Chap.8 review 2022

1. A ball of mass m_B is released from rest and acquires velocity of magnitude v_B before hitting the ground. The ratio of the magnitude of the momentum the Earth acquires to the magnitude of the momentum the ball acquires is

a. 0. b. $\left(\frac{m_B}{m_E}\right)^2$ c. $\frac{m_B}{m_E}$ d. 1 e. $\frac{m_E}{m_B}$ ANS: D

1. m_B Earth for ball-earth sys. $\vec{P}_{tot}$ conserves

$\Rightarrow 0 = \vec{P}_B + \vec{P}_E \Rightarrow P_B / P_E = 1.$

2. The speed of a 2.0-kg object changes from 30 m/s to 40 m/s during a 5.0-s time interval. During this same time interval, the velocity of the object changes its direction by 90°. What is the magnitude of the average total force acting on the object during this time interval?

a. 30 N b. 20 N c. 40 N d. 50 N e. 6.0 N ANS: B

2. 2 kg 30 m/s, $\Delta t = 5$ s. 40 m/s, ΔP, $P_i = 2\times30 = 60$, $\Delta P = \sqrt{60^2+80^2} = 100$

$P_f = 2\times40 = 80$

$\Rightarrow F_{avg} = \frac{\Delta P}{\Delta t} = \frac{100}{5} = 20$ N

3. A catapult fires an 800-kg rock with an initial velocity of 100 m/s at a 40° angle to the ground. The magnitude of the vertical impulse the catapult receives from the rock is

a. 5.1×10^4 N·s. b. 6.1×10^4 N·s. c. 8.0×10^4 N·s. d. 5.0×10^5 N·s. e. 6.0×10^5 N·s.

ANS: A

3. 800 kg 100 m/s 40°

$I_y = \Delta P_y = P \sin 40° = 800 \times 100 \sin 40°$

$= 5.1 \times 10^4$

4. A 6.0-kg object moving 5.0 m/s collides with and sticks to a 2.0-kg object. After the collision the composite object is moving 2.0 m/s in a direction opposite to the initial direction of motion of the 6.0-kg object. Determine the speed of the 2.0-kg object before the collision.

a. 15 m/s b. 7.0 m/s c. 8.0 m/s d. 23 m/s e. 11 m/s ANS: D

4. O → P_2 ← O ⇒ ← OO : $\vec{p}$ conserves

6 kg 5 m/s 2 kg 2 m/s, 8 kg

$P_6 + P_2 = 6\times5 + P_2 = -(2+6)\times2 = -16$

$\Rightarrow P_2 = -16-30 = -46 \quad \Rightarrow V_2 = \frac{46}{2} = 23$ m/s

5. A 3.0-kg object moving in the positive x direction has a one-dimensional elastic collision with a 5.0-kg object initially at rest. After the collision the 5.0-kg object has a velocity of 6.0 m/s in the positive x direction. What was the initial speed of the 3.0 kg object?

a. 6.0 m/s b. 7.0 m/s c. 4.5 m/s d. 8.0 m/s e. 5.5 m/s ANS: D

5. 1 O $\xrightarrow{v_i}$ O 2 elastic: $V_{2f} = \frac{2m_1}{m_1+m_2} v_{1i} = 6.0 = \frac{2\times3}{3+5} v_{1i} = \frac{6}{8} v_{1i}$

3 kg 5 kg

$\Rightarrow V_{1i} = \frac{4\times6}{3} = 8$ m/s

6. A 5.0-g particle moving 60 m/s collides with a 2.0-g particle initially at rest. After the collision each of the particles has a velocity that is directed 30° from the original direction of motion of the 5.0-g particle. What is the speed of the 2.0-g particle after the collision?

a. 72 m/s b. 87 m/s c. 79 m/s d. 94 m/s e. 67 m/s ANS: B

6. 5g 60 m/s 2g
1 O → O 2 ⇒ 5g v_{1f} 30° 30° 2g v_{2f}

before

collision ⇒ $\vec{P}_{tot}$ conserves ⇒ $\begin{cases} P_x \\ P_y \end{cases}$ conserves

$P_x = 5g\times60 = 5g\, v_{1f}\cos30° + 2g\, v_{2f}\cos30°$

$\Rightarrow 300 = 5\times\frac{\sqrt{3}}{2} v_{1f} + 2\times\frac{\sqrt{3}}{2} v_{2f}$

$P_y = 0 = 5g\, v_{1f}\sin30° - 2g\, v_{2f}\sin30°$

$\Rightarrow v_{1f} = \frac{2}{5} v_{2f}$ substitute to P_x ⇒ $300 = 5\times\frac{\sqrt{3}}{2}\cdot\frac{2}{5} v_{2f} + \sqrt{3}\, v_{2f}$

$\Rightarrow 300 = 2\sqrt{3}\, v_{2f} \Rightarrow v_{2f} = 300/2\sqrt{3} = 87$ m/s

7. At the instant a 2.0-kg particle has a velocity of 4.0 m/s in the positive x direction, a 3.0-kg particle has a velocity of 5.0 m/s in the positive y direction. What is the speed of the center of mass of the two-particle system?

a. 3.8 m/s b. 3.4 m/s c. 5.0 m/s d. 4.4 m/s e. 4.6 m/s ANS: B

7. 2kg ① $\rightarrow$ 4 m/s $\uparrow$ 5.0 m/s ② 3kg $\vec{P}_{CM} = \vec{P}_1 + \vec{P}_2$ $\vec{P}_{CM}$ $\vec{P}_2 = 3\times5 = 15$

$\vec{P}_1 = 2\times4 = 8$

$\therefore P_{CM} = \sqrt{15^2+8^2} = 17 = (2+3)\vec{V}_{CM} \Rightarrow V_{CM} = \frac{17}{5} = 3.4$ m/s

8. In an elastic collision between two bodies of equal mass, with body 2 initially at rest, body 1 moves off at angle θ relative to the direction of its initial velocity and body 2 at angle ϕ. The sine of the sum of θ and ϕ, $\sin(\theta + \phi)$, is equal to

a. 0.
b. 0.500.
c. 0.707.
d. 0.866.
e. 1.00.

ANS: E

8. m m before θ ϕ after $\because \theta+\phi = 90°$ $\therefore \sin(\theta+\phi) = \sin 90° = 1$

9. A 500-g firework explodes into two pieces of equal mass at an instant when it is traveling straight up at 10 m/s. If one half shoots off horizontally to the left at 20 m/s, what is the velocity, in m/s, of the other half immediately after the explosion? (The x axis is directed right; the y axis up.)

a. $-20\hat{\mathbf{i}} - 20\hat{\mathbf{j}}$ b. $-20\hat{\mathbf{i}} + 20\hat{\mathbf{j}}$ c. $+20\hat{\mathbf{i}} - 20\hat{\mathbf{j}}$ d. $+20\hat{\mathbf{i}} + 20\hat{\mathbf{j}}$ e. $-20\hat{\mathbf{i}} + 20\hat{\mathbf{k}}$

9. 10 m/s 500g $\Rightarrow$ 20 m/s 250g 250g $\vec{V}_f = ?$ explosion $\Rightarrow \vec{p}$ conserves

$\therefore \vec{P}_c = 500g \times 10\hat{j}$

$= -250g\times20\hat{i} + 250\vec{V}_f$

$\Rightarrow \vec{V}_f = \frac{500\times10\hat{j} + 250\times20\hat{i}}{250} = +20\hat{i} + 20\hat{j}$

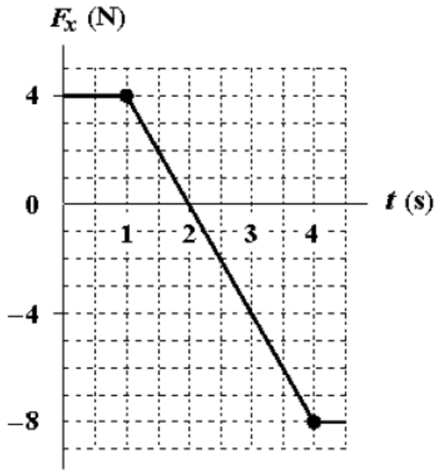
10. A car of mass m_1 traveling at velocity v passes a car of mass m_2 parked at the side of the road. The momentum of the system of two cars is

a. 0. b. m_1v. c. $(m_1 - m_2)v$. d. $\dfrac{m_1 v}{m_1 + m_2}$ e. $(m_1 + m_2)v$. ANS: B

10. m_1 $\circ \rightarrow v$ $P_{tot} = m_1 v + 0 = m_1 v$

m_2 $\square$

11. The only force acting on a 2.0-kg object moving along the x axis is shown. If the velocity v_x is –2.0 m/s at $t = 0$, what is the velocity at $t = 4.0$ s?



a. –2.0 m/s
b. –4.0 m/s
c. –3.0 m/s
d. +1.0 m/s
e. +5.0 m/s

ANS: C

11. $\int F\,dt = \Delta P = (1+2)\times 4/2 - \frac{2\times 8}{2} = 6-8 = -2 = 2\times v(4s) - 2\times(-2)$

$\Rightarrow -2 = 2v(4s) + 4 \quad \Rightarrow v(4s) = -6/2 = -3$

12. A ball of mass m_B is released from rest and acquires velocity of magnitude v_B before hitting the ground. The ratio of the kinetic energy the Earth acquires to the kinetic energy the ball acquires is

a. 0. b. $\left(\dfrac{m_B}{m_E}\right)^2$. c. $\dfrac{m_B}{m_E}$. d. 1 e. $\dfrac{m_E}{m_B}$. ANS: C

12. m_B $\because \vec{P}_B + \vec{P}_{earth} = 0 \Rightarrow P_{earth} = P_B$

E $\quad KE_B = P_B^2/2m_B. \quad KE_E = P_{earth}^2/2m_E \Rightarrow \dfrac{KE_E}{KE_B} = \dfrac{m_B}{m_E}$

13. A 3.0-kg ball with an initial velocity of $(4\hat{\mathbf{i}} + 3\hat{\mathbf{j}})$ m/s collides with a wall and rebounds with a velocity of $(-4\hat{\mathbf{i}} + 3\hat{\mathbf{j}})$ m/s. What is the impulse exerted on the ball by the wall?

a. $+24\hat{\mathbf{i}}$ N·s b. $-24\hat{\mathbf{i}}$ N·s c. $+18\hat{\mathbf{j}}$ N·s d. $-18\hat{\mathbf{j}}$ N·s e. $+8.0\hat{\mathbf{i}}$ N·s

ANS: B

13. impulse $I = \Delta\vec{P} = \vec{P}_f - \vec{P}_i = 3\times(-4\hat{i}+3\hat{j}) - 3.0\times(4\hat{i}+3\hat{j})$
$= -24\hat{i}$

14. A 2.0-kg object moving 5.0 m/s collides with and sticks to an 8.0-kg object initially at rest. Determine the kinetic energy lost by the system as a result of this collision.

a. 20 J b. 15 J c. 30 J d. 25 J e. 5.0 J ANS: A

14. collision ⇒ $\vec{p}$ conserves ⇒ $P_i = 2\times5 = P_f = 10$
$KE_f = P_f^2/2m_f = \frac{10^2}{2\times(2+8)} = 5$, $KE_i = P_i^2/2m_i = \frac{10^2}{2\times2} = 25$
⇒ KE loss = 25−5 = 20 J

15. A 3.0-kg object moving 8.0 m/s in the positive x direction has a one-dimensional elastic collision with an object (mass = M) initially at rest. After the collision the object of unknown mass has a velocity of 6.0 m/s in the positive x direction. What is M?

a. 7.5 kg b. 5.0 kg c. 6.0 kg d. 4.2 kg e. 8.0 kg ANS: B

15. 3kg → 8 m/s, M before; M → 6 m/s after
elastic, $v_{2f} = \frac{2m_1}{m_1+m_2} v_{1i} = \frac{6}{3+M}\times 8 = 6 \Rightarrow M = 5$ kg