Unit 11: Waves – Activity 1

Understanding Motion of a Particle in a Wave

Objective 1.1

You will learn to interpret individual particle motion in a wave.

Materials: one simulation panel (Fig. 1.1) and a mobile device installed with metronome app

Activity 1.1

Together with your partner, simulate the periodic motion of a single particle in a transverse wave that has a period of T= 12 s and an amplitude of A = 12 cm using a simulation panel and metronome.

You must complete at least one oscillation of a particle in a wave with a period of T = 12 s i.e. the particle completed a full cycle of its oscillation in 12 s.

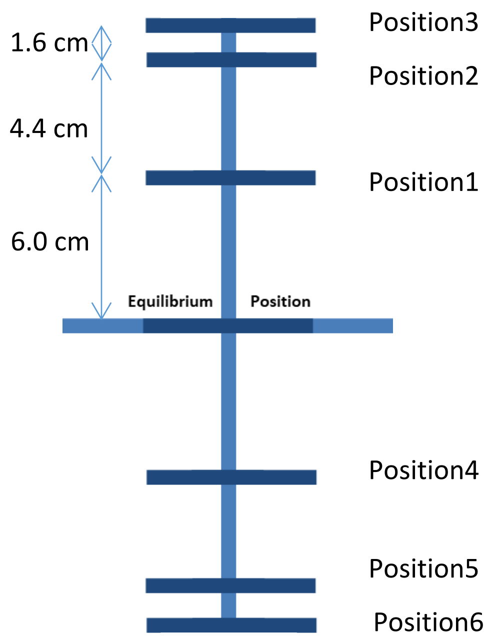


Fig. 1.1. Particle positions

Looking closer at the motion of a particle in a wave you just simulated, it took 1 s for the particle to move from equilibrium position to position 1 over a distance of 6 cm.

Then the particle took 1s to move from position 1 to position 2 over a distance of 4.4 cm.

Finally, the particle took 1s to move from position 2 to position 3 over a distance of 1.6 cm.

<u>Questions</u>

In the study of General Wave Properties, displacement of a single particle refers to distance of the particle from its equilibrium position.

1. Explain how displacement is measured on the simulation panel.

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

2. Explain how the term "*displacement*" is defined differently in the periodic motion of a single particle compared with the way it is introduced and used in Kinematics.

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

3. Explain how the simulation demonstrates the periodic motion of a single particle.

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

4. State and explain the limitations of the simulation.

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

5. By convention, displacement above equilibrium position is taken as positive.

Complete **Table 1.2** and plot the displacement against time of a particle motion for one complete oscillation from t = 0 s to t = 12 s.

Indicate the direction of motion for each time (↑ or ↓).

time / s	displacement / cm	direction of motion (↑ or ↓)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Table 1.2

6. Explain why time is recorded in whole number in Table 1.2 and not in decimal place.

………………………………………………………………………………………………

………………………………………………………………………………………………

7. Plot the displacement against time graph of a single particle motion for one complete oscillation from t = 0 s to t = 12 s in **Fig. 1.3.**

Indicate clearly the direction of motion for each displacement (↑ or ↓) beside each data point.

Draw a smooth curve to join the points.

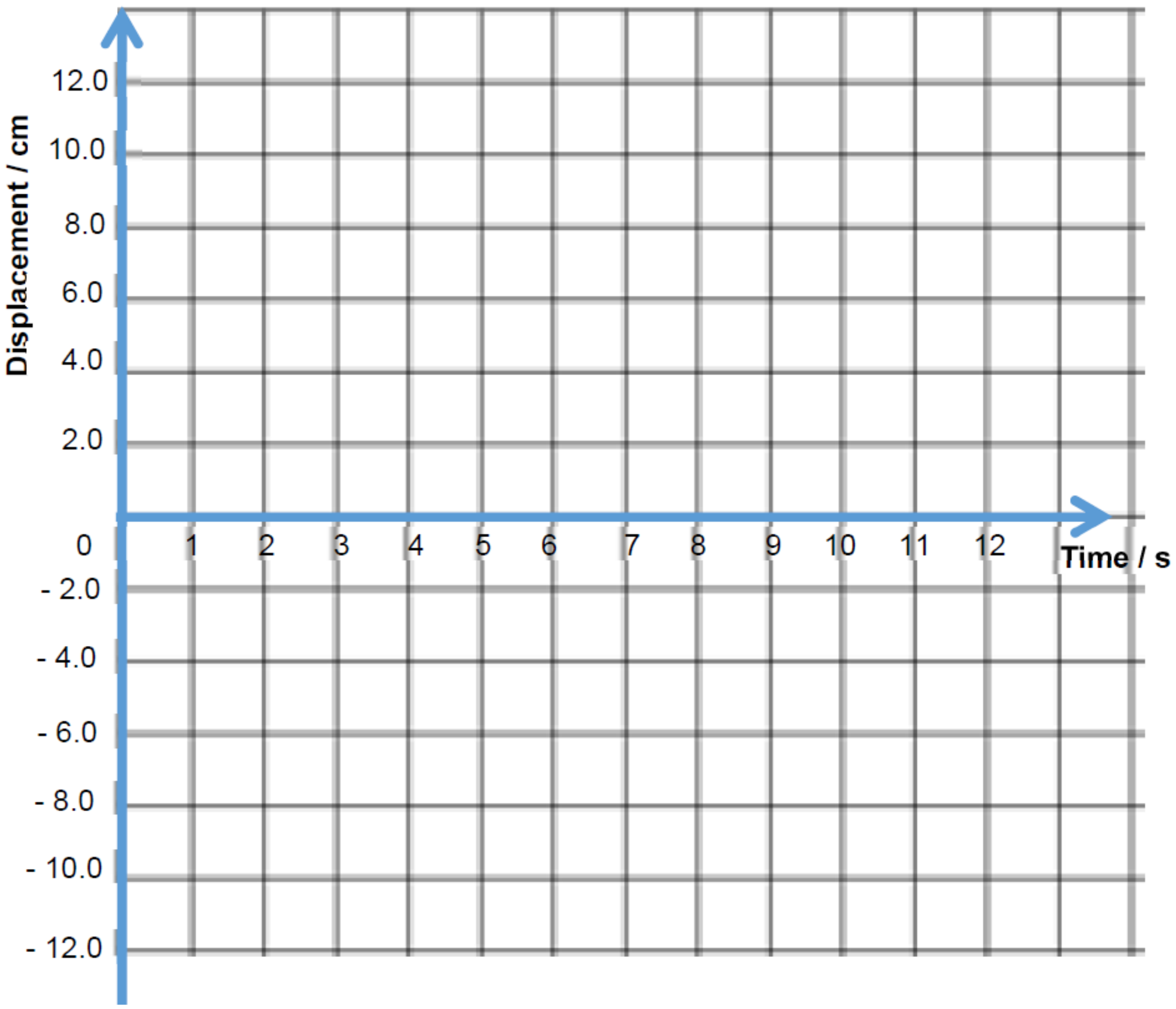


Fig. 1.3 Displacement-time graph of a particle motion in a wave

8. Calculate the average speed of the particle between the positions and complete **Table 1.4.**

positions	length between positions /cm	time taken to travel / s	average speed between positions / cm/s
between equilibrium position and position 1	6.0	1	
between position 1 and position 2	4.4	1	
between position 2 and position 3	1.6	1	

Table 1.4

a. State the position of the particle where the instantaneous speed is the fastest.

……………………………………………………………………………………………

b. Based on data collected in the table above, describe the changes in the speed of the particle from the equilibrium position to position 3.

……………………………………………………………………………………………

c. Based on data collected in the table above, describe the changes in the speed of the particle from position 3 to the equilibrium position.

……………………………………………………………………………………………

d. Describe the changes in the speed of the particle from the equilibrium position to position 6 and back to the equilibrium position.

……………………………………………………………………………………………

……………………………………………………………………………………………

e. State the two positions of the particle where the instantaneous speed is the slowest.

……………………………………………………………………………………………

Understanding Particle Motion in a Wave Using Displacement-Time Graph

Objective 1.2

You will learn to interpret single particle motion in a wave using displacement-time graph.

Activity 1.2

The displacement-time graph shown in **Fig. 1.5** is derived from plotting the displacement against time of a particle motion for one complete oscillation in Activity 1.1 from t = 0 s to t = 12 s.

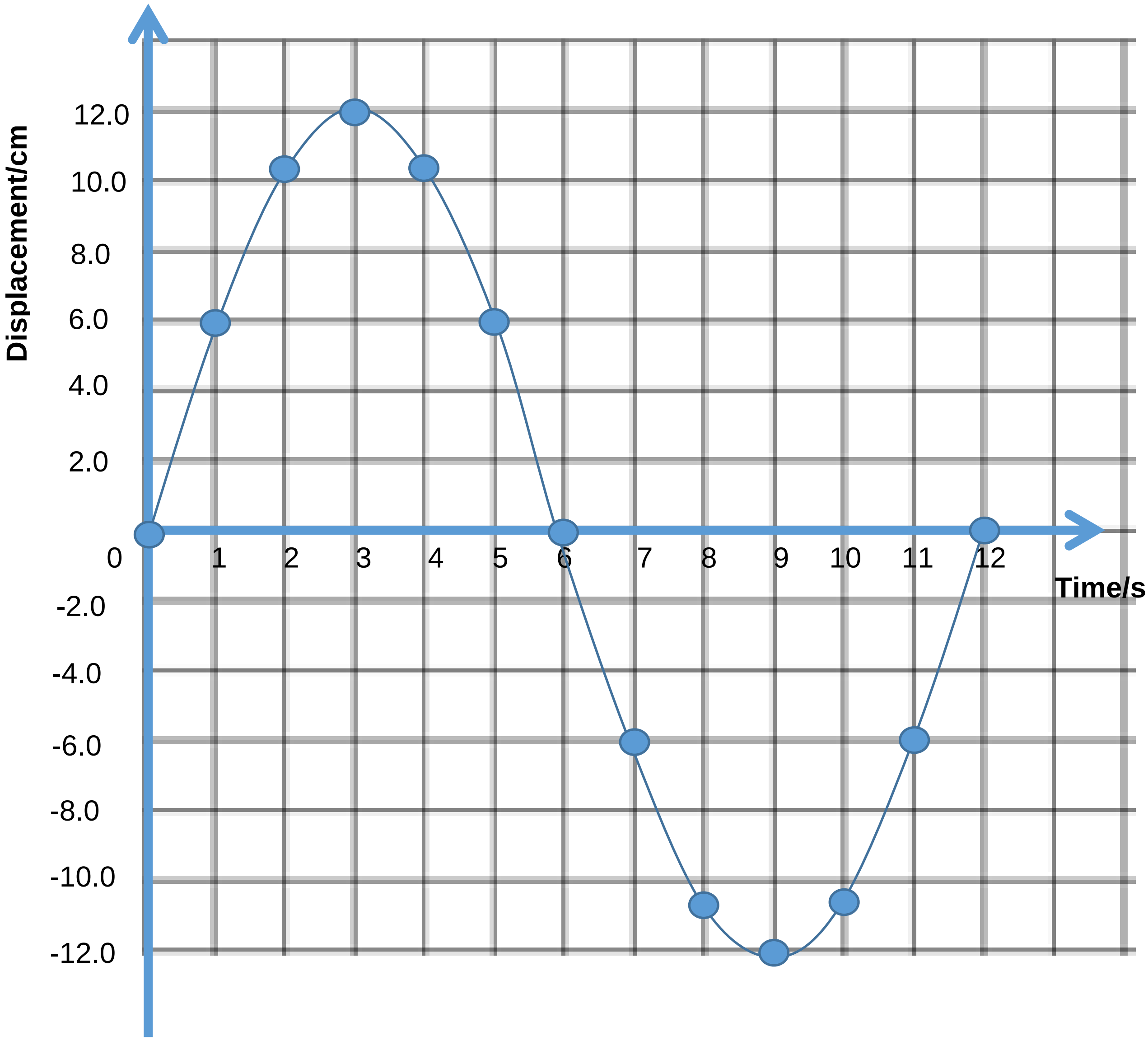


Fig. 1.5. Displacement-time graph of a particle motion in a wave

Questions

2. State and explain the two instants or times in **Fig. 1.5** where the instantaneous speed of the particle is zero.

State : times where instantaneous speed is zero are t = …………… s and

t = …………… s

Explain : ……………………………………………………………………………………..

………………………………………………………………………………………………

3. State and explain the three instants or times in **Fig. 1.5** where the instantaneous speed of the particle is maximum.

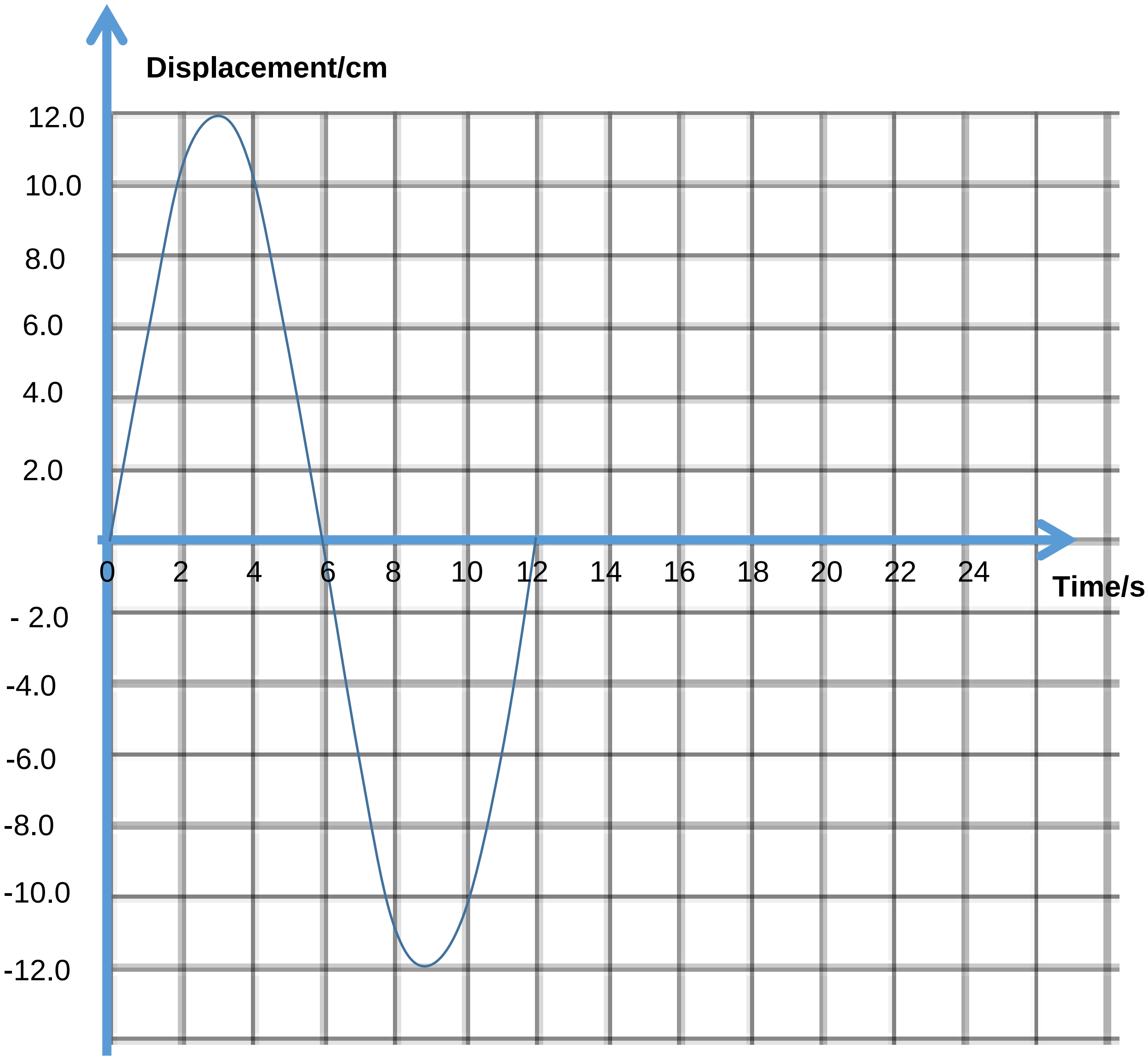
State : times where instantaneous speed is maximum are t = …………… s,

t = …………… s and t = …………… s

Explain : ……………………………………..……………………………………………

………………………………………………………………………………………………

5. Complete the displacement-time graph of the single particle motion from **t = 12 s to t = 24 s** using the grid below.



End of Activity 1

Activity 3 (Optional)

From time t = 12 s to t = 24 s, one student will monitor one complete wave motion of a particle, the other student monitors how far a crest has moved.

1. Explain the relationship between the average speed of a single particle motion and the speed of wave motion ($v = \lambda f$).

   ……………………………………………………………………………………………………

   ……………………………………………………………………………………………………

   ……………………………………………………………………………………………………

   ……………………………………………………………………………………………………