

Harmonic oscillator – additional tasks

1. Calculate the amplitude and initial phase of the harmonic motion performed by a material point along a straight line if at time $t = 0$ the point's deflection is $x=0.05\text{m}$ and its velocity $V=0.2\text{ m/s}$. The frequency of the oscillation is $f=1\text{ [Hz]}$.
2. A wooden plank placed in the horizontal plane performs harmonic vibrations in the horizontal direction with period $T = 5\text{s}$. A body lying freely on the board begins to slide when the amplitude of the vibration reaches the value $x_0=0.5\text{ m}$. What is the coefficient of friction between this body and the plank?
3. For an oscillator subjected to a damping force proportional to its velocity:
 - A) the displacement is a sinusoidal function of time
 - B) the velocity is a sinusoidal function of time
 - C) the frequency is a decreasing function of time
 - D) the mechanical energy is constant
 - E) none of the above is true
4. The period of a simple pendulum is 1 s on Earth. When brought to a planet where g is one-tenth that on Earth, its period becomes:
A) 1 s B) $\frac{1}{\sqrt{10}}\text{ s}$ C) $1/10\text{ s}$ D) $\sqrt{10}\text{ s}$ E) 10 s
5. Three physical pendulums, with masses m_1 , $m_2 = 2m_1$, and $m_3 = 3m_1$, have the same shape and size and are suspended at the same point. Rank them according to their periods, from shortest to longest.
A) 1, 2, 3 B) 3, 2, 1 C) 2, 3, 1 D) 2, 1, 3 E) All the above are the same
6. In simple harmonic motion, the magnitude of the acceleration is:
 - A) constant
 - B) proportional to the displacement
 - C) inversely proportional to the displacement
 - D) greatest when the velocity is greatest
 - E) never greater than g
7. Three physical pendulums, with masses m_1 , $m_2 = 2m_1$, and $m_3 = 3m_1$, have the same shape and size and are suspended at the same point. Rank them according to their periods, from shortest to longest.
A) 1, 2, 3 B) 3, 2, 1 C) 2, 3, 1 D) 2, 1, 3 E) All the above are the same
8. Five hoops are each pivoted at a point on the rim and allowed to swing as physical pendulums. The masses and radii are
hoop 1: $M = 150\text{g}$ and $R = 50\text{ cm}$
hoop 2: $M = 200\text{g}$ and $R = 40\text{ cm}$
hoop 3: $M = 250\text{g}$ and $R = 30\text{ cm}$

hoop 4: $M = 300\text{g}$ and $R = 20\text{ cm}$

hoop 5: $M = 350\text{g}$ and $R = 10\text{ cm}$

9. Order the hoops according to the periods of their motions, smallest to largest.

A) 1, 2, 3, 4, 5 D) 1, 2, 5, 4, 3

B) 5, 4, 3, 2, 1 E) 5, 4, 1, 2, 3

C) 1, 2, 3, 5, 4

10. Two vibrating motions of equal amplitudes and initial phases with periods $T_1 = 3\text{s}$ and $T_2 = 3.1\text{ s}$ overlap to give the resultant motion. Determine the amplitude and period of the resultant harmonic motion obtained by superposition of the two oscillations.

11. Investigate the motion (determine amplitude, phase, angular frequency ect.) of a ball moving along a perpendicular tunnel passing through the center of the earth. We know that in the interior of the earth the force acting on the ball is directly proportional to its distance from the center of the earth and is directed toward the center of the earth. The initial velocity of the ball at the entrance to the channel is zero. The radius of the earth R is given. Calculate the time and velocity when the ball passes the center of the Earth.