Q1.
Which formula could be correct for the speed *v* of ocean waves in terms of the density ρ of sea water, the acceleration of free fall g, the depth *h* in the ocean, and the wave length λ?
(Note: Unit for wave length λ is meter (m) and unit for density ρ is kg/m^3)

A) $v = \sqrt{g\lambda}$
B) $v = \sqrt{\frac{g}{h}}$
C) $v = \sqrt{\rho g h}$
D) $v = \sqrt{g\rho}$
E) $v = \sqrt{\frac{\rho g}{h}}$

Q2.
The mass of a piece of card board is 20 g. Its length and width are 8.0 and 3.0 inches, respectively. If the thickness of the card board is 0.50 mm, what is the density of the card board in kg/m^3?
(1 inch = 2.54 cm)

A) 2.58×10^{3}
B) 1.67×10^{-2}
C) 1.67×10^{-3}
D) 2.58×10^{-4}
E) 2.45×10^{5}

Q3.
A ball is dropped (free fall) from a certain height. The ball hits the ground with speed *v* and rebounds vertically upward with the same speed *v*. What is the change in velocity of the ball during impact with the ground ($\hat{j}$ is a unit vector along the positive y-axis)? Neglect air resistance.

A) $+2v\ \hat{j}$
B) $-2v\ \hat{j}$
C) $+v\ \hat{j}$
D) $-v\ \hat{j}$
E) 0

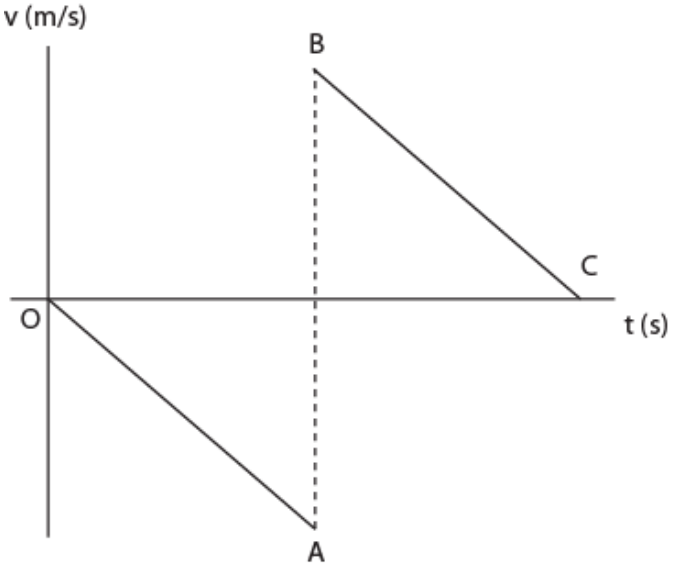
Q4.
A particle moves along the x-axis. Its position *x* as a function of time *t* is given by:

$$x = 12t - 2t^2,$$

where *x* is in meters and *t* is in seconds. At what time (in seconds) does the particle change its direction of motion?

A) 3
B) 4
C) 5
D) 6
E) 2

Q5.
A ball is dropped from a certain height and bounces back vertically upward after hitting the ground. **Figure 1** shows the velocity-time sketch of the ball. Line OA shows the downward motion of the ball and line BC shows the upward motion of the ball (after rebound). The slopes of lines OA and BC must be equal because



A) the acceleration due to gravity remains constant
B) the velocity remains the same before and after impact with the ground
C) the rebound height is equal to the height from where the ball was dropped
D) the speed before and after impact with the ground is not the same
E) the velocity changes its direction during impact.

Q6.
Stone A is thrown vertically upward from the ground with an initial speed of 9.8 m/s. After 1 second, stone B is thrown with the same speed vertically upward from the same position. Find the time (in seconds) at which they will be at the same height simultaneously.

A) 1.5
B) 1.0
C) 2.0
D) 1.2
E) 2.5

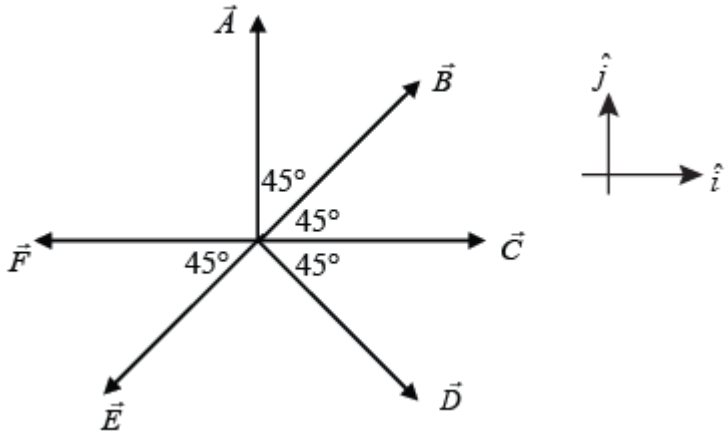
Q7.

Consider two non-zero vectors $\vec{A}$ and $\vec{B}$. If $\left|\vec{A}+\vec{B}\right|^2 = \left|\vec{A}\right|^2 + \left|\vec{B}\right|^2$, then:

A) None of the other answers is true.
B) $\vec{A}$ and $\vec{B}$ must be parallel and in opposite directions.
C) The angle between $\vec{A}$ and $\vec{B}$ must be 45°.
D) The angle between $\vec{A}$ and $\vec{B}$ must be 60°.
E) $\vec{A}$ and $\vec{B}$ must be parallel and in the same direction.

Q8.

Six vectors ($\vec{A}$, $\vec{B}$, $\vec{C}$, $\vec{D}$, $\vec{E}$ and $\vec{F}$) of magnitude 10.0 each are shown in **Figure 2**. Find the resultant of these vectors in unit vector notations.



A) $7.07\,\hat{i} + 2.93\,\hat{j}$
B) $7.07\,\hat{i} - 2.93\,\hat{j}$
C) $2.93\,\hat{i} + 7.07\,\hat{j}$
D) $2.93\,\hat{i} - 7.07\,\hat{j}$
E) $60.0\,\hat{j}$

Q9.
If $\vec{d}_1 = 3\hat{i} - 2\hat{j}$ and $\vec{d}_2 = -5\hat{i} + 2\hat{j}$, find $\left(\vec{d}_1 + \vec{d}_2\right) \cdot \left(\vec{d}_1 - \vec{d}_2\right)$.

A) –16
B) 8
C) 15
D) – 4
E) 0

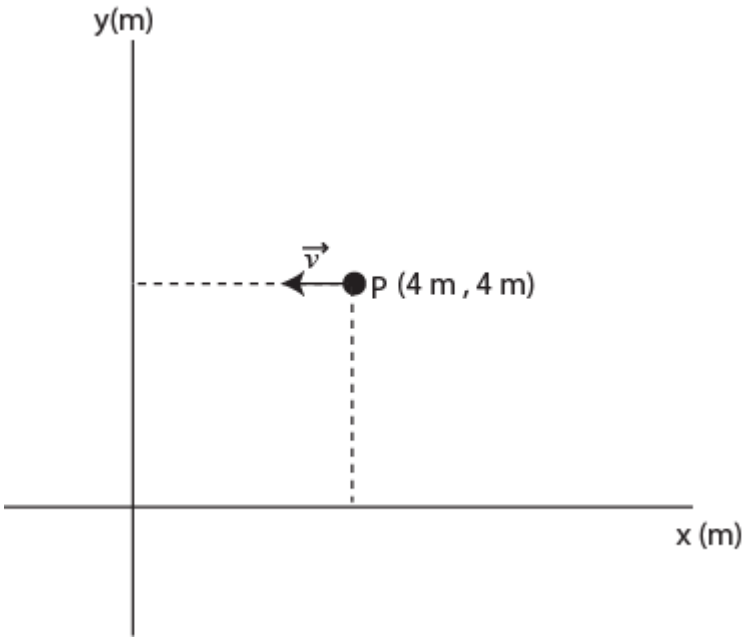
Q10.
A particle is moving in the horizontal *xy*-plane with a constant acceleration. If it starts from the origin with an initial velocity $\vec{v}_0 = 4\hat{i} + 4\hat{j}$ m/s, and 2 seconds later reaches the position $4\hat{i} + 5\hat{j}$ m, find its velocity at time *t* = 2 s.

A) $1\hat{j}$ m/s
B) $8\hat{i} + 9\hat{j}$ m/s
C) $9\hat{i} + 8\hat{j}$ m/s
D) $4\hat{i} + 6\hat{j}$ m/s
E) $3\hat{i} + 2\hat{j}$ m/s

Q11.
A straight river has a steady speed of 0.5 m/s. A boy swims upstream a distance of 500 m and swims back to the starting point. If the boy can swim at a speed of 1.5 m/s in still water, calculate the total time taken for his round trip?

A) 750 s
B) 667 s
C) 500 s
D) 1000 s
E) 2000 s

Q12.
A particle moves horizontally in uniform circular motion in a horizontal *xy* plane. At one instant it moves through the point P at coordinates (4 m, 4 m) with a velocity of $-6\hat{i}$ m/s and an acceleration of $12\hat{j}$ m/s^2 where $\hat{i}$ and $\hat{j}$ are unit vectors along *x* and *y* axes, respectively (**Figure 3**). Find the *x* and *y* coordinates of the center of the circular path.

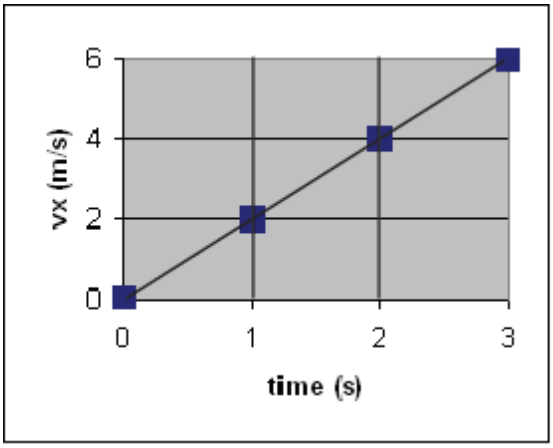


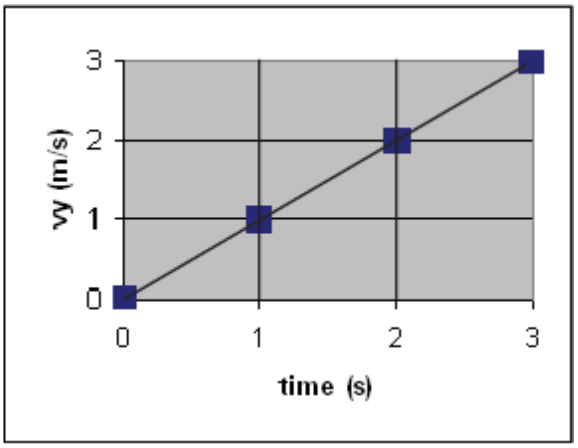
A) (4 m, 7 m)
B) (4 m, 6 m)
C) (7 m, 7 m)
D) (6 m, 4 m)
E) (0 m, 0 m)

Q13.
While flying horizontally at a constant velocity a plane drops a package through a trap door in its floor. The plane continues at the same velocity. At the instant the package strikes the ground, neglecting air friction, the plane will be (Choose the CORRECT answer):

A) Directly over the package.
B) Far behind the package.
C) In front of the package.
D) Just behind the package.
E) At a relative position which depends on the plane's speed.

Q14.
A constant force in the *xy*-plane pushes a 2.0 kg object across a horizontal frictionless floor on which an *x*-*y* coordinate system is drawn. The *x* and y components of the velocity of the object as a function of time are shown in **Figure 4**. The magnitude of the force is:

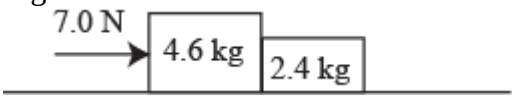




A) 4.5 N
B) 6.0 N
C) 2.2 N
D) 4.0 N
E) 3.0 N

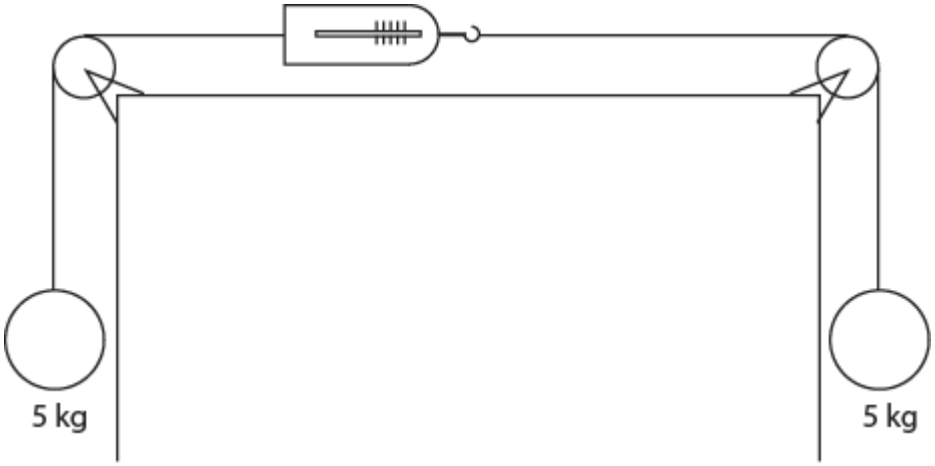
Q15.
A large block of mass 4.6 *kg* and a small block of mass 2.4 *kg* are in contact on a frictionless table as shown in **Figure 5**. A horizontal force of 7.0 *N* is applied to the larger block. What is the magnitude of the force between the two blocks?

Fig#



A) 2.4 N
B) 4.6 N
C) 7.0 N
D) 3.2 N
E) 0 N

Q16.
The system shown in **Figure 6** is in equilibrium. If the spring scale is calibrated in N, what does it read?

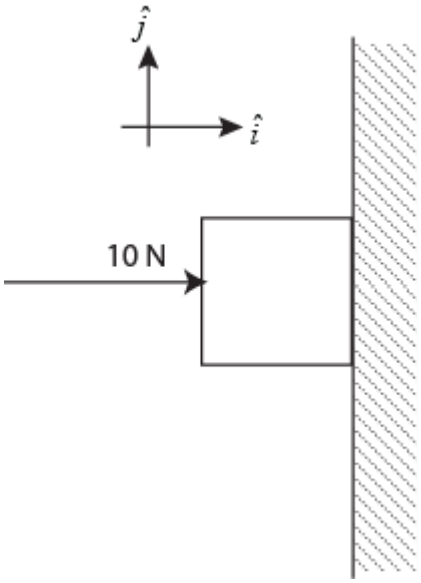


A) 49
B) 98
C) 75
D) 0
E) 25

Q17.
A 500 N man is riding in an elevator. At a certain instant his feet push against the floor with a force greater than 500 N. At this instant, the elevator may be (Choose the **CORRECT** Answer):

A) Moving downward but decreasing in speed
B) Moving upward but decreasing in speed
C) Moving downward but increasing in speed
D) Not moving (Standing still)
E) Moving at a constant speed

Q18.
As shown in **Figure 7**, a block weighing 5.0 N is held at rest against a vertical wall by a horizontal force of magnitude 10 N. The coefficient of static friction between the wall and the block is 0.60, and the coefficient of kinetic friction is 0.40. In unit vector notation, find the force on the block from the wall.



A) $-10\ \hat{i} + 5.0\ \hat{j}$
B) $+10\ \hat{i} - 5.0\ \hat{j}$
C) $-10\ \hat{i} - 5.0\ \hat{j}$
D) $-10\ \hat{i} - 6.0\ \hat{j}$
E) $+10\ \hat{i} + 6.0\ \hat{j}$

Q19.
A 20.0 kg block is initially at rest on a rough, horizontal surface. A horizontal force of 75.0 N is required to set the block in motion. After it is in motion, a horizontal force of 60.0 N is required to keep the block moving with constant speed. Find the coefficients of static and kinetic friction.

A) 0.383; 0.306
B) 0.450; 0.306
C) 0.330; 0.286
D) 0.432; 0.185
E) 0.234; 0.123

Q20.
A car rounds a flat curved road (radius = 100 m) at a speed of 25.0 m/s and is about to slide at this speed. What is the coefficient of static friction between the tires of the car and the road?

A) 0.638
B) 0.250
C) 0.753
D) 0.800
E) 0.105