

Physics 206
Assignment 1
(Try Q2, Q4, and any other eight)

1. A body of mass 5 kg is suspended by a spring, which stretches 0.1 m when the body is attached. It is then displaced downward as additional 0.05m and released. Find the amplitude, period, and frequency of the resulting Simple Harmonic Motion.
 (ans: $A=0.05$ m, $T=0.635$ s, $f=1.57$ Hz)



- 2(a) A spring is mounted as shown in the figure. By attaching a spring balance to the free end and pulling sideways, we determine that the force is proportional to the displacement, a force of 4.0 N causing a displacement of 0.02 m. We attach a 2 kg body to the end, pull it aside a distance of 0.04 m and released. Find the force constant of the spring.
 (ans: 200 N/m)

- 2(b) Find the frequency of vibration.
 (ans: $f=1.59$ Hz, angular frequency $\rightarrow \omega=2\pi f=10$ rad /s).

- 2(c) Compute the maximum velocity attained by the vibrating body.
 (ans: ± 0.4 m/s).

- 2(d) Compute the maximum acceleration.
 (ans: ± 4.0 m/s²)

- 2(e) Compute the velocity and acceleration when the body has moved halfway in towards the centre from its initial position.
 (ans: $v= -0.35$ m/s, $a= -2.0$ m/s²)

- 2(f) How much time is required for the body to move halfway into the centre from its initial position?
 ans: ($\pi/30$ s, or 0.11S).

3. The system in Q.2 is given an initial displacement of 0.05 m and initial velocity of 2m/s. Find the amplitude, the phase angle, and the total energy of the motion, and with an equation for the position as a function of time. (ans: $A=0.206$ m, $\theta_0=-76^\circ = -1.33$ rad, $E=4.25$ J, $x=(0.206) \cos\{(10)t-1.33 \text{ rad}\}$)

- 4(a) A certain string has a linear mass density of 0.25 kg/m and is stretched with a tension of 25 N. One end is given a sinusoidal motion with frequency 5 Hz and amplitude 0.01m. At time $t=0$, the end has zero displacement and is moving in the positive y-direction. Find the wave speed, amplitude, angular frequency, period, wavelength, and wave number.
 (ans: $v=10$ m/s, $A=0.01$ m, $\omega=31.4$ rad/s, $T=0.2$ s, $\lambda=2.0$ m, $k=3.14$ /m).

- 4(b) Write the wave function describing the wave.
 (ans: $(0.01\text{m}) \sin\{31.4 t-3.14 x\}$).

- 4(c) Find the position of the point at $x= 0.25$ m, and $t= 0.1$ s.
 (ans 0.00707 m).

- 4(d) Find the transverse velocity of the point, $x=0.25$ m at time $t=0.1$ s.
 (ans: -0.22 m/s.

- 4(e) Find the slope of the string at the point $x=0.25$ m at time $t=0.1$ s.
 (ans: 0.022).

5. It is 16m from crest to crest in a system of waves. If 20 waves pass a given point each minute, find the speed of waves.
 (ans: 5.33 m/s)

6. If the displacement along a wave is given by $y=0.05 \sin (20\pi t-0.1\pi x)$, where distances are in meters, and times in seconds, what are the amplitude, frequency, wavelength, and speed of the wave motion?
 (ans: $A=0.05$ m, $f=10$ Hz, $\lambda=20$ m, $v=200$ m/s)

7. The displacement of a particle in centimetres is given by $y=8 \sin (2\pi ft)$. If $f=20$ Hz, find the displacement and the velocity of the particle at a time $t=0.01$ s and 0.07 s.
(ans: $y=7.61$ cm, $v=3.11$ m/s, $y=4.70$ cm, $v=-8.13$ m/s)
8. The speed of sound in water is 1500 m/s. A sound wave from an underwater explosion approaches the surface at an angle of incidence of 60° . What is the angle of refraction in air? (speed of sound in air=340m/s)
(ans: 11.3°)
9. A set of circular ripples is produced on the surface of a pond by throwing a stone into water. At a certain instant, the first crest is 4 m from the point where the stone hit the water, and the fourth crest is 70cm from the same point. What is the wavelength of the disturbance?
(ans: 1.1 m)
10. Standing waves are produced in a stretched rope. If the distance between successive nodes is 0.04m, what is the wavelength? If the wave travels with a speed of 84m/s, what is the frequency?
(ans: $\lambda=0.08$ m, $f=1050$ Hz)
11. When a sound wave is transferred from one medium to another, its frequency does not change. If the wavelength of a disturbance is 17cm in air, find its wavelength in water, steel, and brass if the speed of sound in water is 1450m/s, in steel 5000m/s, in brass 3500m/s, and in air 340 m/s.
(ans: 0.725 m, 2.5 m, 1.75 m).
12. One end of a stretched rope is given a periodic transverse motion with a frequency of 10Hz. The rope is 50 m long, and has mass of 0.5 kg, and is stretched with a tension of 400 N. (a) Find the wave speed and the wavelength. (b) If the tension is doubled, how much the frequency be changed to maintain the same wavelength?
(ans: (a) 200 m/s, 20 m, (b) Increase by $2^{1/2}$)
13. The equation of a certain traveling transverse wave is $y = 200 \sin 2\pi \left(\frac{t}{0.01} - \frac{x}{30} \right)$, where x and y are in centimetres and t is in seconds. What are (a) the amplitude, (b) the wavelength, (c) the frequency, and (d) the speed of propagation of the wave?
ans: (a) 200 cm, (b) 30.0 cm, (c) 100 Hz, (d) 3000 cm/s).
14. A steel wire 6 m long has a mass of 60 g and is stretched with a tension of 1000 N. What is the speed of propagation of a transverse wave in the wire?
(ans: 316 m/s)
15. The speed of sound in water is about 1480 m/s. Find the frequency of a sound wave such that its wavelength in water is the same as the wavelength in air at 20° C of a sound wave of frequency 1000 Hz. The speed of sound at 0° C is 331.4 m/s.
(ans: 4311 Hz)
16. A sinusoidal wave on a string is described by the equation: $y = (0.15\text{m}) \sin(10 \pi t - 3 \pi x + \pi/4)$, where x is in meters and t in seconds. If the mass per unit length of this string is 12.0 g/m, determine (a) the speed of the wave, (b) the wavelength, (c) the frequency, and (d) the power transmitted to the wave.
(ans: 3.33m/s, 0.667 m, 5.0 Hz, 0.444W)
17. (a) Determine the speed of transverse waves on a string under tension of 80.0 N if the string has a length of 2.00 m and a mass of 5.00 g. (b) Calculate the power required to generate these waves if they have a wavelength of 16.0 cm, and amplitude of 4.00 cm.
(ans: 179 m/s, 17.7 kW)