9.1 Lab: Orienteering

Objectives: You will learn to use *Maple* to perform vector addition and scalar multiplication, to convert between rectangular and polar or spherical coordinates and to plot points and dot-to-dot pictures.

You are strongly encouraged to work with a partner.

Before Lab: [13]Read subsections ?? and ?? and section ??. Also read the *Maple* help pages:

```
> ?plot
> ?plot,options
> ?spacecurve
> ?plot3d,options
```

and the `VecCalc` help page:

```
> ?simplifyvec
```

Maple Commands: You will need to use the *Maple* commands for addition and scalar multiplication of vectors, and the following `plot` and `spacecurve` commands:

- *Maple* can `plot` a list of points as follows:

```
> plot([[1,0], [2,3], [3,0], [0,2], [4,2]], style=point,
> symbol=diamond, symbolsize=24);
```

Look at the help on `plot,options` to turn off the axes or change the `symbol` or `symbolsize`.

- If you leave off the option `style=point`, *Maple* will connect the dots with line segments. To connect back to the start, you must repeat the starting point:

```
> plot([[1,0], [2,3], [3,0], [0,2], [4,2], [1,0]], axes=none);
```

What shape did you get?

- You can also plot points and dot-to-dot pictures in 3-dimensions. For example, here is a cube:

```
> spacecurve({[[0,0,0], [0,1,0], [1,1,0], [1,0,0], [0,0,0], [0,0,1],
> [0,1,1], [1,1,1], [1,0,1], [0,0,1]], [[0,1,0], [0,1,1]], [[1,1,0],
> [1,1,1]], [[1,0,0], [1,0,1]]}, orientation=[30,60]);
```

Notice that several dot-to-dot pieces are put together by enclosing them in braces and separating them by commas. Try dragging the plot with you mouse.

`VecCalc` **Commands:** Enter your points as ordered pairs or triples in square brackets, `[ ]`, not angle brackets, `< >`. You may need to use the `VecCalc` commands `r2d` (convert radians to degrees), `d2r` (convert degrees to radians), `r2p` (convert rectangular to polar), `p2r` (convert polar to rectangular), `r2s` (convert rectangular to spherical), `s2r` (convert spherical to rectangular).

[13]Stewart's Calculus: 6 ed. Ch. 13, 6ET ed. Ch. 12

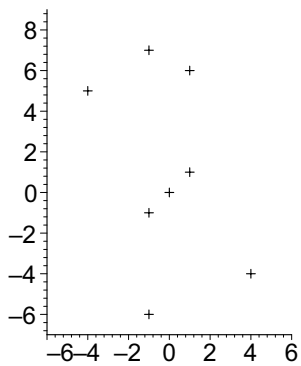
Lab Requirements: Start the `VecCalc` package by executing:

```
> with(VecCalc): VCalias:
```

Answer the following questions. Number each problem either in a text region or using a *Maple* comment. Where appropriate, you must explain your reasoning in text regions. Save your file now and after each problem. Print your worksheet to turn in as a lab report.

1. **Orienteering:** You start at the origin and travel South-East for 15 paces. Then you travel West-South-West for 20 paces. Finally you travel North-North-West for 27 paces. Construct a vector for each of these travel segments. If you want to go directly back to the origin, in what direction should you travel and how many paces will it take? Give the direction in degrees East or West of North. Plot your path. Remember, South-South-East is halfway between South and South-East. Also remember, *Maple* works in radians!

2. **Going Hunting:** Plot the constellation Orion as shown below:



3. **Starfleet 3D Orienteering:** Galactic Coordinates are specified by taking the origin at the center of mass of the galaxy, with the galaxy in the xy-plane, the x-axis passing through the sun, (We're still heliocentric!) and the z-axis specified by the right hand rule so that when you are on the positive z-axis, the galaxy rotates counterclockwise from the positive x-axis to the positive y-axis.

   You start at the galactic origin and successively make each of the following motions. Where do you end up? Plot your path. Remember, *Maple* works in radians!

   Each motion is specified in spherical coordinates where ρ is the distance you travel, ϕ is the polar angle measured down from the positive z-axis and θ is the azimuthal angle measured counterclockwise from the positive x-axis. Give your final position in spherical coordinates.

   (a) $(\rho, \theta, \phi) = (2 \text{ lightyears}, 30°, 135°)$
   (b) $(\rho, \theta, \phi) = (4 \text{ lightyears}, 300°, 120°)$
   (c) $(\rho, \theta, \phi) = (3 \text{ lightyears}, 225°, 30°)$