Exercise - V

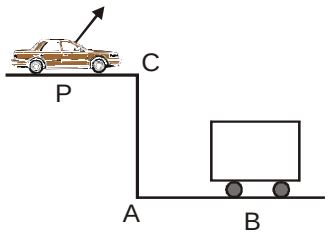
JEE-Problems

1. Two trolleys A and B of equal masses M are moving in opposite directions with velocities $\vec{v}$ and $-\vec{v}$ respectively on separate horizontal frictionless parallel tracks. When they start crossing each other, a ball of mass m is thrown from B to A and another of same is thrown from A to B with velocities normal to $\vec{v}$. The balls may be thrown in following two ways
(i) balls from A to B to A are thrown simultaneously.
(ii) ball is thrown from A to B after the ball thrown from B reaches A.
Which procedure would lead to a larger change in the velocities of the trolleys ? **[REE-2000]**

2. A wind-powered generator converts wind energy into electrical energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into electrical energy. For wind speed v, the electrical power output will be proportional to **[IIT(Scr.)-2000]**
(A) v (B) v^2
(C) v^3 (D) V^4

3. Two particles of masses m_1 and m_2 in projectile motion have velocities $\vec{v}_1$ and $\vec{v}_2$ respectively at time t = 0. They collide at time t_0. Their velocities become $\vec{v}'_1$ and $\vec{v}'_2$ at time $2t_0$ while still moving in air. The value of $[(m_1\vec{v}_1 + m_2\vec{v}_2) - (m_1\vec{u}_1 + m_2\vec{u}_2)]$ is **[IIT(Scr.)-2001)]**
(A) zero (B) $(m_1 + m_2)gt_0$
(C) $2(m_1 + m_2)gt_0$ (D) $\frac{1}{2}(m_1 + m_2)gt_0$

4. A car P is moving with a uniform speed of $5(3^{1/2})$m/s towards a carriage of mass, 9 Kg at rest kept on the rails at a point B as shown in fig. The height AC is 120 m. Cannon balls of 1 Kg are fired from the car with an initial velocity 100 m/s at an angle 30° with the horizontal. The first canon ball hits the stationary carriage after a time t_0 ans stricks to it. Determine t_0. At t_0, the second cannon ball is fired. Assume that the resistive force between the rails and the carriage is constant and ignore the vertical motion of the carriage throughout. If the second ball also hits and sticks to the carriage. What will be the horizontal velocity of the carriage just after the second impact ? **[IIT-2001]**



5. Two block of masses 10 kg and 4 kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of 14 m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is **[IIT(Scr.)-2002]**
(A) 30 m/s (B) 20 m/s
(C) 10 m/s (D) 5 m/s

6. STATEMENT-1
In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.
because
STATEMENT-2
In an elastic collision, the linear momentum of the system is conserved
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

7. The balls, having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$, undergo a collision in free space. There is no external force acting on the balls. Let $\vec{p}_1$ and $\vec{p}_2$ be their final momenta. The following options(s) is (are) **NOT ALLOWED** for any non-zero value of p, a_1, a_2, b_1, b_2, c_1 and c_2. **[JEE 2008]**

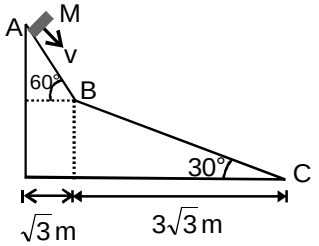
(A) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$

(B) $\vec{p}'_1 = c_1\hat{k}$; $\vec{p}'_2 = a_2\hat{i} + b_2\hat{j}$; $\vec{p}'_2 = c_2\hat{k}$

(C) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$

(D) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j}$; $\vec{p}'_2 = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$; $\vec{p}'_2 = a_2\hat{i} + b_1\hat{j}$

Paragraph for Question No. 8 to 10
A small block of mass M moves on a frictionless surface of an inclined plane, as shown in figure. The angle of the incline suddenly changes from 60° to 30° at point B. The block is initially at rest at A. Assume that collisions between the block and the incline are totally inelastic (g = 10 m/s^2). Figure : **[JEE 2008]**



8. The speed of the block at point B immediately after it strikes the second incline is

(A) $\sqrt{60}\,m/s$ (B) $\sqrt{45}\,m/s$

(C) $\sqrt{30}\,m/s$ (D) $\sqrt{15}\,m/s$

9. The speed of the block at point C, immediately before it leaves the second incline is

(A) $\sqrt{120}\,m/s$ (B) $\sqrt{105}\,m/s$

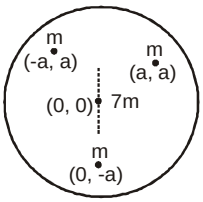
(C) $\sqrt{90}\,m/s$ (D) $\sqrt{75}\,m/s$

10. If collision between the block and the incline is completely elastic, then the vertical (upward) component of the velocity of the block at point B, immediately after it strikes the second incline is

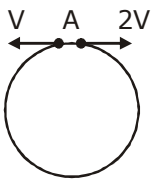
(A) $\sqrt{30}\,m/s$ (B) $\sqrt{15}\,m/s$

(C) 0 (D) $-\sqrt{15}\,m/s$

11. Look at the drawing given in the figure which has been drawn with ink of uniform line-thickness. The mass of ink used to draw each of the two inner circles, and each of the two line segments is m. The mass of the ink unsed to draw the outer circle is 6m. The coordinates of the centres of the different parts are outer circle (0, 0), left inner circle (–a, a), right inner circle (a, a), vertical line (0, 0) and horizontal line (0, – a). The y-coordinate of the centre of mass of the ink in this drawing is **[JEE 2009]**



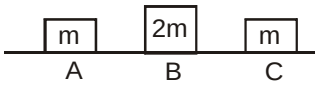
12. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circle orbit. Their tangential velocities are v and 2v, respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particulars will again reach the point A ?



(A) 4 (B) 3

(C) 2 (D) 1 **[JEE 2009]**

13. Three objects *A*, *B* and *C* are kept in a straight line on a frictionless horizontal surface. These have masses *m*, 2*m* and *m*, respectively. The object *A* moves towards *B* with a speed 9 ms^{-1} and makess an elastic collision with it. There after, *B* makes completely inelastic collision with *C*. All motions occur on the same straight line. Find the final speed (in ms^{-1}) of the object *C*. **[JEE 2009]**



14. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverse its direction and moves with a speed of 2 ms^{-1}. Which of the following statement(s) is (are) correct for the system of these two masses ?

(A) Total momentum of the system is 3 kg ms^{-1}

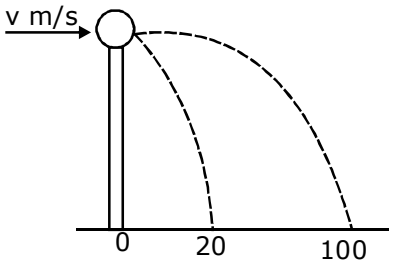
(B) Momentum of 5 kg mass after collision is 4 kg ms^{-1}

(C) Kinetic energy of the centre of mass is 0.75 J

(D) Total kinetic energy of the system is 4 J

[JEE 2010]

15. A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg traveling with a velocity V m/s in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The initial velocity V of the bullet is



(A) 250 m/s (B) $250\sqrt{2}$ m/s

(C) 400 m/s (D) 500 m/s

[JEE 2011]