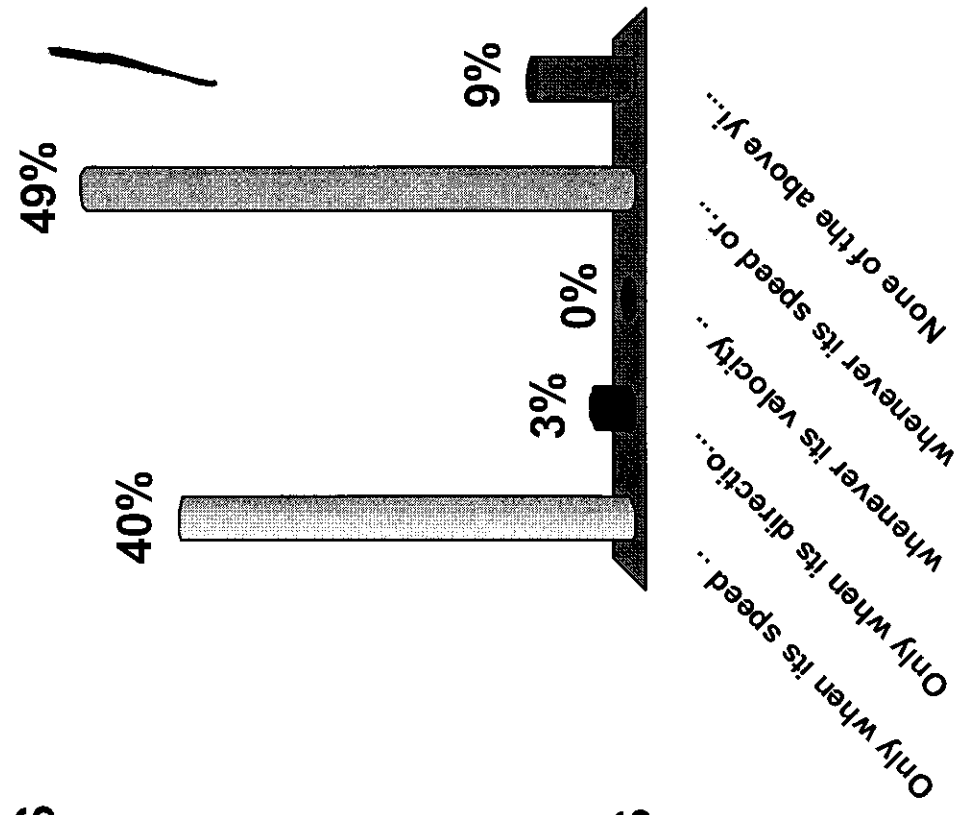


# An object is accelerating (i.e. has $a \neq 0$ ):

1. Only when its speed is changing.
2. Only when its direction is changing.
3. whenever its velocity is very large.
4. whenever its speed or direction is changing.
5. None of the above yields a true statement.



The correct answer is 4: An object is accelerating (i.e. has  $\mathbf{a} \neq 0$ ):

4. whenever its speed or direction is changing.

Recall the definition of instantaneous acceleration:

$\mathbf{a}(t) = \left| \frac{\Delta \mathbf{v}}{\Delta t} \right|$  ( $= \left| \mathbf{v}_f - \mathbf{v}_i \right| / \Delta t$ , with  $\Delta t$  very small), and recall that  $\mathbf{a}$  and  $\mathbf{v}$  are vectors.

Then if the speed is changing,  $\left| \mathbf{v}_f - \mathbf{v}_i \right| \neq 0$  and  $\mathbf{a}$  is clearly  $\neq 0$ .

But if the direction changes, then also  $\left| \mathbf{v}_f - \mathbf{v}_i \right| \neq 0$ , because for vectors  $\left| \mathbf{v}_f - \mathbf{v}_i \right| = 0$  if and only if  $\mathbf{v}_f$  and  $\mathbf{v}_i$  are the same in both magnitude AND direction.

Therefore a change in either speed or direction, or both, implies that  $\mathbf{a} \neq 0$ .