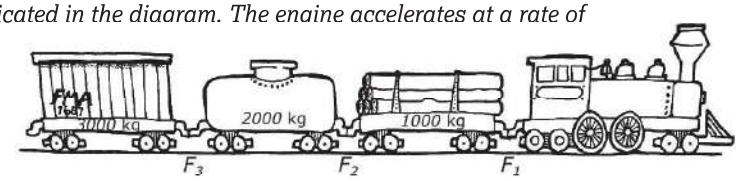
NAME _____ DATE _____

Scenario

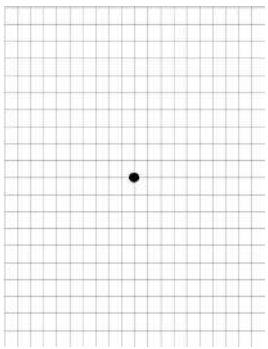
A train engine pulls a train with three cars. Each car has the mass shown. Suppose that the cars are connected by metal bars with the tensions indicated in the diagram. The engine accelerates at a rate of $2\ \text{m/s}^2$. *Assume that the cars travel on bearings with negligible friction.*



Using Representations

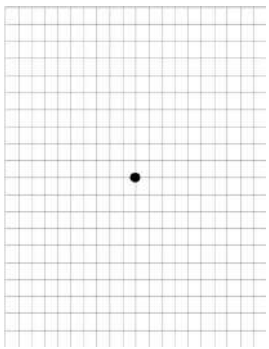
PART A: The dots below represent the three train cars. Draw free-body diagrams showing and labeling the forces (not components) exerted on each car. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces. Each force must be represented by a distinct arrow starting on and pointing away from the dot. For each diagram, write an equation that relates the horizontal forces in the diagram to acceleration.

Forces on the 3,000 kg car



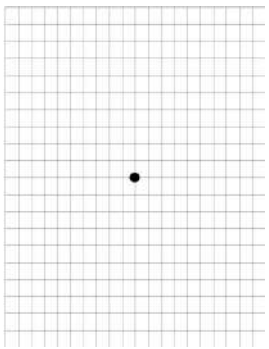
_____ = _____

Forces on the 2,000 kg car



_____ = _____

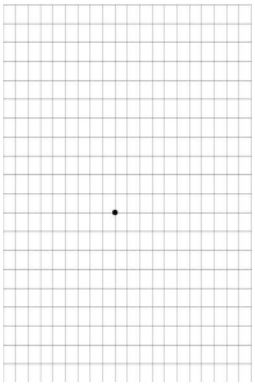
Forces on the 1,000 kg car



_____ = _____

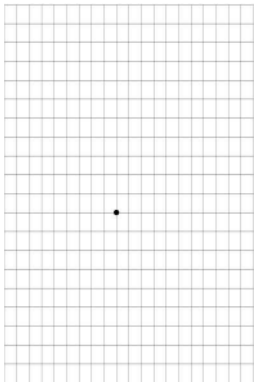
PART B: The dots below represent three different systems. Draw free-body diagrams showing and labeling the forces (not components) exerted on each *system*. Draw the relative lengths of all the vectors to reflect the relative magnitudes of all the forces. Each force must be represented by a distinct arrow starting on and pointing away from the dot. For each diagram, write an equation that relates the forces in the diagram to acceleration.

Forces on the system of the 2,000 kg and 3,000 kg cars



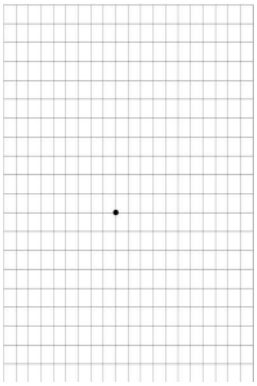
_____ = _____

Forces on the system of the 2,000 kg and 1,000 kg cars



_____ = _____

Forces on system of the 3,000 kg, 2,000 kg, and 1,000 kg cars



_____ = _____

Quantitative Analysis

PART C: Use the equations you wrote above to find each of the three tensions: F_1, F_2, and F_3.

Argumentation

PART D: Without referencing any math or any numbers, explain why F_1 is the greatest tension and F_3 is the smallest tension, even though F_3 is connected to the greatest mass.