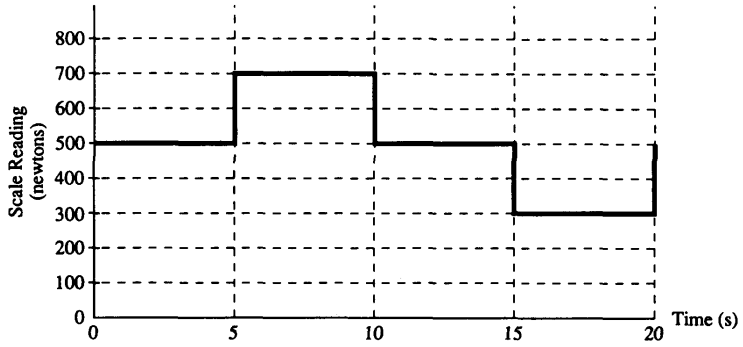
AP FIZZIX: Mid Term Review Practice FR Probs. Solutions provided separately.



1. A student whose normal weight is 500 newtons stands on a scale in an elevator and records the scale reading as a function of time. The data are shown in the graph above. At time t = 0, the elevator is at displacement x = 0 with velocity v = 0. Assume that the positive directions for displacement, velocity, and acceleration are upward.

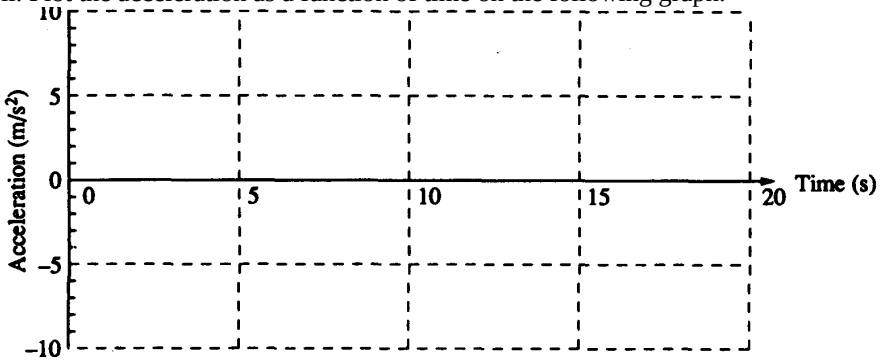
a. On the diagram below, draw and label all of the forces on the student at t = 8 seconds.

b. Calculate the acceleration a of the elevator for each 5-second interval.

i. Indicate your results by completing the following table.

Time Interval (s)	0-5	5-10	10-15	15-20
a (m/s^2)				

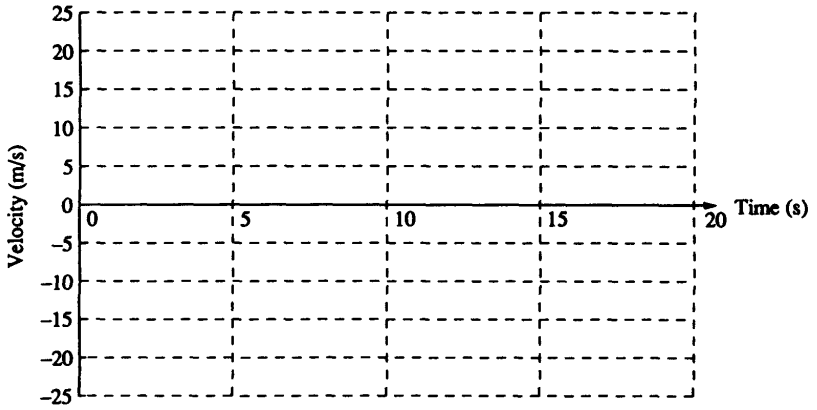
ii. Plot the acceleration as a function of time on the following graph.



c. Determine the velocity v of the elevator at the end of each 5-second interval.

i. Indicate your results by completing the following table.

Time (s)	0-5	5-10	10-15	15-20
v (m/s)	_____	_____	_____	_____



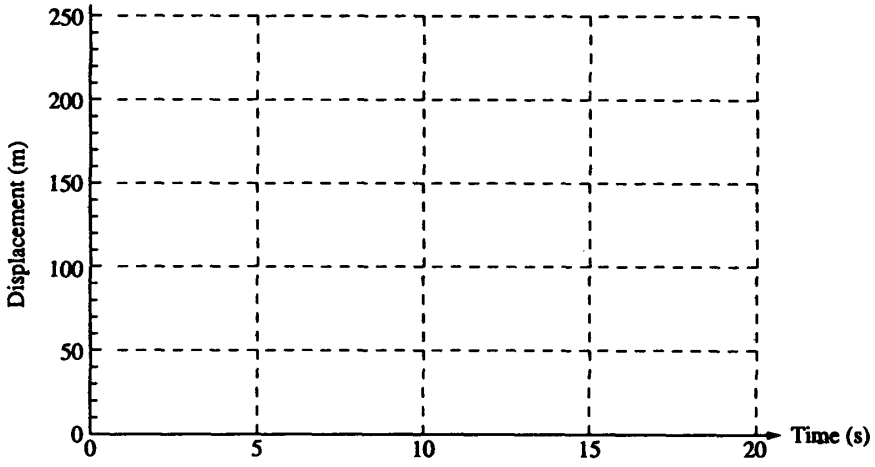
ii. Plot the velocity as a function of time on the following graph.

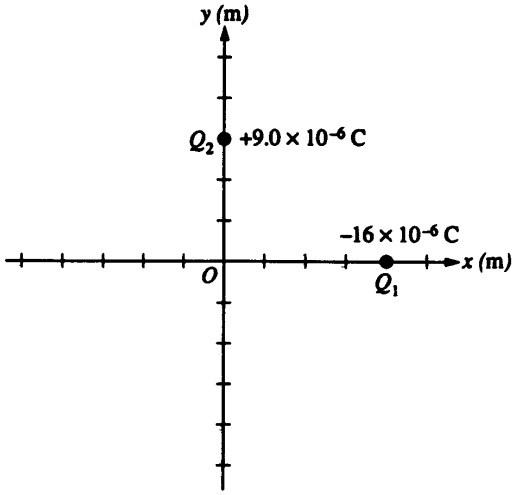
d. Determine the displacement x of the elevator above the starting point at the end of each 5-second interval.

i. Indicate your results by completing the following table.

Time (s)	0-5	5-10	10-15	15-20
x (m)	_____	_____	_____	_____

ii. Plot the displacement as a function of time on the following graph.



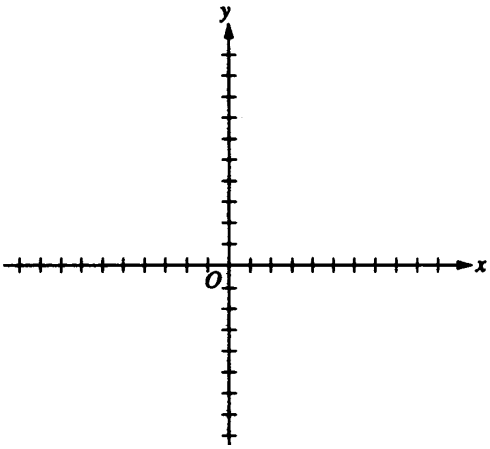


2. A charge Q_1 = -16 x 10^{-6} coulomb is fixed on the x-axis at +4.0 meters, and a charge Q_2 = + 9 x 10^{-6} coulomb is fixed on the y-axis at + 3.0 meters, as shown on the diagram above.

a. i. Calculate the magnitude of the electric field E_1 at the origin O due to charge Q_1

ii. Calculate the magnitude of the electric field E_2 at the origin O due to charge Q_2.

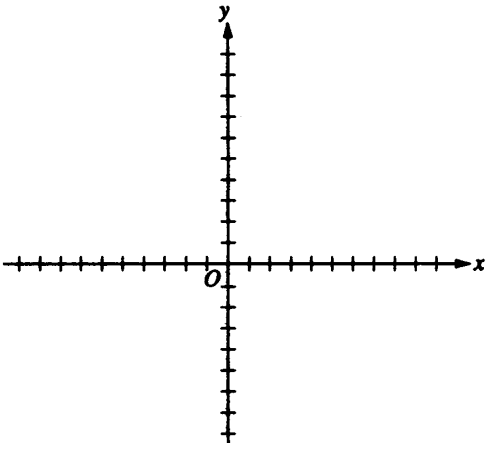
iii. On the axes below, draw and label vectors to show the electric fields E_1 and E_2 due to each charge, and also indicate the resultant electric field E at the origin.



b. Calculate the electric potential V at the origin.

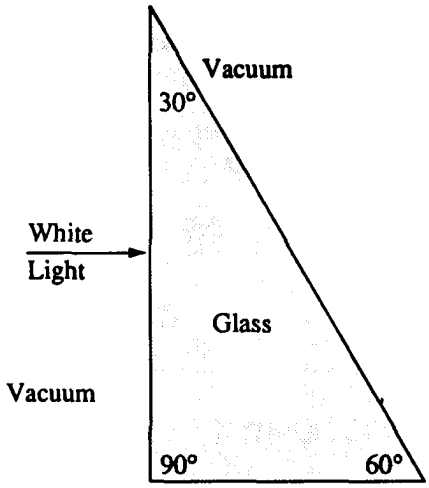
A charge Q_3 = -4 x 10^{-6} coulomb is brought from a very distant point by an external force and placed at the origin.

c. On the axes below, indicate the direction of the force on Q_3 at the origin.



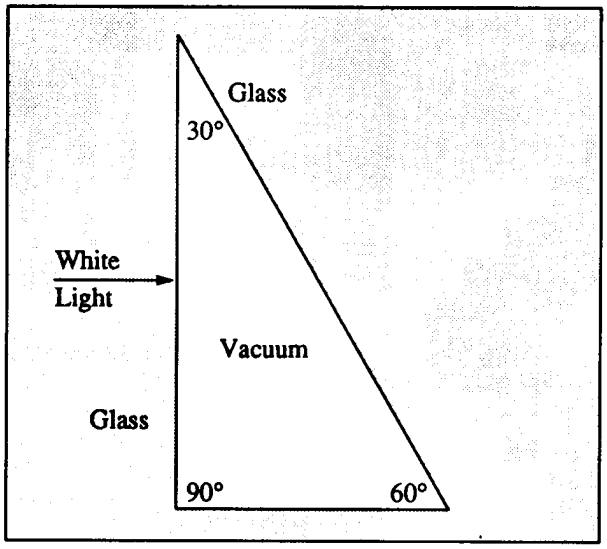
d. Calculate the work that had to be done by the external force to bring Q_3 to the origin from the distant point.

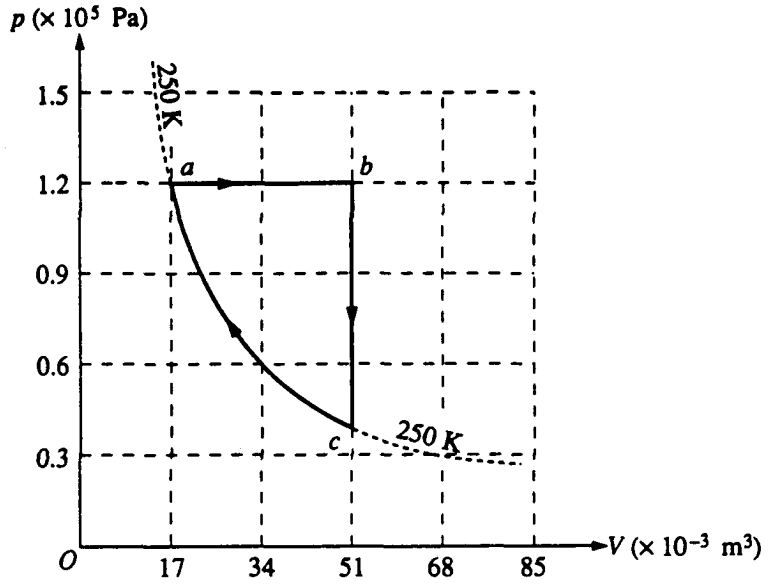
	Wavelength in Vacuum	Index of Refraction of Glass
Red Light	700 nm	1.5
Blue Light	480 nm	1.6



3. The glass prism shown above has an index of refraction that depends on the wavelength of the light that enters it. The index of refraction is 1.50 for red light of wavelength 700 nanometers (700 x 10^{-9} meter) in vacuum and 1.60 for blue light of wavelength 480 nanometers in vacuum. A beam of white light is incident from the left, perpendicular to the first surface, as shown in the figure, and is dispersed by the prism into its spectral components.

a. Determine the speed of the blue light in the glass.
b. Determine the wavelength of the red light in the glass.
c. Determine the frequency of the red light in the glass.
d. On the figure above, sketch the approximate paths of both the red and the blue rays as they pass through the glass and back out into the vacuum. Ignore any reflected light. It is not necessary to calculate any angles, but do clearly show the change in direction of the rays, if any, at each surface and be sure to distinguish carefully any differences between the paths of the red and the blue beams.
e. The figure below represents a wedge-shaped hollow space in a large piece of the type of glass described above. On this figure, sketch the approximate path of the red and the blue rays as they pass through the hollow prism and back into the glass. Again, ignore any reflected light, clearly show changes in direction, if any, where refraction occurs, and carefully distinguish any differences in the two paths.



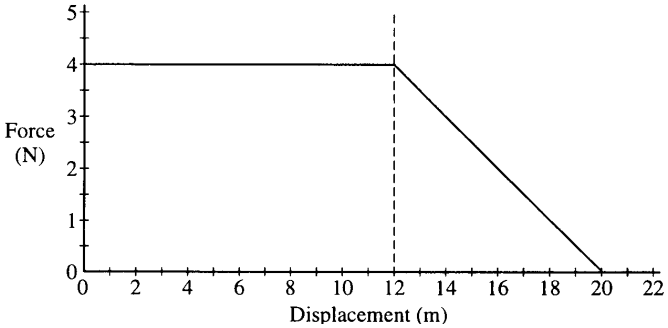


4. One mole of an ideal monatomic gas is taken through the cycle abca shown on the diagram above. State a has volume $V_a = 17 \times 10^{-3}$ cubic meter and pressure $P_a = 1.2 \times 10^5$ pascals, and state c has volume $V_c = 51 \times 10^{-3}$ cubic meter. Process ca lies along the 250 K isotherm. The molar heat capacities for the gas are $C_p = 20.8$ J/mole K, and $C_v = 12.5$ J/mole K. Determine each of the following.

a. The temperature T_b of state b
b. The heat Q_{ab} added to the gas during process ab
c. The change in internal energy $U_b - U_a$
d. The work W_{bc} done by the gas on its surroundings during process bc

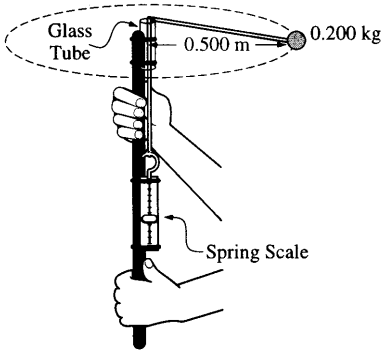
The net heat added to the gas for the entire cycle 1,800 joules. Determine each of the following.

e. The net work done by the gas on its surroundings for the entire cycle
f. The efficiency of a Carnot engine that operates between the maximum and minimum temperatures in this cycle



5. A 0.20 kg object moves along a straight line. The net force acting on the object varies with the object's displacement as shown in the graph above. The object starts from rest at displacement x = 0 and time t = 0 and is displaced a distance of 20 m. Determine each of the following.

a. The acceleration of the particle when its displacement x is 6 m.
b. The time taken for the object to be displaced the first 12 m.
c. The amount of work done by the net force in displacing the object the first 12 m.
d. The speed of the object at displacement x = 12 m.
e. The final speed of the object at displacement x = 20 m.
f. The change in the momentum of the object as it is displaced from x = 12 m to x = 20 m



Not Necessarily To Scale

6. To study circular motion, two students use the hand-held device shown above, which consists of a rod on which a spring scale is attached. A polished glass tube attached at the top serves as a guide for a light cord attached the spring scale. A ball of mass 0.200 kg is attached to the other end of the cord. One student swings the teal around at constant speed in a horizontal circle with a radius of 0.500 m. Assume friction and air resistance al negligible.

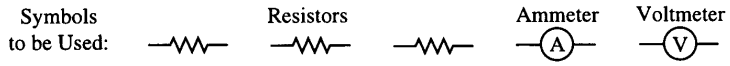
a. Explain how the students, by using a timer and the information given above, can determine the speed of the ball as it is revolving.
b. How much work is done by the cord in one revolution? Explain how you arrived at your answer.
c. The speed of the ball is determined to be 3.7 m/s. Assuming that the cord is horizontal as it swings, calculate the expected tension in the cord.
d. The actual tension in the cord as measured by the spring scale is 5.8 N. What is the percent difference between this measured value of the tension and the value calculated in part c. ?
e. The students find that, despite their best efforts, they cannot swing the ball so that the cord remains exactly horizontal.
   i. On the picture of the ball below, draw vectors to represent the forces acting on the ball and identify the force that each vector represents.

   ii. Explain why it is not possible for the ball to swing so that the cord remains exactly horizontal.
   iii. Calculate the angle that the cord makes with the horizontal.

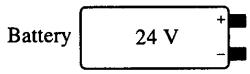
7. Three identical resistors, each of resistance 30 Ω are connected in a circuit to heat water in a glass beaker. 24 V battery with negligible internal resistance provides the power.

a. The three resistors may be connected in series or in parallel.
   i. If they are connected in series, what power is developed in the circuit?
   ii. If they are connected in parallel, what power is developed in the circuit?

b. Using the battery and one or more of the resistors, design a circuit that will heat the water at the fastest rat when the resistor(s) are placed in the water. Include an ammeter to measure the current in the circuit and a voltmeter to measure the total potential difference of the circuit. Assume the wires are insulated and have no resistance. Draw a diagram of the circuit in the box below, using the following symbols to represent the components in your diagram.



Draw your diagram in this box only.



c. The resistor(s) in the circuit in part (b) are now immersed in a 0.5 kg sample of water, which is initially at 298 K. The specific heat of water is 4,200 J/kg.K. Assume that all of the heat produced is absorbed by the water.
   i. Calculate the amount of time it takes for the water to begin to boil.
   ii. Under actual experimental conditions, would the time taken for the water to boil be longer or shorter than the calculated time in part (c) i ? Justify your answer.

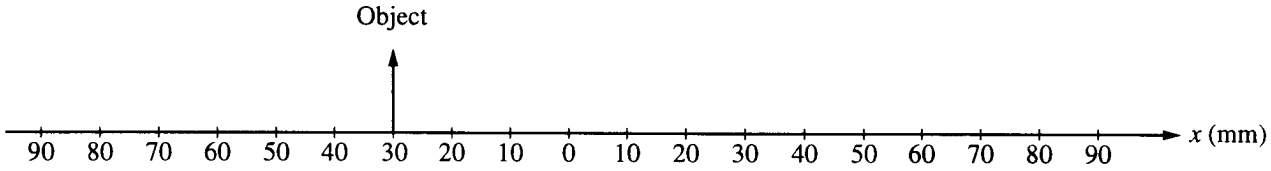
d. As the circuit continues to provide energy to the water, vapor is formed at the same temperature as the boiling water. Where has the energy used to boil the water gone?

8. An object is placed 30 mm in front of a lens. An image of the object is located 90 mm behind the lens.

a. Is the lens converging or diverging? Explain your reasoning.

b. What is the focal length of the lens?

c. On the axis below, draw the lens at position x = 0. Draw at least two rays and locate the image to show the situation described above.



d. Based on your diagram in (c), describe the image by answering the following questions in the blank spaces provided.

Is the image real or virtual?_____

Is the image smaller than, larger than, or same size as the object? _____

Is the image inverted or upright compared to the object? _____

e. The lens is replaced by a concave mirror of focal length 20 mm. On the axis below, draw the mirror at position x = 0 so that a real image is formed. Draw at least two rays and locate the image to show this situation