TUTORIAL CHAPTER 4 – OSCILLATORY MOTIONS

1. The sun subtends an angle of about 0.5º to us on the Earth, 150 million km away. What is the radius of the sun?

2. Calculate the angular velocity of

   (a) the second hand,

   (b) the minute hand,

   (c) the hour hand of a clock.

   (d) State in *rad/s*, what is the angular acceleration in each case.

3. A child rolls a ball on a level floor 4.5 m to another child. If the ball makes 15.0 revolutions, what is its diameter?

4. A bicycle with 68-cm diameter tries travels 7.0 km. How many revolutions do the wheels make?

5. An elastic cord is 65 cm long when a weight of 55 N hangs from it and is 85 cm long when a weight of 80 N hangs from it. What is the "spring" constant of this elastic cord?

6. A small fly of mass 0.15 g is caught in a spider's web. The web vibrates predominately with frequency of 4.0 Hz.

   (a) What is the value of the effective spring constant k for the web?

   (b) At what frequency would you expect the web to vibrate if an insect of mass 0.50 g were trapped.

7. A 0.50 kg mass at the end of a spring vibrates 3.0 times per second with an amplitude of 0.15 m. Determine

   (a) the velocity when it passes the equilibrium point

   (b) the velocity when it is 0.10 m from equilibrium

   (c) the total energy of the system

   (d) the equation describing the motion of the mass, assuming that at $t = 0$, x was maximum.

8. A mass of 1.62 kg stretches a vertical spring 0.315 m. If the spring is stretched an additional 0.130 m and released, how long does it take to reach the (new) equilibrium position again?

9. A mass sitting on a horizontal, frictionless surface is attached to one end of a spring; the other end is fixed to a wall. 3.0 J of work is required to compress the spring by 0.12 m. If the mass is released from rest with the spring compressed, it experiences a maximum acceleration of 15 m/s^2. Find the value of

   (a) the spring constant

   (b) the mass.

10. A spring of force constant 210 N/m vibrates with an amplitude of 28.0 cm when 0.250 kg hangs from it.

    (a) What is the equation describing this motion as a function of time? Assume that the mass passes through the equilibrium point with positive velocity at $t = 0$.

    (b) At what times will the spring have its maximum and minimum extension?

11. A 25.0 g bullet strikes a 0.600 kg block attached to a fixed horizontal spring whose spring constant is 6.70×10^3 N/m and sets it into vibration with an amplitude of 21.5 cm. What was the speed of the bullet before impact if the two objects move together after impact?

12. (a) At what displacement from equilibrium is the energy of a SHO half KE and half PE?

    (b) At what displacement from equilibrium is the speed half the maximum value?

13. A bungee jumper with mass 65.0 kg jumps from a high bridge. After reaching his lowest point, he oscillates up and down, hitting a low point eight more times in 34.7 s. He finally comes to rest 25.0 m below the level of the bridge. Calculate the spring constant and the unstretched length of the bungee cord.

14. The length of a simple pendulum is 0.66 m, the pendulum bob has a mass of 310 grams, and it is released at an angle of 12º to the vertical.

    (a) With what frequency does it vibrate? Assume SHM.

    (b) What is the pendulum bob's speed when it passes through the lowest point of the swing?

    (c) What is the total energy stored in this oscillation, assuming no losses?

15. Derive a formula for the maximum speed v_o of a simple pendulum bob in terms of g, the length L, and the angle of swing θ_o.

Answers:

1. $R_{Sun} = 6.5 \times 10^5$ km

2. (*a*) 0.105 rad/s. (*b*) 1.75×10^{-3} rad/s. (*c*) 1.45×10^{-4} rad/s.

    (*d*) For each case, the angular velocity is constant, so the angular acceleration is zero.

3. $D = 9.5$ cm.

4. $N = 3.3 \times 10^3$ revolutions.

5. $k = 1.3 \times 10^2$ N/m.

6. (*a*) $k =$ 9.5×10^{-2} N/m. (*b*) $f_2 =$ 2.2 Hz.

7. (*a*) $v_0 = 2.8$ m/s. (*b*) $v = 2.1$ m/s. (*c*) E = 2.0 J.

(*d*) $x = (0.15\text{ m})\cos[2\pi\,(3.0\text{ Hz})t]$.

8. $t = 0.282$ s.

9. (*a*) $k = 4.2 \times 10^2$ N/m. (*b*) $m = 3.3$ kg.

10. (*a*) $x = (0.280\text{ m})\sin[(29.0\text{ s}^{-1})t]$.

(*b*) It will take one-quarter period to reach the maximum extension, so the spring will have maximum extensions at 0.0542 s, 0.271 s, 0.488 s, … .

It will take three-quarters period to reach the minimum extension, so the spring will have minimum extensions at 0.163 s, 0.379 s, 0.596 s, … .

11. $v = 557$ m/s.

12. (*a*) $x = 0.707A$. (*b*) $x = 0.866A$.

13. $k = 136$ N/m. $L = 20.3$ m.

14. (*a*) $f = 0.61$ Hz. (*b*) $v_0 = 0.53$ m/s. (c) $\text{PE}_\text{i} = mgh = 0.044$ J.

15. $v_0 = \theta_o(gL)^{1/2}$