Oscillations

Assertion Reason Questions

Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.

1. Assertion (A): A simple pendulum is mounted on a truck which moves with constant velocity. The time period of the pendulum will increase.
Reason (R): The effective length of the pendulum will decrease.

Ans. (d) A is false and R is also false.
Explanation: The time period will be the same. Time period is the time taken by a pendulum to complete one oscillation. If it is inside a truck, as the train undergoes horizontal motion, it will not have any impact on the motion of the pendulum. Hence, the time period and frequency will be the same. Only velocity with respect to ground will differ.

2. Assertion (A): When a particle is at an extreme position performing
Reason (R): SHM, its momentum is equal to zero. At an extreme position, the velocity of a particle performing SHM is equal to zero.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: In SHM, kinetic energy is maximum at the mean position and zero at the extreme positions, while potential energy is zero at the mean position and maximum at the extreme positions. At the equilibrium position, the velocity is at its maximum and the acceleration (a) has fallen to zero. Simple harmonic motion is characterised by this changing acceleration that always is directed toward the equilibrium position and is proportional to the displacement from the equilibrium position.

3. Assertion (A): When a person sitting on a glide, stands up, the swing's periodic time increases.
Reason (R): The effective length of the swing will decrease in a girl's standing position.

Ans. (d) A is false and R is also false.
Explanation: A girl is sitting on a swing when she stands up, the periodic time of the swing will increase. Now, when the girl is sitting on the swing and swinging, the centre of gravity of the girl is close to the ground meaning at a higher distance from the point of suspension. When the girl stands up the centre of gravity shifts to a higher level from the ground, hence the effective length of the swing decreases. Now, from the formula of time period, we know,

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

So, in this problem, $l_1 > l_2$.
Hence, the time period of the swing will be
$T_1 > T_2$.

4. Assertion (A): All oscillatory motions are necessarily periodic motions but all periodic motions are not oscillatory.
Reason (R): Simple pendulum is an oscillatory example of motion.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: All oscillatory motions are necessarily periodic motions, but air periodic motions are not oscillatory. Simple pendulum is an example of oscillatory motion.

5. Assertion (A): For a harmonic oscillation, the plot of velocity and displacement is a straight line.
Reason (R): Velocity changes uniformly with displacement in simple harmonic motion

Ans. (d) A is false and R is also false.
Explanation: In a simple harmonic oscillator, the velocity is given by:

$$v = \omega\sqrt{a^2 - y^2}$$

$$v^2 = \omega^2 a^2 - \omega^2 y^2$$

Dividing both sides by $\omega^2 a^2$.

$$1 = \frac{v^2}{\omega^2 a^2} + \frac{y^2}{a^2}$$

This is an equation of the ellipse. And the velocity does not change uniformly with displacement in harmonic motion.

6. Assertion (A): Time average K.E. and the time average P.E. are not exactly equal in simple pendulum.
Reason (R): Friction is not negligible in a simple pendulum.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: The sum of K.E. and P.E. is constant they are not equal. Since, their sum is constant at any instant, at some instant they may be equal. Near the mean position K.E. is maximum while P.E. is minimum. Near the extremes it is just the opposite. So, if the time interval is chosen near the mean position or near the extremes the average K.E. and P.E. will not be equal. The variations of the K.E. and P.E. are exactly similar in one time period except that K.E. is maximum at the mean position while P.E. is maximum at the extremes. So, the average P.E. and K.E. are equal in one time period.

7. Assertion (A): In SHM, kinetic energy is zero when potential energy is maximum.
Reason (R): In SHM, the kinetic and potential energies become equal when the displacement
is $\frac{1}{\sqrt{2}}$ times the amplitude.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: When the displacement of a particle executing SHM is y, then

$$KE = \frac{1}{2} m \omega^2 (a^2 - y^2)$$

and $$PE = \frac{1}{2} m \omega^2 y^2$$

For $$K.E = P.E$$
or $$2y^2 = a^2$$
Or $$y = \frac{a}{\sqrt{2}}$$

Since total energy remains constant throughout the motion, which is E = K.E. + P.E. So, when P.E. is maximum then K.E. is zero and vice versa.

8. Assertion (A): The graph of total energy of a particle in SHM w.r.t. position is a straight line with zero slope.
Reason (R): Total energy of the particle in SHM remains constant throughout its motion.

Ans. (b) Both A and R are true and R is the correct explanation of A.

Explanation: The total energy of S.H.M.

= kinetic energy of particle + potential energy of particle. The variation of total energy of the particle in SHM with time is shown in a graph.