Test 2
PH 241

Dr. Weppner
Nov. 2007

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. [5 pts] Can kinetic energy ever be negative? Explain

No. $\frac{1}{2}mv^2$

$m > 0$ $v^2 > 0$

2. [8 pts] Explain, using conservation of momentum, how a swimmer propels herself forward in the water?

the swimmer - water system conserves momentum.

The water pushes swimmer
- the swimmer pushes water } 3rd law

the swimmer is thus propeled forward
the water is propeled backward

3. [10 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

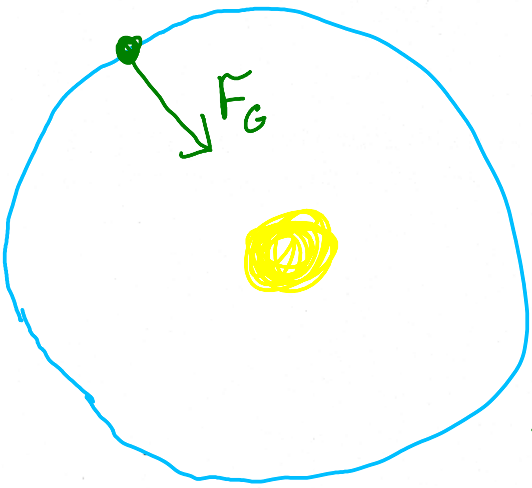
(D) The answer depends on the masses of the two carts

$\Delta p = F \Delta t$

F is same

Δt is 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 eliptical (the radius changes).

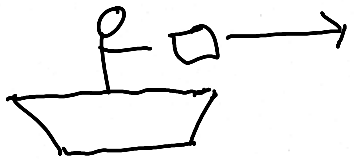


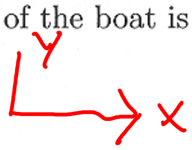
The force is ⊥ to the movement which is tangent to the circle. So W=0 always!

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] A child in a boat throws a 5.40 kg package out horizontally with a speed of 10.0 m/s. Calculate the velocity of the boat immediately after, assuming it was initially at rest. The mass of the child is 26.0 kg and that of the boat is 57.0 kg.

Conservation of momentum





at rest

$$0 = (5.4\,kg)(10\,m/s) + (26\,kg + 57\,kg)V'$$

$$V' = -.65\,m/s$$

6. [14 pts] A 145 g baseball is dropped from a tree 12.0 m above the ground.
(a) With what speed would it hit the ground if air resistance could be ignored?
(b) If it actually hits the ground with a speed of 8.0 m/s, what is the average force of air resistance (friction) exerted on it?

No air resistance ⟺ Energy is conserved

PE → KE $\quad mgh = \frac{1}{2}mv^2$ so $V = \sqrt{2gh}$

$$= \sqrt{2(9.8\,m/s^2)(12\,m)}$$

$$= 15.3\,m/s$$

b) $W_{TOT} = \Delta K = W_{AR} + W_G$ (while in air)

$$\Delta K = K_f - K_o = \frac{1}{2}m(8\,m/s)^2 - \frac{1}{2}m(0\,m/s)^2$$

$$= 4.64\,J$$

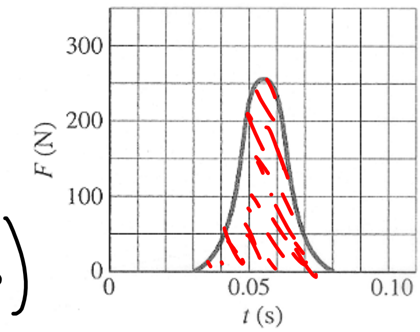
$$4.64\,J = W_{AR} + mgh = W_{AR} + 17.07\,J$$

$$W_{AR} = -12.43\,J = \bar{F}_{AR} \cdot d = F_{AR}(12\,m)$$

$$F_{AR} = \pm 1.0\,N$$

7. **[20 pts]** Suppose the force acting on a tennis ball (mass = .060 kg) as a function of time is given by the graph below. Use the graph to estimate
(a) the total impulse given the ball
(b) the speed of the ball after being struck, assuming the ball is being served so it is at rest initially.

Area = Impulse



~11 squares

Each square A = 50N(.01s)

= .5 NS

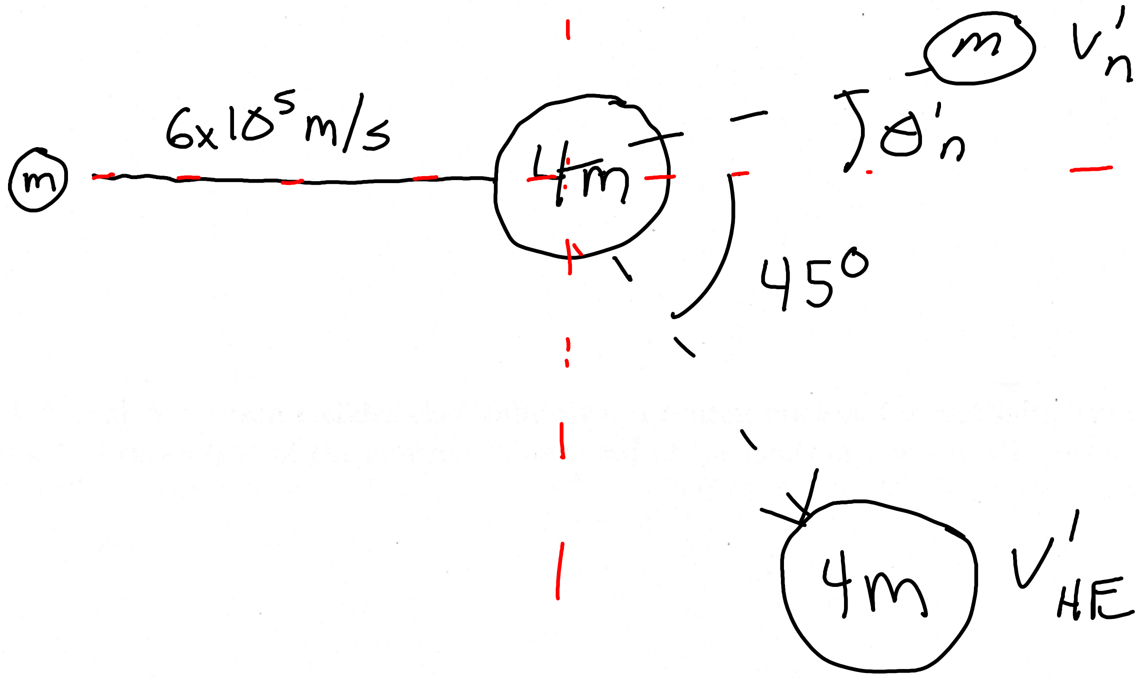
so I = 11 x .5NS = 5.5 NS

b) $I = \Delta p = mv_f - mv_o$

5.5 kg m/s = (.060kg) V_f

V_f = 92 m/s

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: $m(6\times10^5 m/s) = mV_n' \cos\theta_n' + 4mV_{HE}' \cos 45^o$

y: $0 = mV_n' \sin\theta_n' - 4mV_{HE}' \sin 45^o$

Energy

$\frac{1}{2}m(6\times10^5 m/s)^2 = \frac{1}{2}mV_n'^2 + \frac{1}{2}(4m)V_{HE}'^2$