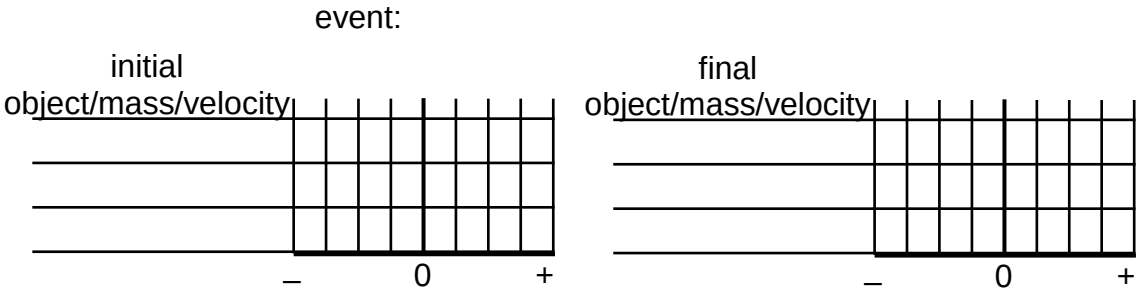
Name_____

Date _____ **Pd** ____

IB Physics – Unit 10 Worksheet 3:

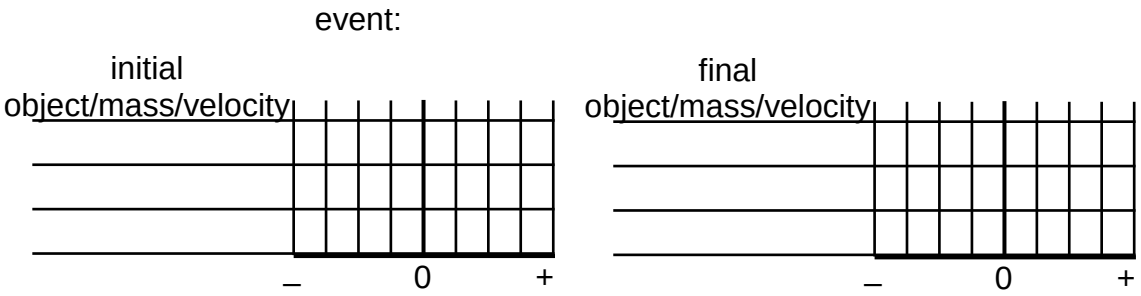
1. Two girls with masses of 50.0 kg and 70.0 kg are at rest on frictionless in-line skates. The taller girl pushes the shorter girl so that the shorter girl rolls away at a speed of 10.0 m/s.
   a. Show the effect of the push on both girls with a momentum conservation diagram.



   b. Momentum conservation equation:

   c. Calculate the impulse that each girl imparts to the other.

2. A 2.0 kg melon is balanced on a circus performer's head. An archer shoots a 50.0 g arrow at the melon with a speed of 30 m/s. The arrow passes through the melon and emerges with a speed of 18 m/s.
   a. Draw a momentum conservation diagram for the stunt.



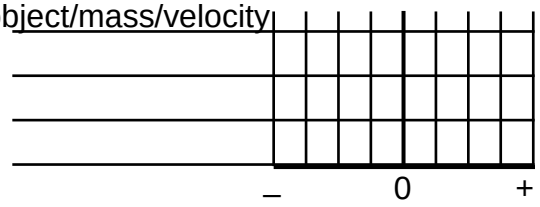
   b. Momentum conservation equation:

   c. Find the speed of the melon as it flies off the performer's head.

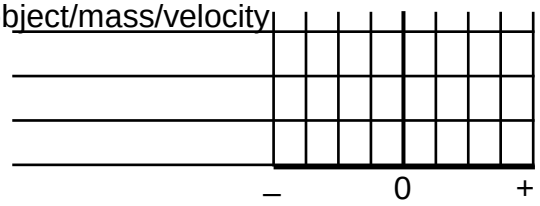
3. Old cannons were built on wheeled carts, both to facilitate moving the cannon and to allow the cannon to recoil when fired. When a 150 kg cannon and cart recoils at 1.5 m/s, at what velocity would a 10.0 kg cannonball leave the cannon?
   a. Complete a conservation of momentum diagram for firing one of these cannons.

event:

initial object/mass/velocity



final object/mass/velocity



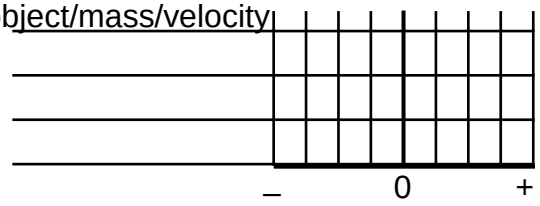
   b. Momentum conservation equation:

   c. Find the velocity of the cannonball.

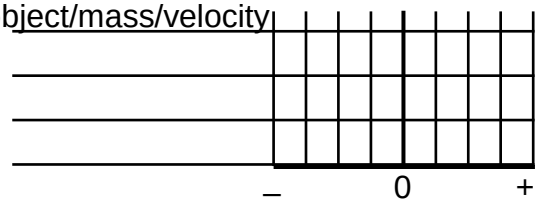
4. On an icy road, a 5000 kg truck rear-ends a 1200 kg car that had been traveling at 13 m/s, causing the truck to slow from 14 m/s to 12 m/s and the car to speed up.
   a. Complete the momentum conservation diagram for the accident.

event:

initial object/mass/velocity



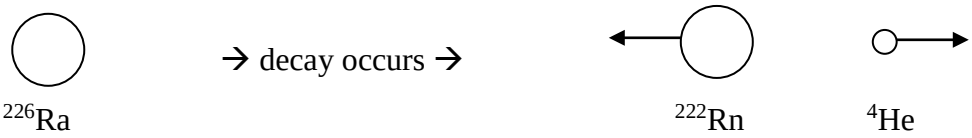
final object/mass/velocity



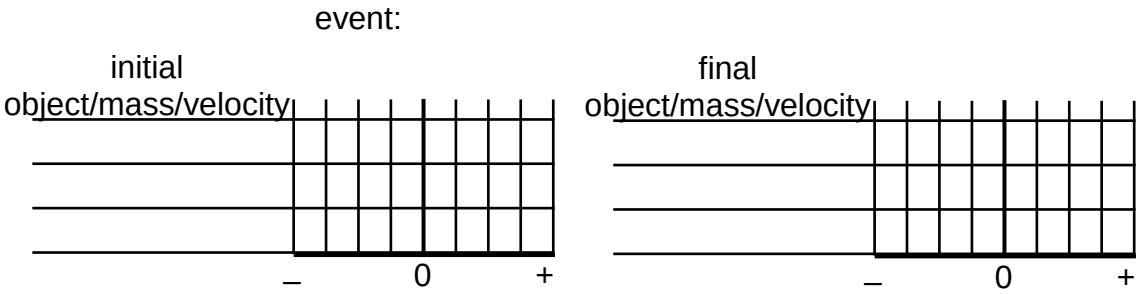
   b. Momentum conservation equation:

   c. Find the final velocity of the car.

5. When radium-226 decays, it becomes radon-222 by ejecting an alpha particle - two protons and two neutrons (a helium nucleus).



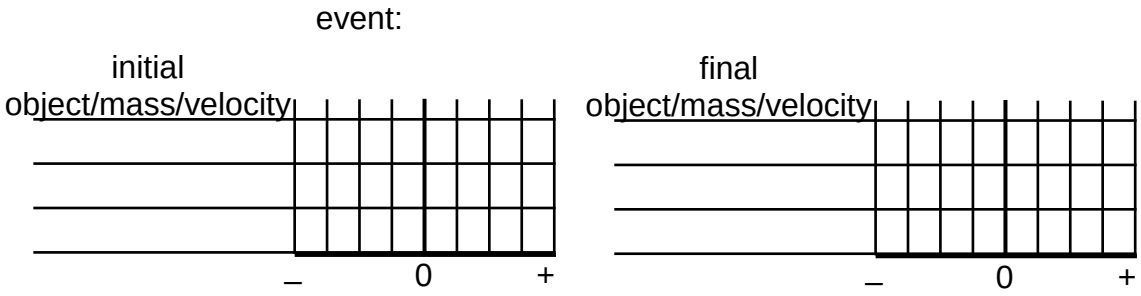
a. Complete a qualitative momentum conservation diagram for the radioactive decay of radium-226. (Recall from chemistry that the isotopic number of an element is related to its mass.)



b. Momentum conservation equation:

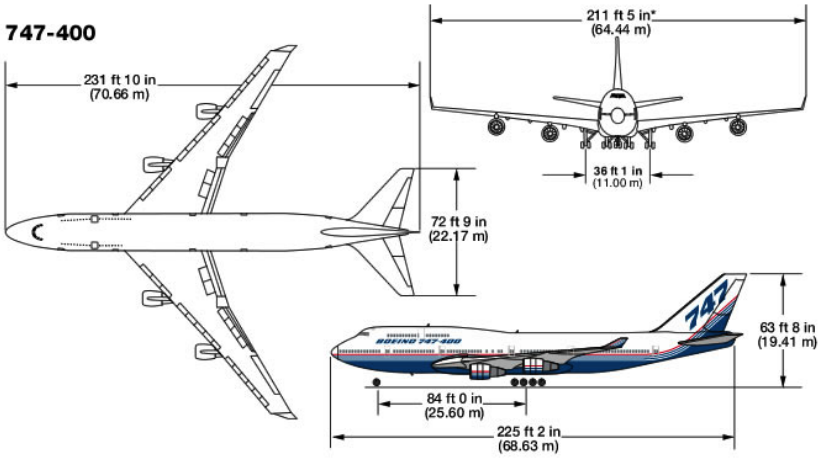
c. How many times larger will the final velocity of the alpha particle be compared to the final velocity of the radon-222?

6. An apple falls from a tree.
   a. Complete a **qualitative** conservation of momentum diagram where the apple is initially attached to the tree and the final situation is just before the apple hits the ground.



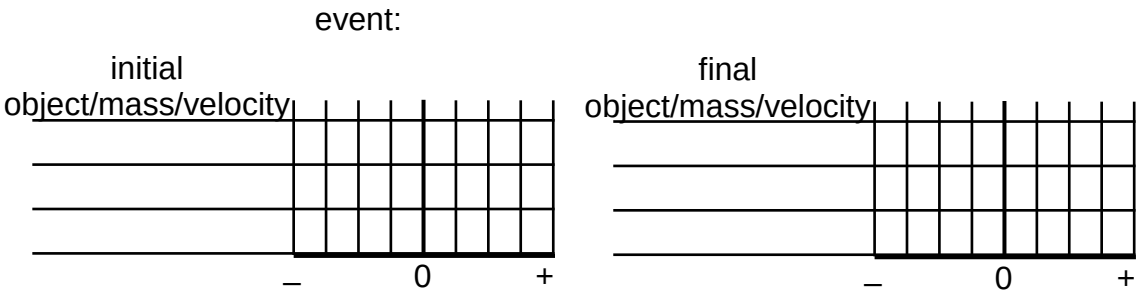
b. Momentum conservation equation:

7. Airplanes maneuver on the ground by using thrust from their jets or propellers. A fully loaded, 396,900 kg Boeing 747-400 gets a total of 1100 kiloNewtons of thrust from its jet engines. (Data from Boeing's website.) Takeoff speed depends on a number of factors like air temperature, airplane weight, and airport elevation, but let us say that liftoff will occur at 170 mph.



a. Determine the time the plane takes to go from 0 to 170 mph. (1 mile = 1600 meters)

b. Complete a conservation of momentum diagram showing how the initially stationary airplane gets to takeoff speed.



c. Momentum conservation equation:

d. Determine the momentum of the airplane at takeoff.

e. Calculate the impulse the plane receives from the engines during takeoff.

f. What additional information would be needed to calculate the velocity of the exhaust gasses from the engines?