Name________________________________

Feb. 22, 2007

Phys 2010, NSCC
Exam #1 — Spring 2007

1.	__________________	(7)
2.	__________________	(7)
3.	__________________	(13)
4.	__________________	(12)
5.	__________________	(13)
6.	__________________	(20)
7.	__________________	(18)
MC	__________________	(10)
Total	__________________	(100)

Multiple Choice

Choose the best answer from among the four! (2) each.

1. One cubic millimeter (1 mm^3) is equal to

a) 10^{-3} m^3

b) 10^{-6} m^3

$\boxed{\textbf{c)}}$ 10^{-9} m^3

d) 10^{-12} m^3

2. If m is a mass, r is a distance and v is a speed, the expression mrv has units of

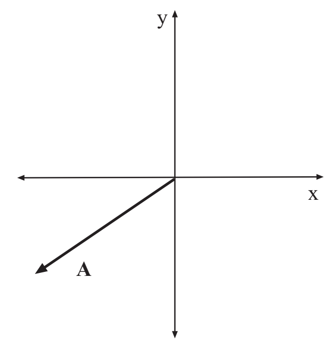
a) $\frac{\text{kg}\cdot\text{m}}{\text{s}}$

$\boxed{\textbf{b)}}$ $\frac{\text{kg}\cdot\text{m}^2}{\text{s}}$

c) $\frac{\text{kg}\cdot\text{m}}{\text{s}^2}$

d) $\frac{\text{kg}^2\cdot\text{m}}{\text{s}^2}$

3. For the vector **A** shown at the right,



a) A_x and A_y are both positive.

b) A_x is positive and A_y is negative.

c) A_x is negative and A_y is positive.

$\boxed{\textbf{d)}}$ A_x and A_y are both negative.

4. What is the angle between the vectors **A** and $-$**A** when they are drawn from a common origin?

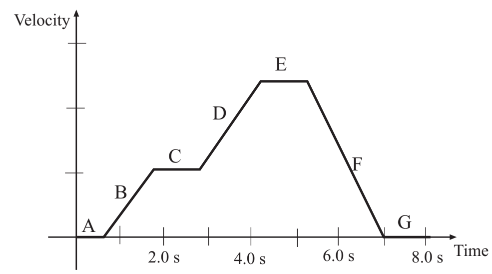
a) 0°

b) 90°

$\boxed{\textbf{c)}}$ 180°

d) 360°

5. Shown here is a graph of velocity versus time for an object moving in a straight line. The various time intervals are labelled A, B, etc. Which sections of the graph correspond to a condition of zero net force?



a) C and E only

b) E, F and G only.

$\boxed{\textbf{c)}}$ A, C, E and G only.

d) F only.

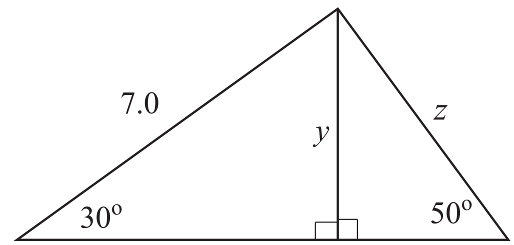
Problems

Show your work and include the correct units with your answers!

1. Convert 2.0 $\frac{\text{kg}\cdot\text{m}^2}{\text{s}}$ to units of $\frac{\text{g}\cdot\text{cm}^2}{\text{s}}$ (7)

$$2.0\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}} = (2.0\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}})\left(\frac{1000\text{ g}}{1\text{ kg}}\right)\left(\frac{100\text{ cm}}{1\text{ m}}\right)^2 = 2.0\times10^7\,\frac{\text{g}\cdot\text{cm}^2}{\text{s}}$$

2. In the two adjoined right triangles shown at the right, find the missing sides y and z. (7)



Get y from

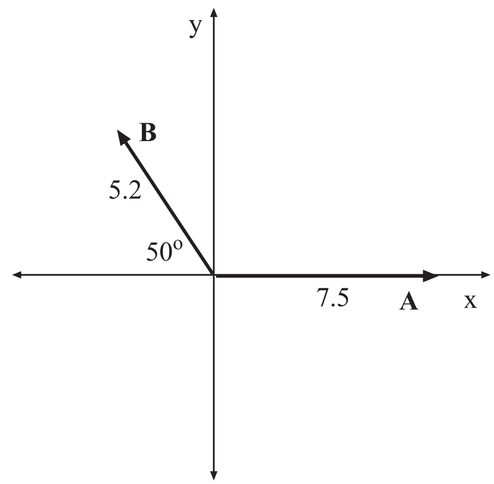
$$\frac{y}{7.0} = \sin 30^\circ \qquad \Longrightarrow \qquad y = 7.0 \sin 30^\circ = 3.5$$

Get z from

$$\frac{y}{z} = \sin 50^\circ \qquad \Longrightarrow \qquad z = \frac{y}{\sin 50^\circ} = 4.57$$

3. Vector **A** has magnitude 7.5 and points in the $+x$ direction. Vector **B** has magnitude 5.2 and is directed at 50° above the $-x$ axis.

Find the magnitude and direction of $\mathbf{A} + \mathbf{B}$. (10)



We can write down:

$$A_x = 7.5 \qquad A_y = 0$$

And:

$$B_x = -5.2 \cos 50^\circ = -3.34 \qquad B_y = 5.2 \sin 50^\circ = 3.98$$

This gives:

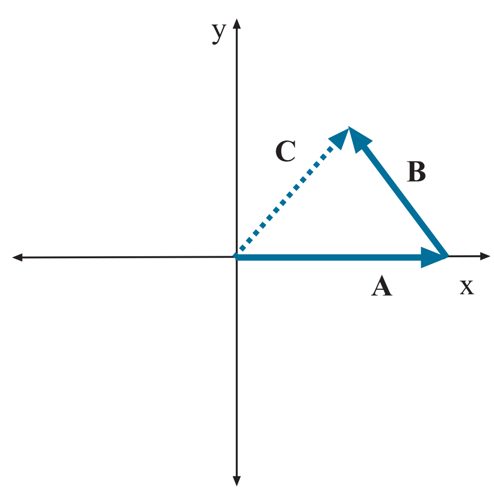
$$C_x = A_x + B_x = 4.16 \qquad C_y = A_y + B_y = 3.98$$

The magnitude and direction of $\mathbf{C}$ are

$$C = \sqrt{C_x^2 + C_y^2} = 5.76 \qquad \tan\theta = \frac{C_y}{C_x} = 0.957 \qquad \Longrightarrow \qquad \theta = 43.7^\circ$$

This angle is in the right quadrant, as shown in the next part.

b) Check your answer to (a) by giving a sketch of the addition of the two vectors. (That is, add them "graphically".) You can use these axes: (3)



4. A car travels in a straight line; its velocity increases uniformly from $2.0\frac{\text{m}}{\text{s}}$ to $30.0\frac{\text{m}}{\text{s}}$ in 15.0 s.

a) What is the acceleration of the car? (6)

The acceleration is

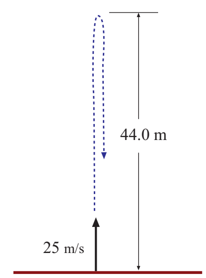
$$a = \frac{v - v_0}{t} = \frac{(30.0\frac{\text{m}}{\text{s}} - 2.0\frac{\text{m}}{\text{s}})}{(15.0\ \text{s})} = 1.87\frac{\text{m}}{\text{s}^2}$$

b) How far does the car travel during the 15.0 s? (6)

We can use $x = \frac{1}{2}(v_0 + v)t$ here. We get:

$$x = \tfrac{1}{2}(2.0\tfrac{\text{m}}{\text{s}} + 30.0\tfrac{\text{m}}{\text{s}})(15.0\ \text{s}) = 240\ \text{m}$$

5. A projectile is fired straight up from the surface of a strange planet with an initial speed of $25.0\frac{\text{m}}{\text{s}}$. It reaches a maximum height of 44.0 m.



a) What is the value of g (the acceleration of gravity) on this planet? (7)

The acceleration is $a = -g$. Use

$$v^2 = 0 = v_0^2 + 2ay \qquad \Longrightarrow \qquad a = \frac{-v_0^2}{2y} = -\frac{(25\frac{\text{m}}{\text{s}})^2}{2(44.0\ \text{m})} = -7.1\frac{\text{m}}{\text{s}^2}$$

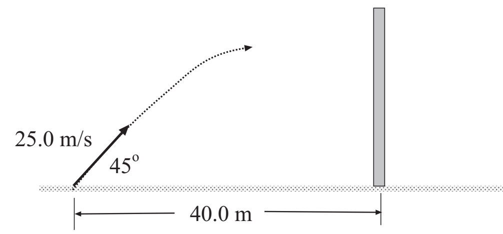
So then the value of g on this planet is $\boxed{7.1\frac{\text{m}}{\text{s}^2}}$.

b) How long did it take the projectile to reach maximum height? (6)

Use the acceleration found in (a):

$$v = 0 = v_0 + at \qquad \Longrightarrow \qquad t = \frac{-v_0}{a} = \frac{-25.0\frac{\text{m}}{\text{s}}}{(-7.1\frac{\text{m}}{\text{s}^2})} = 3.5\ \text{s}$$

6. A projectile is fired from ground level at a speed of $25.0\frac{\text{m}}{\text{s}}$ at an angle of 45° above the horizontal. A very big wall is located at a distance of 40.0 m from the firing point.



a) How long does it take the projectile to strike the wall? (8)

Here,

$$v_{0x} = v_0 \cos 45° = 17.7\frac{\text{m}}{\text{s}} \qquad v_{0x} = v_0 \sin 45° = 17.7\frac{\text{m}}{\text{s}}$$

The projectile hits the wall when $x = 40.0$ m. Use the x equation of motion to solve for x:

$$x = 40.0 \text{ m} = v_{0x}t + \tfrac{1}{2}a_x t^2 = (17.7\tfrac{\text{m}}{\text{s}})t + 0 \qquad \Longrightarrow \qquad t = \frac{(40.0 \text{ m})}{(17.7\frac{\text{m}}{\text{s}})} = 2.26 \text{ s}$$

b) At what height does the projectile strike the wall? (8)

Find the value of y at the time found in part (a). Use the y equation of motion:

$$y = v_{0y}t + \tfrac{1}{2}a_y t^2 = (17.7\tfrac{\text{m}}{\text{s}})(2.26 \text{ s}) + \tfrac{1}{2}(-9.8\tfrac{\text{m}}{\text{s}^2})(2.26 \text{ s})^2 = 15.0 \text{ m}$$

c) When it struck the wall, was the projectile still going up or was it on the way down? How do you know? (4)

At the time the projectile hit the wall, the value of v_y was

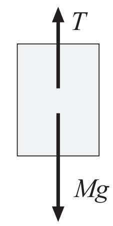
$$v_y = v_{0y} + a_y t = 17.7\tfrac{\text{m}}{\text{s}} + (-9.8\tfrac{\text{m}}{\text{s}^2})(2.26 \text{ s}) = -4.45\tfrac{\text{m}}{\text{s}}$$

The value is negative, meaning that the projectile was *decreasing* in height, so it was on the way down.

7. An elevator and its contents have a total mass of 1500 kg. It has a *downward* accleration of magnitude $2.0\frac{\mathrm{m}}{\mathrm{s}^2}$.

a) Draw a force ("free--body") diagram for the elevator. (4)

Forces on the elevator are the tension in the cable, T upward and the weight Mg downward.



b) What is the tension in the cable? (7)

If the up direction is positive, the acceleration of the elevator is $-2.0\frac{\mathrm{m}}{\mathrm{s}^2}$. Adding up the upward forces, we get

$$F_{\mathrm{net},\,y} = T - Mg = Ma$$

Then the tension in the cable is

$$T = Mg + Ma = M(g + a_y) = (1500\ \mathrm{kg})(9.8\tfrac{\mathrm{m}}{\mathrm{s}^2} - 2.0\tfrac{\mathrm{m}}{\mathrm{s}^2}) = 1.17 \times 10^4\ \mathrm{N}$$

c) If there is a man of mass 80 kg inside the elevator standing on a spring–scale (while it accelerates downward), what is the reading of the scale? (7)

A similar free-body diagram for the man has the force of the scale upward and the force of gravity (mg) downward. The acceleration of the man is also $-2.0\frac{\mathrm{m}}{\mathrm{s}^2}$ so Newton's 2nd law gives

$$F_{\mathrm{scale}} - mg = ma \qquad \Longrightarrow \qquad F_{\mathrm{scale}} = mg + ma = m(g + a)$$

This gives

$$F_{\mathrm{scale}} = (80\ \mathrm{kg})(9.8\tfrac{\mathrm{m}}{\mathrm{s}^2} - 2.0\tfrac{\mathrm{m}}{\mathrm{s}^2}) = 624\ \mathrm{N}$$

You must show all your work and include the right units with your answers!

$$A_x = A\cos\theta \qquad A_y = A\sin\theta \qquad A = \sqrt{A_x^2 + A_y^2} \qquad \tan\theta = A_y/A_x$$

$$v_x = v_{0x} + a_x t \qquad x = v_{0x}t + \tfrac{1}{2}a_x t^2 \qquad v_x^2 = v_{0x}^2 + 2a_x x \qquad x = \tfrac{1}{2}(v_{0x} + v_x)t$$

$$v_y = v_{0y} + a_y t \qquad y = v_{0y}t + \tfrac{1}{2}a_y t^2 \qquad v_y^2 = v_{0y}^2 + 2a_y y \qquad y = \tfrac{1}{2}(v_{0y} + v_y)t$$

$$g = 9.80\tfrac{\mathrm{m}}{\mathrm{s}^2} \qquad R = \frac{2v_0^2\sin\theta\cos\theta}{g} \qquad \mathbf{F}_{\mathrm{net}} = m\mathbf{a} \qquad \mathrm{Weight} = mg$$

$$F = G\frac{m_1 m_2}{r^2} \qquad G = 6.67 \times 10^{-11}\,\frac{\mathrm{N\cdot m^2}}{\mathrm{kg^2}}$$

$$\text{If} \quad ax^2 + bx + c = 0 \quad \text{then} \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\,.$$