Test 2 **Dr. Weppner**
PH 241N **Nov. 2005**

NAME _____ ☐ Pledged SCORE____ / 100 pts

Remember to get full credit label answers with correct units, show all work, draw diagrams, give axis directions, write all applicable formuli.

1. [8 pts] A lump of soft clay of mass m falls from a height h above the floor (initially at rest), where it crashes and comes again to rest.
(A) How much work is done by the floor on the clay?
(B) How much work does gravity do on the clay?
(C) What is the total work done on the clay during the fall and collision?

A) $\uparrow F_N \downarrow d \quad W_F = -W_G = -mgh$

B) $\downarrow F_g \downarrow d \quad W_g = -\Delta U = mgh$

C) $W_{Net} = \Delta KE = 0$

2. [6 pts] Show that the amount of force that a human imparts on an airbag during a car accident would be less than the force the human would impart if the airbag were missing.

Δp is same for both situations

$\Delta p = \bar{F}\Delta t$

if Δt is small then $\bar{F}$ is large
if Δt is large then $\bar{F}$ is small

3. [4 pts] Two carts with different masses are at rest on a horizontal track. A person pushes each cart for 2 seconds. ignoring friction and assuming an equal force was exerted on both cars, the momentum of the light cart after the push is

(A) ~~smaller than the heavier car~~
(B) the same as the heavier car
(C) ~~larger than the heavier car~~
(D) The answer depends on the masses of the two carts

$\Delta p = \bar{F}\Delta t$

4. [10 pts] Referring to the figure, if the speed of the block is 4.0 m/s before the hill, what would be the speed of the block after the hill?

$\frac{1}{2}m(4m/s)^2 = E_i$

$E_f = \frac{1}{2}mv_f^2 + mg(-2m)$

$E_f = E_i$

$\frac{1}{2}v_f^2 + g(-2m) = \frac{1}{2}16m^2/s^2$

$v_f = 7.4 m/s$ BUT it never makes it over the Hill

$E_T = mg(2m)$ $E_i = \frac{1}{2}m(16m^2/s^2)$

$E_T > E_i$!

5. [6 pts] A firecracker explodes in midair. Considering all the fragments in mid-air right after the explosion compared to right before the explosion,

(A) the total KE remains constant
(B) the total momentum decreases
(C) the total KE decreases
(D) the total momentum remains constant
(E) none of these

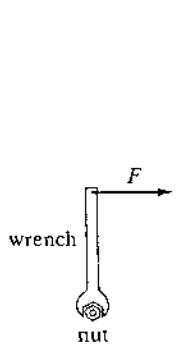
Explain your answer. All Explosions Conserve momentum

6. [8 pts] You are using a wrench and trying to loosen a rusty nut. Which of the arrangements shown is most effective in loosening the nut? List in order of descending efficiency.

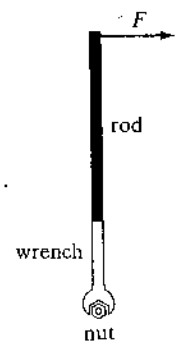
2 most effective

1 = 4

3 least effective



1



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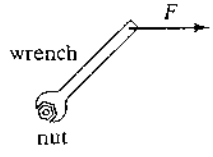

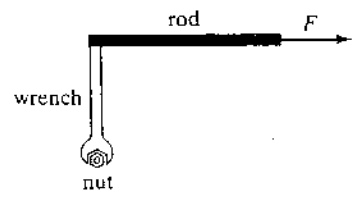

7. [6 pts] What is the torque about the origin of a force $\vec{F} = \ldots$ applied at position $\vec{r} = 1.0m\hat{i} - 3.0m\hat{k}$?

8. [8 pts] A solid disk ($I = \frac{1}{2}mR^2$), a hoop ($(I = mR^2)$, and a sphere ($I = \frac{2}{5}mR^2$) roll down an incline at 40°. Show that no matter what the size or mass of the objects, the sphere will always win. Show all work.

Angle does not matter Energy Conservation

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\frac{I}{R^2}v^2$$

if $I = \frac{1}{2}mR^2$ Solid Disk

$$mgh = \frac{1}{2}mv^2 + \frac{1}{4}mv^2 = \frac{3}{4}mv^2$$

$$v = \sqrt{\frac{4}{3}gh}$$

$I = mR^2$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}mv^2$$

$$v = \sqrt{gh}$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mv^2\right)$$

$$gh = \frac{7}{10}v^2$$

$$v = \sqrt{\frac{10}{7}gh}$$

Largest

9. [14 pts] A railroad freight car of mass 31800 kg collides with a stationary caboose car. They stick together and 27% of the initial kinetic energy is lost to thermal energy, sound, vibrations, and so on. Find the mass of the caboose.

(1) $\left(\frac{1}{2} m_f V^2\right)(.73) = \frac{1}{2}(m_f + m_c) V_f^2$ Energy

(2) $m_f V = (m_f + m_c) V_f$ Momentum

$\frac{(1)}{(2)}$ dividing 2Eq (Math trick!)

$\frac{1}{2} V(.73) = \frac{1}{2} V_f$

$V(.73) = V_f$

Stick in (2)

$m_f V = (m_f + m_c)(.73) V$

$m_f = (m_f + m_c)(.73)$

$.27 m_f = m_c = 8586 \text{ kg}$

10. [14 pts] A track is mounted on a large wheel that is free to turn with negligable friction about a vertical axis [illegible]. A toy train of mass m is placed on a track and, with the system initially at rest, the electrical power is turned on. The train reaches a steady speed of v with respect to the track. What is the angular speed of the wheel if its mass M and its radius R? Treat the wheel as a hoop with $I = MR^2$.