6

Assertion–Reason-Type Questions

*Each of the following questions contains an assertion (***Statement 1***) and a reason (***Statement 2***). Each question has four choices (a, b, c and d), out of which only one is correct.*

(a) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation of Statement 1.

(b) Statement 1 is true, Statement 2 is true; Statement 2 is not a correct explanation of Statement 1.

(c) Statement 1 is true, Statement 2 is false.

(d) Statement 1 is false, Statement 2 is true.

1. **Statement 1:** The formula connecting u, v and f for a spherical mirror is valid only for those mirrors whose sizes are very small compared to their radii of curvature.

   Statement 2: The laws of reflection are strictly valid for plane surfaces but not for large spherical surfaces.

2. **Statement 1:** If the accelerating potential in an X-ray tube is increased, the wavelengths of the characteristic X-rays do not change.

   Statement 2: When an electron beam strikes the target in an X-ray tube, part of the kinetic energy is converted into X-ray energy.

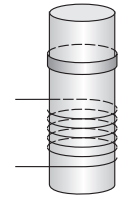
3. **Statement 1:** A block of mass m starts moving on a rough horizontal surface with a velocity v. It stops due to friction between the block and the surface after moving through a certain distance. The surface is now tilted to an angle of 30° with the horizontal, and the same block is made to go up on the surface with the same initial velocity v. The decrease in mechanical energy in the second situation is smaller than that in the first situation.

   Statement 2: The coefficient of friction between the block and the surface decreases with the increase in the angle of inclination.

4. **Statement 1:** For an elastic collision between two bodies, the relative speed of the bodies after the collision is equal to the relative speed before the collision.

   Statement 2: In an elastic collision, the linear momentum of the system is conserved.

5. **Statement 1:** A vertical iron rod has a coil of wire wound over it at the bottom end. An alternating current flows in the coil. The rod goes through a conducting ring as shown in the figure. The ring can float at a certain height above the coil.



   Statement 2: In the above situation, a current is induced in the ring, which interacts with the horizontal component of the magnetic field to produce an average force in the upward direction.

6. **Statement 1:** If there is no external torque on a body about its centre of mass, the velocity of the centre of mass remains constant.

   Statement 2: The linear momentum of an isolated system remains.

7. **Statement 1:** The total translational kinetic energy of the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

   Statement 2: The molecules of a gas collide with each other and the velocities of the molecules change due to the collisions.

8. **Statement 1:** A piece of cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table.

   Statement 2: For every action there is an equal and opposite reaction.

9. **Statement 1:** The stream of water flowing at a high speed from a garden hosepipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

   Statement 2: In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant.

10. **Statement 1:** Two cylinders, one hollow (metallic) and the other solid (wooden) with the same mass and identical dimensions are simultaneously allowed to roll without stopping, down an inclined

plane from the same height. The hollow cylinder will reach the bottom of the inclined plane first.

Statement 2: By the principle of conservation of energy, the total kinetic energy of both the cylinders are identical when they reach the bottom of the incline.

11. **Statement 1:** An astronaut in an orbiting space station above the earth experiences weightlessness.

    Statement 2: An object moving around the earth under the influence of the earth's gravitational force is in a state of free fall.

12. **Statement 1:** In a metre-bridge experiment, the null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.

    Statement 2: Resistance of a metal increases with temperature.

13. **Statement 1:** It is easier to pull a heavy object than to push it on a level ground.

    Statement 2: The magnitude of frictional force depends on the nature of the two surfaces in contact.

14. **Statement 1:** For practical purposes, the earth is used as a reference at zero potential in electrical circuits.

    Statement 2: The electrical potential of a sphere of radius R with charge Q uniformly distributed on the surface is given by $\frac{Q}{4\pi\varepsilon_0 R}$.

15. **Statement 1:** The sensitivity of a moving-coil galvanometer is increased by placing a suitable magnetic material as a core.

    Statement 2: Soft iron has a high magnetic permeability and cannot be easily magnetized or demagnetized.

16. **Statement 1:** For an observer looking out through the window of a fast-moving train, the nearby objects appear to move in the opposite direction, while the distant objects appear to be stationary.

    Statement 2: If the observer and the object are moving with the velocities v_1 and v_2 respectively with reference to a laboratory frame, the velocity of the object vis-a-vis the observer is $v_1 - v_2$.

Answers

1. c	**2.** b	**3.** c	**4.** b	**5.** a	**6.** d
7. b	**8.** b	**9.** a	**10.** d	**11.** a	**12.** d
13. b	**14.** b	**15.** c	**16.** b		

Hints and Solutions

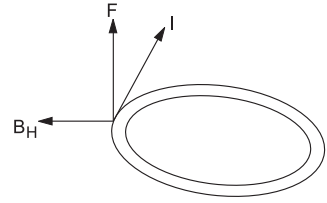
1. All the formulae relating u, v and f are valid for paraxial rays.

2. The increase in accelerating potential (V) decreases the magnitude of cut-off wavelength $\left(\lambda_{\min} = \frac{hc}{eV}\right)$ but does not affect the characteristic spectrum.

3. In the second case, work is done against friction as well as gravity while moving up the incline. The coefficient of friction is the property of the nature of the surfaces in contact, and not of the inclination.

4. The coefficient of restitution (e) for an elastic collision is unity, where velocity of separation = e × (velocity of approach).
Linear momentum is always conserved.

5. The interaction between the induced current (I) and the horizontal component of the magnetic field (B_H) creates an average force upward which makes the ring float by balancing its weight.



6. $\vec{\tau}_{CM} = 0$ means that the external force passes through the centre of mass, so rotation will not occur, but linear acceleration will increase $\vec{v}_{CM}$.

7. The total kinetic energy of translation, $\frac{1}{2}MC_{rms}^2 = \frac{3}{2}RT = \frac{3}{2}pV$, where M is the molar mass.

8. Inertia of rest.

9. Apply the principle of continuity $a_1v_1 = a_2v_2$. For the vertically upward motion, velocity decreases, so area a increases, which causes spread like a fountain. Same principle is applicable for the vertically downward motion.

10. The acceleration of a body rolling down an inclined plane is

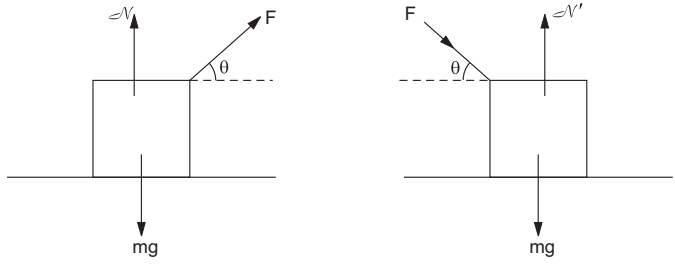
$$\left[a = \frac{g\sin\theta}{1 + \frac{K^2}{R^2}}\right]$$

under the condition $(a)_{solid} > (a)_{hollow}$, so the solid cylinder will reach the bottom first. Kinetic energy is gained by the loss in potential energy which is the same for both the cylinders.

11. For the frame orbiting the earth (noninertial), the weight mg is balanced by the pseudo-force. Hence normal reaction is zero, which leads to apparent weightlessness. The situation is equivalent to the state of free fall.

12. Increase in temperature increases the resistance. Hence to keep the position of null points unchanged, the standard resistance has to be increased.

13. The two figures given below show the pulling force F and pushing force F.



(i) During pull, $N + F \sin\theta = mg$, so $N = mg - F \sin\theta$.

(ii) During push, $N' = (mg + F \sin\theta) > N$

$$\Rightarrow \quad f' = \mu N' > f (= \mu N).$$

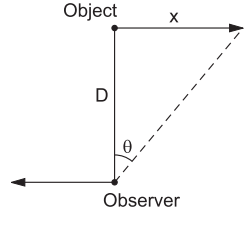
Hence, pull is easier than push.

14. Both the statements are independently true.

15. By placing a magnetic material of high permeability increases B, hence current sensitivity $\left(NB\frac{A}{C}\right)$ is increased. A magnetic substance with high permeability can be easily magnetised or demagnetised.

16. The relative displacement of the distant object (x) with respect to the observer subtends a small angle θ. Since $\tan\theta = \frac{x}{D}$, the distant objects appear to be at rest.

For statement 2, $\vec{v}_{2,1} = \vec{v}_2 - \vec{v}_1$ is true.



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