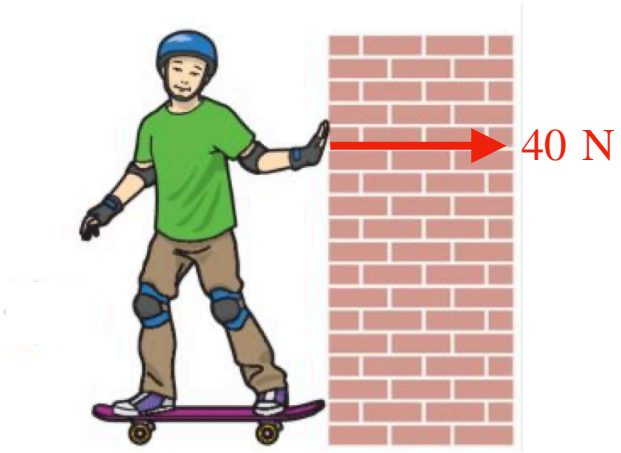
Ch. 5 HW Newton's 3rd Law

Extra Credit Option: Each student may obtain up to +5 points extra credit from this HW set to be added towards Exam I. (see Syllabus "Extra Credit' for details)

1) **(15 pts)** A skateboarder stands next to a wall on a frictionless skateboard and pushes the wall with a force of 40 N.



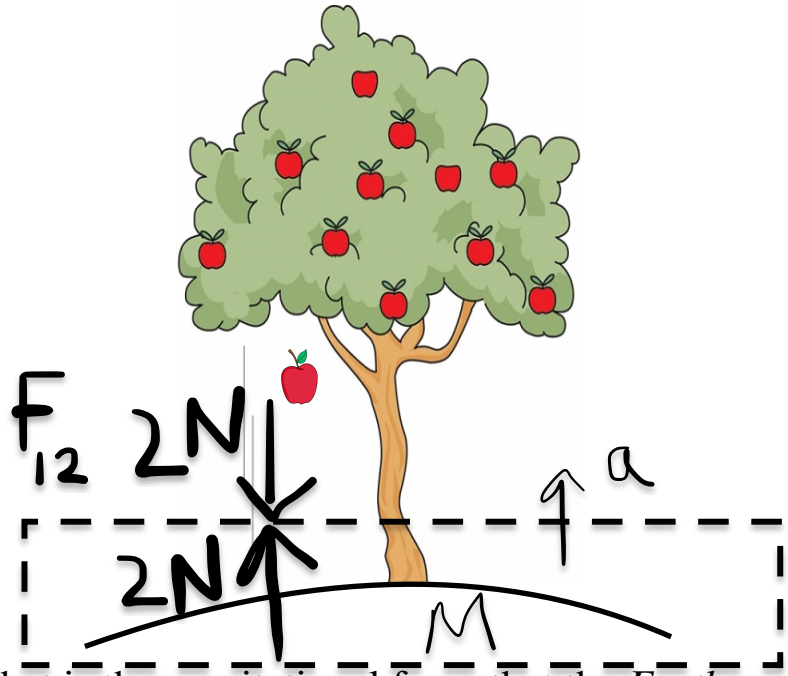
a) **(5 pts)** How hard does the wall push on the skateboarder? (Draw magnitude and direction)

b) **(5 pts)** If the skateboarder's mass is 80 kg, how much would he accelerate and in which direction ?

c) **(5 pts)** How much would the skateboarder accelerate if he were push the wall with twice as much force ?

2) **(15 pts)** An apple of mass m = 0.2 kg falls (assume negligible air resistance) from an apple tree due to the gravitational pull from the Earth

F_12 = m*g = 0.2*10 = 2 N



a) **(5 pts)** What is the gravitational force that the *Earth exerts on the apple*. (Draw magnitude and direction)

b) **(5 pts)** Does the apple exert a force on the Earth ? If so, what is the force that the *apple exerts on the Earth*. (Draw magnitude and direction)

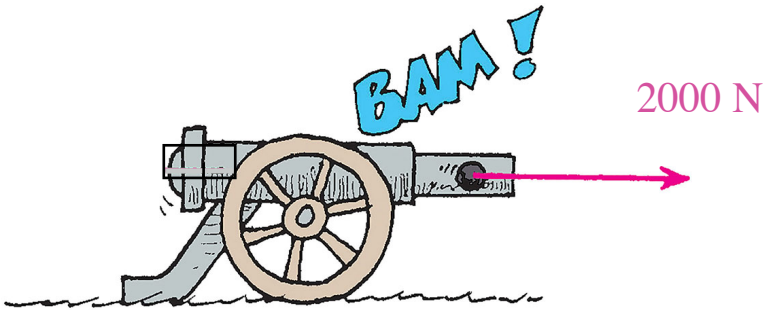
c) **(5 pts)** If the mass of the Earth is $M_e = 5.97 \times 10^{24}$ kg, what is the acceleration of the Earth towards the apple ? (*hint:* use the result from part (b) and Newton's 2nd law; think of the pull force the apple exerts on Earth)

F_net = M * a

2 N = M_e * a_e

a_e = 2 N / 5.97 x 10^24 kg = 3.3 x 10^-25 m/s2

3) **(15 pts)** A cannonball is fired from a canon with a force of 2000 N



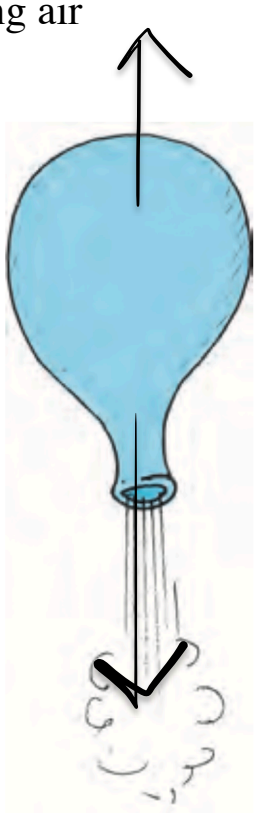
a) **(5 pts)** If the *cannonball* has a mass of $m = 200$ kg, calculate its acceleration

b) **(5 pts)** Draw the recoil force (magnitude and direction) on the canon in the figure

c) **(5 pts)** If the canon has a mass of $M = 4{,}000$ kg calculate the acceleration of its recoil

0.01

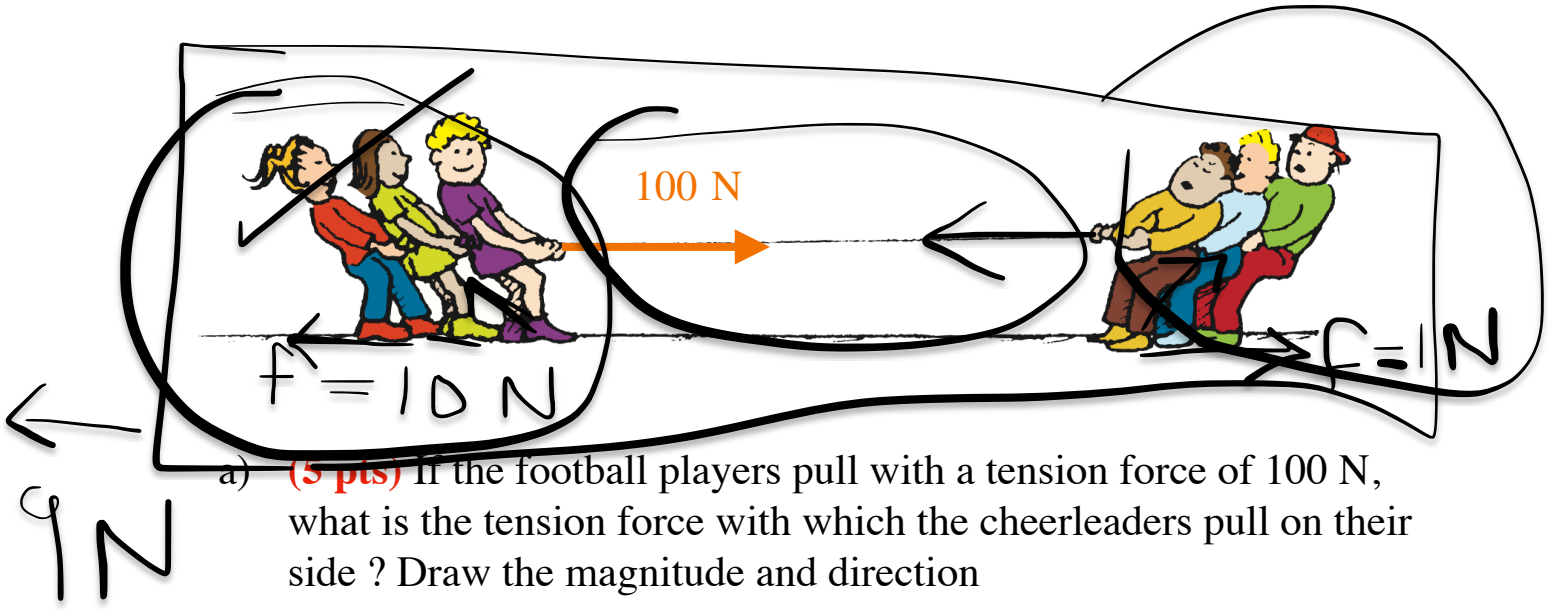
4) **(10 pts)** A 0.1-kg ballon is released and initially moves upward as it recoils from the escaping air



a) **(5 pts)** If the air escapes with a force of 10 N, what is the reaction force with which the ballon recoils upward ?

b) **(5 pts)** Given the mass of the ballon is 0.01 kg, what is its acceleration upward due to the recoiling force ? (Assume the weight of the ballon is negligible)

5) **(15 pts)** A tug-of-war is performed between a group of cheerleaders and football players on a polished floor that's somewhat slippery, with the football players wearing socks and the cheerleaders wearing rubber-soled shoes.



a) **(5 pts)** If the football players pull with a tension force of 100 N, what is the tension force with which the cheerleaders pull on their side ? Draw the magnitude and direction

b) **(5 pts)** A horizontal frictional force is exerted by the floor to the football players of 1 N, whereas the frictional force exerted by the floor to the cheerleaders is of 10 N. Draw the friction force in both cases (magnitude and direction)

c) **(5 pts)** What is the **net** external force being exerted on: (i) the cheerleaders and (ii) the football players (Draw magnitude and direction of the force in each case). Who wins the tug-of-war and why ?