

SIMPLE HARMONIC MOTION WORKSHEET 2

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1. A body oscillates vertically in simple harmonic motion with an amplitude of 30 mm and a frequency of 5 Hz. Calculate the acceleration of the particle :
- at the extremities of the motion,
 - at the centre of the motion,
 - at a position midway between the centre and an extremity.

2. The piston in a particular car engine moves in approximately *simple harmonic motion* with an amplitude of 8 cm. The mass of the piston is 0.8 kg and the piston makes 100 oscillations per second. Calculate :
- the maximum value of the acceleration of the piston,
 - the force needed to produce this acceleration.

3. A mass of 0.2 kg is attached to the lower end of a light helical spring and produces an extension of 5.0 cm. Calculate :
- the force constant of the spring.

The mass is now pulled a further distance of 2.0 cm and released.

Calculate :

- the periodic time of subsequent oscillations
- the maximum value of the acceleration during the motion.

[Assume that the acceleration due to gravity $g = 10 \text{ m s}^{-2}$]

4. A body vibrates in *simple harmonic motion* with an amplitude of 30 mm and a frequency of 0.50 Hz.
- Calculate :
 - the maximum acceleration,
 - the maximum velocity,
 - the magnitude of the acceleration and velocity when the body is displaced 10 mm from its equilibrium position.
 - State the values of the constants A (in m) and ω (in rad s^{-1}) in the equation $y = A \sin \omega t$ which describes the motion of the body.

5. A body of mass 0.10 kg oscillates in *simple harmonic motion* with an amplitude of 5.0 cm and a frequency of 0.50 Hz.

- Calculate :
 - the maximum value of its kinetic energy and
 - the minimum value of its kinetic energy

- (b) State where the the body has the maximum and minimum values of the kinetic energy calculated in (a)(i) and (a)(ii) respectively.
6. One model for the hydrogen chloride molecule describes it as a positively charged hydrogen atom linked by a *springy bond* to a negatively charged chlorine atom. This model is shown in Figure 1

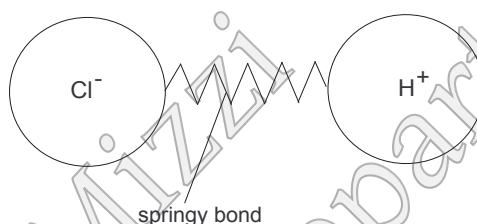


Figure 1: A model for the hydrogen chloride molecule

The mass of the chlorine atom is in fact much larger than that of the hydrogen atom so that the chlorine atom may be considered to be fixed as the hydrogen atom oscillates about a fixed position.

- (a) Explain what can be said about the magnitude and the direction of the net force on the hydrogen atom if the oscillations are assumed to be simple harmonic.
- (b) The frequency of oscillations of the hydrogen atom is 8.8×10^{13} Hz. The mass of the hydrogen atom is 1.67×10^{-27} kg. Calculate the force per unit extension, k , of the *springy bond*.
7. A mass oscillates in simple harmonic motion on one end of a spring of force constant 40 N m^{-1} . If the amplitude of the motion is 30 mm, calculate the maximum kinetic energy of the mass.
8. A spring rests on a frictionless, horizontal surface. One end of the spring is attached to the a fixed point. A mass of 0.15 kg is attached to the other end. After the mass is gently displaced through a distance of 0.02 m from its equilibrium position O and released, it oscillates in simple harmonic motion with a period of 4 s. Determine;
- (a) the velocity and acceleration of the mass when it is 0.015 m away from O,
- (b) the shortest time it takes to travel from one point 0.01 m from one side of O to another point which is also 0.01 m from O but on the opposite side,
- (c) the total energy of the system.
9. A particle of mass 0.10 g moves in simple harmonic motion. At time $t = 0.0$ s, the particle is at its maximum positive displacement of 10.0 mm from the equilibrium point. It next returns to this position when 2.0 s later. Calculate :
- (a) the angular frequency,

- (b) the maximum velocity,
- (c) the maximum kinetic energy.

10. Figure 2 shows a 0.30-kg mass which is tethered by two identical springs of force constant 2.5 N m^{-1} .

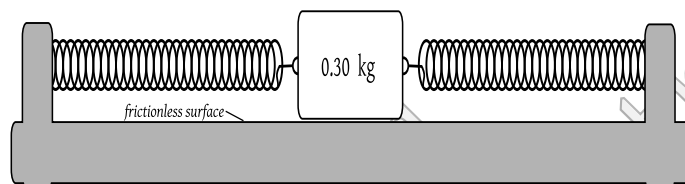


Figure 2: A mass tethered by two identical springs

If the mass is now displaced by 20 mm to the left of its equilibrium position and released, calculate :

- (a) the periodic time and the frequency of subsequent oscillations,
- (b) the acceleration at the centre and extremities of the oscillation.