1. A 2 kg turtle dives horizontal off his 1 kg raft floating in his tank. If the turtle leaves the raft going 0.2 m/s relative to the ground, what speed does the raft move in the opposite direction?

$p_i = p_f$ This is an "explosion"

$(m_1+m_2)v_0 = m_1v_2 + m_2v_3$

↑ start together w/ same speed — separate w/ equal momentum

$(2+1)(0) = 2v_2 + 1v_3$

$0 = 2(0.2) + 1v_3$

$-0.4 \frac{m}{s} = v_3$

negative indicates going opposite direction

2. If in the above problem, the turtle is in contact with the raft during the "dive" for 0.2 seconds, what is the force acting on the raft? What is the force acting on the turtle?

$\Delta p = Ft$ (same for both objects)

$\Delta(mv) = F \cdot t$

$2(0.2) = F(0.2)$

$2N = F_r$

Since 3rd Law action reaction pair

$F_1 = -F_2$

$F_T = -F_r = -2$

3. A tennis star (75 kg) returns a tennis ball (0.7 kg) out at a speed of 34 m/s that was originally moving at her at 19 m/s. What is the change in momentum of the racket? What was the impulse delivered to the ball?

$\Delta p = \Delta(mv) = m\Delta v = 0.7(-34-19)$

$\Delta p = -37.1 \frac{kgm}{s}$

$J = \Delta p = -37.1 \frac{kgm}{s}$

direction is arbitrary, so could be positive

4. An astronaut (86 kg) on a space walk (outside of the shuttle) throws Space Cat (4.8 kg) at a speed of 25 m/s, relative to the shuttle, at an angle of 40 degrees above horizontal away from himself. What is the speed of the astronaut after launching our feline superhero?

$p_i = p_f \qquad m_1v_1 + m_2v_2 = m_1v_3 + m_2v_4$

$0 + 0 = m_1v_3 + m_2v_4$

$m_1v_3 = -m_2v_4$

$86(v_3) = -(4.8)(25)$

$v_3 = -1.4 \frac{m}{s}$

5. A student slides a 5 kg watermelon to the left at a speed of 14 m/s along a frictionless table while his teacher slides the student's 0.3 kg calculator at the watermelon from the other direction at a speed of 24 m/s. The calculator penetrates the watermelon and becomes lodged in the center. What speed do the watermelon and calculator now move?

$p_i = p_f \qquad m_1v_1 + m_2v_2 = (m_1 + m_2)v_3$

($m_1 + m_2$: become one mass)

$5(14) + 0.3(-24) = (5+0.3)v_3$

(-24: other direction)

$\frac{70 + -7.2}{5.3} = v_3$

$11.8 \frac{m}{s} = v_3$

positive so to the left

6. A positive impulse of 16 N-s is applied to 1.3 kg toy car. What is the speed of the car if it was initially moving at 5 m/s in the positive direction?

$J = \Delta p \qquad J = mv_f - mv_i = m(v_f - v_i)$

$\frac{J}{m} + v_i = v_f$

$\frac{16}{1.3} + 5 = v_f = 17.3 \frac{m}{s}$