1) The position, $x$, of an object is given by the equation $x = A + B(t + Ct^2)$, where $t$ refers to time. What are the dimensions of $A$, $B$, and $C$, respectively?
(L – length, T-time).

(A) $L$, $L/T$, $T^{-1}$
(B) $L$, $L$
(C) $L$, $L/T$, $L/T^2$
(D) $L$, $T$, $T$
(E) $L$, $T$, $T^2$

2) The position of an object is given as a function of time as $x(t) = (-3.00 \text{ m/s})t + (1.00 \text{ m/s}^2)t^2$. What is the average velocity of the object between $t = 0.00 \text{ s}$ and $t = 2.50 \text{ s}$?

(A) $-0.500 \text{ m/s}$
(B) $2.60 \text{ m/s}$
(C) $0.500 \text{ m/s}$
(D) $1.30 \text{ m/s}$
(E) $2.00 \text{ m/s}$

3) A car starts from rest and accelerates with a constant acceleration of $1.00 \text{ m/s}^2$ for $3.00 \text{ s}$. The car continues for $5.00 \text{ s}$ at constant velocity. How far has the car traveled from its starting point?

$\text{x}(t=3) = 0 + 0.5(3 \text{ m/s}^2)(3 \text{ s})^2 = 4.5 \text{ m}$
$\text{v}(t=3) = 0.5(1 \text{ m/s}^2)(3 \text{ s}) = 1.5 \text{ m/s}$
$\text{x}(t=5) = 0 + 0.5(3 \text{ m/s}^2)(5 \text{ s}) + 0.5(1 \text{ m/s}^2)(5 \text{ s})^2 = 15 \text{ m}$

(A) $15.0 \text{ m}$
(B) $4.50 \text{ m}$
(C) $19.5 \text{ m}$
(D) $24.0 \text{ m}$
(E) $9.00 \text{ m}$

4) A plane has an eastward heading at a speed of $156 \text{ m/s}$ (relative to the air). A $20 \text{ m/s}$ wind is blowing southward while the plane is flying. The velocity of the plane relative to the ground is

$\text{v}_{\text{plane}} = (156 \text{ m/s}) \hat{\imath} + 0 \hat{j}$

$\text{v}_{\text{wind}} = 0 \hat{\imath} - (20 \text{ m/s}) \hat{j}$

$\text{v}_{\text{tot}} = (156 \text{ m/s}) \hat{\imath} - (20 \text{ m/s}) \hat{j}$

$\text{v}_{\text{tot}} = 157 \text{ m/s}$

(A) $157 \text{ m/s}$ at an angle $7.3^\circ$ east of south.
(B) $157 \text{ m/s}$ at an angle $7.3^\circ$ south of east.
(C) $136 \text{ m/s}$ at an angle $7.4^\circ$ south of east.
(D) $155 \text{ m/s}$ at an angle $7.4^\circ$ south of east.
(E) $136 \text{ m/s}$ at an angle $7.4^\circ$ east of south.

5) A teacher sends her students on a treasure hunt. She gives the following instructions:

1. Walk $300 \text{ m}$ north
2. Walk $400 \text{ m}$ northwest
3. Walk $700 \text{ m}$ east-southeast and the treasure is buried there.

As all the other students walk off following the instructions, Joe physics student quickly adds the displacements and walks in a straight line to find the treasure. How far and in what direction does Joe need to walk?

$\text{A} = 0 \hat{\imath} + 300 \hat{j}$
$\text{B} = -283 \hat{\imath} + 283 \hat{j}$
$\text{C} = 647 \hat{\imath} - 283 \hat{j}$
$\text{D} = 564 \hat{\imath} + 31 \hat{j}$

$\text{F} = 481 \hat{\imath} + 40 \hat{j}$

(A) $187 \text{ m}$ in a direction $67.3^\circ$ north of east
(B) $399 \text{ m}$ in a direction $52.5^\circ$ north of east
(C) $284 \text{ m}$ in a direction $28.2^\circ$ west of north
(D) $481 \text{ m}$ in a direction $40.9^\circ$ north of east
(E) The treasure position cannot be reached in one straight walk.
6) A car moves from the point \((3.0 \text{ m})i + (5.0 \text{ m})j\) to the point \((8.0 \text{ m})i - (7.0 \text{ m})j\) in 2.0 s. What is the magnitude of the average velocity of the car?

\(\vec{\Delta x} = 5 \hat{i} - 12 \hat{j}\)

\(\frac{\Delta x}{\Delta t} = \frac{\sqrt{5^2 + (-12)^2}}{2} = \frac{5}{12} \approx 2.5 \hat{i} - 6 \hat{j}\)

\(|\vec{v}| > 6.5 \text{ m/s}\)

A) 6.5 m/s  B) 3.3 m/s  C) 4.5 m/s  D) 13 m/s  E) 9.0 m/s

7) A car moves from the point \((3.0 \text{ m})i + (5.0 \text{ m})j\) to the point \((8.0 \text{ m})i - (7.0 \text{ m})j\) in 2.0 s. What is the direction of the average velocity of the car?

\[\theta = \tan^{-1}\left(\frac{-8}{5}\right) = -67^\circ\]

A) 52° from the x-axis  B) 33° from the x-axis  C) 67° from the x-axis  D) -33° from the x-axis  E) 67° from the x-axis

8) A hockey puck slides off the edge of a table with an initial velocity of 26.0 m/s. The height of the table above the ground is 2.00 m. What is the angle below the horizontal of the velocity of the puck just before it hits the ground? (Neglect air resistance)

\[v_y = v_x \sin(0.638) = 6.2 \text{ m/s}\]

\[\theta = \tan^{-1}\left(\frac{6.2}{25}\right) = 13.5^\circ\]

A) 13.5°  B) 77.2°  C) 72.6°  D) 31.8°  E) 12.8°

9) A bullet is fired through a board, 14.0 cm thick, with its line of motion perpendicular to the face of the board. If it enters with a speed of 450 m/s and emerges with a speed of 220 m/s, what is the bullet's acceleration (assumed to be constant) as it passes through the board?

\[v^2 = v_o^2 + 2a(x-x_o)\]

\[220^2 = 450^2 + 2a(0.14)\]

\[a = \frac{220^2 - 450^2}{2 \times 0.14} = -550 \text{ km/s}^2\]

A) -500 km/s²  B) -550 km/s²  C) -360 km/s²  D) -520 km/s²  E) -275 km/s²

10) A projectile is thrown from the top of a building with an initial velocity of 30 m/s in the horizontal direction. If the top of the building is 30 m above the ground, how fast will the projectile be moving just before it strikes the ground? (Neglect air resistance)

\[30 = v_o x + \frac{1}{2}gt^2 \rightarrow t = 2.475\]

\[v_y = g(2.475) = 24.2 \text{ m/s}\]

\[|v_{tot}| = \sqrt{30^2 + 24.2^2} = 38.5 \text{ m/s}\]

A) 35 m/s  B) 39 m/s  C) 31 m/s  D) 43 m/s  E) 54 m/s
11) A 0.14-km wide river flows with a uniform speed of 4.0 m/s toward the east. It takes 20 s for a boat to cross the river to a point directly north of its departure point on the south bank. What is the speed of the boat relative to the water?

A) 5.7 m/s
B) 8.5 m/s
(C) 8.1 m/s
D) 7.0 m/s
E) 6.4 m/s

12) A rock is projected from the edge of the top of a building with an initial velocity of 12.2 m/s at an angle of 53° above the horizontal. The rock strikes the ground a horizontal distance of 25 m from the base of the building. Assume that the ground is level and that the side of the building is vertical. How tall is the building? (Neglect air resistance)

A) 25.3 m
B) 29.6 m
C) 27.4 m
D) 23.6 m
E) 18.9 m

13) A car travels in a due northerly direction at a speed of 55 km/h. The traces of rain on the side windows of the car make an angle of 60 degrees with respect to the horizontal. If the rain is falling vertically with respect to the earth, what is the speed of the rain with respect to the earth?

A) 48 km/h
B) 95 km/h
C) 58 km/h
D) 32 km/h
E) 80 km/h

14) Two forces are the only forces acting on a 3.0-kg object which moves with an acceleration of 3.0 m/s² in the positive y direction. If one of the forces acts in the positive x direction and has a magnitude of 8.0 N, what is the magnitude of the other force?

A) 12 N
B) 14 N
C) 16 N
D) 18 N
E) 22 N
15) Given the vectors $|\vec{A}| = 15$ and $\vec{B} = 12\hat{i} - 16\hat{j}$, what is the magnitude of $\vec{A} - \vec{B}$ if the direction of vector $\vec{A}$ is $80^\circ$ above the x-axis.

\[
\vec{A} - \vec{B} = (2.6 - 12)\hat{i} + (14.8 + 16)\hat{j} = -9.4\hat{i} + 30.8\hat{j}
\]

\[|\vec{A} - \vec{B}| = 32.2\]

A) 15
B) 35
C) 32
D) 5.0
E) 23

16) A book weighing 30 N rests on a table. The reaction force to the weight of the book is

A) an upward force of 30 N exerted on the book by the table
B) a downward force of 30 N exerted on the table by the book
C) an upward force of 30 N exerted on the table by the book
D) a downward force of 30 N exerted on the book by the earth
E) an upward force of 30 N exerted on the earth by the book

17) A skier is being pulled by a tow rope at a constant velocity up a slope of 25 degrees. The mass of the skier is 80 kg. Including a friction force between the snow and the skis of 100 N, what is the magnitude of the net force on the skier?

A) 0 N
B) 100 N
C) 884 N
D) 684 N
E) None of the other answers.

\[
\text{constant velocity } \Rightarrow \text{ acceleration } = 0 \Rightarrow \Sigma F = 0
\]