Navigation Unit Definition

The following definitions are all very important. Please make sure you UNDERSTAND them. Ask an instructor if you need clarification.

Great Circle: A circle on the surface of a sphere that passes through the centre of the sphere, cutting it into two equal parts

Rhumb Line: A curved line on the surface of the Earth, cutting all the meridians it meets at the same angle. All parallels of latitude are rhumb lines. The meridians of longitude and the equator are rhumb lines as well as great circles.

Relief: A representation of group elevation above sea level on aeronautical maps. There are three ways to show relief on a map: layer tinting (map colored to represent different levels of elevation), contour lines (lines drawn on a chart joining areas of equal elevation ASL) and spot heights (high elevations are marked by a dot with spot height written beside the dot).

Isogonic Lines: Lines on a map joining places of equal variation.

Agonic Line: The line of zero variation. There is one in each of the eastern and western hemispheres.

Indicated Airspeed: Speed shown on the airspeed indicator

True Airspeed: Speed of the aircraft relative to the air

Groundspeed: Speed of the aircraft relative to the ground

Track: The direction the aircraft intends to take over the ground

Track made good: Actual path travelled by the aircraft over the ground

Heading: The direction that the aircraft nose (longitudinal axis) is pointing, measured clockwise from the north.

Variation: The angle between the true meridian and magnetic meridian. Also referred to as the magnetic variation

Drift angle: The angle between the heading being flown and the track made good over the ground.

Navigation Activity

Part 1: Basic Foundations

Materials

- ICAO Ruler
- VNC
- Douglas Protractor
- Pencils
- From the Ground Up Book
- CFS – Canadian Flight Supplement

Follow the steps and complete the questions. Use your FTGU, CFS and navigation definition sheet to help you find the answers.

1. Ensure you have the Toronto VNC. What is the scale? _____
2. When is the chart valid until? _____
3. Locate Kingston Airport. Determine the longitude and latitude coordinates.
   Latitude: _____ Longitude: _____
4. How many runways does Kingston have? _____
5. What is maximum elevation level in surrounding area (quadrant) of Kingston? _____
6. What frequency should the pilot change to when they are near Kingston airport? _____
7. What class of airspace surrounds Kingston Airport? _____
8. Over Kingston prison, what class of airspace is present? _____
9. Name the major highway passing through Kingston? _____
10. Calculate the distance between Trenton Airport and Kingston Airport in NM. _____
11. Imagine you are flying in a Cessna 172R from Kingston Airport to Brockville Airport at a speed of 100 knots. Calculate the time it will take to reach there. _____ mins
12. What is the runway numbering at Brockville airport? _____ & _____
13. What is the elevation of Brockville airport? _____
14. If you are flying to Brockville airport, what must the plane be equipped with? _____
    (Note: you do not require this when flying over Kingston)
15. What other activity should the pilot be aware of when flying in the surrounding area of Brockville airport? _____
16. If you are flying from Brockville airport to Smith Falls airport using pilotage, what reference would you use on the ground to help you navigate to your destination? _____

Part 2: Preparation for Flight

The thanksgiving weekend is coming up and you have decided to take your friends up for a cross country flight. However as the PIC you must plan out the journey to avoid any delays. You have decided to fly from London to Brampton with a stop in Waterloo.

1. Draw out your intended track from the departure point to your destination, with a pencil, using the ruler provided.
2. What is the total distance you will cover on your journey? _____ NM
3. Determine the direction to Waterloo in degrees true. _____
4. Determine the direction to Brampton from Waterloo in degrees true. _____
5. Apply the magnetic variation to find the direction of the track in degrees magnetic.
6. The compass card shows that deviation is 4 degrees west. Apply this knowledge to determine the compass heading. _____
7. Now measure your track and divide it into equal intervals of 10 miles.
8. Study the vicinity of the track for landmarks. Determine 2-3 landmarks at each 10 mile interval that you will be easily able to identify during the flight. _____
9. Determine the ground elevation Woodstock _____ and determine a flight altitude that will be safe to clear any high ground. Altitude will be flying at: _____
10. Does your track proceed through any restricted area? _____
11. What class of airspace is London airport? _____ Waterloo Airport? _____ Brampton Airport? _____
12. Are you passing through any body of water through your entire journey? _____ If yes, what must you ensure? _____ _____ _____
13. Are there any main roads you can follow to navigate to your destinations? _____
14. Name 4 towns you will pass through during your journey? _____
15. How long will it take you to arrive at Waterloo airport if you are flying at 100 knots? _____

Part 3: Unexpected Phenomena

It looks like you have done quite a bit of preparation already and have carefully prepared your charts and determined the compass heading. Following a track over the ground between the point of departure and the destination can be a simple matter except for one thing: WIND. It can displace the aircraft right or left of its intended track. To account for wind, the heading of the aircraft must be adjusted somewhat into the wind. In effect, the airplane will be flying slightly sideways along the required track. This is known as **crab.**

Now you must determine what heading to take up in order to get back on the required track (if winds are present) and what heading to fly once back on track in order to reach the destination. To do this, you must draw out 10 degree drift lines on either side of the route.

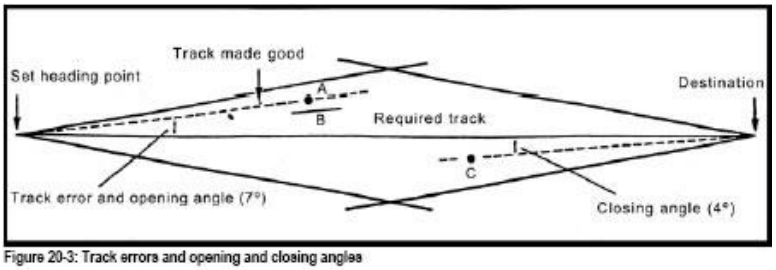

Figure 20-3: Track errors and opening and closing angles

Draw out the ten degree drift lines (dashed) on your VNC.

If you have flown away from your track, you can change the heading either to return to the track or to fly directly to the destination on a new track. If you have not passed the halfway point, it is usually better to return to the required track since this the route that has been studies and prepared on the chart. There are two methods by which you return to your required track a) the double track error method b) the visual alteration method.

Use the Double Track Error method to answer the following questions.

1. You want to fly from London to Waterloo. What is a total distance of the flight? ____NM
2. What is the compass heading that you need to fly? Assume deviation is 4^{o}E. _____
3. Suppose, 12 nautical miles in, you realize that you are not on track. You calculate that you are 5^{o} off of your intended track. Visually, you are able to see that the town on Embro is to your left. How many degrees do you need to turn to return to your track? ___
4. What direction do you have to turn? (East or West) _____
5. What heading (true) do you have to fly to return to your track? _____
6. How will you know when you have intersected your intended track?

   _____
7. Once you have intersected your track, state the number of degrees, along with the direction, you will have to turn to maintain your intended track? _____
8. After all of the corrections, what heading will you be flying? _____

Where indicated, **use the visual altercation method** to answer the following question:

1. You want to fly from Oshawa to Lindsay but you have heard that Peterborough airport makes great burgers so you want to have lunch in there first. What will be your total distance? _____NM
2. What is the compass heading you need to fly to get to Peterborough airport? _____
3. What is the compass heading you need to fly to get to Lindsay airport? _____
4. You takeoff from Oshawa at 1000 hrs but after a few minutes you spot a water tower with the words "Orono" written on it. You are puzzled to see this as you don't remember seeing this in your preparation. As luck would have it, you forgot to bring your protractor and flight computer with you on your flight. Oh no! Luckily, you have tons of fuel remaining so you circle around the water tower at a safe altitude while you figure out what to do. Describe two ways you can get back on track. (note: use of NDB is not an option, instead use the **visual altercation method**)
    a. _____
    b. _____
5. Hopefully (luckily) you were able to figure how to return to your original track because you were really looking forward to grabbing that lunch! When you land in Peterborough, you note the time (1050 hrs) and request someone to fuel your aircraft, while you eat lunch. As you munch on your burger, you want to know why it took so long to arrive in Peterborough. You had planned to fly at an average indicated airspeed of 90 knots (throughout all legs) which you successfully maintained. How many extra nautical miles did you travel? _____NM
6. As you finish devouring your lunch, you realize that the time is now 1115hrs. You need to be at Lindsay airport by noon at the latest. You want to know if you will still make it. With your predetermined IAS, what time will you reach Lindsay? _____
7. You depart from Peterborough with high hopes. As you reach the town of Mount Pleasant, you start to feel very sick (a turn out the burger wasn't that good after all). Being a good pilot, you decide to land immediately. Given that you are authorized to land anywhere, what is the closest AND most practical place to land? _____
8. As if you day couldn't get any worse, you are unable to locate the runway visually. Name four distinct landmarks that can help you find the runway.
    a. _____ c. _____
    b. _____ d. _____
9. Eventually you locate the runway and land safely. After using the restroom, you feel much better and decide to continue your journey. Before you takeoff, you notice that your fuel tanks are really low. The person you trusted to fuel your aircraft didn't do it properly and now you are really starting to regret that burger pit-stop. Nonetheless, you have 2 gallons of usable few remaining. From your Pilot's operating Handbook (POH) you determine that your aircraft consumes fuel at a rate of 26 gal/h at cruising speed (90

knots). You want to know if you can make it to Lindsay without refueling. Calculate the amount of fuel required to get to Lindsay from your current location. ____ gal

10. Do you need to refuel? _____ (yes or no)
11. If you answer yes, how much fuel do you need? _____ gal
12. In using the restroom and performing all these calculations, among other activities, you have wasted a lot of time. In fact it is now, 1155 hrs. You realize that at your predetermined IAS you will not get to Lindsay on time. Therefore you must fly faster. Calculate the IAS you must fly so that you will reach Lindsay at noon exactly. _____ IAS
13. You arrive in Lindsay safely! Congratulations.

Although not discussed, another method that can be used to at any distance along the track to get back on the predetermined track is **opening and closing angles method.**
Determine the opening and closing angle at your current position and add them together. In order to fly to your destination, adjust your heading to this amount. Although used in situations where more than half the flight has been completed, **this method can be used at any distance along the track.**

Use the **<u>One in Sixty Rule</u>** to determine the number of degree correction required by pilot to return to his original track.

An aircraft flying from Hanover to Kingston is 3 miles off its track after travelling 30 miles.
What will be the error in the track? _____
What should the correction to the compass heading be? _____
Is there anything else the pilot should do to ensure he is back on track? _____

<u>Return to departure point – assuming no wind drift</u>
The same pilot (above example) decides that he no longer wants to travel to London and wants to head back to the departure point. He will need to calculate the reciprocal or reverse of his outbound heading to determine the heading to take up for the homebound flight.

The reciprocal is found by adding or subtracting 180. Adding if the direction is 180 degrees or less. Subtracting if it is greater than 180 degrees.

So if his track heading was 187 degrees, what would his reciprocal heading be to return to the point of departure? _____