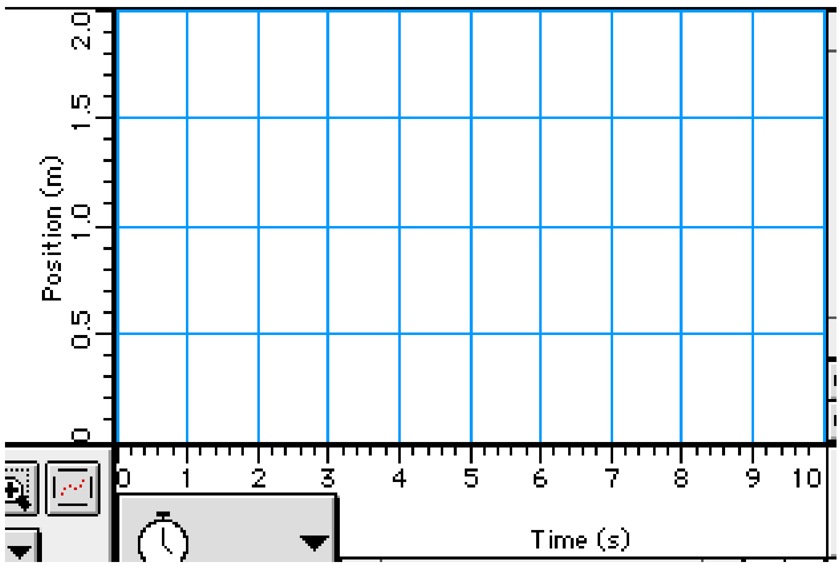
Some example questions relating to the material for Exam I:

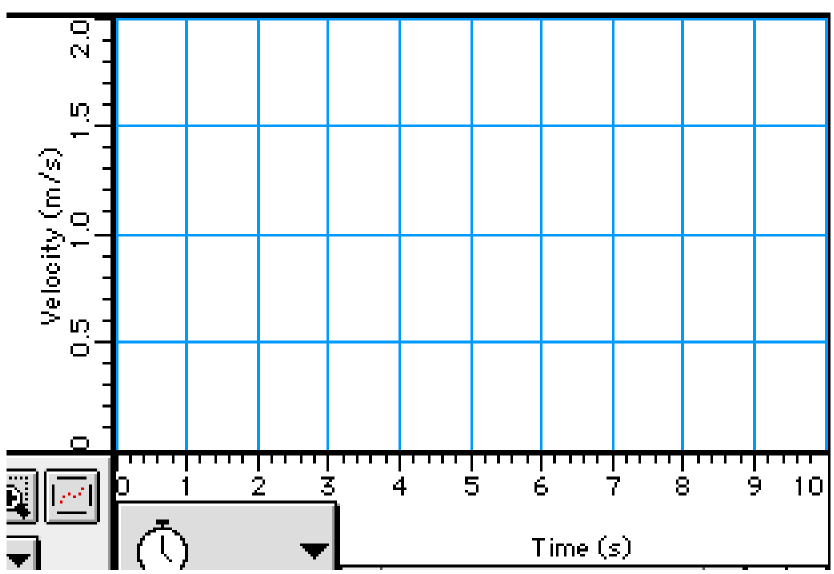
Set #1:

Questions 1-3 refer to the Lab “Motion in 1-dimension.”

1. On the graph provided sketch what you would theoretically expect to see in the Lab “Motion in 1-dimension” for the target motion: stand 1 meter away from the motion sensor for 2 seconds; walk toward the motion sensor 0.5 meters for the next 2 seconds; stand still for 2 seconds; walk away from the motion sensor 0.5 meters for the next 2 seconds; stand still for 2 seconds.



2. On the graph provided sketch what you would theoretically expect to see if you changed the vertical axis in the previous display to “Digital 1, velocity.”



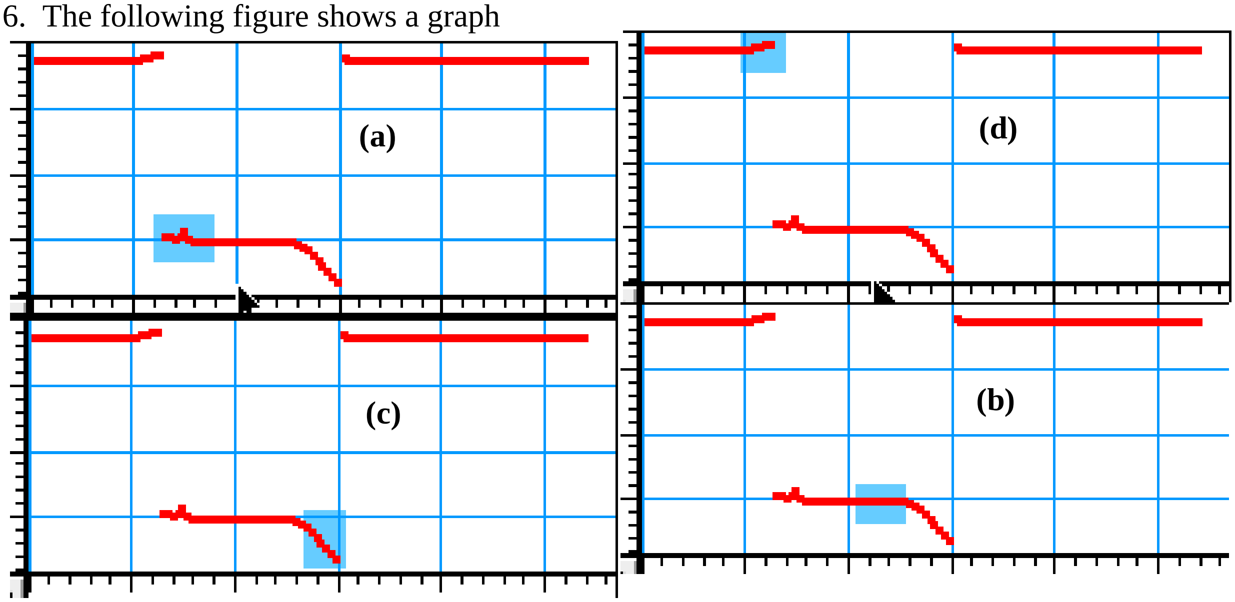
3. In practice, the second graph has a lot of fluctuations—some irregular, some regular. The *irregular* fluctuations result (a) because you can't stay in the beam, (b) because walking is a series of accelerations followed by decelerations, (c) from the way you breathe, (d) because small uncertainties in position propagate to larger uncertainties in velocity when differences are taken.

Questions 4-7 refer to the Lab "Terminal Velocity."

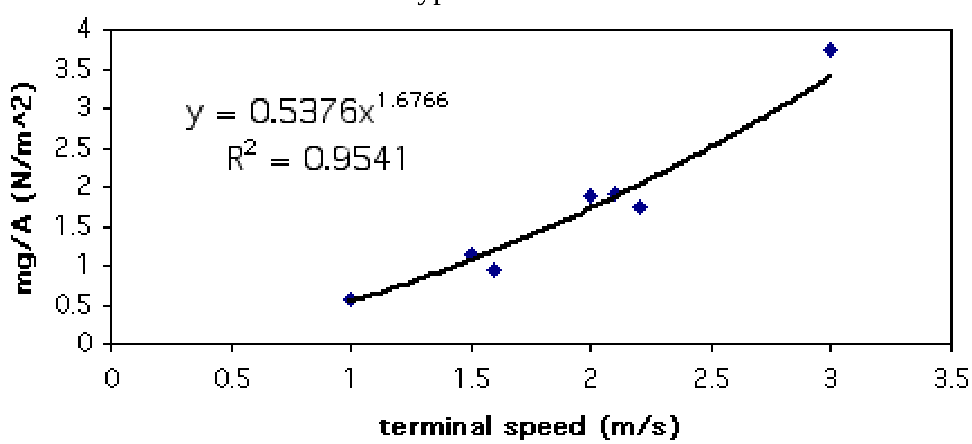
4. The force of air resistance on a falling balloon was assumed to be $kA(v_{terminal})^{1/p}$. The fundamental dimensions (M, L, T) of this expression are (a) LT^{-1}, (b) $L^{2+p}T^{-p}$, (c) $M^pL^{-p}T^{-p}$, (d) MLT^{-2}.

5. In the Lab a statistical analysis was performed on a small subset of the data taken in each run. Which of the following best represents the subset of data selected for this purpose?

6. The following figure shows a graph

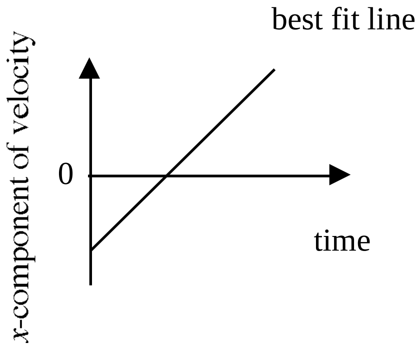


created by the Excel sheet "balloon" for a typical set of data.



On the graph, **circle the ONE data point** that corresponds to the run "large balloon, no paper clip."

7. Which of the following best represents the empirical value of the exponent p in the force law kAv^p, according to the data shown? (a) 0.5376, (b) 1.6766, (c) 1/1.6766, (d) 0.9541.



8. Suppose the density of a solid is D and its average atomic mass is M. Which of the following represents the average spacing between atoms in the solid? (a) D/M, (b) M/D, (c) $(D/M)^{1/3}$, (d) $(M/D)^{1/3}$

9. The atoms in a solid or liquid are said to be about the same size as the atomic spacing in the solid or liquid because (a) solids and liquids are difficult to compress, (b) atoms become much larger when they are in the gas phase, (c) atoms are in electronically excited states in the gas phase, (d) the electrons of atoms in solids and liquids are all confined inside the respective nuclei.

10. Macroscopic friction is caused by microscopic forces between atoms arising primarily from their (a) gravitational, (b) electrical, (c) strong nuclear, (d) weak nuclear interactions.

12. A force $\vec{F}_1$ has x-component +5 N, and y-component +2 N. A second force $\vec{F}_2$ has x-component –3 N, and y-component –3 N. The x- and y-components, respectively, of $\vec{F}_1 + \vec{F}_2$ are (a) 8 N, 5 N, (b) 7 N, -6 N, (c) 3 N, -1 N, (d) 3.16 N, 18.4° below the positive x-axis.

13. The velocity of a particle at one instant has an x-component of +30 m/s and a y-component of –40 m/s. Given that the instantaneous speed is the *magnitude* of the instantaneous velocity, what is the particle's instantaneous speed? (a) 10 m/s, (b) 50 m/s, (c) 70 m/s, (d) 2500 m/s.

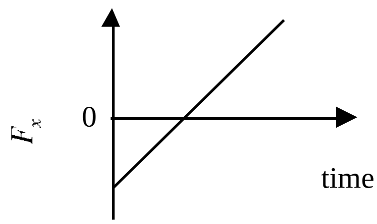
14. The x-position of a particle is sampled every 0.5 s, as in the following table.

Time (s)	x-position (m)
0.0	+3.0
0.5	+2.2
1.0	+3.0
1.5	+1.0
2.0	-0.5

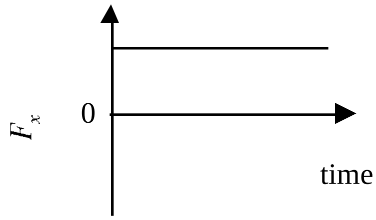
Which *one* of the following is true? (a) The x-component of the average velocity in the interval 0.0 s to 1.0 s is 0.0 m/s. (b) The average speed in the interval 0.0 s to 1.0 s is 0.0 m/s. (c) The x-component of the instantaneous velocity at 1.0 s is +3.0 m/s. (d) The x-component of the instantaneous velocity throughout the interval 1.0 s to 2.0 s is always negative.

15. The x-component of a particle's velocity is sampled every 0.5 s. The data are fit with a straight line as shown in the figure to the right. Assuming the fit is a good approximation to the motion, which of the following best represents the x-component of the *net force* on the particle as a function of time.

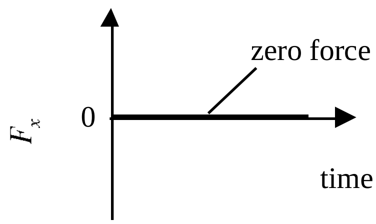
(a)



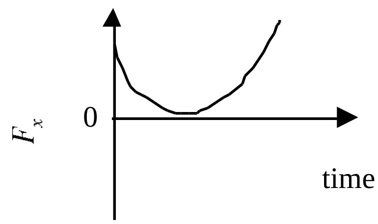
(b)



(c)



(d)



16. A 9.8 N force causes a 1 kg mass to have an acceleration of 9.8 m/s^2. This situation is most closely related to Newton's (a) First Law of Motion, (b) Second Law of Motion, (c) Third Law of Motion, (d) Law of Universal Gravitation.

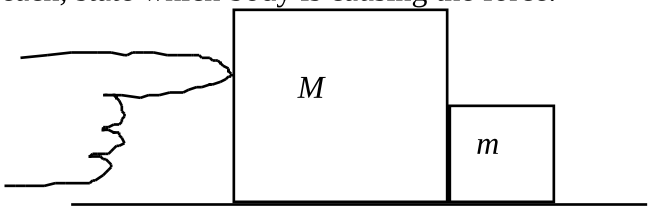
17. A woman weighing 500 N stands in an elevator that is traveling upward. At a given instant the speed of the elevator, as well as that of the woman, is 10 m/s and both are decreasing at the rate of 2 m/s^2. At that instant, the floor of the elevator exerts a force on the woman that is (a) about 400 N, pointing up, (b) 500 N, pointing up, (c) 500 N, pointing down, (d) about 600 N, pointing up.

18. A soccer ball approaches a soccer player with a speed of 10 m/s. The player heads the ball with the net result that the ball travels off in the opposite direction with a speed of 15 m/s. The player stays more-or-less in place. During the time the player's head is contact with the ball the head exerts an average force of magnitude 100 N. Which *one* of the following is true concerning the magnitude of the average force the ball exerts on the player's head during that time? (a) It must be about zero since the head doesn't move much. (b) It's hard to say from the information given, but it certainly must be less than 100 N or else the ball wouldn't reverse direction. (c) Nothing can be said about the magnitude of the force because neither the mass of the ball nor the time of contact is given. (d) It's 100 N.

19. A large protein consists of a strand of about 10,000 atoms coiled up into a ball. If the strand were pulled out into a line about how long (order of magnitude) would the strand be? (a) 10^4 m, (b) 1 m, (c) 10^{-2} m, (d) 10^{-6} m

Set #2:

1. A finger pushes with force of magnitude P on a block of mass M as shown in the figure. In turn, M pushes m. The two blocks slide over a frictionless, horizontal surface with the same acceleration, a. Draw a free body diagram for each mass with all forces clearly labeled. For each, state which body is causing the force.

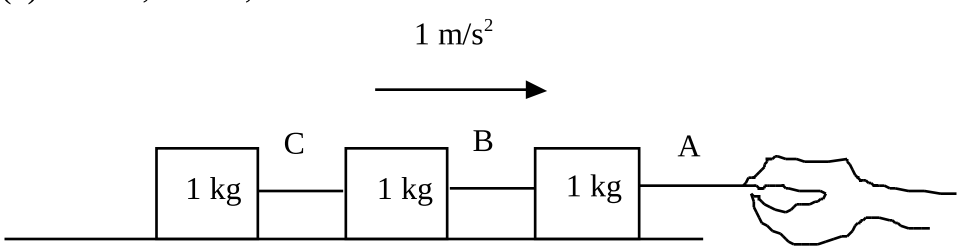


2. For the situation depicted in Question 1, the magnitude of the force <u>of m on M</u> is (a) P, (b) Ma, (c) ma, (d) none of these

3. Suppose that the finger pushes on m instead of M, but still with a force of magnitude P. The magnitude of the force of m on M now is (a) P, (b) Ma, (c) ma, (d) none of these.

4. A 5 kg mass initially traveling with a speed of 3 m/s, slams into a 1 kg mass initially at rest. After the collision, the 5 kg mass is traveling with a speed of 2 m/s and the 1 kg mass is propelled in the same direction, leaving the collision with a speed of 5 m/s. During the time the two masses are in contact the ratio of the magnitude of the force of the 5 kg on the 1 kg to the magnitude of the force of the 1 kg on the 5 kg is (a) 5, (b) 1, (c) 1/5, (d) the 1 kg mass doesn't exert a force on the 5 kg mass.

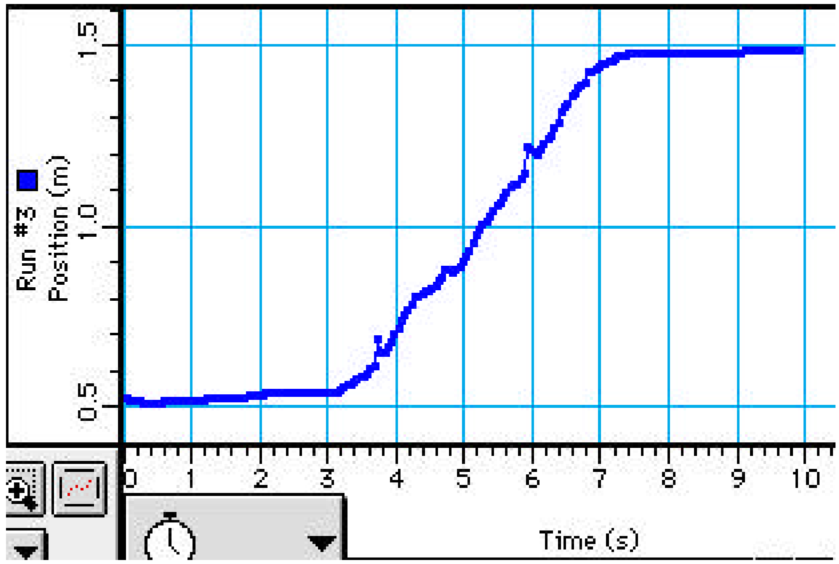
5. Three 1 kg masses connected by strings, as shown, slide together over a frictionless surface with the same acceleration, 1 m/s^2. Which of the following represents the tension in each of the strings? (a) A=3 N, B=2 N, C=1 N, (b) A=3 N, B=1 N, C=2 N, (c) A=1 N, B=1 N, C=1 N, (d) A=1 N, B=2 N, C=3 N.



6. A woman weighing 500 N is a traveling upward in an elevator at a constant speed of 9.8 m/s. The magnitude of the force of the floor on the woman during this ascent is (a) 500 N, (b) greater than 500 N, (c) less than 500 N but greater than 0 N, (d) the floor does not exert a force on the woman in this case.

7. The terminal speed of a balloon falling in air is of the form $(mg/kA)^{1/p}$. The fundamental dimensions (M, L, T) of this expression are (a) $ML^{-2}T^{-2}$, (b) $M^{1/p}L^{-2/p}T^{-2/p}$, (c) LT^{-1}, (d) it depends on the dimensions of k.

8. In the first of the exercises in the lab “Motion” (stand for 3 s, walk **away** for 4 s, stand for 3 s) a team records the data shown to the right. The average velocity during the walking phase is about (a) 1.0, (b) 0.38, (c) 0.25, (d) -0.25 m/s.



9. A graph of velocity versus time for the same data set as in question 3 shows approximately 0 values for the first 3 and the last 3 seconds. For the intermediate 4 seconds the velocity shows several fairly large variations. That is most likely because (a) the sensor is making timing errors, (b) small measurement errors in position become large velocity errors, (c) walking consists of a series of positive and negative accelerations, (d) human error.

10. A molecule of DNA taken from a bacterium is about 10^8 base pairs long. If this molecule were stretched out in a line its length would be about (a) $2x10^{-10}$ m, (b) $2x10^{-2}$ m, (c) $2x10^2$ m, (d) $2x10^8$ m.