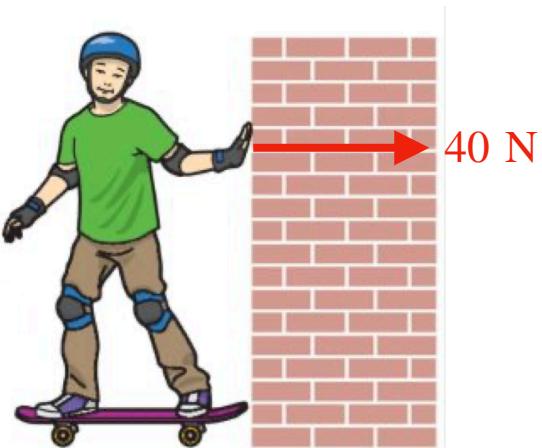


Ch. 5 HW Newton's 3rd Law

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.

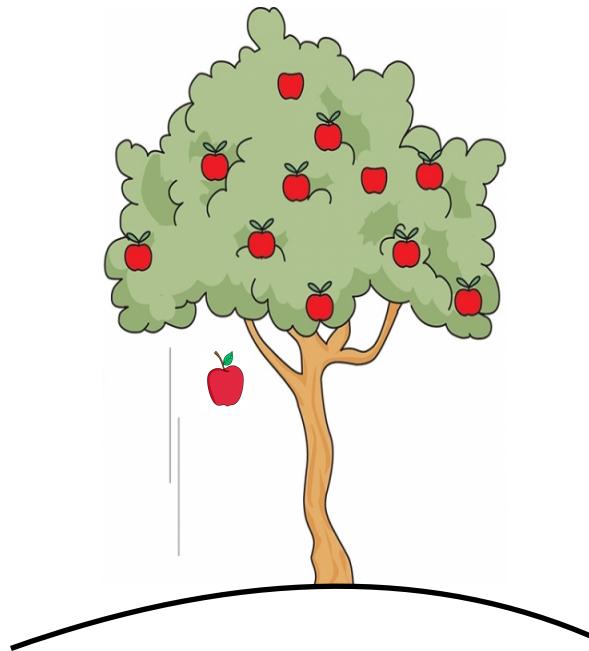


- a) **(5 pts)** How hard does the wall push on the skateboarder? (Draw magnitude and direction)

- 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 to push the wall with twice as much force ?

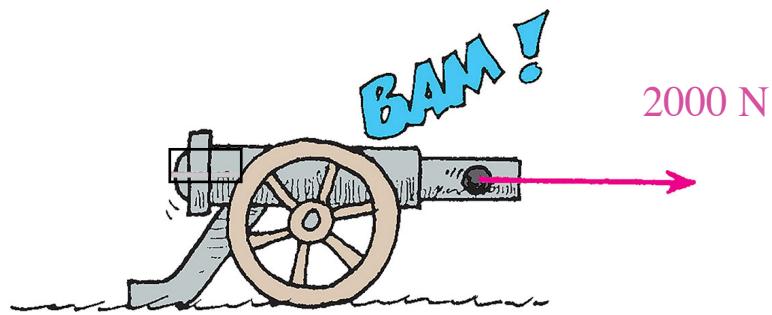
- 2) (15 pts) An apple of mass $m = 0.2 \text{ kg}$ falls (assume negligible air resistance) from an apple tree due to the gravitational pull from the Earth



- 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 $M_e = 5.97 \times 10^{24} \text{ kg}$, 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)

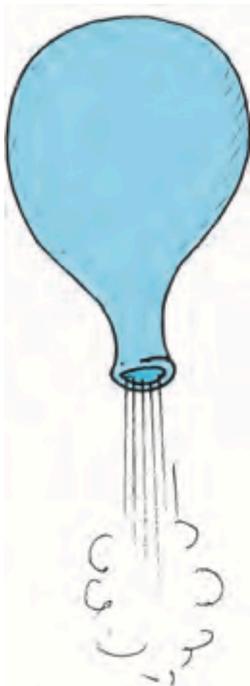
□ □ □

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



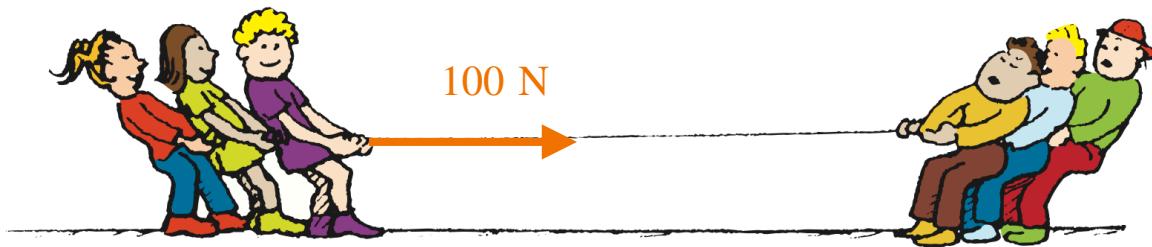
- a) (5 pts) If the *cannonball* has a mass of $m = 200 \text{ kg}$, calculate its acceleration
- b) (5 pts) Draw the recoil force (magnitude and direction) on the canon in the figure
- c) (5 pts) If the canon has a mass of $M = 4,000 \text{ kg}$ calculate the acceleration of its recoil

- 4) **(10 pts)** A 0.01-kg balloon 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 balloon recoils upward ?
- b) **(5 pts)** Given the mass of the balloon is 0.01 kg, what is its acceleration upward due to the recoiling force ? (Assume the weight of the balloon 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 ?