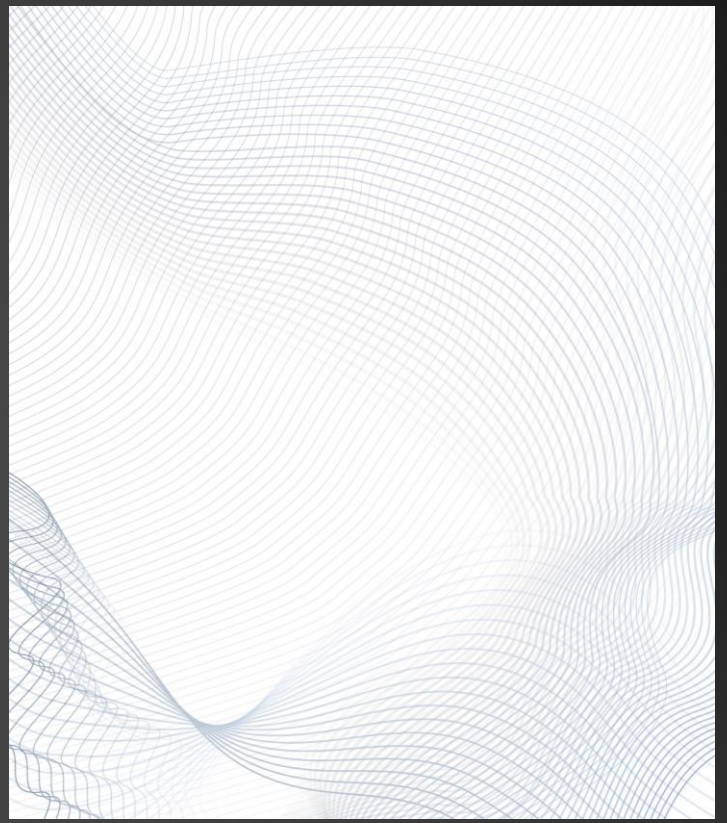
SIMPLE HARMONIC MOTION AND WAVES

Conceptual Questions

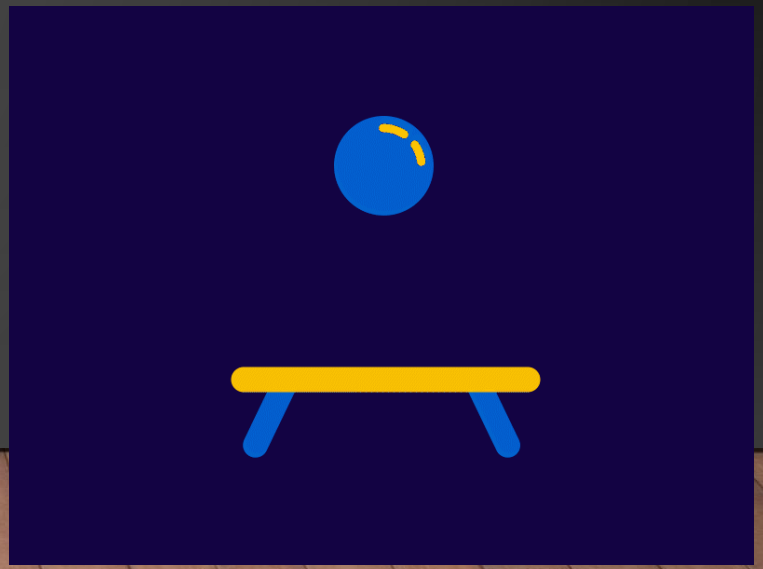


QUESTION#1

Give an example of vibratory motion which is not simple harmonic motion. Give a reason of you selection.

Answer:

When a ball is dropped from an elevation on a perfectly elastic surface then the motion is vibratory motion but not simple harmonic because the restoring force F_{res} is equal to mg which is a constant. The essential condition for SHM is $F_{res} \propto -x$, which is not satisfied in this case.



QUESTION#2

At extreme position, velocity is zero but acceleration is maximum in SHM. How can you theoretically explain it?

Answer:

At extreme position velocity is zero as body stops there for a moment but acceleration is maximum because change in velocity is maximum at extreme position. Mathematically,

$$v = \omega\sqrt{x_0^2 - x^2}$$

At extreme, $x = x_o$

$$v = \omega\sqrt{x_0^2 - {x_o}^2}$$

$$v = \omega\sqrt{0}$$

$$\boxed{v = 0}$$

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

At extreme, $x = x_o$

$$a = -\omega^2 x_o$$

That is the maximum value of acceleration for a given SHM.

QUESTION#3

What will happen to the acceleration of mass spring system if its mass is doubled.

Answer:

The acceleration of the system will be reduced to half as mass and acceleration are inversely related by Newton's 2nd law of motion.

$$a = -\left(\frac{k}{m}\right)x$$

If mass is doubled then $m' = 2m$

$$a' = -\left(\frac{k}{m'}\right)x = -\left(\frac{k}{2m}\right)x$$

$$a' = \frac{1}{2}\left[-\left(\frac{k}{m}\right)x\right]$$

$$\boxed{a' = \frac{1}{2}[a]}$$

QUESTION#4

A simple pendulum has time period T. What will happen to its time period if its thread length is shorten to half ?

Answer: The time period will become $\frac{1}{\sqrt{2}}$T.

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

Since length is reduced to half then $l' = \frac{l}{2}$

$$T' = 2\pi\sqrt{\frac{l/2}{g}}$$

$$T' = \frac{1}{\sqrt{2}}\left[2\pi\sqrt{\frac{l}{g}}\right] \quad \Rightarrow \quad \boxed{T' = \frac{1}{\sqrt{2}}T}$$

QUESTION#5

A simple pendulum has time period of 4 seconds. Will its time period remain same or change, if its steel bob is replaced by wood bob of same size ?

Answer:

The time period will remain same as simple pendulum's time period is independent of mass of bob.

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

QUESTION#6

Same masses are attached to different springs, one is vibrating faster. Why?

Answer:

One mass is vibrating faster because it is attached with the spring that has high spring constant.

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

Since springs are different so their spring constants k will also be different. Higher k will have lower time period T and lower time period shows that mass will complete its cycle fast.

QUESTION#7

A simple pendulum has time period "T" in Murree. In Karachi, it has different time period. What would you do to make its time period same as it was in Murree?

Answer:

I will increase the length to make $T_{MURREE} = T_{KARACHI}$.

Time period of pendulum is given by: $T = 2\pi\sqrt{\frac{l}{g}}$

As we know $g_K > g_M$,so for same length, time period of Karachi pendulum will be less as $T \propto \frac{1}{\sqrt{g}}$.

Therefore, for making time period of both equal, we have to increase the length of Karachi Pendulum.

QUESTION#8

What will happen to the frequency of waves in a ripple tank if time period of electrical vibrator is decreased? What will happen to the wave speed?

Answer:

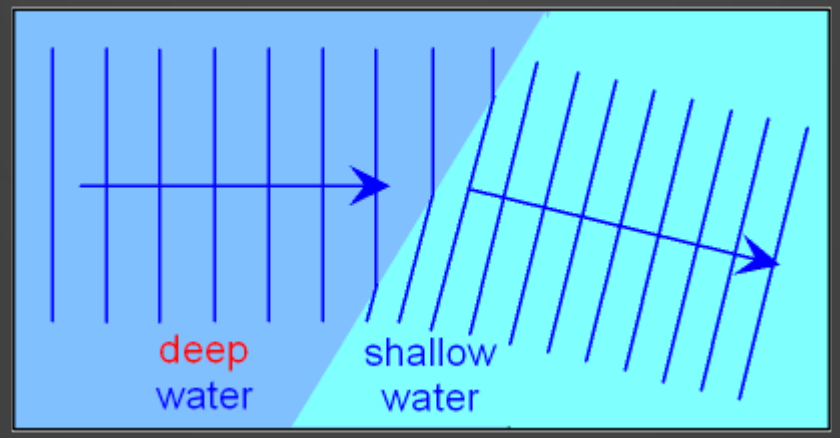
- The frequency of waves will be increased on decreasing time period T as : $f \propto \frac{1}{T}$
- The speed will remain same as speed of water waves depend on depth of water. Moreover, increase in f will not result in increase in speed v as wavelength λ will decrease and overall product of "f λ" will remains constant.

QUESTION#9

Why do water waves refract at the boundary of shallow water and deep water in ripple tank experiment?

Answer:

- Refraction happens because the speed of water waves changes.
- Water waves travel slowly in shallow water and faster in deeper water.
- This speed difference the main reason of direction difference (i.e., refraction).



QUESTION#10

Under what conditions are the waves diffracted most?

Answer:

- Smaller the opening between the slits (gap) , greater will be diffraction.
- Highest diffraction occurs when the gap is even smaller than wavelength of the wave.