Name______________________________

Phys 2010, NSCC
Exam #1 — Fall 2005

1.	________________	(7)
2.	________________	(12)
3.	________________	(11)
4.	________________	(10)
5.	________________	(14)
6.	________________	(19)
7.	________________	(8)
8.	________________	(9)
MC	________________	(10)
Total	________________	(100)

Multiple Choice

Choose the best answer from among the four!

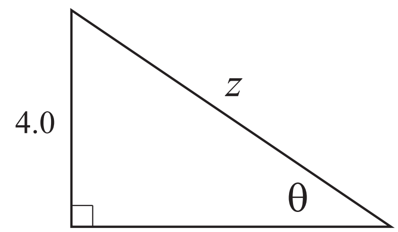
1. A square meter (1 m^2) is equal to

a) 0.01 cm^2
b) 100 cm^2
$\boxed{\textbf{c)}}$ 10^4 cm^2
d) 10^6 cm^2

2. If vector **A** has magnitude 10.0 and vector **B** has magnitude 7.0, it is impossible for the vector $\mathbf{A} + \mathbf{B}$ to have magnitude

$\boxed{\textbf{a)}}$ 2.0
b) 3.0
c) 10.0
d) 15.0

3. The side z of the triangle is given by



a) $4.0 \tan\theta$

b) $4.0 \cos\theta$

$\boxed{\textbf{c)}}$ $\frac{4.0}{\sin\theta}$

d) $\frac{4.0}{\tan\theta}$.

4. If we take a 5.0 kg mass from the Earth to the surface of the Moon,

$\boxed{\textbf{a)}}$ Its mass will be the same but its weight will change.

b) Its weight will be the same but its mass will change.

c) Its mass and weight will remain the same.

d) Both its mass and weight will be different.

5. 1 Newton is equal to

a) $1\,\frac{\text{kg}\cdot\text{m}}{\text{s}}$

$\boxed{\textbf{b)}}$ $1\,\frac{\text{kg}\cdot\text{m}}{\text{s}^2}$

c) $1\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}}$

d) $1\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}^2}$

Problems

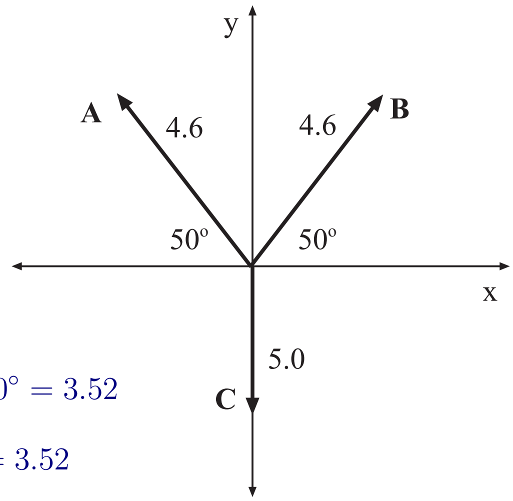
Show your work and include the correct units with your answers!

1. Change $11.4\,\frac{\text{cm}^3}{\text{s}}$ to units of $\frac{\text{m}^3}{\text{hr}}$. (7)

$$11.4\,\frac{\text{cm}^3}{\text{s}} = \left(11.4\,\frac{\text{cm}^3}{\text{s}}\right)\left(\frac{1\text{ m}}{100\text{ cm}}\right)^3\left(\frac{60\text{ s}}{1\text{ min}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right) = 4.1\times10^{-2}\,\frac{\text{m}^3}{\text{hr}}$$

2. Vectors **A**, **B** and **C** are as shown at the right; **A** and **B** both have magnitude 4.60, with **A** directed at 50° above the $-x$ axis and **B** directed at 50° above the $+x$ axis. The vector **C** has magnitude 5.00 and points in the $-y$ direction.

Find the magnitude and direction of the sum of these three vectors. (12)



The components of the three vectors are:

$A_x = -(4.60)\cos 50^\circ = -2.96 \qquad A_y = (4.60)\sin 50^\circ = 3.52$

$B_x = (4.60)\cos 50^\circ = 2.96 \qquad B_y = (4.60)\sin 50^\circ = 3.52$

$C_x = 0 \qquad C_y = -5.00$

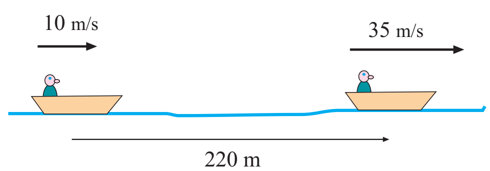
Then the sum of the three vectors ($\mathbf{R}$) has components given by

$$R_x = A_x + B_x + C_x = 0 \qquad R_y = A_y + B_y + C_y = 2.04$$

which is a vector of magnitude $\boxed{2.04}$ and points in the $\boxed{+y \text{ direction}}$, namely at $\boxed{90^\circ}$ from the $+x$ axis.

3. A speedboat increases its speed uniformly from $10\frac{\text{m}}{\text{s}}$ to $35\frac{\text{m}}{\text{s}}$ in a distance of 220 m.

a) Find the magnitude of its acceleration. (6)



Here we have motion in one dimension with $v_0 = +10\frac{\text{m}}{\text{s}}$, $v = +35\frac{\text{m}}{\text{s}}$ and $x = 220$ m. We can find a using:

$$v^2 = v_0^2 + 2ax \qquad \Longrightarrow \qquad a = \frac{v^2 - v_0^2}{2x} = \frac{(35\frac{\text{m}}{\text{s}})^2 - (10\frac{\text{m}}{\text{s}})^2}{2(220 \text{ m})} = 2.56\frac{\text{m}}{\text{s}^2}$$

The acceleration of the speedboat is $\boxed{2.56\frac{\text{m}}{\text{s}^2}}$.

(b) Find the time it takes the boat to travel the 220−m distance. (5)

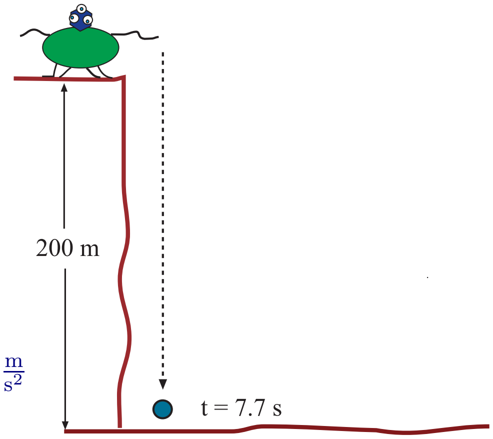
We now have the acceleration so we can use $v = v_0 + at$:

$$v = v_0 + at \qquad \Longrightarrow \qquad t = \frac{v - v_0}{a} = \frac{35\frac{\text{m}}{\text{s}} - 10\frac{\text{m}}{\text{s}}}{2.56\frac{\text{m}}{\text{s}^2}} = 9.77 \text{ s}$$

It takes the boat $\boxed{9.77 \text{ s}}$ to travel the distance.

4. On a strange planet we drop a rock from a high place and find that it takes 7.7 s to fall 200 m.

What is the value of the acceleration of gravity, g, on this planet? (10)



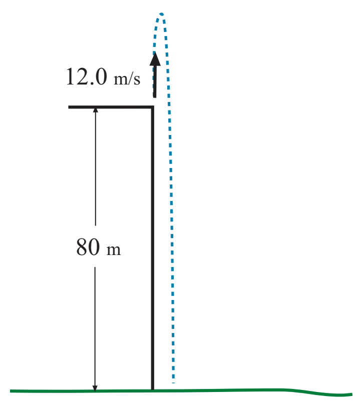
The rock starts at the origin and at $t = 7.7\ \mathrm{s}$ it is at $x = -200\ \mathrm{m}$. Its initial velocity v_0 is zero and its acceleration is $-g$. Then we have

$$x = -\tfrac{1}{2}gt^2 \qquad \Longrightarrow \qquad g = -\frac{2x}{t^2} = -\frac{2(-200\ \mathrm{m})}{(7.7\ \mathrm{s})^2} = 6.75\tfrac{\mathrm{m}}{\mathrm{s}^2}$$

The acceleration of gravity on this planet is $\boxed{6.75\frac{\mathrm{m}}{\mathrm{s}^2}}$.

5. We stand at the top of a building which is 80.0 m tall and throw a ball upward with speed $12.0\frac{\mathrm{m}}{\mathrm{s}}$. The ball goes up and then falls down and hits the ground (80.0 m below the starting point).

a) What is the velocity of the ball when it hits the ground? (8)



We are given the initial velocity and final coordinate and we know the acceleration ($a = -g$); we can find the final velocity using

$$v^2 = v_0^2 + 2ax \qquad \Longrightarrow \qquad v^2 = (+12\tfrac{\mathrm{m}}{\mathrm{s}})^2 + 2(-9.8\tfrac{\mathrm{m}}{\mathrm{s}^2})(-80.0\ \mathrm{m}) = 1.71\times 10^3\,\tfrac{\mathrm{m}^2}{\mathrm{s}^2}$$

If we simply take the square root we get $v = 41.4\frac{\mathrm{m}}{\mathrm{s}}$ which isn't right since the velocity at impact must be a *negative* number. We have to use the *other* solution,

$$v = -41.4\tfrac{\mathrm{m}}{\mathrm{s}}$$

At impact, the ball has a velocity of $\boxed{-41.4\frac{\mathrm{m}}{\mathrm{s}}}$.

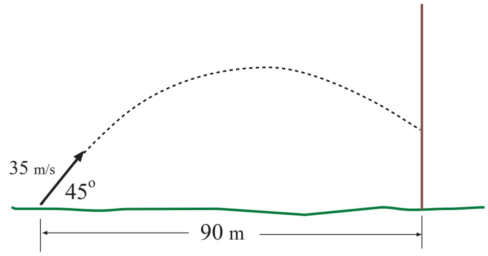
b) How long was the ball in flight? (6)

We now have the final velocity and since we know the initial velocity and the acceleration we can get the time:

$$v = v_0 + at \qquad \Longrightarrow \qquad t = \frac{v = v_0}{a} = \frac{(-41.4\frac{\mathrm{m}}{\mathrm{s}}) - (12.0\frac{\mathrm{m}}{\mathrm{s}})}{(-9.8\frac{\mathrm{m}}{\mathrm{s}^2})} = 5.4\ \mathrm{s}$$

The ball was in flight for $\boxed{5.4\ \mathrm{s}}$.

6. A projectile is launched from ground level with speed $35.0\frac{\text{m}}{\text{s}}$ at an angle of $45°$ above the horizontal. It flies toward a tall building 90 m from the launch point.



a) How long was the projectile in flight? (7)

The components of the projectile's initial velocity are

$$v_{0x} = v_0 \cos\theta = (35.0\tfrac{\text{m}}{\text{s}}) \cos 45° = 24.7\tfrac{\text{m}}{\text{s}} \qquad v_{0y} = v_0 \sin\theta = (35.0\tfrac{\text{m}}{\text{s}}) \sin 45° = 24.7\tfrac{\text{m}}{\text{s}}$$

We know the x coordinate of the projectile at impact, so we can solve for t:

$$x = v_{0x}t + 0 \qquad \Longrightarrow \qquad t = \frac{x}{v_{0x}} = \frac{90.0 \text{ m}}{24.7\frac{\text{m}}{\text{s}}} = 3.64 \text{ s}$$

The projectile hits the building $\boxed{3.64 \text{ s}}$ after being launched.

b) At what height did the projectile hit the side of the building? (6)

We need to find the y coordinate of the projectile at the time found in part (a).

$$y = v_{0y}t + \tfrac{1}{2}at^2 \qquad \Longrightarrow \qquad y = (24.7\tfrac{\text{m}}{\text{s}})(3.64 \text{ s}) + \tfrac{1}{2}(-9.8\tfrac{\text{m}}{\text{s}^2})(3.64 \text{ s})^2 = 25.0 \text{ m}$$

The projectile hits the building at a height of $\boxed{25.0 \text{ m}}$.

c) What were the components of the velocity of the projectile at the time that it hit the building? (6)

Find v_x and v_y at the time found in (a):

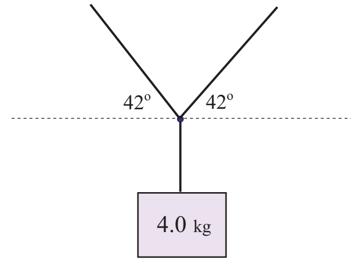
$$v_x = v_{0x} + 0 = 24.7\tfrac{\text{m}}{\text{s}}$$

$$v_y = v_{0y} + a_y t = 24.7\tfrac{\text{m}}{\text{s}} + (-9.8\tfrac{\text{m}}{\text{s}^2})(3.64 \text{ s}) = -11.0\tfrac{\text{m}}{\text{s}}$$

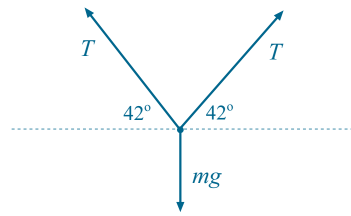
(The y component is negative because at $t = 3.64$ s the projectile has already reached maximum height and is descending.)

7. A 4.0 kg mass is supported by two ropes, both of which are inclined at 42° from the horizontal (as shown at the right).

What is the tension in each of the two upper ropes? (8)



We look at the forces acting at the place where all the strings join.



The forces here must add to zero (since this point is motionless). That the x forces add to zero is obvious from the symmetry of the force vectors. Since the y forces add to zero, we have:

$$T \sin 42^\circ + T \sin 42^\circ - (4.0\ \text{kg})(9.8\tfrac{\text{m}}{\text{s}^2}) = 0$$

where we have used that fact that the tension in the vertical rope is equal to mg, the weight of the hanging mass and also that the tension in the two upper ropes is the *same*, again from the symmetry of the forces.

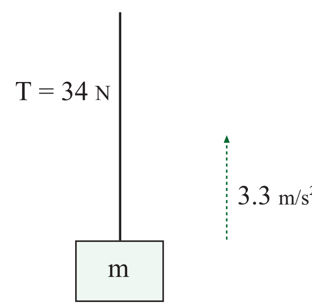
Solve the above equation for T:

$$2T \sin 42^\circ = 39.2\ \text{N} \qquad \Longrightarrow \qquad T = \frac{(39.2\ \text{N})}{2 \sin 42^\circ} = 29.3\ \text{N}$$

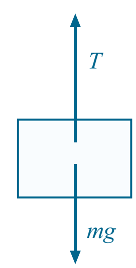
The tension in each rope is $\boxed{29.3\ \text{N}}$.

8. A string is attached to a mass m. When we pull upward on the string, giving it a tension of 34.0 N the mass accelerates upward at a rate of $3.30\frac{\text{m}}{\text{s}^2}$.

What is the value of m? (9)



The forces acting on m are as shown here:



The string tension T pulls upward and the force of gravity mg pulls downward. The total (upward) force is equal to ma, where $a = +3.30\frac{\text{m}}{\text{s}^2}$. So we write:

$$T - mg = m(3.30\tfrac{\text{m}}{\text{s}^2}) \qquad \Longrightarrow \qquad T = m(3.30\tfrac{\text{m}}{\text{s}^2} + g) = m(13.1\tfrac{\text{m}}{\text{s}^2})$$

Solve for m:

$$m = \frac{T}{(13.1\frac{\text{m}}{\text{s}^2})} = \frac{(34.0\ \text{N})}{(13.1\frac{\text{m}}{\text{s}^2})} = 2.60\ \text{kg}$$

The mass m is $\boxed{2.60\ \text{kg}}$.

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

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

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

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

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