Name____________________Date____________Partners________________

HOMEWORK FOR UNIT 5-1: FORCE AND MOTION

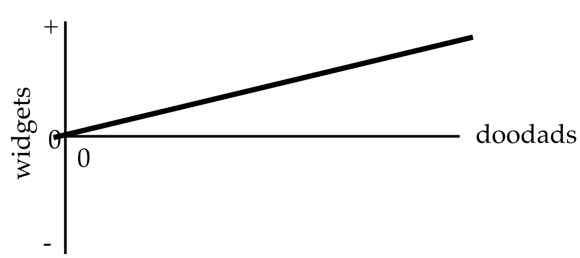
1. You are given ten identical springs. Describe how you would develop a scale of force (ie., a means of producing repeatable forces of a variety of sizes) using these springs. *Decide on an extension length of the spring for which one spring extended by this length exerts one unit of force on the object to which it is attached. Two springs both connected to the object, pulling in parallel and both extended by this length would exert two units of force and so forth up to 10 units of force for 10 springs, extended by the standard length, all connected to the object and all pulling in the same direction.*

2. Describe how you would use a force probe and the springs in (1) to develop a quantitative scale of force. *Connect the springs to the hook on the force probe. Use these springs to calibrate the probe. One spring stretched to the predetermined length would correspond to 1 unit during the calibration procedure, 5 springs, in parallel pulled o the standard length would be entered as 5 units. The force probe should then be calibrated quantitatively to measure any force within its range in terms of the spring units.*

3. What is meant by a proportional relationship? Is this the same as a linear relationship? Explain. *"proportional" means that the dependent variable is a constant multiple, either positive or negative, of the independent variable. "Linear"means that the dependent variable is a constant multiple of the independent variable plus or minus a constant offset.*

4. Given the table of data below for widgets and doodads, how would you determine if the relationship between widgets and doodads is a proportional one? Sketch on the axes on the right of the table what the graph would look like if widgets are proportional to doodads. *Divide the number of widgets by the number of doodads in each case. If the ratio is more or less the same in each case they are probably proportional. (except for the case 0.0/0.0!)*

widgets	doodads
0.0	0.0
150.5	10.0
305.0	20.0
442.7	30.0
601.3	40.0



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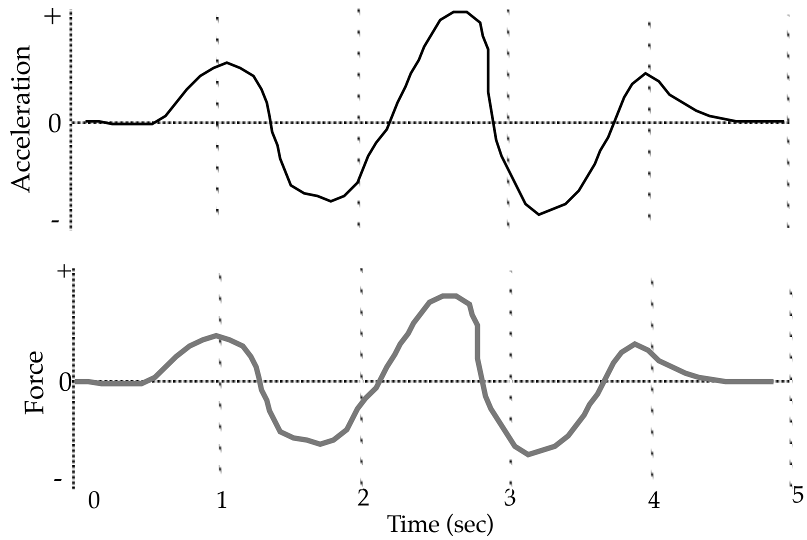
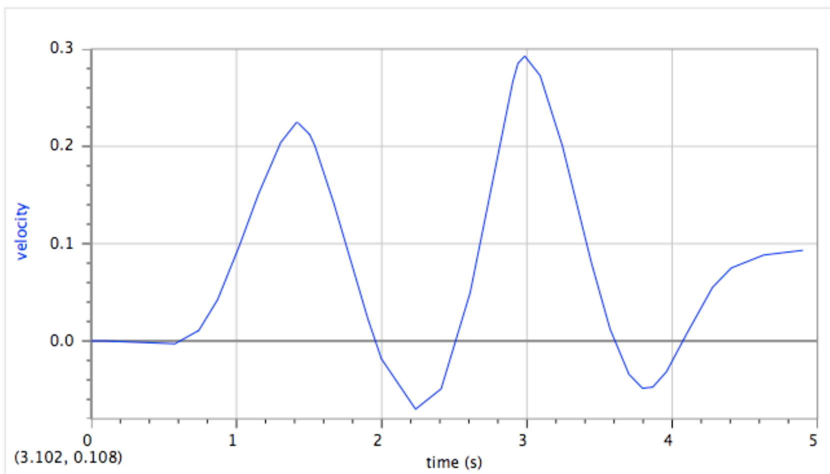
5. A force is applied which makes an object move with the acceleration shown below. Assuming that friction is negligible, sketch a force-time graph of the force on the object on the axes below.



Explain your answer: *Force and acceleration are proportional*

6. Roughly sketch the velocity-time graph for the object in question 5 on the axes below.



7. A cart can move along a horizontal line (the + position axis). It moves with the velocity shown below.

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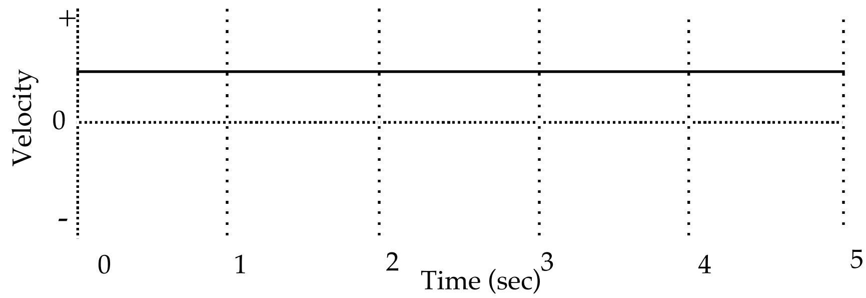
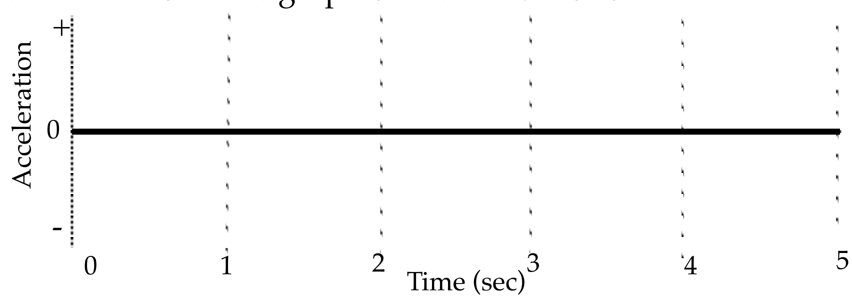
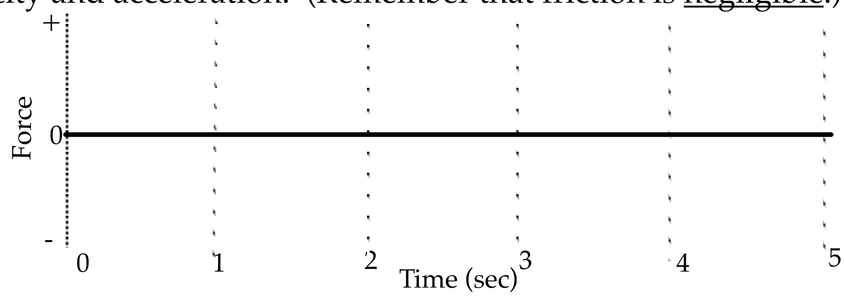


Assuming that friction is so small that it can be neglected, sketch on the axes that follow the acceleration-time graph of the cart's motion.



Sketch on the axes below the force which must act on the cart to keep it moving with this velocity and acceleration. (Remember that friction is negligible.)



Explain both of your graphs. *If velocity is constant then acceleration is zero. Zero acceleration implies that the net force is zero.*

Questions 8-10 refer to an object which can move in either direction along a horizontal line (the + position axis). Assume that friction is so small that it can be neglected. Sketch the shape of the graph of the force applied to the object which would produce the motion described.

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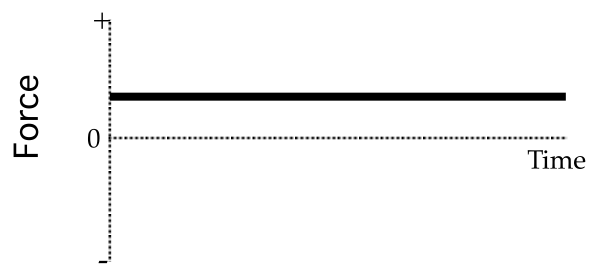
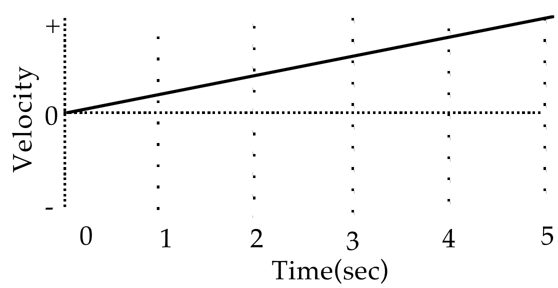
8. The object moves away from the origin with a constant velocity.

9. The object moves toward the origin with a constant velocity.

10. The object moves away from the origin with a steadily increasing velocity (a constant acceleration).



Questions 11-12 refer to an object which can move along a horizontal line (the + position axis). Assume that friction is so small that it can be ignored. The object's velocity-time graph is shown on the right.



11. Sketch the shapes of the acceleration-time and force-time graphs on the axes below.

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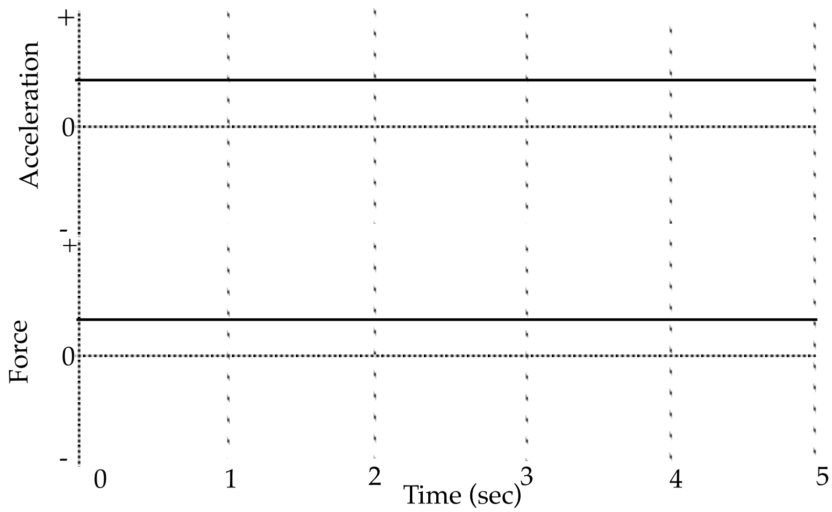
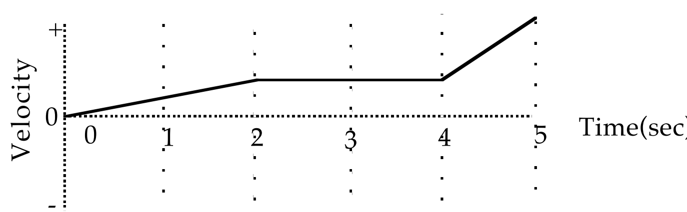
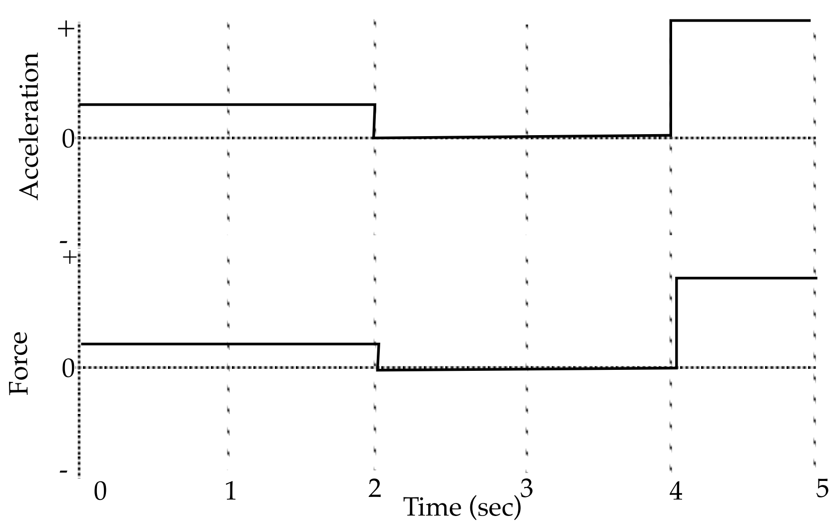


12. Suppose that the force applied to the object were twice as large. Sketch with dashed lines on the same axes above the force, acceleration and velocity.

Questions 13 refers to an object which can move along a horizontal line (the + position axis). Assume that friction is so small that it can be ignored. The object's velocity-time graph is shown



13. Sketch the shapes of the acceleration and force graphs on the axes below.



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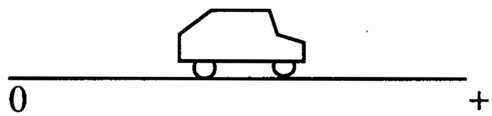
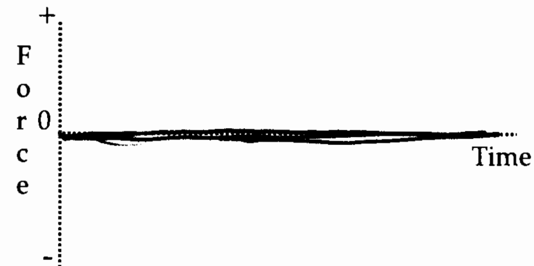
HOMEWORK FOR UNIT 5-2: COMBINING FORCES

Questions 1--5 refer to a toy car which can move in either direction along a horizontal line (the + position axis).

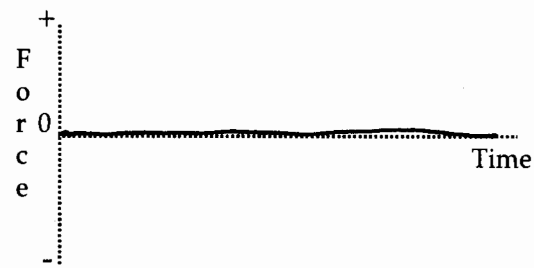


Assume that friction is so small that it can be ignored. Sketch the shape of the graph of the applied force which would keep the car moving as described in each statement.

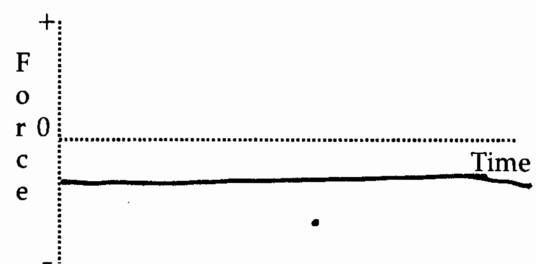
1. The toy car moves away from the origin with a constant velocity.



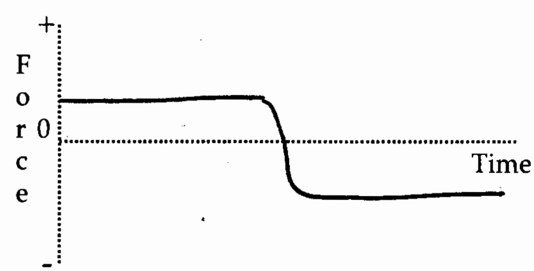
2. The toy car moves toward the origin with a constant velocity.



3. The toy car moves away from the origin with a steadily decreasing velocity (a constant acceleration).

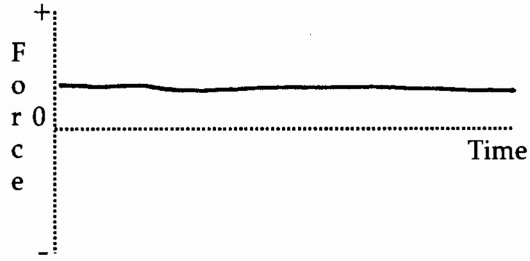


4. The toy car moves away from the origin, speeds up and then slows down.

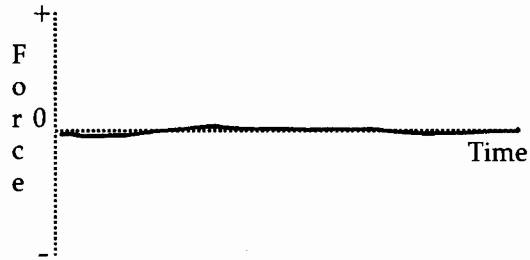


5. The toy car moves toward the origin with a steadily increasing velocity (a constant acceleration).

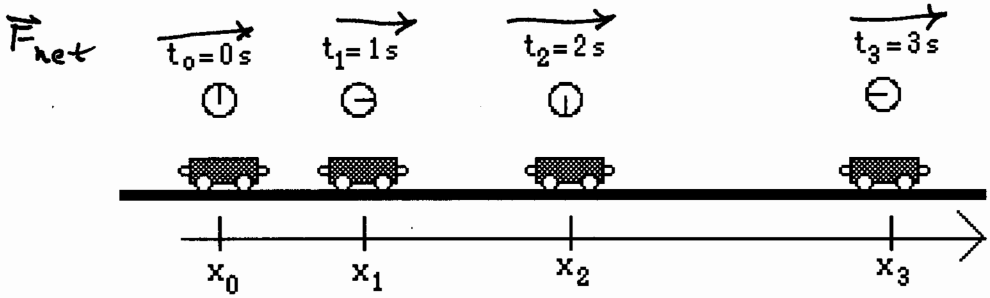
increasing = less negative



6. The toy car is given a push away from the origin and released. It continues to move with a constant velocity. Sketch the force after the car is released.



7. A cart is moving toward the right and speeding up, as shown in the diagrams below. Draw arrows above the cart representing the magnitudes and directions of the net (combined) forces you think are needed on the cart at t = 0 s, t = 1 s, etc. to maintain its motion with a steadily increasing velocity.



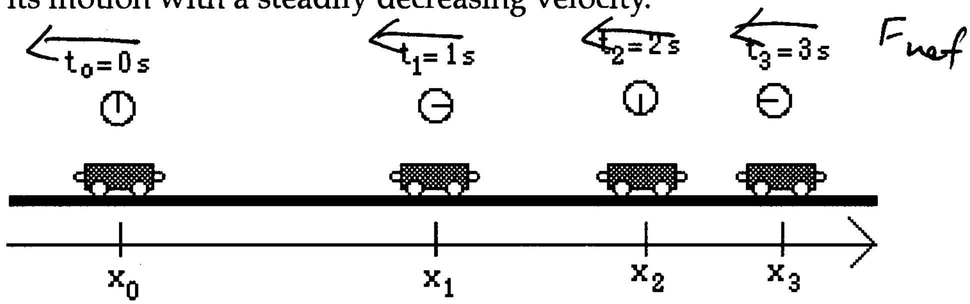
Explain the reasons for your answers.

The acceleration appears constant implying net Force in the direction of acceleration.

8. If the positive direction is toward the right, what is the sign of the force at t = 2 sec in question 7. Explain.

positive. see explanation
net force is in direction of velocity change.

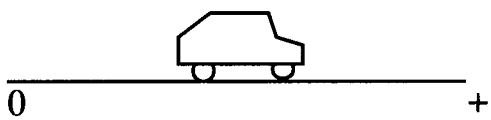
9. A cart is moving toward the right and slowing down, as shown in the diagrams below. Draw arrows above the cart representing the magnitudes and directions of the net (combined) forces you think are needed on the cart at t = 0 s, t = 1 s, etc. to maintain its motion with a steadily decreasing velocity.



Explain the reasons for your answers. Motion is in positive direction and slowing. Therefore, the acceleration is negative; and net force is towards the left.

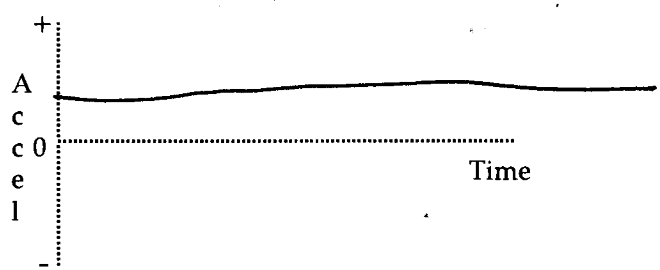
10. If the positive direction is toward the right, what is the sign of the force at t = 2 sec in question 9? Explain. Negative
See above

11. A toy car can move in either direction along a horizontal line (the + position axis).



Assume that friction is so small that it can be ignored. A force toward the right of constant magnitude is applied to the car.

Sketch on the axes below using a solid line the shape of the acceleration-time graph of the car.

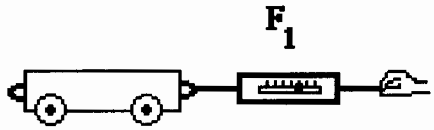


Explain the shape of your graph in terms of the applied force.

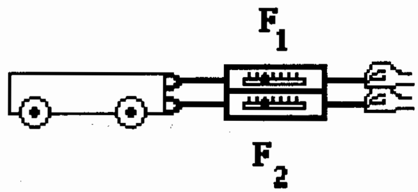
acceleration is proportional to force .

In questions 12-15, assume that friction is so small that it can be ignored.

12. The spring scale in the diagram below reads 10.5 N.



The cart moves toward the right with an acceleration toward the right of 3.25 m/s/s. Now two forces are applied to the cart with two different spring scales as shown below. The spring scale F_1 still reads 10.5 N.



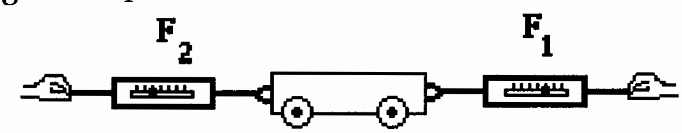
$$\frac{F_1 + F_2}{F_1} = \frac{5.50\ m/s^2}{3.25\ m/s^2}$$

$$F_2 = \left(\frac{5.50}{3.25} - 1\right) F_1$$

The cart now moves toward the right with an acceleration toward the right of 5.50 m/s/s. What does spring scale F_2 read? Show your calculations, and explain.

$$F_2 = 7.1\ N$$

13. Now two forces are applied to the cart with two different spring scales as shown below. The spring scale F_1 still reads 10.5 N.

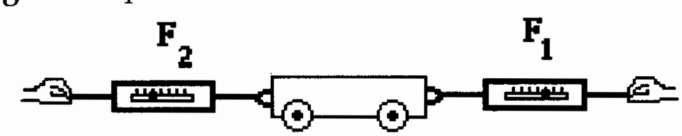


The cart now moves toward the right with an acceleration toward the right of 2.50 m/s/s. What does spring scale F_2 read? Show your calculations, and explain.

$$\frac{F_1 - F_2}{F_1} = \frac{2.5}{3.25}$$

$$F_2 = \left(1 - \frac{2.5}{3.25}\right) F_1 = 2.37\ N$$

14. Again two forces are applied to the cart with two different spring scales as shown below. The spring scale F_1 still reads 10.5 N.



The cart moves with a constant velocity toward the right. What does spring scale F_2 read? Show your calculations, and explain.

$$F_1 + F_2 = 0$$

Name Key Date________ Partners________

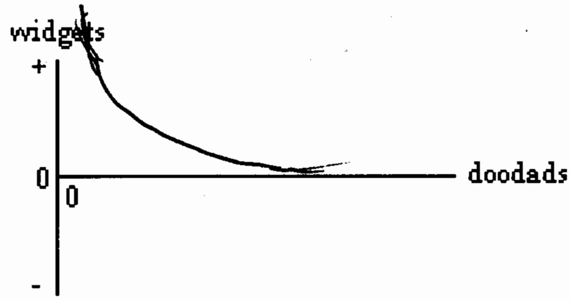
HOMEWORK FOR UNIT 5-3: FORCE, MASS AND ACCELERATION

1. Given the table of data below for widgets and doodads, how would you determine if the relationship between widgets and doodads is an inversely proportional one? Sketch on the axes on the right of the table what the graph would look like if widgets are inversely proportional to doodads, and write the form of the equation which relates widgets to doodads in this case. Multiply number of widgets by number of doodads. If the product is the same in each case (or almost so) the proportionality is inverse

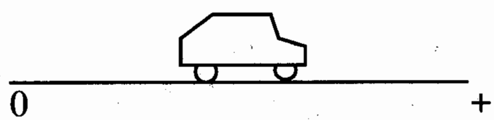
$wd = C$, $c \approx 120$

or $w = d/c$

widgets	doodads
125.0	10.0
59.0	20.0
42.0	30.0
30.5	40.0
23.5	50.0

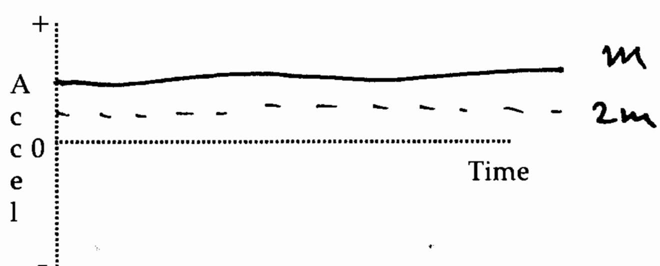


Questions 2-3 refer to a toy car which can move in either direction along a horizontal line (the + position axis).



Assume that friction is so small that it can be ignored. A force toward the right of constant magnitude is applied to the car.

2. Sketch on the axes below using a solid line the shape of the acceleration-time graph of the car.



3. Suppose that the mass of the car were twice as large. The same constant force is applied to the car. Sketch on the axes above using a dashed line the acceleration-

time graph of the car. Explain any differences in this graph compared to the acceleration-time graph of the car with the original mass.

Doubling the mass halves the acceleration if mass is the same: From Newton's second law

4. When a force is applied to an object with mass equal to the standard kilogram, the acceleration of the mass is 3.25 m/s/s. (Assume that friction is so small that it can be ignored.) When the same magnitude force is applied to another object, the acceleration is 2.75 m/s/s. What is the mass of this object? What would the object's acceleration be if a force twice as large were applied to it? Show your calculations.

$\frac{m}{1 kg} = \frac{3.25 m/s^2}{2.75 m/s^2}$

$m = (3.25/2.75)\ 1\ kg =$

If mass is doubled

$a = 2 \times 3.25\ m/s^2$

$= 6.5\ m/s^2$

5. Given an object with mass equal to the standard kilogram, how would you determine if a force applied it has magnitude just equal to one newton? (Assume that friction is so small that it can be ignored.)

check to see if the acceleration is $1\ m/s^2$

6. Why is it necessary to calibrate the force probe? Describe how this is done.

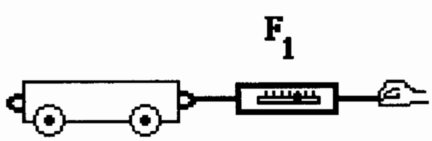
The force probe output is a voltage not force. The voltage is assumed proportional to the applied force, but the proportionality constant is not known unless it's calibrated. To calibrate apply 2 known (2 times) and record the voltages. The slope of V vs F provides the prop.

In questions 7, assume that friction is so small that it can be ignored.

7. The spring scale in the diagram below reads 10.5 N.

$F = ma$

$m = F/a = 10.5\ N/3.$

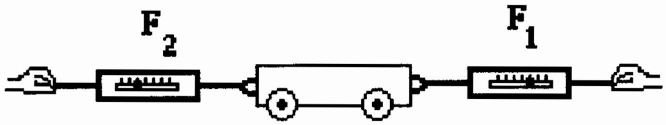


If the cart moves toward the right with an acceleration toward the right of 3.25 m/s/s, what is the mass of the cart? Show your calculations, and explain.

$m = \frac{10.5 N}{3.25 m/s^2} = 3.15$

In questions 8-10, friction may not be ignored.

15. Again two forces are applied to the cart with two different spring scales as shown below. The spring scale F_1 still reads 10.5 N.



The cart moves toward the left with an acceleration toward the left of 2.50 m/s/s. What does spring scale F_2 read? Show your calculations, and explain.

$$\frac{F_1 - F_2}{F_1} = \frac{-2.5}{3.25}$$

$$-F_2 = \left(1 + \frac{2.5}{3.25}\right) F_1$$

$$F_2 = -\left(1 + \frac{2.5}{3.25}\right) F_1 = -1.77 \times 10.5 \text{ N}$$

$$= -18.6 \text{ N}$$