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For united for the solution of the second for the solution of the second for the solution of the second for the shown in Figs. 3.9 (a), (b) and (c), respectively. Note that the graph curves upward for positive acceleration; downward for negative acceleration and it is a straight line for zero acceleration. As an exercise, identify in Fig. 3.3. the regions of the curve that correspond to these three cases.

> Although acceleration can vary with time, our study in this chapter will be restricted to motion with constant acceleration. In this case, the average acceleration equals the constant value of acceleration during the interval. If the velocity of an object is  $v_i$  at t = 0 and v at time t, we have



(a) positive acceleration; (b) negative acceleration, and (c) zero acceleration.

Let us see how velocity-time graph looks like for some simple cases. Fig. 3.10 shows velocitytime graph for motion with constant acceleration for the following cases :

(a) An object is moving in a positive direction with a positive acceleration, for example the motion of the car in Fig. 3.3 between t = 0 s and t = 10 s.

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- (b) An object is moving in positive direction with a negative acceleration, for example, motion of the car in Fig 3.3 between *t* = 18 s and 20 s.
- (c) An object is moving in negative direction with a negative acceleration, for example the motion of a car moving from O in Fig. 3.1 in negative x-direction with increasing speed.
- (d) An object is moving in positive direction till time  $t_1$ , and then turns back with the same negative acceleration, for example the motion of a car from point O to point Q in Fig. 3.1 till time  $t_1$  with decreasing speed and turning back and moving with the same negative acceleration.

An interesting feature of a velocity-time graph for any moving object is that **the area under the** curve represents the displacement over a given time interval. A general proof of this



Fig. 3.10 Velocity-time graph for motions with constant acceleration. (a) Motion in positive direction with positive acceleration. (b) Motion in positive direction with negative acceleration, (c) Motion in negative direction with negative acceleration, (d) Motion of an object with negative acceleration that changes direction at time  $t_i$ . Between times 0 to  $t_i$ , its moves in positive x - direction and between  $t_1$  and  $t_{o}$  it moves in the opposite direction.