Oscillations Supplementary Questions

Study Guide 22

Part 1 - Simple Harmonic Motion: Displacement, Velocity and Acceleration

1. An object is set into simple harmonic motion of period 2.00 seconds and amplitude 20.0 cm. Initially, the object is released from rest and then begins its oscillations. Determine the displacement of the object from its equilibrium position at:
   i) $t = 0$ s;
   ii) $t = 0.25$ s;
   iii) $t = 0.50$ s;
   iv) $t = 1.00$ s.

2. A body oscillates vertically in simple harmonic motion with an amplitude of 40 mm and a frequency of 4 Hz. Calculate the acceleration of the body at:
   i) the extremities of the motion;
   ii) the equilibrium position;
   iii) 20 mm from the equilibrium position.

3. An object oscillates with simple harmonic motion described by the equation $x = 1.8 \cos (4\pi t)$. For this body, determine:
   i) the amplitude of oscillations;
   ii) the frequency of oscillations;
   iii) the time period for one oscillation;
   iv) the maximum speed experienced during oscillations;
   v) the maximum acceleration experienced during oscillations.

4. A body oscillates in simple harmonic motion with an amplitude of 2.5 cm and a period of 0.25 s. Determine:
   i) the frequency of oscillations;
   ii) the maximum acceleration of the body;
   iii) the maximum speed of the body.

5. In order to test how well pilots can recognise objects when seated in a juddering helicopter they are subjected to vibrations of frequency from 1 Hz to 45 Hz. If a pilot is being tested with vibrations of frequency 40 Hz and amplitude 0.50 mm, determine the pilot's:
   i) maximum speed;
   ii) maximum acceleration.

6. A 3.0 V10 formula one engine had a rev limit of 20,000 revolutions per minute and pistons that moved approximately in simple harmonic motion with a amplitude of 1.25 cm. For such a piston, which has a mass of 0.20 kg, determine:
   i) the frequency of oscillations;
   ii) the maximum speed experienced during oscillations;
   iii) the maximum acceleration experienced during oscillations;
   iv) the force required to produce such a maximal acceleration.

7. A short pendulum oscillates with SHM such that its acceleration a is related to its displacement x by the equation a = - 300 x. Determine the frequency of oscillations for such a pendulum.

8. A loudspeaker produces musical notes by oscillating a diaphragm. If the amplitude of oscillations of the diaphragm is limited to 1.6×10^{-3} mm, what range of frequencies would result in an acceleration of the diaphragm exceeding 9.81 m/s^2?

9*. A sewing machine needle moves up and down with simple harmonic motion. If the total vertical motion of the tip of the needle is 15 mm and it makes 25 stitches in 6 seconds, what is the maximum speed of the tip of the needle.

10*. Some sand is sprinkled on a horizontal membrane which vibrates vertically with simple harmonic motion. The amplitude is gradually increased to 0.10 cm when the sand just fails to make continuous contact with the membrane. Calculate the frequency of vibration.

11*. A dock has a tidal entrance at which the water is 10 m deep at 12pm, the time at which the tide is at its lowest. The water is 30 m deep when the tide is at its highest, which follows at 6:15pm. A container ship, requiring a minimum depth of 17.5 m, needs to enter the dock as soon as possible that afternoon. Calculate the earliest time the ship could just clear the entrance to the dock.

Answers - Oscillations Supplementary Questions

Part 1

1.	i)	0.2 m	ii)	0.141 m	iii)	0 m	iv)	-0.2 m
2.	i)	25.3 m/s^2	ii)	0 m/s^2	iii)	12.6 m/s^2		
3.	i)	1.8 m	ii)	2 Hz	iii)	0.5 s	iv)	22.6 m/s
	v)	284 m/s^2						
4.	i)	4 Hz	ii)	15.8 m/s^2	iii)	0.628 m/s		
5.	i)	0.126 m/s	ii)	31.6 m/s^2				
6.	i)	333.3 Hz	ii)	26.2 m/s	iii)	54,800 m/s^2	iv)	11,000 N

7. 2.76 Hz

8. 394 Hz

9*. 0.196 m/s

10*. 15.8 Hz

11*. 2:37 pm