FIRST MIDTERM

Name (print)  SOLUTION  Name (signed)  

Discussion Instructor (circle one): Baselgia  Morrill  Reeve  Stoops  Zhang  

Discussion  Section #  

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!  
Use the conversion constants and data given on the front page.  

(a) Convert 1652 m to feet.  
\[ \text{Since} \ 1 \text{m} = 3.28 \text{ft} \ \left( \frac{3.28 \text{ft}}{1 \text{m}} \right) = 5420 \text{ ft} \]

(b) Convert 356 m/s to ft/s.  
\[ \frac{\text{m}}{s} \times 3.28 \frac{\text{ft}}{\text{m}} = 1170 \text{ ft/s} \]

(c) On a small planet a stone is dropped. After falling 13.0 m it has a speed of 9.80 m/s. Find the value of g on this planet.  
\[ V_f^2 = V_i^2 + 2a(x_f-x_i) \]  
\[ V_f = 9.8 \text{ m/s} \]  
\[ x_f - x_i = 13 \text{ m} \]  
\[ V_i = 0 \]  
\[ a = \frac{V_f^2 - V_i^2}{2(x_f-x_i)} \]  
\[ a = 3.69 \text{ m/s}^2 \]

(d) On the moon, how much time elapses for a dropped object to acquire a downward velocity of 33.0 m/s?  
\[ V_f = V_i + at \]  
\[ t = \frac{V_f - V_i}{a} \]  
\[ V_i = 0 \text{ m/s} \]  
\[ V_f = 33 \text{ m/s} \]  
\[ a = 1.67 \text{ m/s}^2 \]  
\[ t = 19.8 \text{ sec} \]

(e) On the moon an object dropped from a cliff lands in 135 s. How high (in m) is the cliff?  
\[ x_f - x_i = V_i t + \frac{1}{2} a t^2 \]  
\[ x_f - x_i = (0 \times 135\text{sec}) - \frac{1}{2} (1.67 \text{m/s}^2)(135\text{sec}) \]  
\[ V_i = 0 \]  
\[ t = 135\text{sec} \]  
\[ g = -1.67 \text{m/s}^2 \]  
\[ x_f - x_i = 1.52 \times 10^4 \text{ m} \]
FIRST MIDTERM

Name (print)  Kristen Stoops  Name (signed)  Average = 19.7  SD = 4.0

Discussion Instructor (circle one): Baselgia  Morrill  Reeve  Stoops  Zhang

Discussion  Section #

SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Given two vectors, \( \vec{A} \) and \( \vec{B} \), given by \( \vec{A} = -2.75 \hat{i} + 4.75 \hat{j} \) and \( \vec{B} = -3.25 \hat{i} + 5.65 \hat{j} \).

(a) Calculate \( \vec{A} + \vec{B} \) (in \( \hat{i}, \hat{j} \) notation).
(b) Calculate \( \vec{B} - \vec{A} \) (in \( \hat{i}, \hat{j} \) notation).
(c) Calculate \( \vec{A} \cdot \vec{B} \).
(d) Calculate the angle between \( \vec{A} \) and \( \vec{B} \).
(e) Calculate the magnitude of \( \vec{B} \).

\[ \begin{align*}
\vec{A} + \vec{B} &= (-2.75 - 3.25) \hat{i} + (4.75 - 5.65) \hat{j} = -6.00 \hat{i} - 0.90 \hat{j} \\
\vec{B} - \vec{A} &= \left[ (-3.25) - (-2.75) \right] \hat{i} + \left[ (-5.65) - (4.75) \right] \hat{j} \\
&= -0.50 \hat{i} - 10.4 \hat{j} \\
\vec{A} \cdot \vec{B} &= A_x B_x + A_y B_y = (-2.75)(-3.25) + (4.75)(-5.65) \\
&= -17.9 \quad \text{° note: this is a scalar quantity!} \\
\cos \Theta_{AB} &= \frac{\vec{A} \cdot \vec{B}}{|\vec{A}| |\vec{B}|} \Rightarrow 120° = \Theta_{AB} \\
|\vec{A}| &= \left[ (-2.75)^2 + (4.75)^2 \right]^{1/2} = 5.49 \text{ units} \\
|\vec{B}| &= \left[ (-3.25)^2 + (5.65)^2 \right]^{1/2} = 6.52 \text{ units}
\end{align*} \]
FIRST MIDTERM

A car skids to a stop with uniform acceleration. The acceleration is \(-20.0 \text{ ft/s}^2\) and the skid marks are 135 ft long.

(a) Calculate the speed at the beginning of the skid.
(b) Calculate the time interval between the beginning of the skid and stopping.
(c) If under the same circumstances the car hits another car after skidding 42 ft, what is its speed at impact?

\[ a = -20.0 \text{ ft/s}^2, \quad x_f - x_0 = 135 \text{ ft}, \quad v_f = 0, \quad v_0 = ? \]

\[ v_f^2 - v_0^2 = 2a(x_f - x_0) \Rightarrow v_0 = \sqrt{v_f^2 - 2a(x_f - x_0)} = \sqrt{0^2 - 2(-20.0)(135)} = 73.48 \Rightarrow 73.5 \text{ ft/sec} = v_0 \]

\[ v_f = v_0 + at \Rightarrow t = \frac{v_f - v_0}{a} = \frac{0 - 73.48}{-20.0} = 3.67 \text{ sec} = t \]

\[ v(\text{ft/s}) = 73.48 \]

\[ v_f = \sqrt{v_0^2 + 2ax} = \sqrt{73.48^2 + 2(-20.0)(42)} = 61.0 \text{ ft/sec} = v \]

Several students misunderstand part (c). The velocity at impact is certainly not 0.

-1 for significant figures ≠ 3.
-1 for missing or incorrect units.
FIRST MIDTERM

SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

A cannon is fired at an angle of 37° and a muzzle velocity of 300 m/s. The ground is level for 1500 m, and then rises in a 45° slope. (In this problem it is important to do the work algebraically as far as possible before putting in any numbers.)

(a) Find the x and y coordinates of the point of impact of the shell on the hill.
(b) Find the time of flight of the shell.

(a) Find the Eq for cannon ball
\[ x = u_0 \cos \theta \cdot t \]
\[ y = u_0 \sin \theta \cdot t - \frac{1}{2} gt^2 \]
\{ +7 if correct \}
Find the Eq for hill
\[ y = x - 1500 \] (Notice \( \tan \theta = \tan 45° = 1 \)) \{ +5 if correct \}
plug \( x \) and \( y \) in terms of \( t \) into \( y = x - 1500 \) and solve for \( t \)
\[ u_0 \sin \theta \cdot t - \frac{1}{2} gt^2 = u_0 \cos \theta \cdot t - 1500 \] \{ +3 if correct \}
\[ 4.9t^2 + u_0 (\cos 37° - \sin 37°) t - 1500 = 0 \]
\[ t = \frac{-59.05 \pm \sqrt{59.05^2 + 4 \times 1500 \times 49}}{9.8} \]
keep"+"one \[ t = 12.48 \text{ sec} = 12.5 \text{ sec} +5 \]

*5 if get correct \( t \); +2 if get the Eq to find the root \( t \)

\[ x = u_0 \cos 37° \cdot t = 299.4 \times 10^3 \text{ m} = 2.99 \times 10^3 \text{ m} \]
\[ y = x - 1500 = 1.49 \times 10^3 \text{ m} = 1.49 \times 10^3 \text{ m} \]
+5 if \( x, y \) were correct, +4 if had the right formula
A cannon is fired at an angle of 37° and a muzzle velocity of 300 m/s. The ground is level for 1500 m, and then rises in a 45° slope. (In this problem it is important to do the work algebraically as far as possible before putting in any numbers.)

(a) Find the x and y coordinates of the point of impact of the shell on the hill.
(b) Find the time of flight of the shell.

\[ x = v_0 \cos \theta t \]
\[ y = v_0 \sin \theta t - \frac{1}{2} gt^2 \]
\[ y = \frac{v_0 \sin \theta}{v_0 \cos \theta} x - \frac{1}{2} \frac{g}{v_0^2} x^2 \cdot \frac{1}{\cos^2 \theta} = x \tan \theta - \frac{1}{2} \frac{g}{v_0^2} x^2 (1 + \tan^2 \theta) + 7 \text{ if correct} \]

\[ \text{Find the Eq for hill} \]
\[ y = x - 1500 \quad (\tan \theta = \tan 45° = 1) \]
\[ y = x \tan \theta - \frac{1}{2} \frac{g}{v_0^2} (x + \tan^2 \theta) \]
\[ y = x \tan \theta - \frac{1}{2} \frac{g}{v_0^2} (1 + \tan^2 \theta) \]
\[ \Rightarrow \frac{4 \cdot 9 \cdot x^2}{90000} (1.568) + x (1 - \tan 37°) - 1500 = 0 \]
\[ 8.54 \times 10^{-5} x^2 + 0.246 x - 1500 = 0 \]
\[ x = \frac{-0.246 \pm \sqrt{(0.246)^2 + 4 \times 1500 \times 8.54 \times 10^{-5}}}{2 \times 8.54 \times 10^{-5}} \]
\[ \text{keep } +' \text{ one } \ x = 2.991 \times 10^3 \text{ m} \]
\[ = 2.99 \times 10^3 \text{ m} \]

\[ y = x - 1500 = 1.49 \times 10^3 \text{ m} \quad +5 \text{ if } x, y \text{ are correct} \]

\[ \frac{y}{\cos \theta} = \frac{x}{\cos \theta} = \frac{1.39 \times 10^3}{300 \cos 37°} = 13.55 \text{ sec} \]
\[ +5 \text{ if correct} \]

\[ \text{find the root } x \quad \text{by } t = \frac{x}{v_0 \cos \theta} = \frac{1.39 \times 10^3}{300 \cos 37°} = 13.55 \text{ sec} \]
\[ +4 \text{ if } x \text{ had the right} \]
FIRST MIDTERM

Name (print) Mark Reeve Name (signed) Mark Reeve

Discussion Instructor (circle one): Hamed Hari Molina Nott Paul Reeve Zhang

Discussion Section #

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) Convert 725 m to feet.

\[
\left(\frac{725 \text{ m}}{1 \text{ m}}\right) \left(\frac{3.281 \text{ ft}}{1 \text{ m}}\right) = 2.378 \times 10^3 \text{ ft} \\
\]

(b) Convert 186 mi/hr to ft/s.

\[
\left(\frac{186 \text{ mi}}{1 \text{ hr}}\right) \left(\frac{1 \text{ km}}{1 \text{ mi}}\right) \left(\frac{1000 \text{ m}}{1 \text{ km}}\right) \left(\frac{3.281 \text{ ft}}{1 \text{ m}}\right) = 272.8 \pm 273 \text{ ft/sec} \\
\]

(c) On a small planet a dropped from rest rock falls 18.0 ft in 17.0s. What is the magnitude of g on this planet?

\[
y = y_0 + v_0 t - \frac{1}{2} g t^2 \quad \Rightarrow \quad g = \frac{y - y_0 - v_0 t}{-\frac{1}{2} t^2} = \frac{0 - 18.0 - 0}{-\frac{1}{2} (17.0)^2} = \frac{1.246 \text{ ft/sec}^2}{g} \\
\]

(d) On the moon an object dropped from rest falls 250 m. What is its velocity after falling 250 m?

\[
g = 1.67 \text{ m/sec}^2 \text{ from data sheet.} \quad v^2 = v_0^2 + 2a(y-y_0) \quad \Rightarrow \quad v = \sqrt{v_0^2 + 2 \cdot 1.67 \cdot (0 - 250)} = \pm 28.9 \text{ m/sec} \\
\]

(e) A ball is thrown straight up on Jupiter (g = 26.5 m/s^2) at a speed of 50.0 m/s (about 100 mi/hr). How high (in meters) does it go?

\[
y_{\text{max}} = \frac{y_0 - v_0^2}{2a} = \frac{0 - (50)^2}{2 \cdot (-26.5)} = \pm 47.2 \text{ m} = y_{\text{max}} \\
\]

Grading: 5 pts. each.

-1 for missing or incorrect units

-1 for one entry or one too few significant figures (5.5)

Notes: A number of students (i.e. about half) made serious errors with significant figures.

All answers are to be reported to three significant figures unless the most significant object is a 1 in which case you are allowed (and encouraged) to use four (as in (c)).

Part (d) really should be negative but since up was not specified no points were taken off for negative answer.
FIRST MIDTERM

Given the following vectors:

\( \vec{A} = 5\hat{i} + 6\hat{j} + 8\hat{k} \)
\( \vec{B} = 3\hat{i} + 8\hat{j} + 8\hat{k} \)
\( \vec{C} = 4\hat{i} + 7\hat{j} - 2\hat{k} \)

(a) Calculate the z component of

\[ \vec{A} + \vec{C} \quad A_z + C_z = 8 + (-2) = 6 \]

(b) Find

\( \vec{A} + \vec{B} \) in \( \hat{i}, \hat{j}, \hat{k} \) notation.

\[ = (5+3)\hat{i} + (6+8)\hat{j} + (8+8)\hat{k} = 8\hat{i} + 14\hat{j} + 16\hat{k} \]

(c) Find the magnitude of.

\[ \vec{A} - \vec{C} = (5-4)\hat{i} + (6-7)\hat{j} + (8+2)\hat{k} = \hat{i} - \hat{j} + 10\hat{k} \]

Magnitude \( = \sqrt{1^2 + 1^2 + 10^2} = 10.10 \)

(d) Calculate the direction of

\[ \vec{A} - \vec{B} = (5-3)\hat{i} + (6-8)\hat{j} + (8-8)\hat{k} = 2\hat{i} - 2\hat{j} \]

\( \tan \theta = \frac{V_y}{V_x} = \frac{-2}{2} \)

\( \theta = -45^\circ \) or \( 315^\circ \)

(As an angle measured counterclockwise from the positive x-axis towards the positive y-axis.

Calculate

\( \vec{B} - \vec{A} + \vec{C} \) in \( \hat{i}, \hat{j}, \hat{k} \) notation.

\[ \begin{array}{c|c|c}
  x & y & z \\
  \vec{B} & 3 & 8 & 6 \\
  -\vec{A} & -5 & -6 & -8 \\
  \vec{C} & 4 & 7 & -2 \\
  \text{sum} & 2 & 9 & -2
\end{array} \]

\[ = 2\hat{i} + 9\hat{j} - 2\hat{k} \]
A ball is thrown up from the edge on top of a building. It is thrown in a way that the ball falls down alongside the building as shown. The building is 102 m high.

(a) If the ball takes 8.00 s to strike the ground, what was its initial velocity (including sign)?
(b) What is the velocity when the ball reaches the ground?
(c) How high above the top of the building does the ball go?

Solution:

\[ a) \quad x = v_0 t - \frac{1}{2} gt^2 \]

\[ v_0 = \frac{\frac{1}{2} g t^2 + x}{t} = \frac{\frac{1}{2} \times 9.8 \times 8.0^2 + (-102)}{8.0} = +26.5 \text{ m/s} \]

\[ b) \quad v = v_0 - gt = 26.5 - 9.8 \times 8.0 = -52.0 \text{ m/s} \]

\[ c) \quad x' = \frac{v_0^2}{2g} = \frac{26.5^2}{2 \times 9.8} = +35.7 \text{ m} \]

In (a), (b), or (c), if you make a wrong unit or significant figure, you get -1 point. In (b), if you have not (-) sign, you get -2 points.
A gun fires a large, slow projectile upwards alongside your building. You have a window that is 9.00 ft from top to bottom. You time the arrival of the projectile at the bottom of your window at 4.00 s and the top at 4.10 s (after leaving the ground). Be careful about rounding off too soon in this problem.

(a) Calculate the initial velocity of the projectile when it left the ground.
(b) Calculate how far it is from the ground to the bottom of your window.

\[ V_0' = \frac{\Delta y}{t} = \frac{\Delta y - \frac{1}{2} a t^2}{t} \]

\[ V_0' = \frac{91.6 - \frac{1}{2} (32)(4)}{4} = 91.6 \text{ ft/sec} \]

Use \( V_0' \) as initial velocity \( V_0 \) for the projectile entering at the ground:

\[ V_0 = V_0' + a t = (91.6) + (32)(4) = (219.6) \text{ ft/sec} \]

\[ V_0 = 220 \text{ ft/sec} \]

\[ V_0' = V_0 - 2a \Delta y \]

\[ d = \frac{V_0^2 - V_0'^2}{2a} = \frac{(91.6)^2 - (220)^2}{2(32)} = 1228.4 \text{ ft} \]
FIRST MIDTERM

Name (print) Condella
Name (signed) ____________________________

Discussion Instructor (circle): Condella DiCarlo Ganesan Holler Reeve

Discussion Section # ________

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) Convert 3742 feet to meters.

\[ 3742 \text{ ft} \times \frac{1 \text{ m}}{3.28 \text{ ft}} = 1141 \times 10^3 \text{ m} \]

(b) Convert 165 ft/s to m/s.

\[ 165 \text{ ft/s} \times \frac{1 \text{ m}}{3.28 \text{ ft}} = 50.3 \text{ m/s} \]

(c) A ball thrown upward on another planet with an initial upward velocity of 17.0 m/s goes 250 m high. Calculate g on this planet.

\[ g = \left| a \right| = \frac{V^2}{2(x-x_0)} = 578 \text{ m/s}^2 \]

(d) On Jupiter (g = 26.5 m/s²) an object is dropped from rest. How fast is it going after it falls 10.0 m?

\[ v = \left( -2g(x-x_0) \right)^{\frac{1}{2}} = 23.0 \text{ m/s} \]

(e) A drag racer accelerates to 250 mi/hr in a distance of 1/4 mile. Calculate the acceleration, in ft/s², assuming that it is uniform.

\[ a = \frac{V^2}{2(x-x_0)} = 125000 \text{ m/}^2 \text{ } \times \frac{5280 \text{ ft}}{1 \text{ mile}} \times \left( \frac{1 \text{ hr}}{3600 \text{ s}} \right)^2 = 50.9 \text{ ft/s}^2 \]
FIRST MIDTERM

Name (print)  
Name (signed)  

Discussion Instructor (circle): Condella  DiCario  Gnesan  Smith  Hollier  Reeve  

Discussion Section #  

SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Given the following vectors:

\[ \vec{A} = -3\hat{i} + 4\hat{j} - 6\hat{k} \]
\[ \vec{B} = 6\hat{i} - 3\hat{j} + 7\hat{k} \]
\[ \vec{C} = -2\hat{i} + 3\hat{j} - 8\hat{k} \]

(a) Calculate the y component of \( \vec{A} + \vec{B} - \vec{C} \).
(b) Find \( \vec{A} - \vec{C} \) in \( i, j, k \) notation.
(c) Calculate the magnitude of \( \vec{B} + \vec{C} \).
(d) Calculate the direction of \( \vec{A} + \vec{B} \) (as an angle measured counterclockwise from the positive x-axis).
(e) Calculate \( \vec{C} - \vec{B} - \vec{A} \) in \( i, j, k \) notation.

(a) Sum y components \( (4 - 3 - 3) \hat{j} = -2 \hat{j} \)
(b) \[ \vec{A} - \vec{C} = -3\hat{i} + 4\hat{j} - 6\hat{k} \]
\[ -(-2\hat{i} + 3\hat{j} - 8\hat{k}) \]
\[ \vec{A} - \vec{C} = -\hat{i} + \hat{j} + 2\hat{k} \]

(c) \[ \vec{B} + \vec{C} = 6\hat{i} - 3\hat{j} + 7\hat{k} \]
\[ + (-2\hat{i} + 3\hat{j} - 8\hat{k}) \]
\[ = 4\hat{i} - \hat{k} \]
\[ \Rightarrow \text{Mag} |\vec{B} + \vec{C}| = \sqrt{(4i)^2 + (-k)^2} = \sqrt{17} \text{ or } 4.12 \]

(d) \[ \vec{A} + \vec{B} = 3\hat{i} + \hat{j} + \hat{k} \]
\[ \tan \theta = \frac{\hat{j}}{\hat{i}} = \frac{1}{3} \Rightarrow \theta = \tan^{-1} \left( \frac{1}{3} \right) = 18.4^\circ \]
\[ 0.322 \text{ rad} \]

(e) \[ \vec{C} - \vec{B} - \vec{A} = -2\hat{i} + 3\hat{j} - 8\hat{k} \]
\[ + (6\hat{i} - 3\hat{j} + 7\hat{k}) \]
\[ - (3\hat{i} + 4\hat{j} - 6\hat{k}) \]
\[ \vec{C} - \vec{B} - \vec{A} = (5\hat{i} + 2\hat{j} - 9\hat{k}) \]
FIRST MIDTERM

A ball is thrown up from the ground beside a building that is 75.0 m high.

10

(a) What is the minimum initial velocity needed so that the ball will just reach the top of the building?

(b) If the initial upward velocity is 50.0 m/s, how much time elapses before the ball strikes the roof on its way down?

(c) What is the velocity of the ball when it strikes the roof in part (b)?

\[ \text{1 Unit each time} \]
\[ 1 \text{ SF} \]

\[ y(t) = y(v(t)) = v_0 t + \frac{1}{2} a_y t^2 \]

\[ y(1) - y(0) = y_0 - \frac{1}{2} a_y t^2 \]

\[ y(1) = y_0 - \frac{1}{2} a_y t^2 \]

\[ \text{75 m} = v_y t - \frac{1}{2} a_y t^2 \]

\[ \frac{dy}{dt} = a_y t - v_y \]

\[ \text{75 m} = v_y t - \frac{1}{2} a_y t^2 \]

\[ 0 = v_y - 9.8 t \]

\[ t = \frac{v_y}{9.8} \]

\[ v_y = ? \]

\[ \text{a} = -9.8 \text{m/s}^2 \]

\[ y_0 = 0 \]

\[ y_f = 75 \text{m} \]

\[ v_y(y_f = 75 \text{m}) = 0 \]

\[ \text{75 m} = v_y t - \frac{1}{2} (9.8) t^2 \]

\[ \text{75 m} = v_y t - \frac{1}{2} (9.8) t^2 \]

\[ 0 = v_y - 9.8 t \]

\[ t = \frac{v_y}{9.8} \]

\[ 75 = v_y^2 \left( \frac{1}{9.8} - \frac{1}{19.6} \right) \]

\[ v_y = 38.3 \text{ m/s} \]

\[ \text{b) } \]

\[ v_y = 50 \text{ m/s} \]

\[ 0 = v_y - 9.8 t \]

\[ 75 = 50 t - \frac{1}{2} (9.8) t^2 \]

\[ -4.9 t^2 + 50 t - 75 = 0 \]

\[ t = \frac{50 \pm \sqrt{2500 + 1470}}{9.8} \]

\[ t = 9.8 \]

\[ 9.8 \]

\[ 043 \]

\[ \text{c) } \]

\[ v(t) = v_y - 9.8 t \]

\[ v(t) = 50 - 9.8 (9.8) \]

\[ t = 1.83 \text{ s} \]
FIRST MIDTERM

Name (print) ________ Name (signed) ________

Discussion Instructor (circle): Condello DiCarlo Gansan Holler Reeve

Discussion Section ________

SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

You start your car (car 1) from rest at point A with an acceleration of 6.00 ft/s². Four and a half (4.50 s) seconds later a second car (car 2) starts from rest at point A, accelerating in the same direction at 7.50 ft/s².

10pts (a) How much time elapses after the second car starts before it catches the first?

5pts (b) How fast is each car going when the second catches the first?

10pts (c) How far from the starting point are each of the two cars when the second is 30 feet behind the first?

a) Perhaps the easiest way to approach the problem is to let t = 0 when the second car starts.

Use \( x = x_0 + v_0t + \frac{1}{2}at^2 \)

where \( x_0 \), and \( v_0 \) = 0.

\( x_1 = \frac{1}{2}a_1(t+4.5)^2 \) and \( x_2 = \frac{1}{2}a_2t^2 \) when \( a_1 = 6.00 \text{ ft/s}^2 \) and \( a_2 = 7.50 \text{ ft/s}^2 \).

They meet when \( x_1 = x_2 \Rightarrow \frac{1}{2}a_1(t+4.5)^2 = \frac{1}{2}a_2t^2 \)

Expanding \( t^2 - 36t - 81 = 0 \) so \( t = \frac{-36 \pm \sqrt{36^2 - 4(-81)}}{2} = 38.1 \text{ sec , choosing the physically relevant solution (t>0)} \)

It is also possible to set it up as: \( \frac{1}{2}a_1(t)^2 = \frac{1}{2}a_2(t-4.5)^2 \)...

b) Use \( v=\sqrt{a_1} \)

\( v_1 = (6)(4.5+38.1) = 256 \text{ ft/sec} \)

\( v_2 = (7.5)(38.1) = 286 \text{ ft/sec} \)

c) There are two possibilities - the first driven (3pts/10 pts only for this solution without the other)

1) Before the second car starts, the first car may go to 30 feet:

\( x_1 = 30 = 0 + \frac{1}{2}(6)(t)^2 \) so \( t = 3.16 \text{ sec which is less than 4.50 - it does happen} \)

So, one solution is \( x_1 = 30.0 \text{ ft/sec} , x_2 = 0.00 \text{ ft/sec} \)

2) This is the only solution needed.

Again \( x_1 = \frac{1}{2}a_1(t+4.5)^2 \) \( x_2 = \frac{1}{2}a_2t^2 \)

\( x_1 - x_2 = 30 \) Substituting \( t^2 - 36t - 81 = 0 \) \( t = \frac{-36 \pm \sqrt{36^2 - 4(-81)}}{2} = 38.1 \text{ sec} \)

At which point \( x_2 = \frac{1}{2}(7.5)(38.1)^2 = 5163 \text{ ft/sec} \)

\( x_1 = x_2 + 30 = 5190 \text{ ft/sec} \)

To three significant figures.

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