Physics 1145 Fall 2022 Test 3 (4 pages)

Name:_________________ November 18, 2022 Total Score:_________/120__

$\sum F_x = ma_x$ $f_S \le \mu_S N$ $f_k = \mu_k N$ $a_c = \frac{v^2}{R}$ $F_{Sx} = -kx$

$\tau = rF\sin\theta$ $\sum \tau = I\alpha$ $v = \omega r$ $a = \alpha r$ $I = \sum_i m_i r_i^2$ $L = I\omega$

$\vec{p} = m\vec{v}$ $\vec{J} = \vec{F}_{avg}\Delta t$ $\vec{P}_f - \vec{P}_i = \vec{J}_{ext}$ $W = Fd\cos\theta$ $\Delta E = W$

$K = \frac{1}{2}mv^2$ $U_{grav} = mgy$ $U_{spring} = \frac{1}{2}kx^2$ $\Delta E_{th} = f_k\Delta x$ $P = W/\Delta t = Fv$

____1. (5) A spring gun shoots out a ball with a certain speed. When the spring is compressed twice the distance it was on the first shot, the potential energy of the spring is

A) reduced by factor of 4 B) halved C) doubled D) quadrupled

____2. (5) A soccer ball of mass M is traveling with a speed V in the positive x-direction. After being kicked by a player's foot, the ball travels in the opposite direction with a speed of $2V$. What was the x-component of the impulse delivered to the ball by the foot?

A) $-MV$ B) MV C) $-3MV$ D) $2MV$

_____3. (5) The work done by a force on an object is zero. This is the case if the force is

A) constant. B) parallel to the displacement.

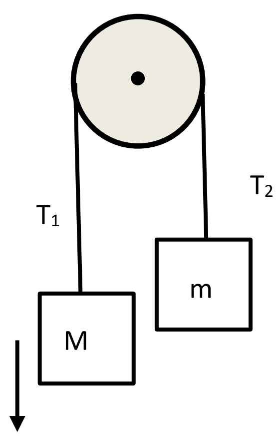
C) conservative D) perpendicular to the displacement

_____4. (5) Two forces of equal magnitudes and opposite directions are acting on an object. We can conclude that the object

A) has to be in static equilibrium. B) cannot be in static equilibrium.

C) might be in static equilibrium, depending on where the forces are applied.

D) has a non-zero linear acceleration.



______5. (5) . Two blocks, of masses m and M, are attached to opposite ends of a massless string that passes over a pulley with moment of inertia I. The block of mass M is accelerating downward. The string does not slip on the pulley. Which statement about the tensions in the string is true?

A) $T_1 = T_2$ B) $T_1 > T_2$ C) $T_2 > Mg$ D) $T_1 < T_2$

_____6.(5) You push an object with force F over a certain distance. If you push the object with the same force over the same distance, but need half the time, your power output is

A) halved B) unchanged C) doubled D) quadrupled

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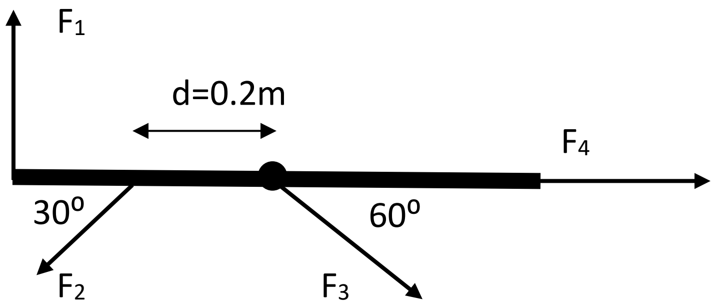
7. (30) A uniform beam of mass 5.0 kg and length 1.0 m can rotate about an axle through its center. Four forces are acting on it as shown in the figure. Their magnitudes are F_1=4.0N, F_2=3.0N, F_3=7N and F_4=12.0N.

The moment of inertia of a uniform beam of mass m and length L about its center of mass is $^1/_{12}\, mL^2$.



a) (20) Calculate the torques due to each of the forces.

b) (10) Calculate the angular acceleration of the beam. Is it clockwise or counter-clockwise?

8.(10) You are using a spring scale with a force constant of 200 N/m to weigh a pumpkin. The spring of initial length 15 cm stretches by 5cm. Calculate the mass of the pumpkin and the potential energy stored in the spring.

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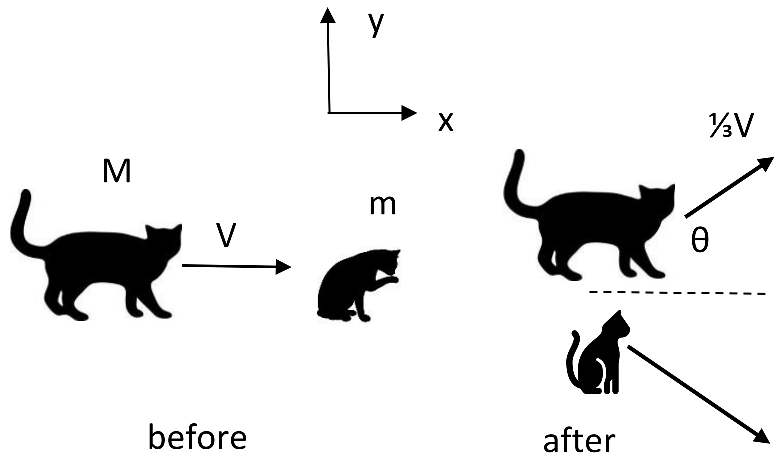
9.(25) Dr. Vojta's kittens are playing on a horizontal floor. Raisin of mass m is originally sitting still, licking her paws. Frodo of mass M is moving with speed V in the positive x-direction and collides with Raisin. Immediately after the collision, Frodo is skidding with speed $\frac{1}{3}V$ at angle θ above the positive x-axis, while Raisin is sliding with an unknown velocity. Derive an expression for the x- and y-components of Raisin's velocity after the collision, in terms of system parameters.



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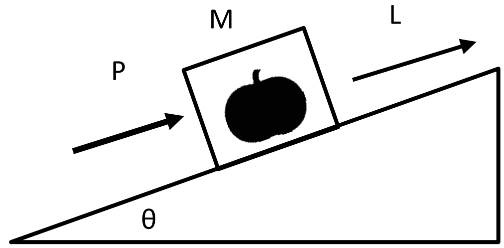
10. (25) A box containing a pumpkin of mass M= 4 kg is pushed up an incline by a force of magnitude P= 40N that is directed parallel to the incline. The box starts from rest. The incline, which makes an angle θ=30º with the horizontal, is rough with a coefficient of kinetic friction μ=0.2 between the box and the incline. The box moves up the ramp for a distance L=2.0m.



Derive **symbolic expressions** in terms of system parameters, and calculate **numerical answers** for:

a) the work W done by the pushing force on the box.

b) the change in gravitational potential energy.

c) the change in thermal energy.

d) the change in kinetic energy.

e) Using your answer from d, calculate a numerical value for the final speed of the box.

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