21.4: Hand-Waving Explanation of the Ponderomotive Force

Let's look again at the vertically stable pendulum—the quiver force has sufficient frequency that although the quivering motion is of small amplitude, it drives the pendulum to the vertical position. To see what's going on, we'll replace the oscillating force with a series of discrete impulses of alternating sign. Remember, the impulse on the pendulum will be in a vertical direction, but the pendulum is constrained to move along the circular arc. Therefore, the impulse it feels is the component along this path. If it is away from the vertical, the greater its deviation the greater the effective impulse, so as it quivers back and forth it feels greater drive pushing it back up towards the vertical, since it feels that impulse when it's further down. If it does feel a downward impulse at its low point, that will set it up for a greater upward impulse as it goes down.

This can also be understood for a charged particle in an oscillating electromagnetic field in terms of radiation pressure. Where the oscillating field is more intense, there is more radiation pressure, so the particle will be driven by the pressure imbalance towards the regions where the field is weakest.