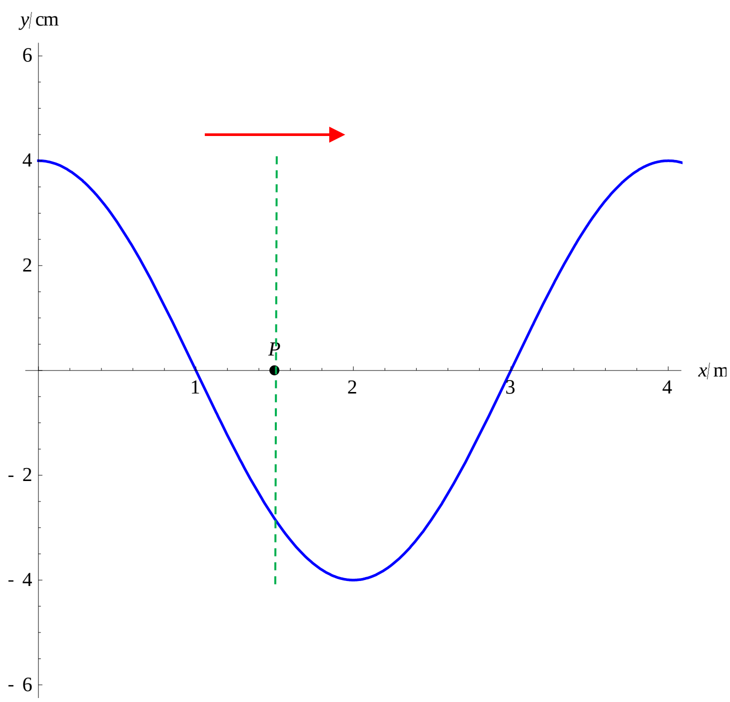
Teacher notes
Topic C

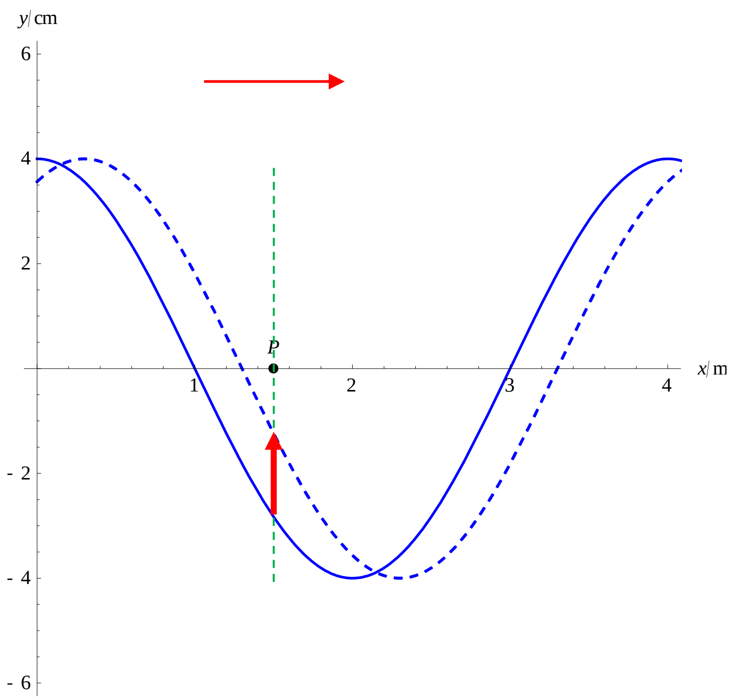
A wave travels through a medium. How do the medium particles move?

This is a common question in exams appearing practically every time.

Consider first a **transverse** wave travelling to the right. The graph of displacement versus position is shown. A medium particle P has been marked. This is the equilibrium position of the particle. Since the wave is transverse the medium particles will travel at right angles to the direction of energy transfer, i.e. up or down in this case. P can only move along the dotted line shown below.



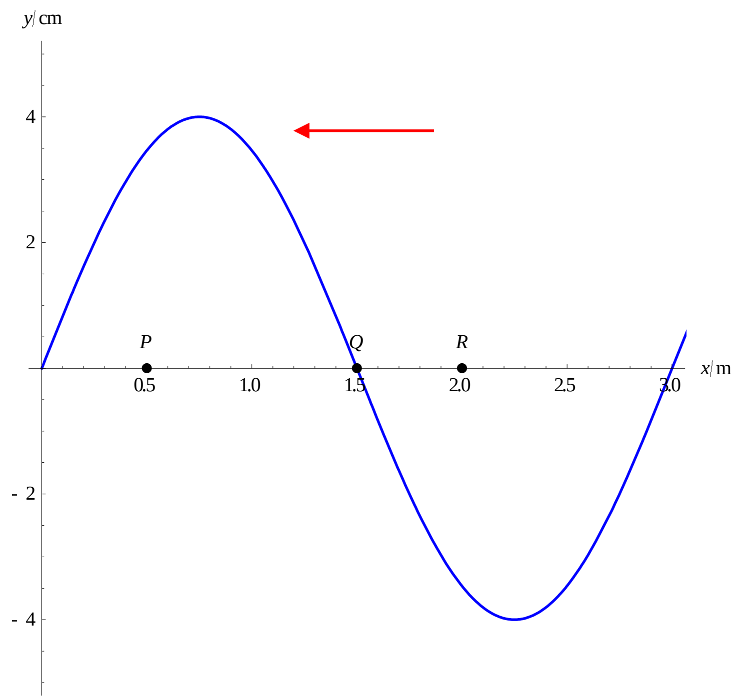
At t = 0, the position of P is about 3 cm lower than its equilibrium position (zero) because the graph says that the displacement is about y = –3 cm. So where is P in the next instant of time? The easiest way to answer the question is to “copy and paste” the original graph of displacement versus time shifted forward a little bit (forward because the wave is going to the right). This is shown with a dashed curve. The new displacement of P is where the dotted green line intersects the blue dotted curve.



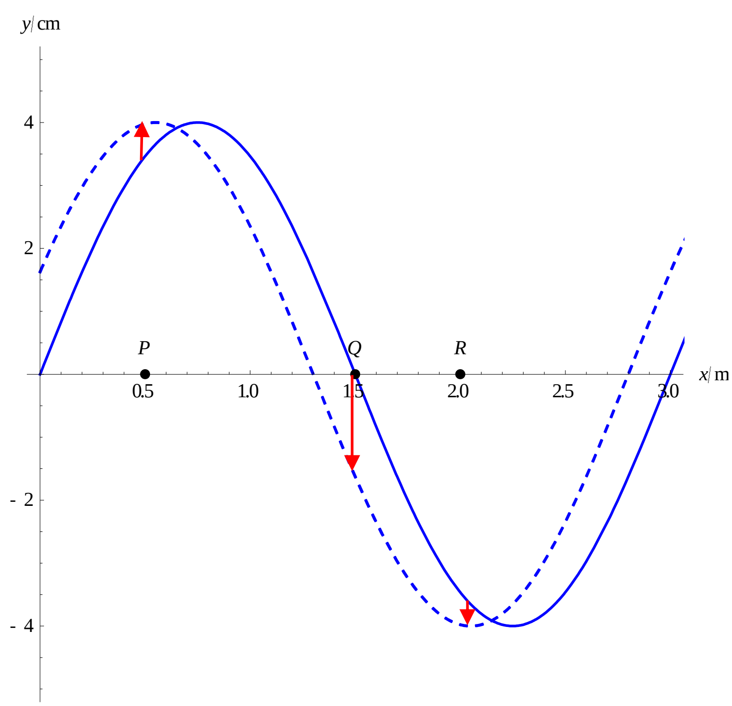
The displacement of P changed from $y = -3$ cm to about $y = -2.5$ cm. This means the particle is moving upward, as also shown by the red arrow.

These questions can be extended to ask about the direction of velocity of medium particles. In this example particle P moved upward. Hence at the time the original graph was taken the direction of velocity of P was up.

Check yourself: for the transverse wave travelling to the *left* find the positions of P, Q and R in the next instant of time.



After an instant the wave is shown by the dotted line:



This means: P moved up and Q and R moved down.

We now go to **longitudinal** waves. This is more complicated. Since the wave is longitudinal, medium particles can only move in the direction of energy transfer or opposite to it. I.e. right or left in the case of a wave travelling to the right or left.

The diagram shows how the displacement varies with distance for a longitudinal wave travelling to the right. *Positive displacements mean motion to the right*. Point P is a point in the medium. The diagram shows the **equilibrium** position of this particle (at *x* = 2 m). This is where this particle would be if there were no wave in the medium. But now we have a wave and according to the graph the displacement of P is about – 3.2 cm. In other words, the actual position of P at this instant is 3.2 cm to *the left* of *x* = 2 m.

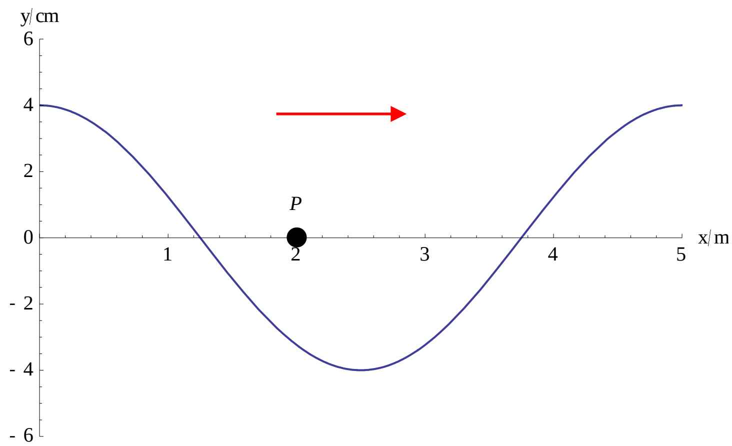


Figure 1

An instant later the wave has moved forward (dashed line).

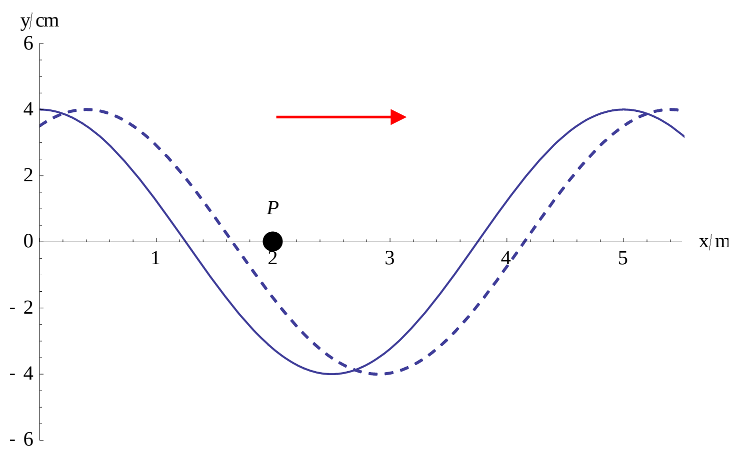
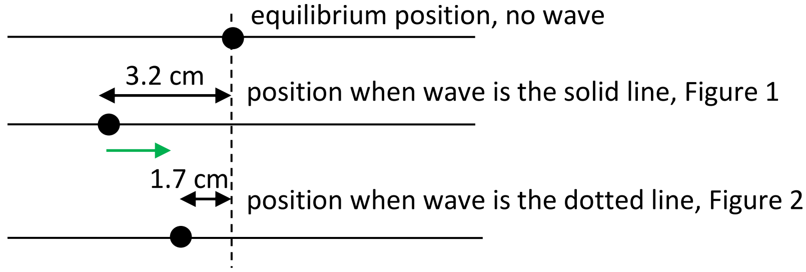


Figure 2

We see that displacement of P is now less negative: it is – 1.7 cm. So P moved from a position of –3.2 cm to the left of *x* = 2 m to a position of –1.7 cm to the left of *x* = 2 m. This means it moved to the right.



Alternatively, draw the vector showing the change in displacement (green vector). It points towards the positive displacements: P moved to the right.