Test 2
PH 241

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ORIG

NAME ______________ SCORE Answer Key

Remember to get full credit label answers with correct units, show all work, draw diagrams (pictures!), give axis directions.

1. [6 pts] Can potential energy ever be negative? Explain.

Yes. Potential energy depends on the coord. system. If the height, for example, is below the origin than potential energy is < 0

2. [8 pts] In a collision between two cars, which would you expect to be more damaging to the occupants: If the cars collide and remain together, or if the two cars collide and rebound backward? Explain.

More damaging is rebound backward

$\Delta mv = \Delta p = -mV_0$ if cars remain together

$\Delta mv = \Delta p = -2mV_0$ if cars bounce off each other $\Delta p = I = \bar{F}\Delta t$

so I is larger and probably Δt is smaller when they bounce off each other. So $\vec{F}$ is larger $\Rightarrow$ more damaging

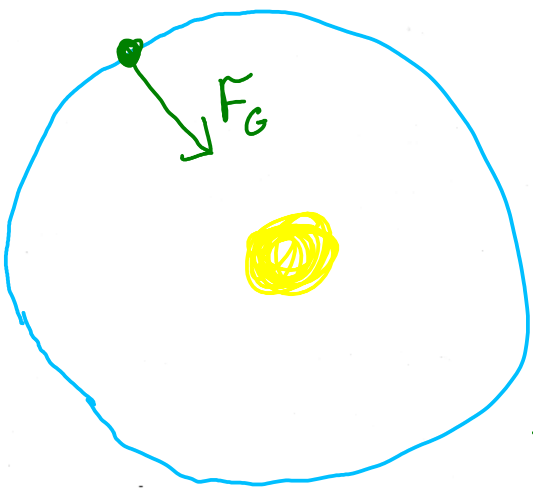
3. [8 pts] Two carts with different masses are at rest on a horizontal track. A person pushes each cart for 2 seconds. ignoring friction and assuming an equal force was exerted on both cars, the momentum of the light cart after the push is

(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

$\Delta p = F \Delta t$

so momentum will be same

4. [8 pts] Explain why the earth going the sun does no work if the motion is circular. Explain how your answer would change if the motion were elliptical.



The force is ⊥ to the movement, which is tangent to the circle. So W=0 always!

if elliptical then there is some force and movement in the radial Direction signifing a gain or loss in Kinetic Energy (or speed) thus some work being done. over a complete revolution then W=0

5. [14 pts] An 85 kg running back moving at 7.0 m/s makes a perfectly inelastic collision with a 105 kg linebacker who is initially at rest? What is the speed of the players just after their collision?

conservation of momentum.

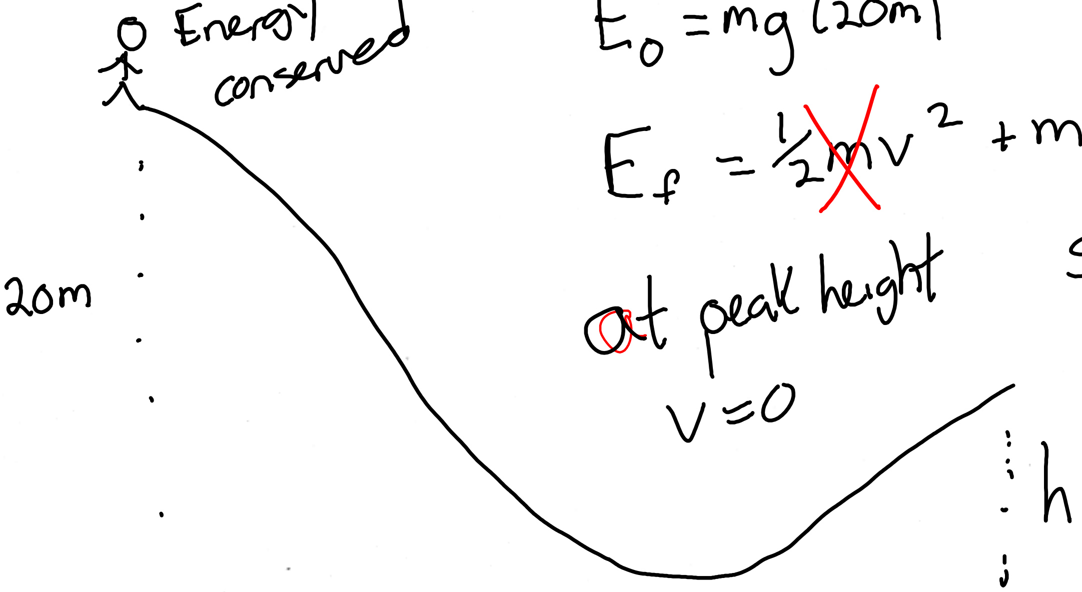
$$m_1 v_1 + \cancel{m_2 v_2} = (m_1 + m_2) v'$$

$$(85 \text{kg})(7 \text{m/s}) = (190 \text{kg}) v'$$

$$v' = 3.13 \text{m/s}$$

6. [14 pts] A 60 kg skier starts from rest at a height of 20 meters. Neglect the effects of air resistance and assume the ramp is frictionless.
(a) What is the maximum height h of his jump above the end of the ramp?
(b) if he increased his weight by putting on a backpack, would h then be greater, less, or the same?

Energy conserved



$$E_0 = mg(20\text{m})$$

$$E_f = \tfrac{1}{2}\cancel{m}v^2 + mgh'$$

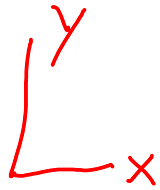
at peak height $v=0$

so $\cancel{m}g(20\text{m}) = \cancel{m}gh'$

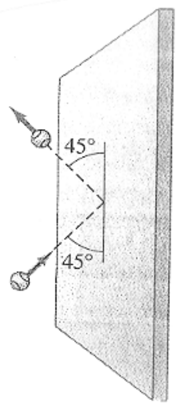
$$h' = 20\text{m}$$

Since m was divided out it does not matter so adding a backpack does not affect height

7 **[20 pts]** A tennis ball of mass $m = .060kg$ and speed $v = 28m/s$ strikes a wall at a 45^o angle and rebounds with the same speed at a 45^o.
(a) What is the impulse given the wall?
(b) if the ball is in contact with the racket for a total of .025 s. What is the average acceleration of the tennis ball during the collision?



$\Delta p = I$



$\Delta p_x = -m(28\,m/s)\cos 45^o - m(28\,m/s)\cos 45^o =$

$\Delta p_y = m(28\,m/s)\sin 45^o - m(28\,m/s)\sin 45^o = 0$ No momentum change in y direction

$\Delta p_x = -2(.060\,Kg)(28\,m/s)\cos 45^o = -2.4\,Kg\,m/s$
$= I$

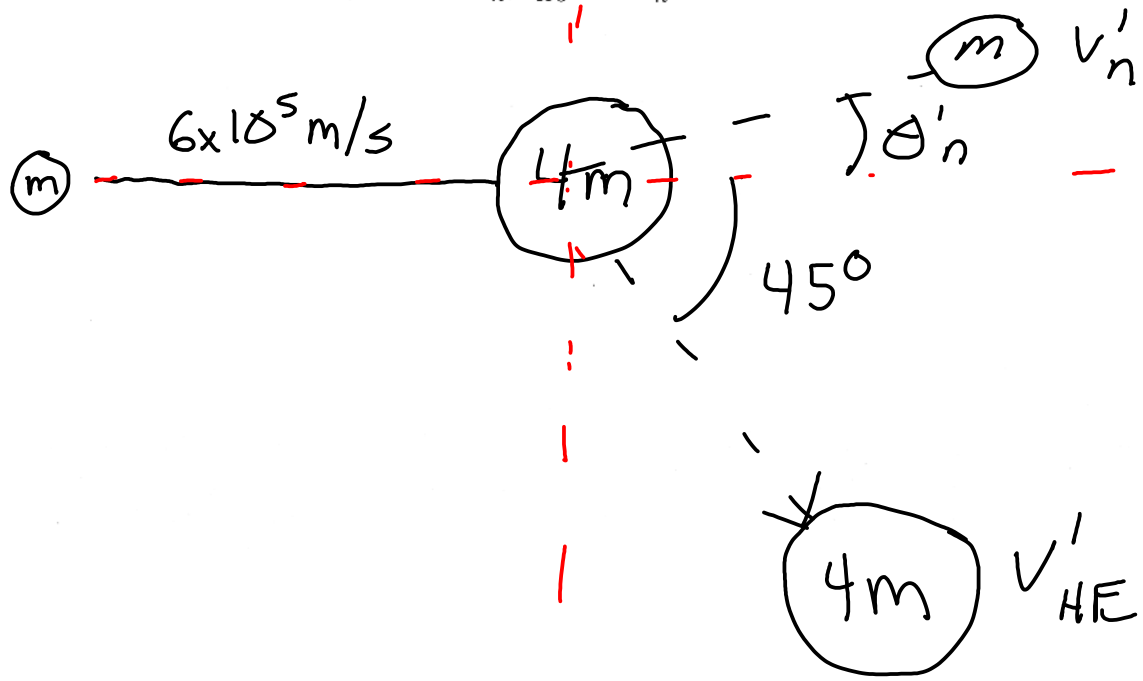
(b)

$I = \bar{F}\Delta t = m\bar{a}\Delta t = -2.4\,Kg\,m/s$

$(.060\,kg)\,\bar{a}\,(.025\,s) = -2.4\,Kg\,m/s$

$\bar{a} = -1600\,m/s^2$

8 [22 pts] A neutron collides elastically with a helium nucleus (at rest initially) whose mass is 4 times that of the neutron. The speed of the neutron was $6.0 \times 10^5 m/s$. After the collision the helium nucleus is observed to go off at $\theta'_{He} = 45^o$. Set up and simplify the equations necessary to find v'_n, v'_{He} and θ'_n. **Do not solve.**



momentum conservation

x: $\cancel{m}(6\times10^5 m/s) = \cancel{m}V'_n \cos\theta'_n + 4\cancel{m}V'_{HE}\cos 45^o$

y: $0 = \cancel{m}V'_n \sin\theta'_n - 4\cancel{m}V'_{HE}\sin 45^o$

Energy

$\cancel{\frac{1}{2}m}(6\times10^5 m/s)^2 = \cancel{\frac{1}{2}m}V'^2_n + \cancel{\frac{1}{2}}(4\cancel{m})V'^2_{HE}$