

# PHYSICS – problem solving exercises

## 7a. Gravitational force

**Notes:** air friction is neglected in all cases, magnitude of free fall acceleration is  $10 \text{ m/s}^2$

### **Problem 1:**

Two particles at a distance  $r$  are attracted by a gravitational force with a magnitude of  $4 \text{ mN}$ . What is the magnitude of the gravitational force, if the distance is (a)  $2r$ , (b)  $r/2$ , and (c)  $r/3$ ?

### **Problem 2:**

Calculate a distance from an Earth's surface where a magnitude of the gravitational acceleration is a half of its value at the Earth's surface. The Earth's radius is  $6370 \text{ km}$ .

**Problem 3:**

Two particles of different masses  $m_1$  and  $m_2$  are originally at a distance  $r$ . How does change the magnitude of the gravitational force, if the masses and distance change to (a)  $2m_1, m_2/4, r/2$ , and (b)  $m_1, 100m_2, 5r$ ?

## 7b. Harmonic oscillations

**Problem 4:**

A 5 kg block on a spring oscillates with a frequency 45 cycles per minute. Calculate the spring constant of the spring.

**Problem 5:**

A simple pendulum of a length  $L = 150$  cm is swinging with a frequency 125 cycles per 300 s. Calculate the magnitude of the gravitational acceleration.

**Problem 6:**

A block on a spring oscillates with a period of 5 s. What is a mass of the block if the spring constant is 9.5 N/m?

**Problem 7:**

How is necessary to change the length of the cord of a single pendulum to obtain a twice as big frequency of swinging?

**Problem 8:**

Hanging of a block of mass on a spring leads to elongation of the spring by 2.5 cm. What is the frequency of this oscillator?

**Problem 9:**

A block of mass on a spring oscillates with a period of 0.5 s. How does the spring shorten after removing the block?

**Problem 10:**

A simple pendulum is swinging with a period of 10 s. What is the length of a cord?

**Problem 11:**

An object undergoing simple harmonic motion takes 0.25 s to travel from one point of zero velocity to the next such point. The distance between those points is 36 cm. Calculate the (a) period, (b) frequency, and (c) amplitude of the motion.

**Problem 12:**

A 0.12 kg body undergoes simple harmonic motion of amplitude 8.5 cm and period 0.20 s. (a) What is the magnitude of the maximum force acting on it? (b) If the oscillations are produced by a spring, what is the spring constant?

**Problem 13:**

A linear harmonic oscillator undergoes an harmonic motion with an amplitude of 15.0 cm and a frequency of 30 Hz. What is (a) the maximal speed and (b) the maximal acceleration adopted by the oscillator?

**Problem 14:**

A 3 kg harmonic oscillator has at a certain instant a kinetic energy of 17 J and a potential energy of 10 J. What is the speed of the oscillator when it goes through an equilibrium point?

**Problem 15:**

What is the maximum acceleration of a platform that oscillates at amplitude 2.20 cm and frequency 6.60 Hz?

**Problem 16:**

A 200 g mass is attached to a spring and undergoes simple harmonic motion with a period of 0.250 s. The total energy of the system is 2.00 J. Find (a) the force constant of the spring and (b) the amplitude of the motion.

**Problem 17:**

A particle moves in simple harmonic motion with a frequency of 3.00 oscillations per second and an amplitude of 5.00 cm. (a) Through what total distance does the particle move during one cycle of its motion? (b) What is its maximum speed? Where does this occur? (c) Find the maximum acceleration of the particle. Where in the motion does the maximum acceleration occur?