PHY105 Problems 3

1. You fly from London Heathrow (0° 27' 41" W, 51° 29' 14" N) to Sydney (151° 10' 38" E,   
   33° 56' 46" S), stopping at Kuala Lumpur (101° 41' 36" E, 2° 44' 36" N) to refuel.
   1. What is the total distance that you fly in nautical miles, assuming both legs of the journey are great circles? How does this compare with the distance you would have flown on a non-stop great circle route?
   2. In what direction does your aircraft set off from Heathrow? In what direction does it set off from Kuala Lumpur?
   3. At what longitude do you cross the equator?
2. Barnacle geese which nest in the high Arctic on Svalbard island (latitude 77° 57' 14" N, longitude 15° 01' 10" E) all winter on the Solway Firth in Scotland (54° 58' 30" N,   
   3° 31' 26" W).
   1. If they were to make this migration in a single great-circle flight, what distance would they have to travel? The geese fly at about 18 m s−1; given that one nautical mile is equal to 1.852 km, how long would the flight take?
   2. In fact the geese stop over on the coast of Norway. One GPS-tracked goose stopped near Trondheim, at a longitude of 8° 43' 35" E and a latitude of 63° 41' 21" N. Assuming that he flew from Svalbard to Trondheim, and then from Trondheim to the Solway, on a great circle route, how far did he travel in total, and what was his total flight time?
3. Sheffield is at a latitude of 53° 23' N.
   1. What is the altitude of the North Celestial Pole as seen from Sheffield?
   2. The *declination* δ of a star is its distance from the celestial equator (positive if North and negative if South); thus, the distance of a star from the North Celestial Pole is   
      90° − δ. For each of the following bright stars, state whether an observer in Sheffield will see the star rise and set, see the star as circumpolar, or never see the star at all:
      * Alnilam, δ = −1° 12' 07";
      * Betelgeuse, δ = 7° 24' 25";
      * Canopus, δ = −52° 41' 45";
      * Deneb, δ = 45° 16' 49".
   3. Is the declination of the Sun (a) positive in winter or (b) positive in summer, for an observer in the Northern hemisphere? Justify your answer.