PH101 ASSESSMENT 1
DUE 26/10/07

1. *Vectors*

a) A displacement vector has a magnitude of 12.0 km in the direction 40.0° west of north. What is the north component of this vector? The west component?

b) Air traffic controllers usually describe the position of an air-craft relative to the airport by altitude, horizontal distance, and bearing. Suppose an aircraft is at altitude 500m, horizontal distance 15 km, and bearing 35° east of north. What What are the x, y and z components (in meters) of the position vector? The x axis is east, the y axis is north, and the z axis is vertical.

2. *More Vectors*

Consider three vectors $\vec{A} = 2\hat{i} - 3\hat{j}$, $\vec{B} = -\hat{i} + a\hat{j} - 5\hat{k}$ and $\vec{C} = -\hat{i} + 4\hat{j} - 5\hat{k}$.

a) The vectors $\vec{A}$ and $\vec{B}$ are perpendicular to each. What is the value of a?

b) What is $3\vec{A} - 2\vec{C}$?

c) What is $\vec{A} \cdot \vec{C}$ and $\vec{A} \times \vec{C}$?

d) Find two unit vectors which are perpendicular to both $\vec{A}$ and $\vec{C}$.

e) What is $\vec{B} \cdot (\vec{C} \times \vec{A})$?

3. *Position, Speed, Velocity and Acceleration*

A particle is moving in three dimensions. Its position vector, $\vec{r}$, is time dependendent and is given by

$$\vec{r} = (6 - 2t)\hat{i} + (3 + 4t - 6t^2)\hat{j} - (1 + 3t - 2t^2)\hat{k}$$

Distances are in meters, and the time, t, in seconds.

a) What is the velocity vector at $t = +3$?

b) What is the speed at $t = +3$?

c) What is the acceleration vector and what is its magnitude at $t = +3$?

Now the particle is moving only along the z-axis, and its position is given by

$$(t^2 - 26 - 3)\hat{k}$$

d) At what time does the particle stand still?

e) Make a plot (a sketch) of z versus time covering $t = -2$ to 4 seconds.

f) Make a plot (a sketch) of the velocity in the z-direction, covering $t = -2$ to 4 seconds.

4. *Stone thrown up vertically*

At time $t = 0$ seconds, we throw a stone from the ground level straight up with a speed of 20m/s (assume $g = 10$ m/s^2 in this problem).

a) At what time (in seconds) will this stone reach its highest point, and how high is it then

above the ground?

b) We now throw a second stone straight up 2 seconds after the first. How many meters above the ground is the first stone at that moment?

c) At what speed should we throw this second stone from the ground if it is to hit the first stone 1 second after the second stone is thrown?

5. *Cricket*

A cricket ball is hit by a batsman and stays in the air for 6 seconds before being caught be a fielder 75 meters from the batsman. At what angle to the horizontal was the ball traveling when it left the bat?

6. *Golf*

a) A golfer wants to drive a ball to a distance of 240 m. If he launches the ball with an elevation angle of 14.0°, what is the appropriate initial speed?

b) If the speed is too great by 0.6 m/s, how much farther will the ball travel when launched at the same angle?

c) If the elevation angle is 0.5° larger than 14.0°, how much farther will the ball travel if launched with the speed calculated in part (a)?

7. *Horse pulling barge*

A horse, walking along the bank of a canal, pulls a barge. The horse exerts a pull of 300 N on the barge at an angle of 30° (see figure). The bargeman relies on the rudder to steer the barge on a straight course parallel to the bank. What transverse force (perpendicular to the bank) must the rudder exert on the barge?

8. *Two Forces*

Two forces $\vec{F}_1$ and $\vec{F}_2$ act on a particle of mass 6.0 kg. The forces are

$$\begin{aligned} \vec{F}_1 &= 2\hat{i} - 5\hat{j} + 3\hat{k} \\ \vec{F}_2 &= -4\hat{i} + 8\hat{j} + \hat{k} \end{aligned}$$

where the force is measured in newtons.

a) What is the net force vector?

b) What is the acceleration vector of the particle, and what is the magnitude of the acceleration?