Name: Group Members:

Physics 200 Tutorial 1

The PRINCIPLE OF RELATIVITY, upon which Einstein's theory of special relativity is based, states that

The laws of physics are the same in all inertial reference frames.

The questions in this tutorial will help remind you what is meant by "the laws of physics" and help you get used to the idea of a REFERENCE FRAME or FRAME OF REFERENCE. We say that all experimenters that are at rest relative to one another are in the same reference frame. An experimenter moving relative to this frame is in a different reference frame.

Physical quantities such as velocity, momentum, and kinetic energy are always defined relative to some frame of reference. Experimenters in different reference frames will measure different values for the velocity/energy/etc... of the same object. Nevertheless, each experimenter will find that their measurements/observations are consistent with the same laws of physics, provided that the two experimenters are moving at a constant velocity relative to one another.

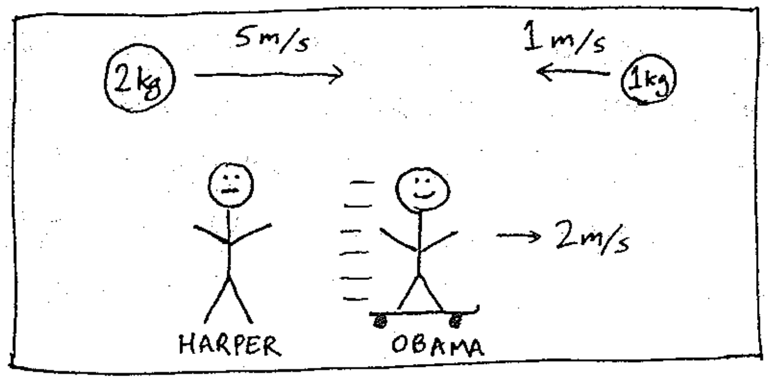
Thus, while physical quantities may be different when observed in different frames, we do not need a different set of equations to do physics in the different frames of reference.

(Note: we have not yet mentioned what is meant by an INERTIAL REFERENCE FRAME. Essentially, this is a non-accelerating frame of reference in which Newton's Laws are valid)

Question 1: Give four examples of laws of physics.

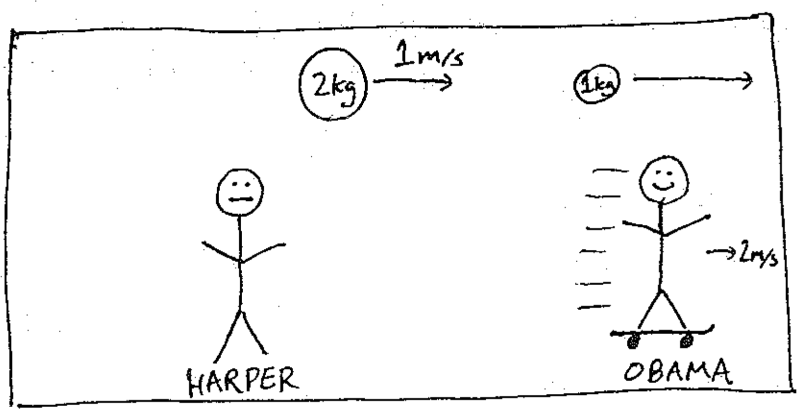
Question 2: Consider the following collision of two bouncy balls:

BEFORE:



Velocities shown are those observed by Harper.

AFTER:



a) What velocity does Harper observe for the 1kg ball after the collision? Is the collision elastic?

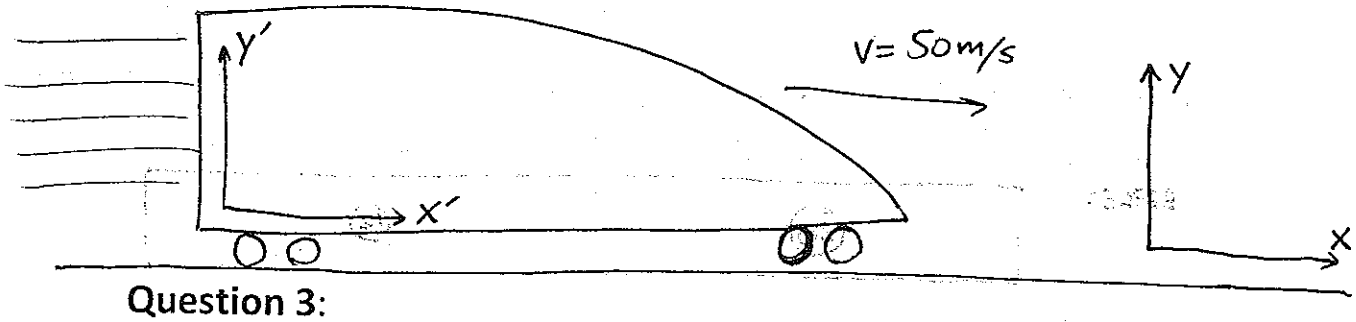
b) Indicate on the diagram the velocities (including direction arrows) of the balls before and after the collision in Obama's frame:

c) Complete the following chart:

	Harper's Frame	Obama's Frame
Total Momentum Before		
Total Momentum After		
Total Kinetic Energy Before		
Total Kinetic Energy After		

d) Do Harper and Obama agree on the momentum and energy of the balls? If not, does this contradict the Principle of Relativity?

e) Do Harper and Obama both agree that energy and momentum are conserved in the collision? Is this guaranteed by the Principle of Relativity?

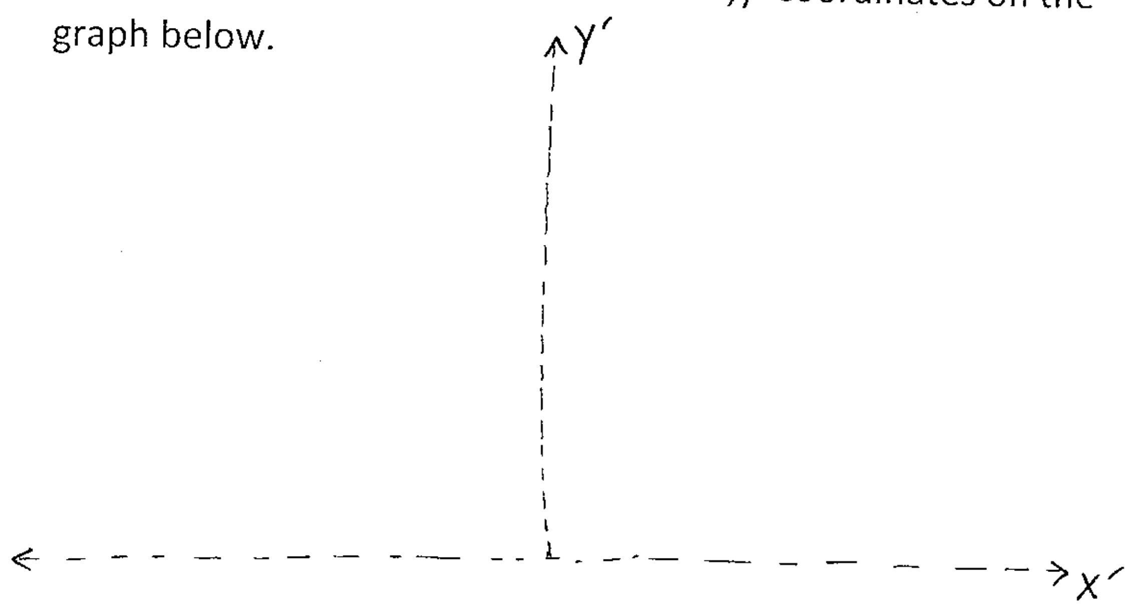


Question 3:

An experimenter on a train moving at 50 m/s relative to the track measures positions using coordinates where the back of the train is x'=0 and the floor of the train is y'=0. At time t'=0, the experimenter drops a kiwifruit at from the ceiling of the train (at x'=5m,y'=2m).

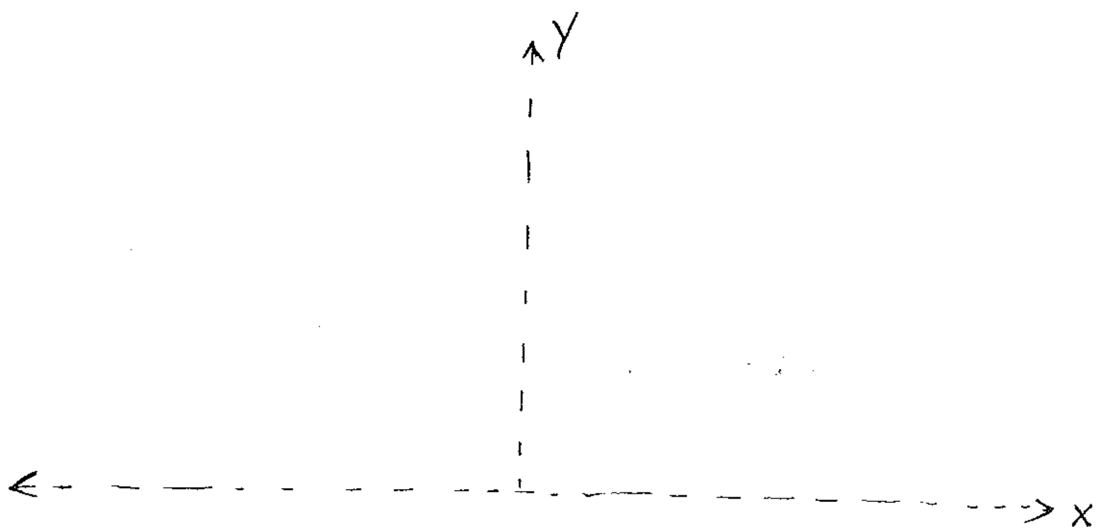
a) In this x',y' coordinates, where is the kiwifruit at a later time t'=T (assume this is before the fruit hits the floor)?

b) Sketch the path of the kiwifruit in the x',y' coordinates on the graph below.



c) An observer outside the train also watches the fruit fall[1] and measures the positions of the fruit in her reference frame (the frame of the track). If the outside observer also calls the fruit's position x=5m, y=2m when it is dropped, and agrees that this happens at t=0, where does she measure the fruit to be at a later time T?

d) Sketch the path of the kiwifruit in the x,y coordinates on the graph below.

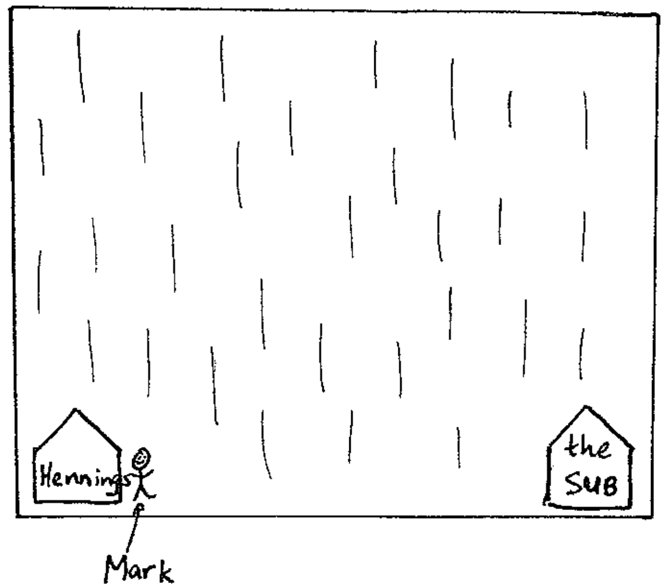


e) Do both observers see the same shape for the fruit's trajectory in space? Do both observers find Newton's 2nd Law to be satisfied?

[1] It''s one of those glass trains

Question 4:

Feeling hungry after a grueling Physics 200 Tutorial, Mark decides to head over to the SUB to get lunch at whatever place has the shortest line. Stepping outside, he finds that it is pouring rain. If Mark wants to stay as dry as possible, should he:



A) Walk slowly

B) Run as fast as possible

C) Go at some specific intermediate speed

D) It depends

Justify your answer by analyzing the problem in the reference frame of the rain, assuming that the rain is all travelling at some constant terminal velocity.

Hints: -start by assuming that the rain is falling straight down. You can also start by using the spherical Mark approximation.

-draw a picture showing Hennings, the SUB, and Mark's path in the reference frame of the rain. How does the path depend on Mark's velocity?