ISP209 Exam 3A **Calculator and Pencil only.** Name:_____
April 10, 2001 **No books or notes.** ID: _____

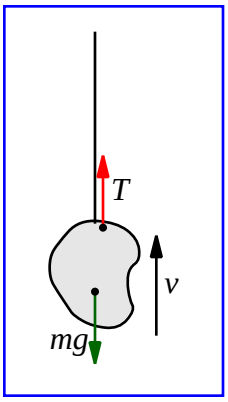
ANSWER 15 MULTIPLE CHOICE QUESTIONS ON THE BUBBLE SHEET

Hooke's law: $F=kx$; Weight: $W = F_G = mg$, $g = 9.81\text{N/kg}$ (on Earth), Torque ($\mathbf{F}$ $\mathbf{r}$): $\tau = Fr$;
Work: $w = \langle \mathbf{F} \rangle \mathbf{s}$; Potential Energy: $PE_S = \frac{1}{2}kx^2$ (spring), $PE_G = mgh$ (gravity on Earth);
Kinetic Energy: $KE = \frac{1}{2}mv^2$; Energy Conservation: $KE + PE = KE_0 + PE_0 + w_{NCF}$;
Momentum: $\mathbf{p} = m\mathbf{v}$; 2nd law ($\mathbf{F}$ const.): $\mathbf{p} = \mathbf{p}_0 + \mathbf{F}t$; No $F_{external}$: Sum($\mathbf{p}$) = Sum($\mathbf{p}_0$)

1. Which action below is due primarily to the weak nuclear force?

a) Killing cancer cells with X-ray photons.
b) Fusing of a proton and neutron to form a deuterium nucleus.
c) Orbiting of the sun around the center of our galaxy.
d) Interaction of a neutrino in matter. (*neutrino*!)
e) None of the above.

2. At a *constant speed*, v, a person raises a rock by an attached string. During the motion, the magnitude of the tension force acting on the rock is



a) equal to the weight of the rock. (balanced forces)
b) pointing downward.
c) greater than the weight of the rock.
d) less than the weight of the rock.
e) zero.

3. Which statement is true: the forces comprising an *Internal* force pair,

a) can't be conservative forces.
b) must be conservative forces.
c) include one conservative and one non-conservative force.
d) can be an action - reaction pair of forces. (must be an action reaction pair)
e) must have the same magnitude and direction.

4. Why does a person *feel* weightless in an orbit 100 miles above the earth?

a) There is no Gravity 100 miles above the earth.
b) The motion parallel to the earth's surface cancels Gravity.
c) There is no air pressure to keep you down.
d) Gravity is balanced by another force on the person.
e) The only force acting on the person is Gravity. (Gravity alone cannot be felt)

5. Consider the speed of a mass, and forces acting on it. Which condition **CANNOT** exist:

a) speed equal to zero, and unbalanced forces. (Where an object changes direction!)
b) speed equal to zero, and balanced forces.
c) speed not equal to zero, and unbalanced forces.
d) speed not equal to zero, and balanced forces.
e) none of the above.

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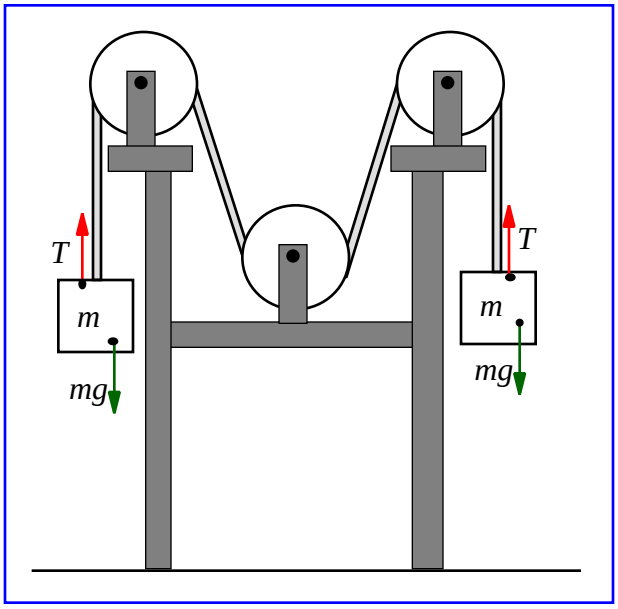
6. A mass, m = 10 kg, starts at rest. Without air friction, after falling a distance of 1000 m, the mass has what kinetic energy?

a) 10^2 J
b) 10^3 J
c) 10^4 J
d) 10^5 J
e) 10^6 J

$$KE + PE = KE_0 + PE_0$$
$$KE + 0 = 0 + mgh = (10\text{kg})(10\text{N/ kg})(1000\text{m})$$
$$= 10^5\text{ J}$$



7. Equal masses are connected by a light string, and suspended by mass-less pulleys, as shown above. What is the tension in the string?

a) mg (tension in rope balances the weight of a mass)
b) $2mg$
c) zero
d) $2mg/3$
e) $1.5mg$

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8. What is the final velocity vector, $\mathbf{v}$, of a mass, m, with initial momentum, $\mathbf{p}_0$, acted on by a constant force, $\mathbf{F}$, for a time, t ? (Use Newton's second law, given above)

a) $\mathbf{v} = \mathbf{F}t$

b) $\mathbf{v} = \frac{\mathbf{p}_0}{m} + \frac{\mathbf{F}}{m}t$ (use $m\mathbf{v} = \mathbf{p}_0 + \mathbf{F}t$)

c) $\mathbf{v} = m\mathbf{p}_0 + m\mathbf{F}t$

d) $\mathbf{v} = \frac{nRt}{\mathbf{p}}$

e) $\mathbf{v} = \mathbf{F}t - \mathbf{p}$

9. A cannon with mass, m_c, is initially at rest on a frictionless surface. Firing a cannonball with mass, m_b, the cannon recoils with the speed, v_c. What is the speed, v_b, of the ball?

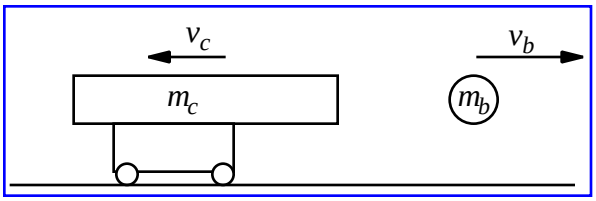
a) $v_b = \frac{m_b}{m_c}v_c$

b) $v_b = \frac{m_c}{m_b}v_c$ (momentum conservation requires $m_b v_b = m_c v_c$.)

c) $v_b = \left(\frac{m_c - m_b}{m_b + m_c}\right)v_c$

d) $v_b = v_c$

e) $v_b = v_c + \frac{m_b}{m_c}v_c$



10. During the collision of a fast moving Porsche (small mass) with a Snow Plow (large mass), compare the magnitude of the forces acting on the Porsche and Plow. The magnitude of the force acting on the Porsche is

a) much larger than the magnitude of the force acting on the Plow.
b) much smaller than the magnitude of the force acting on the Plow.
c) balanced by the magnitude of the force acting on the Plow.
d) equal to the magnitude of the force acting on the Plow. (action - reaction pair)
e) a little smaller than the magnitude of the force acting on the Plow.

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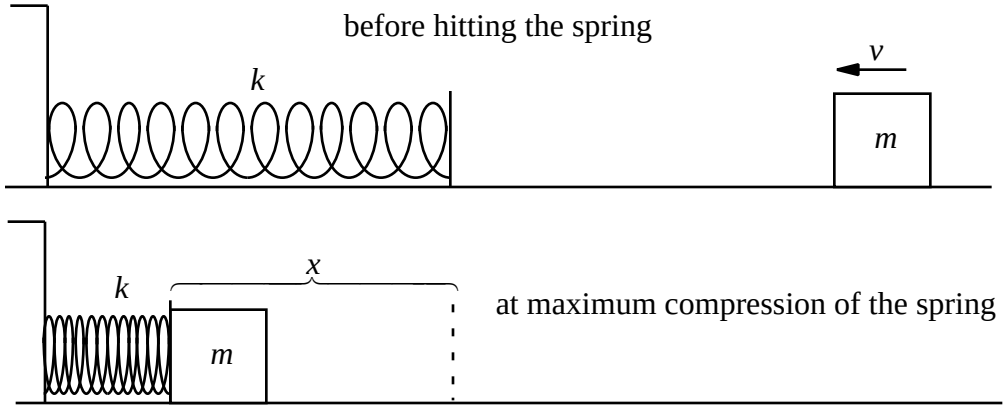

On a frictionless surface, a mass, m = 2 kg, moves at a speed, v, and hits an ideal spring, spring constant, k = 200 N/m. The spring's *maximum* compression is x = 0.5 m.

11) Determine the spring potential energy, *PE*, at the maximum compression.

a) 25 J b) 100 J c) 90 J d) 400 J e) 0 J

$$PE = \frac{1}{2}kx^2 = (100\ \text{N/m})(0.5\ \text{m})^2 = 25\ \text{J}$$

12) Determine the maximum force, *F*, the spring applies to the mass during the compression (hint: use Hooke's law).

a) 25 N b) 100 N c) 90 N d) 400 N e) 0 N

$$F = kx = (200\ \text{N/m})(0.5\ \text{m}) = 100\ \text{N}$$

13) Determine the speed, v, of the mass before it hits the spring (hint: use Energy Conservation).

a) 5m/s b) 10m/s c) 15m/s d) 20m/s e) 25m/s

$KE_0 + PE_0 = KE + PE$

$\frac{1}{2}mv^2 + 0 = 0 + 25\ \text{J}$

$v^2 = 25\ \text{m}^2/\text{s}^2 \quad \rightarrow \quad v = 5\text{m/s}$

14) Determine the speed, v, of the mass when the compression of the spring is 0.3m (on its way to the 0.5 m maximum compression).

a) 1m/s b) 2m/s c) 3m/s **d) 4m/s** e) 5m/s

$KE_0 + PE_0 = KE + PE; \qquad PE = \frac{1}{2}kx^2 = (100\ \text{N/m})(0.3\ \text{m})^2 = 9\ \text{J}$

$25\ \text{J} + 0 = \frac{1}{2}mv^2 + 9\ \text{J}$

$\frac{1}{2}mv^2 = 25\ \text{J} - 9\ \text{J} = 16\ \text{J}; \qquad v^2 = 16\ \text{m}^2/\text{s}^2 \rightarrow \quad v = 4\text{m/s}$

15) When the spring compresses the maximum distance, determine the momentum transferred from the mass to the Earth.

a) 0Ns b) 5Ns **c) 10Ns** d) 20Ns e) 25Ns

$\text{Sum}(\mathbf{p}) = \text{Sum}(\mathbf{p}_0)$

$\mathbf{p}_{\text{earth}} + 0 = 0 + mv_0 = (2\ \text{kg})(5\ \text{m/s}) = 10\ \text{Ns}$