}^2} = 16\text{kg}$$



13. Acting on a mass, *m,* sliding to the right on flat surface is a (sliding) frictional force, f = 100 N. After making a displacement, s = 50 m, the mass stops. At the beginning of the displacement, what was the kinetic energy of the mass? (Note: w_{NC} is not zero)

<u>a) 5000 J</u> b) 200 J c) 5 J d) 500 J e) 50 J

$$PE + KE = PE_0 + KE_0 + w_{NC}; \quad w_{NC} = \mathbf{F}\cdot\mathbf{s} = (-100\text{ N})(+50\text{ m}) = -5000\text{ J}$$

$$0 + 0 = 0 + KE_0 + w_{NC}$$

$$KE_0 = -w_{NC} = -(-5000\text{ J}) = 5000\text{ J}$$

14. Two equal strength people play catch. One person catches 10 baseballs, each carrying 2.5 joules of energy. How much of this energy can this person put into throwing just one baseball?

<u>exactly: a) 0 J</u>, b) 2.5 J, c) 25 J, d) 250 J, or e) any amount from 0 J to 2.5 J

(The energy of caught baseballs heats the catching person. This energy is unuseable by the person. The energy of caught baseballs will NOT aid in throwing a baseball.)