Quiz No. 4

Student Name: **Group No.:**

Please Choose the Correct Answer

1) The wavelength of light visible to the human eye is on the order of 5×10^{-7} m. If the speed of light in air is 3×10^{8} m/s, find the frequency of the light wave.

a. 3×10^{7} Hz b. 4×10^{9} Hz c. 5×10^{11} Hz d. 6×10^{14} Hz e. 4×10^{15} Hz

2) The speed of a 10-kHz sound wave in seawater is approximately 1500 m/s. What is its wavelength in sea water?

a. 5.0 cm b. 10 cm c. 15 cm d. 20 cm e. 29 cm

3) If $y = 0.02 \sin(30x - 400t)$ (SI units), the wavelength of the wave is

a. $\pi/15$ m b. $15/\pi$ m c. 60π m d. 4.2 m e. 30 m

4) If $y = 0.02 \sin(30x - 400t)$ (SI units), the velocity of the wave is

a. 3/40 m/s b. 40/3 m/s c. $60\pi/400$ m/s d. $400/60\pi$ m/s e. 400 m/s

5) A restoring force of magnitude F acts on a system with a displacement of magnitude x. In which of the following cases will the system undergo simple harmonic motion?

A) $F \propto \sqrt{x}$ B) $F \propto \sin x$ C) $F \propto x^2$ D) $F \propto x$ E) $F \propto 1/x$

6) An object is executing simple harmonic motion. What is true about the acceleration of this object? (There may be more than one correct choice.)

A) The acceleration is a maximum when the displacement of the object is a maximum.
B) The acceleration is a maximum when the speed of the object is a maximum.
C) The acceleration is a maximum when the displacement of the object is zero.
D) The acceleration is zero when the speed of the object is a maximum.
E) The acceleration is a maximum when the object is instantaneously at rest.

7) In simple harmonic motion, the speed is greatest at that point in the cycle when

A) the magnitude of the acceleration is a maximum. B) the displacement is a maximum.
C) the magnitude of the acceleration is a minimum. D) the potential energy is a maximum.
E) the kinetic energy is a minimum.

8) If we double only the amplitude of a vibrating ideal mass-and-spring system, the mechanical energy of the system

A) increases by a factor of $\sqrt{2}$. B) increases by a factor of 2. C) increases by a factor of 3. D) increases by a factor of 4. E) does not change.

9) A sewing machine needle moves up and down in simple harmonic motion with an amplitude of 1.27 cm and a frequency of 2.55 Hz.

(a) What is the maximum speed of the needle?
(b) What is the maximum acceleration of the needle?

RE

Answer: (a) 0.203 m/s (b) $3.26\ m/s^2$

10) A simple harmonic oscillator has an amplitude of 3.50 cm and a maximum speed of 26.0 cm/s. What is its speed when the displacement is 1.75 cm?
A) 12.0 cm/s (B) 22.5 cm/s C) 14.2 cm/s D) 15.0 cm/s E) 17.0 cm/s

11) An object that weighs 2.450 N is attached to an ideal massless spring and undergoes simple harmonic oscillations with a period of 0.640 s. What is the spring constant of the spring?
A) 2.45 N/m B) 12.1 N/m (E) 24.1 N/m D) 0.102 N/m E) 0.610 N/m

12) A 0.25 kg ideal harmonic oscillator has a total mechanical energy of 4.0 J. If the oscillation amplitude is 20.0 cm, what is the oscillation frequency?
(A) 4.5 Hz B) 1.4 Hz C) 2.3 Hz D) 3.2 Hz

13) An object of mass 8.0 kg is attached to an ideal massless spring and allowed to hang in the Earth's gravitational field. The spring stretches 3.6 cm before it reaches its equilibrium position. If this system is allowed to oscillate, what will be its frequency?
(A) 2.6 Hz B) 0.0045 Hz C) 0.67 Hz D) 2.1 Hz

14) A 2.25-kg object is attached to a horizontal an ideal massless spring on a frictionless table. What should be the spring constant of this spring so that the maximum acceleration of the object will be g when it oscillates with amplitude of 4.50 cm? $K = 490\ N/m$

Answer:

15) An object of mass 6.8 kg is attached to an ideal massless spring of spring constant 1690 N/m and the amplitude is 33cm. The object is Calculate the maximum speed the object reaches during its motion.

Answer: $V_{max} = 5.2\ m/s$

"Sheet 4"

1 $f = \frac{c}{\lambda} = \frac{3 \times 10^8}{5 \times 10^{-7}} = \boxed{6 \times 10^{14}\ Hz}$

2 $\lambda = \frac{V}{f} = \frac{1500}{10 \times 10^3} = 0.15m = \boxed{15\ cm}$

3 $\because k = 30\ rad/m$

$$k = \frac{2\pi}{\lambda}$$

$$\therefore \lambda = \frac{2\pi}{k} = \frac{2\pi}{30} = \boxed{\frac{\pi}{15}\ m}$$

4 $k = 30\ rad/m \qquad w = 400\ rad/s$

$$\because k = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2\pi}{k} = \frac{2\pi}{30} = \frac{\pi}{15}$$

$$\because w = 2\pi f \Rightarrow f = \frac{w}{2\pi} = \frac{400}{2\pi} = \frac{200}{\pi}$$

$$\therefore V = \lambda f = \frac{\pi}{15} \times \frac{200}{\pi} = \boxed{\frac{40}{3}\ m/s}$$

[9] $A = 1.27\,cm = 1.27 \times 10^{-2}\,m$

$f = 2.55\,Hz$ (a) V_{max} (b) a_{max}

(a) $V_{max} = \omega A = (2\pi f) A$

$= (2\pi \times 2.55) \times (1.27 \times 10^{-2}) =$ **0.203 m/s**

(b) $a_{max} = \omega^2 A = (2\pi \times 2.55)^2 \times (1.27 \times 10^{-2}) =$ **3.26 m/s²**

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[10] $A = 3.5\,cm = 3.5 \times 10^{-2}\,m$, $V_{max} = 26 \times 10^{-2}\,m/s$

$V = ??$ at $X = 1.75 \times 10^{-2}\,m$

answer

$\because V_{max} = A\omega$

$\therefore \omega = \frac{V_{max}}{A} = \frac{26 \times 10^{-2}}{3.5 \times 10^{-2}} = 7.43$ rad/sec

$\because V = \omega \sqrt{A^2 - X^2} = 7.43 \sqrt{(3.5 \times 10^{-2})^2 - (1.75 \times 10^{-2})^2}$

$= 0.225\,m/s =$ **22.5 cm/s**

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[11] $W = mg = 2.45\,N$, $T = 0.64\,s$, $K = ??$

answer

$$m = \frac{W}{g} = \frac{2.45}{9.8} = 0.25 \text{ kg}$$

$$\because T = 2\pi\sqrt{\frac{m}{k}}$$

$$\therefore T^2 = 4\pi^2 \frac{m}{k}$$

$$\therefore k = \frac{4\pi^2 m}{T^2} = \frac{4\pi^2 \times (0.25)}{(0.64)^2} = \boxed{24.1 \text{ N/m}}$$

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12 $m = 0.25$ kg , $E = 4$ J , $A = 0.20$ m

$f = ??$

~ answer ~

$$\because E = \frac{1}{2} k A^2$$

$$\therefore k = \frac{2E}{A^2} = \frac{2 \times 4}{(0.2)^2} = 200 \text{ N/m}$$

$$\because W = \sqrt{\frac{k}{m}} = \sqrt{\frac{200}{0.25}} = 28.28 \text{ rad/s}$$

$$\therefore f = \frac{W}{2\pi} = \frac{28.28}{2\pi} = \boxed{4.5 \text{ Hz}}$$

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13 $m = 8$ kg , $X = 3.6$ cm $= 3.6 \times 10^{-2}$ m

$f = ?$

~ answer ~

$\therefore mg = kX$

$\therefore k = \frac{mg}{X} = \frac{8 \times 9.8}{3.6 \times 10^{-2}} = 2177.78 \text{ N/m}$

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{2177.78}{8}} = \boxed{2.6 \text{ Hz}}$

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14 $m = 2.25 \text{ kg}$, $k = ?$, $a_{max} = g$, $A = 4.5 \text{ cm}$

answer

$\therefore a_{max} = \omega^2 A \Rightarrow \omega^2 = \frac{a_{max}}{A} = \frac{9.8}{4.5 \times 10^{-2}} = 217.78$

$\therefore \omega^2 = \frac{k}{m} \Rightarrow k = m\omega^2 = 2.25 \times 217.78 = \boxed{490 \text{ N/m}}$

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15 $m = 6.8 \text{ kg}$, $k = 1690 \text{ N/m}$

$A = 33 \text{ cm} = 0.33 \text{ m}$, $V_{max} = ?$

answer

$V_{max} = A\omega = A\sqrt{\frac{k}{m}}$

$= 0.33\sqrt{\frac{1690}{6.8}} = \boxed{5.2 \text{ m/s}}$