شركة تدريب هندسي

E.CAMP

الطريق الدائري بجوار المدرسة المعمارية

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PHYSICS 1

Final - Revision 1

2021 - 2022 No.13

"Oscillatory Motion" (MCQ) هام جداً

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?

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 5

1. $f = \dfrac{c}{\lambda} = \dfrac{3\times10^{8}}{5\times10^{-7}} = \boxed{6\times10^{14}\ Hz}$

2. $\lambda = \dfrac{V}{f} = \dfrac{1500}{10\times10^{3}} = 0.15m = \boxed{15\ cm}$

3. $\because K = 30\ rad/m$

$K = \dfrac{2\pi}{\lambda}$

$\therefore \lambda = \dfrac{2\pi}{K} = \dfrac{2\pi}{30} = \boxed{\dfrac{\pi}{15}\ m}$

4. $K = 30\ rad/m \quad w = 400\ rad/s$

$\because K = \dfrac{2\pi}{\lambda} \Rightarrow \lambda = \dfrac{2\pi}{K} = \dfrac{2\pi}{30} = \dfrac{\pi}{15}$

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

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

9 $A = 1.27\,cm = 1.27\times10^{-2}\,m$

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

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

$= (2\pi \times 2.55)\times(1.27\times10^{-2}) = \boxed{0.203\,m/s}$

(b) $a_{max} = W^2A = (2\pi\times2.55)^2\times(1.27\times10^{-2}) = \boxed{3.26\,m/s^2}$

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10 $A = 3.5\,cm = 3.5\times10^{-2}\,m$, $V_{max} = 26\times10^{-2}\,m/s$

$V = ??$ at $X = 1.75\times10^{-2}\,m$

answer

$\because V_{max} = AW$

$\therefore W = \frac{V_{max}}{A} = \frac{26\times10^{-2}}{3.5\times10^{-2}} = 7.43\,rad/sec$

$\because V = W\sqrt{A^2 - X^2} = 7.43\sqrt{(3.5\times10^{-2})^2 - (1.75\times10^{-2})^2}$

$= 0.225\,m/s = \boxed{22.5\,cm/s}$

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11 $W = mg = 2.45\,N$, $T = 0.64\,s$, $k = ??$

answer

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

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

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

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

$\boxed{12}$ $m = 0.25\ kg$, $E = 4J$, $A = 0.20m$

$f = ??$

~ answer ~

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

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

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

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

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

$f = ?$

~ answer ~

$\because mg = kx$

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

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

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

- answer -

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

$\because w^2 = \frac{k}{m} \Rightarrow k = mw^2 = 2.25 \times 217.78 = \boxed{490}\ N/m$

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

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

answer

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

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

Quick Quiz A grandfather clock depends on the period of a pendulum to keep correct time. (i) Suppose a grandfather clock is calibrated correctly and then a mischievous child slides the bob of the pendulum downward on the oscillating rod. Does the grandfather clock run (a) slow, (b) fast, or (c) correctly? (ii) Suppose a grandfather clock is calibrated correctly at sea level and is then taken to the top of a very tall mountain. Does the grandfather clock now run (a) slow, (b) fast, or (c) correctly?

$T \propto L \uparrow$

$T \propto \frac{1}{\sqrt{g \downarrow}}$

$T = 2\pi\sqrt{\frac{L}{g}}$

Example 1. Christian Huygens (1629–1695), the greatest clockmaker in history, suggested that an international unit of length could be defined as the length of a simple pendulum having a period of exactly 1 s. How much shorter would our length unit be if his suggestion had been followed? **What if** Huygens had been born on another planet? What would the value for g have to be on that planet such

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$L = \frac{T^2 g}{4\pi^2} = \frac{1 \times 9.8}{4\pi^2} = \boxed{0.248\,m}$$

$$\rightarrow g = \frac{4\pi^2 L}{T^2}$$

Simple harmonic motion

1. In simple harmonic motion, the restoring force must be proportional to the:
A. amplitude
B. frequency
C. velocity
D. displacement
E. displacement squared
ans: D

$F = -KX \Rightarrow F \propto X$

2. An oscillatory motion must be simple harmonic if:
A. the amplitude is small
B. the potential energy is equal to the kinetic energy
C. the motion is along the arc of a circle
D. the acceleration varies sinusoidally with time
E. the derivative, dU/dx, of the potential energy is negative
ans: D

$a = -A\omega^2 \cos(\omega t + \phi)$

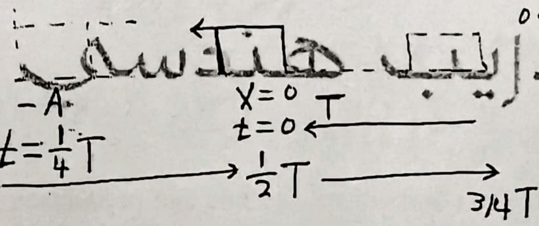
3. In simple harmonic motion, the magnitude of the acceleration is:
A. constant
B. proportional to the displacement
C. inversely proportional to the displacement
D. greatest when the velocity is greatest
E. never greater than g
ans: B

$a = -\omega^2 X$

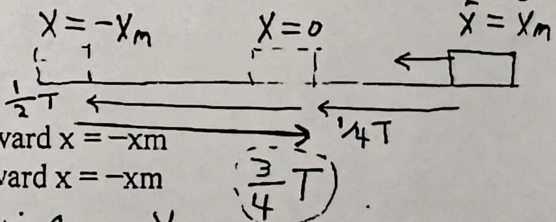
أبعد ما يمكن

4. A particle is in simple harmonic motion with period T. At time t = 0 it is at the equilibrium point. Of the following times, at which time is it furthest from the equilibrium point?
A. 0.5T
B. 0.7T
C. T
D. 1.4T
E. 1.5T
ans: B

الجسم يعود لمكانه عند $0.5T, T, 1.5T, 2T$



5. A particle moves back and forth along the x axis from x = −xm to x = +xm, in simple harmonic motion with period T. At time t = 0 it is at x = +xm. When t = 0.75T:
A. it is at x = 0 and is traveling toward x = +xm
B. it is at x = 0 and is traveling toward x = −xm
C. it at x = +xm and is at rest
D. it is between x = 0 and x = +xm and is traveling toward x = −xm
E. it is between x = 0 and x = −xm and is traveling toward x = −xm
ans: A



$\frac{1}{4}T$ to $X=0$ and moving $-X$

$\frac{1}{2}T$ to $X=-X_m$ & $\frac{3}{4}T$ to $X=0$ to $+X_m$

6. A particle oscillating in simple harmonic motion is:
A. never in equilibrium because it is in motion
B. never in equilibrium because there is always a force
C. in equilibrium at the ends of its path because its velocity is zero there
D. in equilibrium at the center of its path because the acceleration is zero there
E. in equilibrium at the ends of its path because the acceleration is zero there
ans: D

$X = 0$

$a = -\omega^2 x \rightarrow a = 0$

$F = -kx \rightarrow F = 0$ equilibrium

7. An object is undergoing simple harmonic motion. Throughout a complete cycle it:
A. has constant speed
B. has varying amplitude
C. has varying period
D. has varying acceleration
E. has varying mass
ans: D

$a = -A\omega^2 \cos(\omega t + \phi)$

8. When a body executes simple harmonic motion, its acceleration at the ends of its path must be:
A. zero
B. less than g
C. more than g
D. suddenly changing in sign
E. none of these
ans: E

$X_{max} \longrightarrow a_{max}$

9. A particle is in simple harmonic motion with period T. At time t = 0 it is halfway between the equilibrium point and an end point of its motion, traveling toward the end point. The next time it is at the same place is:
A. t = T ← الرقم ده صحيح ولكن ليس
B. t = T/2   Next time الـ
C. t = T/4
D. t = T/8
E. none of the above
ans: E

$X=0 \quad X=\frac{1}{2}A \quad X=A$

$\frac{1}{2}A = A\cos^{-1}\left(\frac{2\pi}{T}t\right) \quad t = \frac{1}{4}T$

$\therefore \frac{2\pi}{T}t = \cos^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{3} \Rightarrow t = \frac{T}{6} \quad \therefore t = 2\left(\frac{1}{4}T - \frac{1}{6}T\right) = \frac{1}{6}T$

10. An object attached to one end of a spring makes 20 complete oscillations in 10 s. Its period is:
A. 2Hz
B. 10 s
C. 0.5Hz
D. 2 s
E. 0.50 s
ans: E

$f = \frac{20}{10} = 2$

$T = \frac{1}{f} = \frac{1}{2}$

11. An object attached to one end of a spring makes 20 vibrations in 10 s. Its frequency is:
A. 2Hz
B. 10 s
C. 0.05 Hz
D. 2 s
E. 0.50 s
ans: A

$$f = \frac{20}{10} = 2 Hz$$

12. An object attached to one end of a spring makes 20 vibrations in 10 s. Its angular frequency is:
A. 0.79 rad/s
B. 1.57 rad/s
C. 2.0 rad/s
D. 6.3 rad/s
E. 12.6 rad/s
ans: E

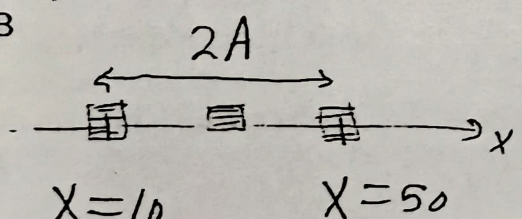
$$f = \frac{20}{10} = 2$$
$$W = 2\pi f$$
$$= 2\pi \times 2$$
$$= 12.6 \text{ rad/s}$$

13. Frequency f and angular frequency ω are related by
A. $f = \pi\omega$
B. $f = 2\pi\omega$
C. $f = \omega/\pi$
D. $f = \omega/2\pi$
E. $f = 2\omega/\pi$
ans: D

$$W = 2\pi f$$
$$f = \frac{W}{2\pi}$$

14. A block attached to a spring oscillates in simple harmonic motion along the x axis. The limits
زمن الحركة من حافة لأخرى = $\frac{1}{2}$ الزمن الدوري للجسم
of its motion are x = 10 cm and x = 50 cm and it goes from one of these extremes to the other in 0.25 s. Its amplitude and frequency are:
A. 40 cm, 2 Hz
B. 20 cm, 4 Hz
C. 40 cm, 2 Hz
D. 25 cm, 4 Hz
E. 20 cm, 2 Hz
ans: B

$$f = \frac{1}{T} = \frac{1}{0.25 \times 2} = \boxed{2 Hz}$$



$$2A = 50 - 10$$
$$\boxed{A = 20 \text{ cm}}$$

15. A weight suspended from an ideal spring oscillates up and down with a period T. If the amplitude of the oscillation is doubled; the period will be:
A. T
D. 1.5T
B. 2T
C. T/2
E. 4T
ans: A

$$T = 2\pi\sqrt{\frac{m}{K}}$$

لا يعتمد على الamplitude

16. In simple harmonic motion, the magnitude of the acceleration is greatest when:
A. the displacement is zero
B. the displacement is maximum
C. the speed is maximum
D. the force is zero
E. the speed is between zero and its maximum
ans: B

$$a = -\omega^2 x$$
$$a \propto x$$

17. In simple harmonic motion, the displacement is maximum when the:
A. acceleration is zero
B. velocity is maximum
C. velocity is zero
D. kinetic energy is maximum
E. momentum is maximum
ans: C

$$v = 0 \longrightarrow x_{max}$$

18. In simple harmonic motion:
A. the acceleration is greatest at the maximum displacement
B. the velocity is greatest at the maximum displacement
C. the period depends on the amplitude
D. the acceleration is constant
E. the acceleration is greatest at zero displacement
ans: A

$$a \propto x$$

19. The amplitude and phase constant of an oscillator are determined by:
A. the frequency
B. the angular frequency
C. the initial displacement alone
D. the initial velocity alone
E. both the initial displacement and velocity
ans: E

$$\because v = \omega\sqrt{A^2 - x^2}$$
$$\therefore A = \sqrt{\frac{v^2}{\omega^2} + x^2}$$

20. The amplitude of any oscillator can be doubled by: ← assume $V_i = 0$
A. doubling only the initial displacement $\therefore A = X$
B. doubling only the initial speed
C. doubling the initial displacement and halving the initial speed if X doubled
D. doubling the initial speed and halving the initial displacement
E. doubling both the initial displacement and the initial speed then A 〃
ans: E

21. It is impossible for two particles, each executing simple harmonic motion, to remain in phase
with each other if they have different: لا يمكن أن يتحرك جسمين
بنفس الطور، إلا إذا كان لهم نفس الزمن الدوري
A. masses
B. periods
C. amplitudes
D. spring constants
E. kinetic energies
ans: B

تسبق

22. The acceleration of a body executing simple harmonic motion leads the velocity by what phase?
A. 0
B. π/8 rad
C. π/4 rad
D. π/2 rad
E. π rad
ans: D

$$a(t) = -A\omega^2 \cos(\omega t + \phi)$$

$$v(t) = -A\omega^2 \sin(\omega t + \phi)$$

الفرق فى الزاوية بين الـ Cos و Sin
يكون $\frac{\pi}{2}$

23. A 0.20-kg object attached to a spring whose spring constant is 500N/m executes simple harmonic
motion. If its maximum speed is 5.0m/s, the amplitude of its oscillation is:
A. 0.0020m
B. 0.10m
C. 0.20m
D. 25m
E. 250m
ans: B

$$v_{max} = \omega A$$

$$v_{max} = \sqrt{\frac{K}{m}}\, A$$

$$5 = \sqrt{\frac{500}{0.2}}\, A$$

$$\therefore A = 0.1\,m$$

24. A 3-kg block, attached to a spring, executes simple harmonic motion according to x = 2 cos(50t)
where x is in meters and t is in seconds. The spring constant of the spring is:
A. 1N/m
B. 100N/m
C. 150N/m
D. 7500N/m
E. none of these
ans: D

$$W = \sqrt{\frac{K}{m}} \Longrightarrow W^2 = \frac{K}{m}$$

$$\therefore K = W^2 m = (50)^2 \times 3 = 7500\ N/m$$

25. A 0.25-kg block oscillates on the end of the spring with a spring constant of 200N/m. If the system has an energy of 6.0 J, then the amplitude of the oscillation is:
A. 0.06m
B. 0.17m
C. 0.24m
D. 4.9m
E. 6.9m
ans: C

$$E = \frac{1}{2} K A^2$$

$$6 = \frac{1}{2} \times 200 \times A^2$$

$$\therefore A = \sqrt{\frac{12}{200}} = 0.2449\ m$$

26. A 0.25-kg block oscillates on the end of the spring with a spring constant of 200N/m. If the system has an energy of 6.0 J, then the maximum speed of the block is:
A. 0.06m/s
B. 0.17m/s
C. 0.24m/s
D. 4.9m/s
E. 6.9m/s
ans: E

$$E = \frac{1}{2} K A^2$$

$$6 = \frac{1}{2} \times 200 A^2 \Longrightarrow A = 0.2449$$

$$V_{max} = WA = \sqrt{\frac{K}{m}} A = \sqrt{\frac{200}{0.25}} \times 0.2449 = 6.9$$

27. A 0.25-kg block oscillates on the end of the spring with a spring constant of 200N/m. If the oscillation is started by elongating the spring 0.15m and giving the block a speed of 3.0m/s, then the maximum speed of the block is:
A. 0.13m/s
B. 0.18m/s
C. 3.7m/s
D. 5.2m/s
E. 13m/s
ans: D

$$W = \sqrt{\frac{K}{m}} = \sqrt{\frac{200}{0.25}} = \sqrt{800}$$

$$\because V = W\sqrt{A^2 - X^2}$$

$$\therefore A = \sqrt{\frac{V^2}{W^2} + X^2}$$

$$A = \sqrt{\frac{(3)^2}{(\sqrt{8})^2} + (0.15)^2} = 0.1837\ m$$

$$V_{max} = WA = \sqrt{800} \times 0.1837 = 5.196\ m/s$$

$$\simeq 5.2\ m/s$$

28. A 0.25-kg block oscillates on the end of the spring with a spring constant of 200N/m. If the oscillation is started by elongating the spring 0.15m and giving the block a speed of 3.0m/s, then the amplitude of the oscillation is:

A. 0.13m
B. 0.18m
C. 3.7m
D. 5.2m
E. 13m
ans: B

$$W = \sqrt{\frac{K}{m}} = \sqrt{\frac{200}{0.25}} = \sqrt{800}$$

$$A = \sqrt{\frac{v^2}{W^2} + X^2} = 0.1837\,m$$

29. An object on the end of a spring is set into oscillation by giving it an initial velocity while it is at its equilibrium position. In the first trial the initial velocity is v0 and in the second it is 4v0. In the second trial: $\rightarrow X = 0$

A. the amplitude is half as great and the maximum acceleration is twice as great
B. the amplitude is twice as great and the maximum acceleration is half as great
C. both the amplitude and the maximum acceleration are twice as great
D. both the amplitude and the maximum acceleration are four times as great
E. the amplitude is four times as great and the maximum acceleration is twice as great
ans: C X

$$\because A = \sqrt{\frac{v^2}{W^2} + \cancel{X^2}_{\to 0}} \Rightarrow A = \frac{v}{W} \Rightarrow A \propto v$$

$$A_{new} = 4A$$

30. A block attached to a spring undergoes simple harmonic motion on a horizontal frictionless surface. Its total energy is 50 J. When the displacement is half the amplitude, the kinetic energy is:

A. zero
B. 12.5J
C. 25 J
D. 37.5J
E. 50 J
ans: D

$$E = P.E + K.E$$

$$\therefore K.E = E - P.E = \frac{1}{2}KA^2 - \frac{1}{2}KX^2$$

$$= \frac{1}{2}KA^2 - \frac{1}{2}K\left(\frac{1}{2}X\right)^2$$

$$= \frac{1}{2}KA^2\left[1 - \frac{1}{4}\right] = 50 \times \frac{3}{4} = \boxed{37.5}$$

31. A mass-spring system is oscillating with amplitude A. The kinetic energy will equal the potential
energy only when the displacement is:

$$K.E = P.E = \frac{1}{2}E$$

A. zero
B. ±A/4
C. ±A/√2
D. ±A/2
E. anywhere between −A and +A
ans: C

$$\therefore \cancel{\tfrac{1}{2}}\cancel{K}X^2 = \cancel{\tfrac{1}{2}}\left(\frac{1}{2}\cancel{K}A^2\right) \Rightarrow X = \frac{\pm A}{\sqrt{2}}$$

$$\therefore X^2 = \frac{A^2}{2}$$

2L

32. If the length of a simple pendulum is doubled, its period will:
A. halve
B. be greater by a factor of √2
C. be less by a factor of √2
D. double
E. remain the same
ans: B

$T = 2\pi\sqrt{l/g}$

$T \propto \sqrt{l}$

33. 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:

عشر $g = \frac{1}{10} g$

A. 1 s
B. 1/√10 s
C. 1/10 s
D. √10 s
E. 10 s
ans: D

$T = 2\pi\sqrt{l/g}$

$T = 2\pi\sqrt{\frac{l}{g/10}}$

$= 2\pi\sqrt{\frac{10l}{g}}$

34. The amplitude of oscillation of a simple pendulum is increased from 1° to 4°. Its maximum acceleration changes by a factor of:
A. 1/4
B. 1/2
C. 2
D. 4
E. 16
ans: D

$A_{new} = 4A$

$a = -w^2 x$

$a \propto x$

35. A simple pendulum of length L and mass M has frequency f. To increase its frequency to 2f:
A. increase its length to 4L
B. increase its length to 2L
C. decrease its length to L/2
D. decrease its length to L/4
E. decrease its mass to <M/4
ans: D

$f = 2\pi\sqrt{g/L}$

$f\uparrow \dashrightarrow l\downarrow$

36. A simple pendulum consists of a small ball tied to a string and set in oscillation. As the pendulum swings the tension force of the string is:
A. constant
B. a sinusoidal function of time
C. the square of a sinusoidal function of time
D. the reciprocal of a sinusoidal function of time
E. none of the above
ans: E

37. A simple pendulum has length L and period T. As it passes through its equilibrium position, the string is suddenly clamped at its midpoint. The period then becomes:
A. 2T
B. T
C. T/2
D. T/4
E. none of these
ans: E

لم تثبيته من المنتصف

$l \longrightarrow \frac{1}{2} l$

$T = 2\pi \sqrt{l/g} \Longrightarrow T_{new} = \frac{1}{\sqrt{2}} T$

38. 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.
ans: E

damping $\propto v$

$A \rightarrow$ Const.

39. A sinusoidal force with a given amplitude is applied to an oscillator. To maintain the largest amplitude oscillation the frequency of the applied force should be:
A. half the natural frequency of the oscillator
B. the same as the natural frequency of the oscillator
C. twice the natural frequency of the oscillator
D. unrelated to the natural frequency of the oscillator
E. determined from the maximum speed desired
ans: B

$f = f_0$ resonance

40. A sinusoidal force with a given amplitude is applied to an oscillator. At resonance the amplitude
of the oscillation is limited by:
A. the damping force
B. the initial amplitude
C. the initial velocity
D. the force of gravity
E. none of the above
ans: A

41. An oscillator is subjected to a damping force that is proportional to its velocity. A sinusoidal force is applied to it. After a long time:
A. its amplitude is an increasing function of time
B. its amplitude is a decreasing function of time
C. its amplitude is constant
D. its amplitude is a decreasing function of time only if the damping constant is large
E. its amplitude increases over some portions of a cycle and decreases over other portions
ans: C

damping $\propto v$

$A \rightarrow$ Const.

42. A block on a spring is subjected to a damping force that is proportional to its velocity and to an applied sinusoidal force. The energy dissipated by damping is supplied by:

A. the potential energy of the spring
B. the kinetic energy of the mass
C. gravity
D. friction
E. the applied force
ans: E

الطاقة المستهلكة يتم تعويضها
من القوة المسلطة

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43. An object of mass (m), oscillating on the end of a spring with spring constant (k), has amplitude (A), it maximum speed:

A. $A(k/m)^{\frac{1}{2}}$ B. A^2k/m C. $A(m/k)^{\frac{1}{2}}$

D. Am/k E. A^2m/k

$\rightarrow$ $v_{max} = A\sqrt{k/m} = A(k/m)^{\frac{1}{2}}$

III Oscillations

1) 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) $F \propto 1/x$

Answer: D

2) 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.

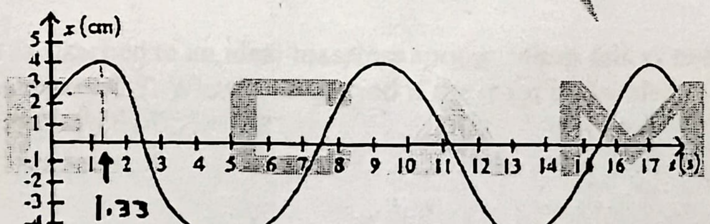
C) The acceleration is a maximum when the displacement of the object is zero.

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.

Answer: A, D, E

3) The simple harmonic motion of an object is described by the graph shown in the figure. What is the equation for the position $x(t)$ of the object as a function of time t?



A) $x(t) = (4.0\text{ m})\sin[(2\pi/8.0\text{ s})t + \pi/3.0]$

B) $x(t) = (4.0\text{ m})\cos[(2\pi/8.0\text{ s})t + 2\pi/3.0]$

C) $x(t) = (4.0\text{ m})\cos[(2\pi/8.0\text{ s})t + \pi/3.0]$

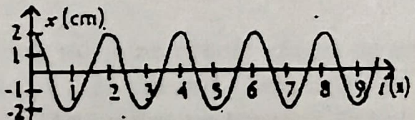
D) $x(t) = (4.0\text{ m})\cos[(2\pi/8.0\text{ s})t - \pi/3.0]$

E) $x(t) = (8.0\text{ m})\cos[(2\pi/8.0\text{ s})t + \pi/3.0]$

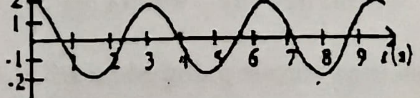
Answer: D

4) Which of following graphs describes simple periodic motion with amplitude 2.00 cm and angular frequency 2.00 rad/s?

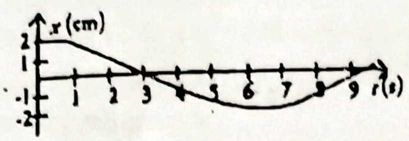
A)



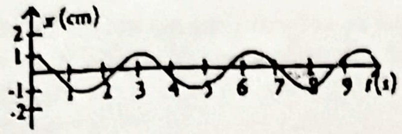
B)



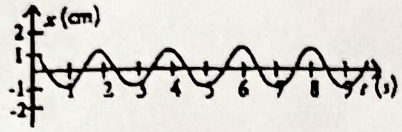
C)



D)



E)



Answer: B

5) A mass M is attached to an ideal massless spring. When this system is set in motion with amplitude A, it has a period T. What is the period if the amplitude of the motion is increased to $2A$?

A) $2T$
B) $T/2$
C) $\sqrt{2}T$
D) $4T$
E) T
Answer: E

6) A mass M is attached to an ideal massless spring. When this system is set in motion, it has a period T. What is the period if the mass is doubled to $2M$?

A) $2T$
B) $T/2$
C) $\sqrt{2}T$
D) $4T$
E) T
Answer: C

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.
Answer: C

8) 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?
Answer: (a) 20.3 cm/s (b) 326 cm/s^2

9) An object is undergoing simple harmonic motion with frequency f = 9.7 Hz and an

amplitude of 0.12 m. At $t = 0.00$ s the object is at $x = 0.00$ m. How long does it take the object to go from $x = 0.00$ m to $x = 0.048$ m?
Answer: 0.0068 seconds

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
Answer: B

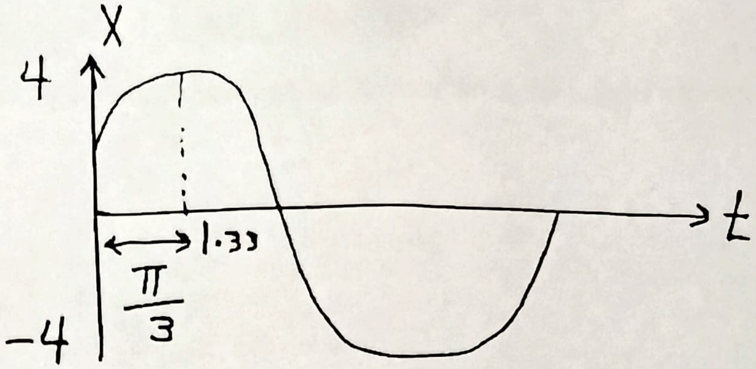
11) An object of mass 8.0 kg is attached to an ideal massless spring and allowed to hang in the Earth's gravitational field. The spring stretches 3.6 cm before it reaches its equilibrium position. If this system is allowed to oscillate, what will be its frequency?
A) 2.6 Hz
B) 0.0045 Hz
C) 0.67 Hz
D)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

12) 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
C) 24.1 N/m
D) 0.102 N/m
E) 0.610 N/m
Answer: C

13) 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?
Answer: 490 N/m

14) 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
Answer: A

$\boxed{3}$



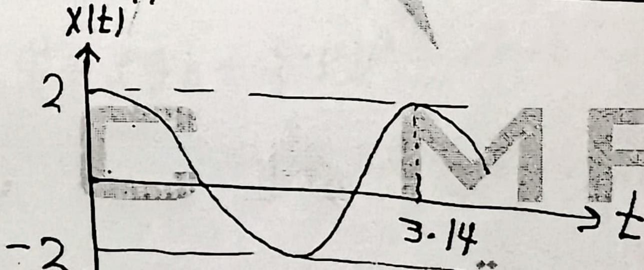
$\boxed{A=4}$

* لو الموجة بدأت متأخرة نأخذ الـ Ø بالسالب.

$X(t)=4\cos\left(\frac{2\pi}{8}t-\frac{\pi}{3}\right)$

$\boxed{4}$ $\boxed{A=2}$, $w=2=2\pi f$.

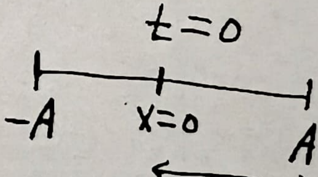
$\therefore f=\frac{2}{2\pi}=\frac{1}{\pi} \Rightarrow \boxed{T=\pi\simeq 3.14}$



$\boxed{9}$ $A=0.12$, $f=9.7\ Hz$

at $t=0$, $X=0$

$t=??$ at $X=0.048$



ربع دورة $Ø=\frac{\pi}{2}$

"answer"

$X(t)=A\cos(wt+Ø)$

$0.048=0.12\cos\left(2\pi*9.7t+\overset{\overset{180}{\downarrow}}{\frac{\pi}{2}}\right)$

$\therefore t=0.00675\simeq\boxed{0.0068\ sec}$

Fluid Dynamics

1. The equation of continuity for fluid flow can be derived from the conservation of:
A. energy
B. mass
C. angular momentum
D. volume
E. pressure
ans: B

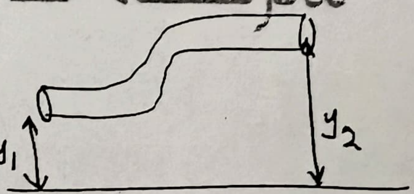
2. Bernoulli's equation can be derived from the conservation of:
A. energy
B. mass
C. angular momentum
D. volume
E. pressure
ans: A

3. Which of the following assumptions is NOT made in the derivation of Bernoulli's equation?
A. Assume streamline flow
B. Neglect viscosity
C. Neglect friction
D. Neglect gravity
E. Neglect turbulence
ans: D

$P + \rho g h + \frac{1}{2}\rho v^2 = Const$

h هى

4. The quantity y appearing in Bernoulli's equation MUST be measured:
A. upward from the center of Earth
B. upward from the surface of Earth
C. upward from the lowest point in the flow
D. downward from the highest point in the flow
E. upward from any convenient level
ans: E



تقاس لأعلى من أى مستوى افتراضى

5. Water flows through a constriction in a horizontal pipe. As it enters the constriction, the water's:
أفقية
اختناق
A. speed increases and pressure decreases
B. speed increases and pressure remains constant
C. speed increases and pressure increases
D. speed decreases and pressure increases
E. speed decreases and pressure decreases
ans: A

عندما يمر الماء باختناق تزداد السرعة و يقل الضغط

$P\downarrow + \frac{1}{2}\rho v^2\uparrow = Const$

أنبوبة أفقية

6. A non-viscous incompressible liquid is flowing through a horizontal pipe of constant cross section. Bernoulli's equation and the equation of continuity predict that the drop in pressure along the pipe:

A. is zero

B. depends on the length of the pipe

C. depends on the fluid velocity

D. depends on the cross-sectional area of the pipe

E. depends on the height of the pipe

ans: A

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

لأن المساحة ثابتة لا تتغير

السرعة ← بالتالى لا يتغير

الضغط.

ضيقة

7. A non-viscous incompressible fluid is pumped steadily into the narrow end of a long tapered pipe and emerges from the wide end. The pressure at the input is greater than at the output. A possible explanation is:

تخرج منه

A. the fluid speed increases from input to output

B. the fluid speed is the same at the two ends

C. the fluid is flowing uphill ← لأعلى

D. the fluid is flowing downhill

E. the fluid is flowing horizontally

ans: C

لأن الضغط عند الدخل كبير

بالتالى يتدفق السائل لأعلى.

8. Consider a pipe containing a fluid, with the fluid being at rest. To apply Bernoulli's equation
to this situation:

A. set v equal to zero because there is no motion

B. set g equal to zero because there is no acceleration

C. set v and g both equal to zero

D. set p equal to the atmospheric pressure

E. cannot be done; Bernoulli's equation applies only to fluids in motion

ans: A

حالة سكون

السرعة = صفر