Simple Force Problems - Newton's First and Second Laws Solutions

1. An object at rest tends to stay at rest and an object with velocity tends to keep this velocity unless acted on by an unbalanced force.
    - A bike will continue rolling along even without someone pedalling.
    - A stone on a table sits on the table, without moving.
2. The acceleration of an object is proportional to the unbalanced force and inversely proportion to its mass.
    - A motorbike has high acceleration because it has a small mass compared to the engine producing the unbalanced force.

3. $We\ must\ assume\ that\ the\ bullet\ accelerates\ the\ entire\ distance\ of\ the\ gun\ barrel.$
   $a = \frac{F}{m} = \frac{3600}{0.025} = 1.44 * 10^5\ ms^{-2}$
   $v^2 = u^2 + 2as\ (where\ initial\ velocity\ is\ 0\ and\ bullet\ must\ travel\ 0.45\ m\ along\ gun)$
   $v^2 = 2 * 1.44 * 10^5 * 0.45 = 1.296 * 10^5$
   $v = \sqrt{1.296 * 10^5} = 360\ ms^{-1}$
4. $First\ find\ the\ required\ acceleration\ to\ stop\ within\ the\ given\ distance$
   $v^2 = u^2 + 2as\ (where\ v = 0)$
   $a = -\frac{u^2}{2s} = -\frac{230^2}{2*0.32} = -8266\ ms^{-2}$ (answer is negative because it is slowing down)
   $Now\ find\ what\ force\ can\ cause\ this\ acceleration$
   $F = ma = 0.012 * -8266 = -99.2\ N$ (answer is negative because force acts against current velocity)
5.
    a. $a = \frac{v-u}{t} = \frac{28-0}{18.7} = 1.50\ ms^{-2}$
    b. $F = ma = 36000 * 1.50 = 54{,}000\ N$
6. The frictional force acts against the car force. The unbalanced force = 8500-1100 = 7400 N
    a. $a = \frac{F}{m} = \frac{7400}{850} = 8.71\ ms^{-2}$
    b. $s = ut + \frac{1}{2}at^2 = 0 * 3.2 + \frac{1}{2} * 8.71 * 3.2^2 = 44.6\ m$
    c. $v = u + at = 0 + 8.71 * 3.2 = 27.9\ ms^{-1}$

7.
    a. $a = \frac{F}{m} = \frac{4400}{2300} = 1.91\ ms^{-2}$
    b. $s = ut + \frac{1}{2}at^2 = 0 * 3.2 + \frac{1}{2} * 1.91 * 3.2^2 = 9.78\ m$
    c. $v = u + at = 0 + 1.91 * 3.2 = 6.11\ ms^{-1}$