**Answers to Sample Test #1**

**Multiple Choice**

1. $\vec{A} + \vec{B} + \vec{C}$ (A)

2. $\vec{A} + (-\vec{C})$ (B)

3. $\vec{A} - (-\vec{B}) + \vec{C}$ (C)

4. DISPLACEMENT = $\Delta \vec{R}$

$|\Delta \vec{R}| = \sqrt{(5 \text{ km})^2 + (1 \text{ km})^2} = 5.1 \text{ km}$ (B)

5. $\vec{v}_\text{avg} = \frac{\Delta \vec{R}}{\Delta t}$

This question was not "perfect", it should have had an angle.

One needs to calculate the time from start to finish.

$\Delta t_1 = \frac{5 \text{ km}}{10 \text{ km/h}} = 0.5 \text{ h}$

$\Delta t_2 = \frac{1 \text{ km}}{2 \text{ km/h}} = 0.5 \text{ h}$

So $\Delta t = \Delta t_1 + \Delta t_2 = 0.5 \text{ h} + 0.5 \text{ h} = 1 \text{ h}$.

The average velocity is $\frac{5.1 \text{ km}}{1 \text{ hr}} = |\vec{v}_\text{avg}| = 5.1 \text{ km/h}$.

at an angle $\alpha \Rightarrow \tan \alpha = \frac{1 \text{ km}}{5 \text{ km}}$ below west. (C)

6. Average speed = 5.1 km/h (C)

This is not the "usual" meaning of average velocity in "car racing" (or any track race). Average velocity or average speed is usually used to describe "lap velocity" = total distance travelled / time interval.
(7) This is a projectile motion problem with the ball travelling with constant \( v_x = v_0 \cos 30^\circ \), and
\( v_y = v_0 \sin 30^\circ - \frac{1}{2} gt^2 \). The person is running with constant velocity \( v_x = 3 \text{ m/s} \).

(8) Here one has to calculate the time it takes the ball to go up from 9.8 m and come down to 2 m.

\[ 2 \text{ m} = 9.8 \text{ m} + 5 \text{ m/s} \sin 30^\circ \cdot t - \frac{1}{2} \cdot 9.8 \text{ m/s}^2 \cdot t^2 \]

\[ 2 \text{ m} = 9.8 \text{ m} + 2.5 \text{ m/s} \cdot t - 4.9 \text{ m/s}^2 \cdot t^2 \]

\[ t = \frac{-2.5 \pm \left[ (2.5)^2 + 4 \times 7.8 \times 4.9 \right]^{1/2}}{-2 \times 4.9} = +1.54 \text{ s}. \]

(9) There is also a negative solution (-1.0 sec) which represents the solution to the same problem if the ball had been thrown "from the left" and reached the 9.8 m height at the 30° angle, still going up.

**Problem 1:**
\[ \frac{3 \text{ inches}}{\text{minute}} \times \frac{0.0254 \text{ m}}{\text{inch}} \times \frac{1}{60 \text{ sec/min}} = 1.27 \times 10^{-3} \text{ m/s} \]

**Problem 2**
\[ \vec{A} + \vec{B} + \vec{C} \]

**Problem 3**
(See next page)
Problem 4

(a) \[ \Delta x = \Delta t_1 + \Delta t_2 + \Delta t_3 = \frac{1 \text{ km}}{10 \text{ km/hr}} + \frac{1 \text{ km}}{5 \text{ km/hr}} + \frac{1 \text{ km}}{2 \text{ km/hr}} = 0.8 \text{ hrs.} \]

(b) \[ \Delta R_x = 1 + 1 = 2 \text{ km}, \quad \Delta R_y = -1 = -1 \text{ km}, \quad \Delta R = \sqrt{((2)^2 + (1)^2)} = 2.23 \text{ km}, \quad \tan \theta = \frac{-1}{2} = -27^\circ \text{ with East (or x)} \]

(c) Average speed is 2.79 km/hr.

Text used in 1999 defined average speed as \text{linear distance travelled} \text{time}, which here will be \[ \frac{3 \text{ km}}{0.8 \text{ hr}} = 3.75 \text{ km/hr}. \]
Problem 1 (121A, 1998)

(a) \[ \vec{R} = 60 \text{ m} \hat{i} + 10 \text{ m} \hat{j} \]
\[ \vec{a} = -9.8 \text{ m/s}^2 \hat{k} \]

(b) \[ \vec{R} = 60 \text{ m} \hat{i} + 10 \text{ m} \hat{j} \]
\[ \vec{v} = \frac{30 \text{ m}}{5} \cos 30^\circ \hat{i} - \frac{30 \text{ m}}{5} \sin 30^\circ \hat{j} \]
\[ \vec{a} = -9.8 \text{ m/s}^2 \hat{k} \]

(c) 
\[ \begin{align*}
\tau &= \text{constant} \\
\theta &= \text{constant} \\
\alpha &= 20^\circ \sin 20^\circ \\
\end{align*} \]

(d) One way is to calculate the time to the ground, another way to calculate \( \Delta x \) directly.
\[ \int \frac{mg}{i} \rightarrow \begin{align*}
0 &= 10 \text{ m} + 30 \text{ m/s} \sin 20^\circ \frac{t}{s} - \frac{1}{2} \frac{9.8 \text{ m/s}^2}{s} t^2 \\
\end{align*} \]
\[ x \rightarrow \begin{align*}
\Delta x &= v_0 \cos \theta \cdot t = 30 \text{ m/s} \cos 20^\circ \cdot t \\
\end{align*} \]
Solve for \( t \) in (1), insert in (2), solve for \( \Delta x \).

Problem 1 (114, 1999)

(b) \( F_{12} \) and \( F_{21} \), \( F_{23} \) and \( F_{32} \)

(c) Yes, mass 2 is accelerating at \( 0.1 \text{ m/s}^2 \), so \( F_{net2} = M_2 a_2 \)

(d) Can be solved using \( F_p - F_{friction} = (M_1 + M_2 + M_3) a \)