Name:

For full credit, make your work clear to the grader. Show the formulas you use, all the essential steps, and results with correct units and correct number of significant figures. Partial credit is available if your work is clear. Point values are given in parenthesis. 1 inch = 2.54 cm, 1 ft = 12 in., 1 mile = 5280 ft. Prefixes: f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}. Use gravity g=9.80 m/s^2.

For these questions 1, 2, and 3, with motion in one dimension, suppose there is some x-axis, and along that axis is positive, and opposite to that axis is negative. a=acceleration, v=velocity, s=speed.

1. (3) Consider an object moving along a straight line. Which one of these is impossible?

   a. a is positive when v is positive. b. a is positive when v is negative.
   c. a is zero when v is constant. d. a is zero when v is increasing.

2. (3) Which one of these would correspond to a car that is braking?

   a. a is positive when v is positive. b. a is positive when v is negative.
   c. a is negative when v is arbitrary. d. a is negative when v is negative.

3. (3) A car has an eastward velocity. If it has an acceleration westward,

   a. its speed is constant. b. its speed is increasing. c. its speed is decreasing.

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4. (12) A car travelling on a straight road initially at 45 km/h accelerates for 5.0 s at a constant acceleration of 8.0 m/s^2. [Hint: Is it necessary to convert km/h to SI units?]

   a) (6) What is the car's final speed, in m/s? In km/h?

   b) (6) How far down the road did the car travel during the acceleration?

5. (8) A bullet travelling at 450 m/s is shot into a tree, stopping inside the wood over a distance of 5.0 cm. Calculate the magnitude of its acceleration in m/s^2 and in "g's", where 1 g = 9.80 m/s^2.

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6. (9) A ball is thrown straight upward and falls back to Earth. Suppose a y-coordinate axis points upward, and the release point is the origin.

a) (3) Instantaneously at the top its flight, which of these quantities are zero? (check all that apply.)

a. displacement. b. speed. c. velocity. d. acceleration.

b) (3) Instantaneously at the top of its flight, which of these quantities are negative? (check all that apply.)

a. displacement. b. speed. c. velocity. d. acceleration.

c) (3) Which of the following quantities never change during the flight? (check all that apply.)

a. displacement. b. speed. c. velocity. d. acceleration.

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7. (12) A stone is thrown upward and reaches a maximum height of 45.0 m above its launch point.

a) (6) What was the speed with which the stone was thrown?

b) (6) How much time elapsed for the stone to return to its launch point?

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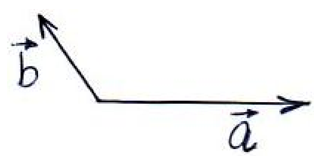
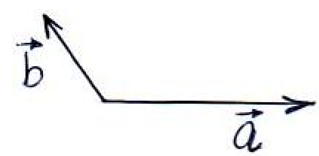
1. (6) A displacement vector $\vec{A}$ points at 60.0° west of north, and its magnitude is $A = 880.0$ m. Calculate its x and y components, where the x-axis points east and the y-axis points north.

2. (8) Sketch on the left diagram below how you would combine the vectors $\vec{a}$ and $\vec{b}$ graphically to form $\vec{c} = \vec{a} + \vec{b}$. Sketch on the right diagram below how you would combine the vectors $\vec{a}$ and $\vec{b}$ graphically to form $\vec{d} = \vec{a} - \vec{b}$.





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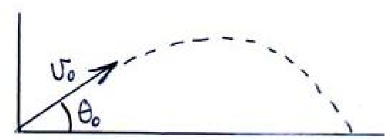
3. (16) A projectile is launched as shown, with initial speed $v_0 = 26.0$ m/s, at an angle of 30.0° above the horizontal. It moves above level ground.



a) (4) When the projectile reaches its maximum height above the ground, what is its speed?

b) (8) Just before it lands, what are the horizontal and vertical components of its velocity?

c) (4) How far from the launch point does the projectile land?

4. (8) Starting from her home, Jane walks 3.0 km east, then 5.0 km south, and finally, 4.0 km west. Now how far is she from her home, as the crow flies?

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5. (12) A small airplane has an airspeed of 320 km/h. It takes off from Manhattan, to take its passengers due north towards Lincoln, Nebraska. But the wind is blowing at an average speed of 86 km/h towards due east.

a) (6) In what direction should the plane be heading (or point) so that its velocity relative to the ground is due north? Give the result as an angle compared to the principle compass directions (like *72° east of north*). [Hint: A diagram is needed!]

b) (6) What will be the resulting groundspeed of the airplane? You can leave it in km/h if you like.

Chapter 2 Equations

$\bar{v} = \frac{\Delta x}{\Delta t}, \quad \Delta x = x - x_0, \quad \text{slope of } x(t) = v(t).$

$\bar{a} = \frac{\Delta v}{\Delta t}, \quad \Delta v = v - v_0, \quad \text{slope of } v(t) = a(t).$

For constant acceleration in one-dimension:

$\bar{v} = \frac{1}{2}(v_0 + v), \quad v = v_0 + at, \quad x = x_0 + v_0 t + \frac{1}{2}at^2, \quad v^2 = v_0^2 + 2a(x - x_0).$

For free fall on earth:

$g = 9.80\ \text{m/s}^2$ downward.

$v_y = v_{y0} - gt, \quad y = y_0 + v_{y0}t - \frac{1}{2}gt^2.$ Using an upward y-axis.

Chapter 3 Equations

Vectors

$V_x = V\cos\theta, \quad V_y = V\sin\theta,$

$V = \sqrt{V_x^2 + V_y^2}, \quad \tan\theta = \frac{V_y}{V_x}.$ θ is the angle from $\vec{V}$ to x-axis.

Projectiles

$\vec{a} = (a_x, a_y) = (0, -g),$ For an upward y-axis.

$R = \frac{v_0^2}{g}\sin 2\theta_0,$ For level ground only.

Relative Motion

$\vec{V}_{\text{BS}} = \vec{V}_{\text{BW}} + \vec{V}_{\text{WS}},$ B=Boat, S=Shore, W=Water.

BS means "boat relative to shore", etc.

Must be applied as a vector equation!