Third Law Answers

1. First find the acceleration of the bullet. Since, the 3rd law states that, "equal and opposite reaction",

$F_{g,b} = F_{b,g}$

$\vec{a}_{bullet} = \frac{v_f - v_i}{t}$

$= \frac{45\ m/s - 0\ m/s}{0.1\ s}$

$= 450\ m/s^2$

$F_{g,b} = F_{b,g}$ → Since $F_{b,g}$ and $F_{g,b}$ are the Fnet on each object

$m_b \vec{a}_b = m_g \vec{a}_g$

$0.15\ kg\ (450\ m/s^2) = 5.5\ kg \cdot \vec{a}_{gun}$

$\vec{a}_{gun} = \frac{0.15\ kg\ (450\ m/s^2)}{5.5\ kg}$

$\vec{a}_{gun} = 12.27\ m/s^2\ (S)$

2. First, what is the mass of the diver? And what is the acceleration of the diver?

Since the weight (i.e. F_g) of diver is given we use $F_g = mg$ to find mass:

$m = \frac{F_g}{g}$

$= \frac{833\ N}{9.8\ m/s^2}$

$m_{diver} = 85\ kg$

$\vec{a}_{diver} = \frac{v_f - v_i}{t}$

$= \frac{2.25\ m/s - 0\ m/s}{0.5\ s}$

$= 4.5\ m/s^2$

$\vec{F}_{b,d} = \vec{F}_{d,b}$

$m_d \vec{a}_d = m_b \vec{a}_b$

$85\ kg\ (4.5\ m/s^2) = 375\ kg \cdot \vec{a}_{boat}$

$\vec{a}_{boat} = \frac{85\ kg\ (4.5\ m/s^2)}{375\ kg}$

$\vec{a}_{boat} = 1.02\ m/s^2\ (E)$

$v_{f\ boat} = at + v_i$

$= 1.02\ m/s^2\ (0.5s) + 0$

$= 0.51\ m/s\ (E)$

3. Start by finding the acceleration then the F_{net}

Find $\vec{a}_{car}$.

$\vec{a}_{car} = \frac{v_f - v_i}{t}$

$= \frac{28\ m/s - 26\ m/s}{2.5\ s}$

$= 0.8\ m/s^2\ (N)$

$\vec{F}_{net} = 999\ kg\ (0.8\ m/s^2\ (N))$

$= 799\ N\ (N)$

4. A little more complicated

$\vec{F}_{B,A} = \vec{F}_{A,B}$ $\quad \vec{a} = \frac{v_f - v_i}{t}$

$m_A a_A = m_B a_B$ $\quad$ since $v_i = 0$, we exclude it

so, $\vec{a} = \frac{v_f}{t}$

$85\,kg\left(\frac{1.5\,m/s}{t}\right) = 110\,kg\left(\frac{v_f}{t}\right)$

$\frac{127.5}{t} = \frac{110 v_f}{t}$

$127.5 = 110 v_f$

$v_f = \frac{127.5}{110}$

$v_f = 1.16\ m/s$

$\vec{V}_{F,B} = 1.16\ \frac{m}{s}\ [E]$

5. Trick question! Each force is the same size
   For every action there is an equal and opposite reaction
   The fact that the bug splatters on the windshield only means that with its smaller mass, it is less able to withstand the larger acceleration resulting from the interaction

6. D
   It is a common misconception that rockets are unable to accelerate in space. The fact is that rockets do accelerate. Rockets are able to accelerate due to the fact that they burn fuel and push the exhaust gases in a direction opposite to the direction which they wish to accelerate.

7. B
   The force on the gun equals the force on the bullet. Yet, acceleration depends on both force and mass. The bullet has a greater acceleration due to the fact that it has a smaller mass. Remember, acceleration and mass are inversely proportional.

8. C
   The student is pulling with 500 N of force in each case
   The rope transmits the force from the physics student to the wall (or to the strong man) and vice versa. Since the force of the student pulling on the wall and the wall pulling on the student are action-reaction force pairs, they must have equal magnitudes. Inanimate objects such as walls can push and pull.