1. Three astronauts leave Cape Canaveral, go to the moon and back, and splash down in the Pacific Ocean. An Admiral bids them goodby at the Cape and then sails to the Pacific Ocean in an aircraft carrier where he picks them up. For their respective journeys do the astronauts or the Admiral have the larger displacement?
2. Can two vectors of different magnitude be combined to give a zero resultant? Can three vectors?
3. Can a vector have zero magnitude if one of its components is not zero?
4. Does it make any sense to call a quantity a vector when its magnitude is zero?
5. If three vectors add up to zero, they must all be in the same plane. Make this plausible.
6. Does a unit vector have units?
7. Name several scalar quantities. Is the value of a scalar quantity dependent on the coordinate system chosen?
8. We can order events in time. For example, event b may precede event c but follow event a, giving us a time order of events a, b, c. Hence there is a sense of time, distinguishing past, present, and future. Is time a vector therefore? If not, why not?
9. Do the commutative and associative laws apply to vector subtraction?
10. Can a scalar product be a negative quantity?
11. (*a*) If $\mathbf{a} \cdot \mathbf{b} = 0$, does it follow that **a** and **b** are perpendicular to one another? (*b*) If $\mathbf{a} \cdot \mathbf{b} = \mathbf{a} \cdot \mathbf{c}$, does it necessarily follow that **b** equals **c**?
12. If $\mathbf{a} \times \mathbf{b} = 0$, must **a** and **b** be parallel to each other? Is the converse true?
13. (*a*) Show that if all of the components of a vector are reversed in direction, then the vector itself is reversed in direction. (*b*) Show that if the compo-

nents of a vector product are all reversed, then the vector product is not changed. (*c*) Is a vector product, then, a vector?

14. Thus far we have discussed addition, subtraction, and multiplication of vectors. Why do you suppose that we do not discuss the division of vectors? Is it possible to define such an operation?
15. Must you specify a coordinate system when you (*a*) add two vectors, (*b*) form their scalar product, (*c*) form their vector product, (*d*) find their components?
16. It is conventional to use the right hand in rules for vector algebra. What changes would be required if a left-hand convention were adopted instead?

2. Each second a rabbit moves half the remaining distance from his nose to a head of lettuce. Does he ever get to the lettuce? What is the limiting value of his average velocity? Draw graphs showing his velocity and position as time increases.
3. Average speed can mean the magnitude of the average velocity vector. Another meaning given to it is that average speed is the total length of path traveled divided by the elapsed time. Are these meanings different? If so, give an example.
4. When the velocity is constant, does the average velocity over any time interval differ from the instantaneous velocity at any instant?
5. Is the average velocity of a particle moving along the x-axis $\frac{1}{2}(v_{x0}+v_x)$ when the acceleration is not uniform? Prove your answer with the use of graphs.
6. Does the speedometer on an automobile register speed as we defined it?
7. (*a*) Can a body have zero velocity and still be accelerating? (*b*) Can a body have a constant speed and still have a varying velocity? (*c*) Can a body have a constant velocity and still have a varying speed?
8. Can an object have an eastward velocity while experiencing a westward acceleration?
9. Can the direction of the velocity of a body change when its acceleration is constant?
10. Can a body be increasing in speed as its acceleration decreases? Explain.
11. Of the following situations, which one is impossible? (*a*) A body having velocity east and acceleration east; (*b*) a body having velocity east and acceleration west; (*c*) a body having zero velocity but acceleration not zero; (*d*) a body having constant acceleration and variable velocity; (*e*) a body having constant velocity and variable acceleration.
12. If a particle is released from rest ($v_{y0}=0$) at $y_0=0$ at the time $t=0$, Eq. 3-17 for constant acceleration says that it is at position y at two different times,

3. A block of mass m is supported by a cord C from the ceiling, and another cord D is attached to the bottom of the block (Fig. 5-10). Explain this: If you give a sudden jerk to D, it will break, but if you pull on D steadily, C will break.

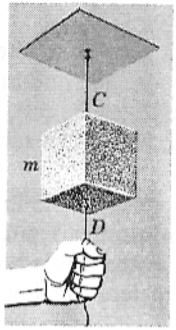

figure 5-10
Question 3

4. A horse is urged to pull a wagon. The horse refuses to try, citing Newton's third law as his defense: "'The pull of the horse on the wagon is equal but opposite to the pull of the wagon on the horse.' If I can never exert a greater force on the wagon than it exerts on me, how can I ever start the wagon moving?" asks the horse. How would you reply?
5. Comment on whether the following pairs of forces are examples of action-reaction: (*a*) the earth attracts a brick; the brick attracts the earth; (*b*) a propellered airplane pulls air in toward the plane; the air pushes the plane forward; (*c*) a horse pulls forward on a cart, accelerating it; the cart pulls backward on the horse; (*d*) a horse pulls forward on a cart without moving it; the cart pulls back on the horse; (*e*) a horse pulls forward on a cart without moving it; the earth exerts an equal and opposite force on the cart.
6. Criticize the statement, often made, that the mass of a body is a measure of the "quantity of matter" in it.
7. Using force, length, and time as fundamental quantities, what are the dimensions of mass?
8. Is the definition of mass that we have given limited to objects initially at rest?
9. Comment on the following statements about mass and weight taken from examination papers. (*a*) Mass and weight are the same physical quantities expressed in different units; (*b*) mass is a property of one object alone whereas weight results from the interaction of two objects; (*c*) the weight of an object is proportional to its mass; (*d*) the mass of a body varies with changes in its local weight.
10. A horizontal force acts on a mass which is free to move. Can it produce an acceleration if the force is less than the weight of that mass?
11. Does the acceleration of a freely falling body depend upon the weight of the body?
12. A bird alights on a stretched telegraph wire. Does this change the tension in the wire? If so, by an amount less than, equal to, or greater than the weight of the bird?
13. In Fig. 5-11, we show four forces which are about equal in magnitude. What combination of three forces, acting together on the same body, might keep that body in translational equilibrium?

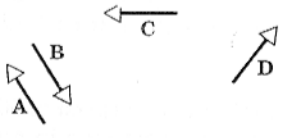

figure 5-11
Question 13

14. Why do raindrops fall with constant speed during the later stages of their descent?
15. In a tug of war, three men pull on a rope to the left at A and three men pull to the right at B with forces of equal magnitude. Now a weight of 5.0 lb is hung vertically from the center of the rope. (*a*) Can the men get the rope AB to be horizontal? (*b*) If not, explain. If so, determine the magnitude of the forces required at A and B to do this.
16. Both the following statements are true; explain them. Two teams having a tug of war must always pull equally hard on one another. The team that pushes harder against the ground wins.

17. A massless rope is strung over a frictionless pulley. A monkey holds onto one end of the rope and a mirror, having the same weight as the monkey, is attached to the other end of the rope at the monkey's level. Can the monkey get away from his image seen in the mirror (*a*) by climbing up the rope, (*b*) by climbing down the rope, (*c*) by releasing the rope?
18. Two objects of equal mass rest on opposite pans of a trip scale. Does the scale remain balanced when it is accelerated up or down in an elevator?
19. You stand on the large platform of a spring scale and note your weight. You then take a step on this platform and notice that the scale reads less than your weight at the beginning of the step and more than your weight at the end of the step. Explain.
20. A weight is hung by a cord from the ceiling of an elevator. From the following conditions, choose the one in which the tension in the cord will be greatest . . . least? (*a*) elevator at rest; (*b*) elevator rising with uniform speed; (*c*) elevator descending with decreasing speed; (*d*) elevator descending with increasing speed.
21. A woman stands on a spring scale in an elevator. In which case below will the scale record the minimum reading . . . the maximum reading? (*a*) elevator stationary; (*b*) elevator cable breaks, free fall; (*c*) elevator accelerating upward; (*d*) elevator accelerating downward; (*e*) elevator moving at constant velocity.