

**Topic 19: Exercises on Harder 3 Unit Simple Harmonic Motion**  
**Level 3**

1. A particle moves in a straight line with simple harmonic motion. At distances  $x_1$  and  $x_2$  from the centre of the motion its speeds are  $v_1$  and  $v_2$  respectively. Show that

(a) its amplitude is  $\sqrt{\frac{x_2^2 v_1^2 - x_1^2 v_2^2}{v_1^2 - v_2^2}}$

(b) its period is  $2\pi \cdot \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$ .

2. On a certain day, the depth of water in a harbour at high tide at 5 *am* is 9 *m*. At the following low tide at 11.20 *am* the depth is 3 *m*. Assuming that the tidal motion is simple harmonic, find the latest time before noon that a ship can enter the harbour if a minimum depth of 7.5 *m* of water is required.

7.06 *am*

3. On a certain day, low water for a harbour occurs at 3.30 *am* and high water at 9.45 *am*, the corresponding depths of water being 5 *m* and 15 *m*. Find between what times during the morning a ship drawing 12.5 *m* of water can safely enter the harbour.

between 7.40 *am* and 11.50 *am*

4. The depth of water in a harbour is  $7.2\text{ m}$  at low water and  $13.6\text{ m}$  at high water. On Monday, low water is at  $2.05\text{ pm}$  and high water at  $8.20\text{ pm}$ . The captain of the ship drawing  $12.3\text{ m}$  of water wants to leave harbour as early on Monday afternoon as he can. Find his earliest leaving time on Wednesday if he fails to leave on Monday or Tuesday.

$7.59\text{ am}$