Name _____ Date _____

CONCEPTUAL **Physical Science** PRACTICE SHEET

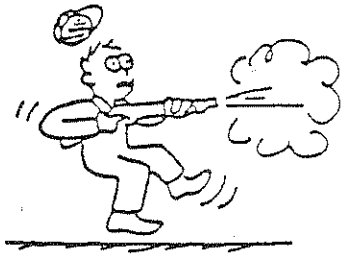
## Chapter 3: Momentum and Energy

*Momentum*

1. A moving car has momentum. If it moves twice as fast, its momentum is _____ as much.

2. Two cars, one twice as heavy as the other, move down a hill at the same speed. Compared to the lighter car, the momentum of the heavier car is _____ as much.

3. The recoil momentum of a gun that kicks is
   (more than) (less than) (the same as)
   the momentum of the gases and bullet it fires.



4. If a man firmly holds a gun when fired, then the momentum of the bullet and expelled gases is equal to the recoil momentum of the
   (gun alone) (gun-man system) (man alone)

5. Suppose you are traveling in a bus at highway speed on a nice summer day and the momentum of an unlucky bug is suddenly changed as it splatters onto the front window.

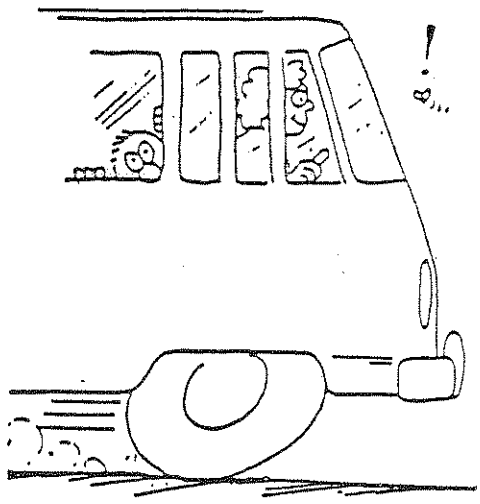
   a. Compared to the force that acts on the bug, how much force acts on the bus?
      (more) (the same) (less)

   b. The time of impact is the same for both the bug and the bus. Compared to the impulse on the bug, this means the impulse on the bus is
      (more) (the same) (less)

   c. Although the momentum of the bus is very large compared to the momentum of the bug, the change in momentum of the bus, compared to the *change* of momentum of the bug is
      (more) (the same) (less)

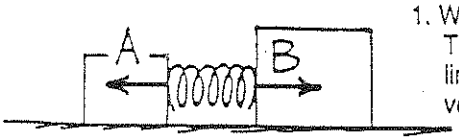
   d. Which undergoes the greater acceleration?
      (bus) (both the same) (bug)

   e. Which therefore, suffers the greater damage?
      (bus) (both the same) (the bug of course!)

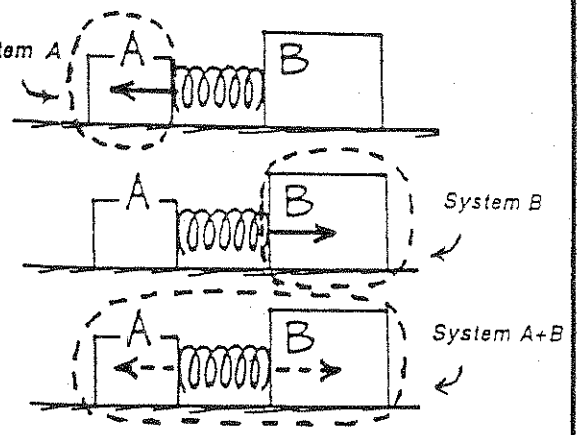


## *Systems*

Momentum conservation (and Newton's 3rd law) apply to *systems* of bodies. Here we identify some systems.




1. When the compressed spring is released, Blocks A and B will slide apart. There are 3 systems to consider here, indicated by the closed dashed lines below — System A, System B, and System A+B. Ignore the vertical forces of gravity and the support force of the table.




*a.* Does an external force act on System A? (yes) (no)

Will the momentum of System A change? (yes) (no)

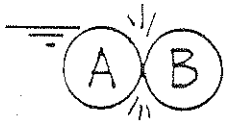
*b.* Does an external force act on System B? (yes) (no)

Will the momentum of System B change? (yes) (no)

*c.* Does an external force act on System A+B? (yes) (no)

Will the momentum of System A+B change? (yes) (no)

2. Billiard ball A collides with billiard ball B at rest. Isolate each system with a closed dashed line. Draw only the external force vectors that act on each system.




*System A*

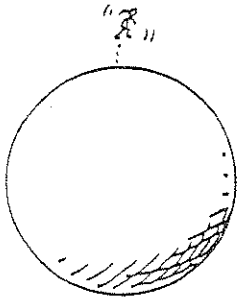

*System B*


*System A+B*

*a.* Upon collision, the momentum of System A (increases) (decreases) (remains unchanged).

*b.* Upon collision, the momentum of System B (increases) (decreases) (remains unchanged).

*c.* Upon collision, the momentum of System A+B (increases) (decreases) (remains unchanged).

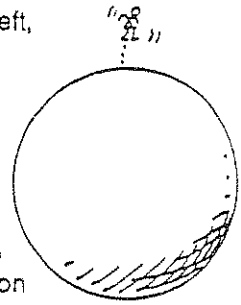


3. A girl jumps upward from the Earth's surface. In the sketch to the left, draw a closed dashed line to indicate the system of the girl.

*a.* Is there an external force acting on her? (yes) (no)

Does her momentum change? (yes) (no)

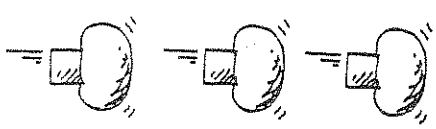
Is the girl's momentum conserved? (yes) (no)



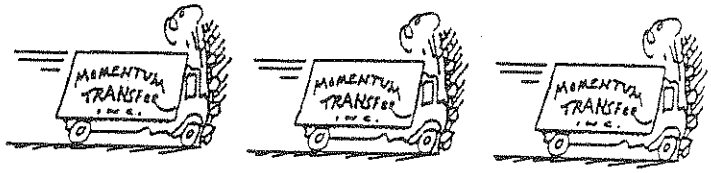
*b.* In the sketch to the right, draw a closed dashed line to indicate the system [girl + Earth]. Is there an external force due to the interaction between the girl and the Earth that acts on the system? (yes) (no)

Is the momentum of the system conserved? (yes) (no)

4. A block strikes a blob of jelly. Isolate 3 systems with a closed dashed line and show the external force on each. In which system is momentum conserved?



5. A truck crashes into a wall. Isolate 3 systems with a closed dashed line and show the the external force on each. In which system is momentum conserved?




thanx to Cedric Linder

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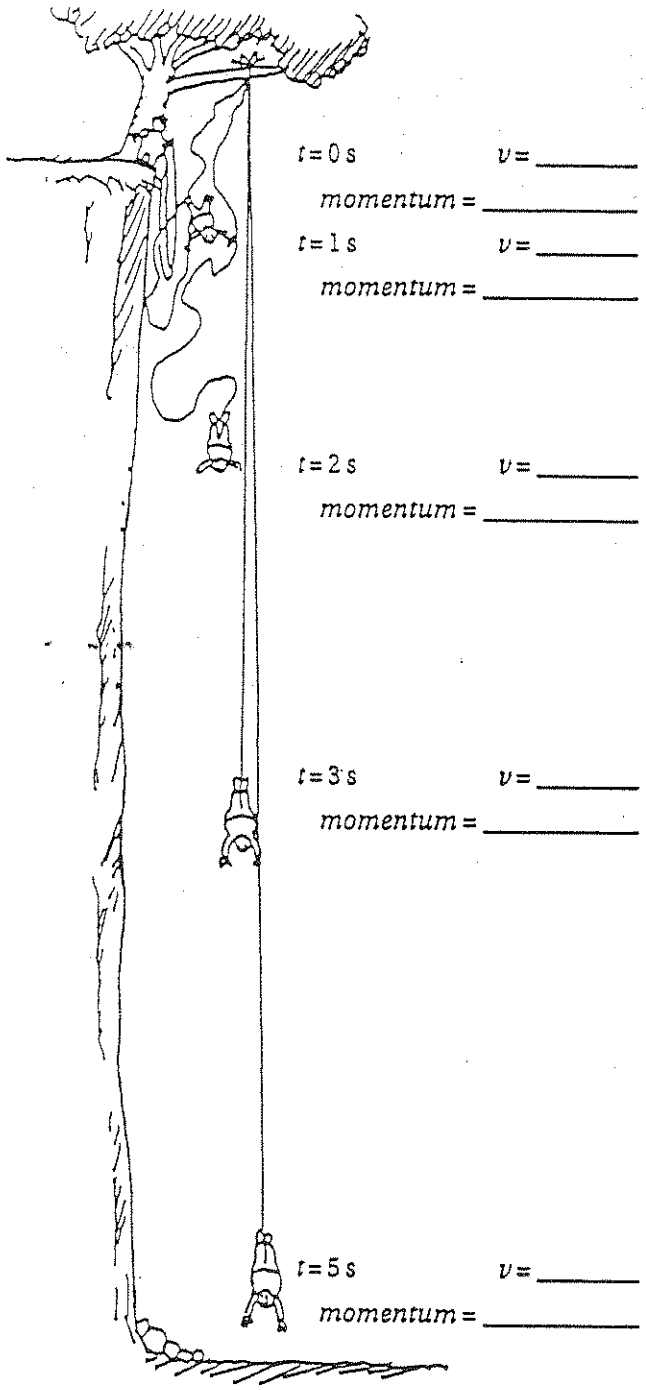
## Chapter 3: Momentum and Energy
### *Impulse—Momentum*



$t = 0$ s $v =$ _____
*momentum* = _____

$t = 1$ s $v =$ _____
*momentum* = _____

$t = 2$ s $v =$ _____
*momentum* = _____

$t = 3$ s $v =$ _____
*momentum* = _____

$t = 5$ s $v =$ _____
*momentum* = _____

Bronco Brown wants to put $Ft = \Delta mv$ to the test and try bungee jumping. Bronco leaps from a high cliff and experiences free fall for 3 seconds. Then the bungee cord begins to stretch, reducing his speed to zero in 2 seconds. Fortunately, the cord stretches to its maximum length just short of the ground below.

Fill in the blanks. Bronco's mass is 100 kg. Acceleration of free fall is 10 m/s².

Express values in SI units (*distance* in m, *velocity* in m/s, *momentum* in kg-m/s, *impulse* in N-s, and *deceleration* in m/s²).

The 3-s free-fall distance of Bronco just before the bungee cord begins to stretch

= _____

$\Delta mv$ during the 3-s interval of free fall

= _____

$\Delta mv$ during the 2-s interval of slowing down

= _____ _____

*Impulse* during the 2-s interval of slowing down

= _____

*Average force* exerted by the cord during the 2-s interval of slowing down

= _____

How about *work* and *energy*? How much KE does Bonco have 3 s after his jump?

_____

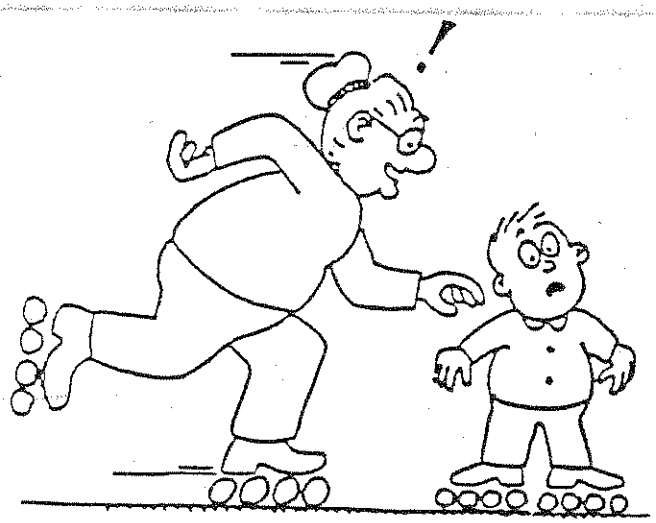
How much does gravitational PE decrease during this 3 s? _____

What two kinds of PE are changing during the slowing-down interval?

_____

## *Conservation of Momentum*

Granny whizzes around the rink and is suddenly confronted with Ambrose at rest directly in her path. Rather than knock him over, she picks him up and continues in motion without "braking."



Consider both Granny and Ambrose as two parts of one system. Since no outside forces act on the system, the momentum of the system before collision equals the momentum of the system after collision.

a. Complete the before-collision data in the table below.

| BEFORE COLLISION | |
|---|---|
| Granny's mass | 80 kg |
| Granny's speed | 3 m/s |
| Granny's momentum | _____ |
| Ambrose's mass | 40 kg |
| Ambrose's speed | 0 m/s |
| Ambrose's momentum | _____ |
| Total momentum | _____ |

b. After collision, does Granny's speed increase or decrease?

_____

c. After collision, does Ambrose's speed increase or decrease?

_____

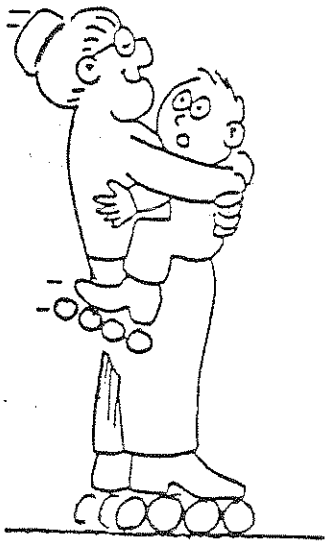
d. After collision, what is the total mass of Granny + Ambrose?

_____

e. After collision, what is the total momentum of Granny + Ambrose?

_____

f. Use the conservation of momentum law to find the speed of Granny and Ambrose together after collision.
(Show your work in the space below.)



New speed = _____