Assignment 1
SPH4U – Near Space Project

1. The Global Space Balloon Challenge is a community of High-Altitude Balloon (HAB) enthusiasts. Go to the Tutorials page on the [Global Space Challenge website](https://balloonchallenge.org/) (https://balloonchallenge.org/) and read the Tutorial on Payloads. Describe at least four functions that the payload container provides. [4]

2. We will be using a 1200 g balloon from High Altitude Science. Note that 1200 g is the mass of the balloon. We will need to investigate the performance of this balloon to determine the maximum mass that we can send to the stratosphere. The link below will provide a tutorial as well as a tool that will allow you to run different scenarios. Describe two feasible scenarios that you tested representing the range of mass that we can lift with a 1200 g balloon. Provide the details for these two feasible scenarios including the payload mass, positive lift, required helium, estimated burst altitude, average ascent rate and average ascent time for each. [8]

https://www.highaltitudescience.com/pages/balloon-performance-calculator

3. How do you determine the right size for your parachute? We will use the drag force, or "wind resistance force" equation, which is

$$F_D = ½ \, \rho \, C_d \, \pi r^2 \, v^2$$

where F_D is the drag force
ρ (Greek letter "rho") is the density of air = 1.22 kg/m^3 near Earth's surface
C_d is the drag coefficient (very similar to a friction coefficient) which is 0.53 for the HAS 1.0m parachute and 0.57 for the 1.5m chute
πr^2 is the area of our circular chute and
v is the velocity through the air

The force of gravity (F_G) on the payload is given by $F_G = m \, g$. To achieve a terminal velocity the net force on the payload must be zero.

$F_{net} = F_G + F_D = 0$
$\therefore F_G = F_D$
$\therefore m \, g = ½ \, \rho \, C_d \, \pi r^2 \, v^2$

a) For the masses from question 3, determine the velocity for both the 1.0m and 1.5m parachute. If a descent rate between 5m/s and 7m/s is desired, do either of these parachutes meet with the requirements of the task? Explain our options for both masses from question 2. [8]

b) What is the proportional relationship between velocity and the radius of a balloon? [2]

4. Flight path prediction is an essential part of Near Space flight, especially when launching in a geographical location such as ours, which is fraught with geographic hazards such as waterways and wetlands, as well as technical hazards such as the radio dark zone in Algonquin Park.   NavCanada is the organization that governs controlled airspace in Canada; we will have to ask their permission to fly our balloon. They also provide tools that can help us predict the path our balloon will follow.

Read [this tutorial on understanding NavCanada wind tables](#).

For the tables shown below, use vectors and an Excel spreadsheet to determine the horizontal displacement of the balloon at 53000 feet if the launch occurred at 10:00 am EST. Provide an answer in meters. Note that this is "controlled airspace" in which aircraft can fly…and only about half the altitude that we hope our balloon will eventually reach. Submit this completed Excel spreadsheet via the dropbox. [22]

STN YYB - NORTH BAY. ONT	for use	3000	6000	9000	12000	18000
FDCN01 CWAO FCST BASED ON 160000 DATA **VALID** 160600	05-09	3327	3228-13	3235-15	3131-19	3031-33
FDCN02 CWAO FCST BASED ON 160000 DATA **VALID** 161200	09-18	3419	3222-15	3129-18	3032-22	3038-34
FDCN03 CWAO FCST BASED ON 160000 DATA **VALID** 170000	18-05	3310	3119-14	3027-15	3038-17	2951-26

STN YYB - NORTH BAY. ONT	for use	24000	30000	34000	39000	45000	53000
FDCN01 KWBC DATA BASED ON 161200Z **VALID 161800Z**	1700-2100Z.	3079-36	308351	297456	296053	284952	283655
FDCN02 KWBC DATA BASED ON 161200Z **VALID 170000Z**	2100-0600Z.	2861-36	286351	286158	285853	275552	284356
FDCN03 KWBC DATA BASED ON 161200Z **VALID 171200Z**	0600-1700Z.	2767-38	278553	277556	277253	276250	275854

We will make the following assumptions:

- The wind travels in the same direction and magnitude across each range. The ranges are defined as 0 – 3000 feet, 3000 feet – 6000 feet, and so on. For example, this means that we will assume that the reading at 3000 feet is relevant over the range from 0 – 3000 feet.
- Assume an ascent rate of 5.0m/s

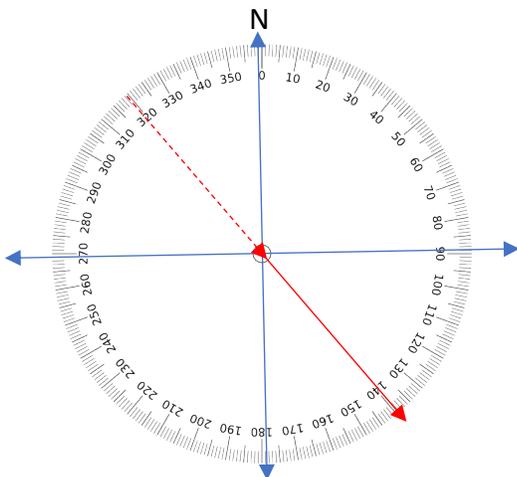Careful with units! The following conversion may come in handy…

- 1 Knot = 0.5144 m/s
- 1 Foot = 0.3048 m

Finding the Direction

- Directions in NavCanada tables are given in degrees clockwise relative to north. In this case north is 0, east is 90, south is 180 and west is 270.
- The angles we use for trigonometry are degrees anti-clockwise relative to the primary axis, or in this context, east. In this case, east is 0, north is 90, west is 180 and south is 270.
- In excel the trig function use radians instead of degrees so a column has been provided to help you remember to complete this conversion

Example: The first 2 digits in the NavCanada table is 32.

NavCanada Tables: Excel Spreadsheet: