Section (5)

Physics (I)

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Revision

1) The expressions for **kinetic energy** $E = \frac{1}{2}mv^2$ (where m is the mass of the body and v is its speed) and **potential energy** $E = mgh$ (where g is the acceleration due to gravity and h is the height of the body) look very different but both describe energy. One way to see this is to note that they have the same dimension.

Solution:

Dimension of **kinetic energy**

$$\frac{1}{2}mv^2 \Rightarrow \mathrm{M}(\mathrm{L}\,\mathrm{T}^{-1})^2 = \mathrm{M}\mathrm{L}^2\mathrm{T}^{-2}$$

Dimension of **potential energy**

$$mgh \Rightarrow \mathrm{M}(\mathrm{L}\,\mathrm{T}^{-2})\mathrm{L} = \mathrm{M}\mathrm{L}^2\mathrm{T}^{-2}$$

Both expressions have the same dimensions, they can therefore be added and subtracted from each other.

2)

In a 100-m linear accelerator, an electron is accelerated to 1.00% of the speed of light (c = $3\text{x}10^8$ m/s) in 40.0 m. (a) What is the electron's acceleration during this 40.0 m?

$$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i): \left[0.01(3\times10^8 \text{ m/s})\right]^2 = 0 + 2a_x(40 \text{ m})$$

$$a_x = \frac{(3\times10^6 \text{ m/s})^2}{80 \text{ m}} = \boxed{1.12\times10^{11} \text{ m/s}^2}$$

3)

Two vectors are give by $\mathbf{A} = 2\mathbf{i} + 3\mathbf{j} + \mathbf{k}$ and $\mathbf{B} = -\mathbf{i} + 2\mathbf{j} + B_z\mathbf{k}$. The magnitude of the resultant $\mathbf{A} + \mathbf{B}$ is 6. What are the two possible values of B_z.

Solution:

The sum of the two vectors is:

$$A + B = (2i + 3j + k) + (-i + 2j + B_z k) = i + 5j + (1 + B_z)k$$

The magnitude of this vector is:

$$|A + B| = \sqrt{1 + 25 + (1 + B_z)^2} = 6$$

Solving for B_z:

$$26 + (1 + B_z)^2 = 36$$

$$B_z = \pm\sqrt{10} - 1$$

$$B_z = 2.16;\ -4.16$$

MCQ

Which one of the quantities below has dimensions equal to $\left[\frac{ML}{T^2}\right]$?

a. mv

b. mv^2

c. $\frac{mv^2}{r}$

d. mrv

e. $\frac{mv^2}{r^2}$

Ans: C

The average speed of a moving object during a given interval of time is always:

A. the magnitude of its average velocity over the interval

B. the distance covered during the time interval divided by the time interval

C. one-half its speed at the end of the interval

Ans: B

The coordinate-time graph of an object is a straight line with a positive slope. The object has:

A. constant displacement
B. steadily increasing acceleration
C. steadily decreasing acceleration
D. constant velocity
E. steadily increasing velocity

Ans: D

An object is thrown vertically upward at 35 m/s. Taking g = 10 m/s^2, the velocity of the object 5 s later is:

A. 7.0 m/s up
B. 15 m/s down
C. 15 m/s up
D. 85 m/s down
E. 85 m/s up

Ans: B

If $\vec{A} = 12\hat{i} - 16\hat{j}$ and $\vec{B} = -24\hat{i} + 10\hat{j}$, what is the direction of the vector $\vec{C} = 2\vec{A} - \vec{B}$?

−49°	a.
−41°	b.
−90°	c.
+49°	d.
+21°	e.

If two collinear vectors $\vec{A}$ and $\vec{B}$ are added, the resultant has a magnitude equal to 4.0. If $\vec{B}$ is subtracted from $\vec{A}$, the resultant has a magnitude equal to 8.0. What is the magnitude of $\vec{A}$?

2.0	a.
3.0	b.
4.0	c.
5.0	d.
6.0	e.

Starting from one oasis, a camel walks 25 km in a direction 30° south of west and then walks 30 km toward the north to a second oasis. What distance separates the two oases?

15 km	a.
48 km	b.
28 km	c.
53 km	d.
55 km	e.

Vectors $\vec{A}$ and $\vec{B}$ each have magnitude L. When drawn with their tails at the same point, the angle between them is 60°. The magnitude of the vector product $\vec{A} \times \vec{B}$ is:

A. $L^2/2$
B. L^2
C. $\sqrt{3}L^2/2$
D. $2L^2$
E. none of these

Ans: C

The value of $\hat{\mathrm{i}} \cdot (\hat{\mathrm{j}} \times \hat{\mathrm{k}})$ is:

A. zero
B. $+1$
C. -1
D. 3
E. $\sqrt{3}$

Ans: B