

Θέμα 7^ο

Navigation I

Pre-reading Activity

Match the terms on the left with their definitions on the right.

1. VFR	a. To be opposite to and delimit.
2. meridian of longitude	b. A set of regulations which allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.
3. parallel of latitude	c. An imaginary great circle on the Earth's surface passing through the North and South geographic poles.
4. perpendicular	d. To cut or divide into two parts, especially two equal parts.
5. subtend	e. An imaginary line around the Earth parallel to the equator.
6. bisect	f. Being at right angles to the horizontal.

1.	2.	3.	4.	5.	6.
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Reading (ΜΕΤΑΦΡΑΣΗ)

Read the text below and check your answers.

Fundamental Concepts in Aeronautical Navigation

Ground maps are mandatory for navigation under the **Visual Flight Rules (VFR)**. The maps or charts used for air navigation are overlaid with a **coordinate grid** showing the local **meridians** of longitude and the **parallels** of latitude. In aviation, locations are generally defined in terms of latitude and longitude, while chart directions are referenced in relation to true north.

Latitude and longitude

Parallels of latitude are imaginary circles drawn around the Earth starting from the **equator** and reducing in **circumference** toward the poles. Parallels are identified by the angle that they **subtend** with the centre of the Earth (measured in degrees, minutes and seconds) and whether they lie north or south of the equator:

- the north pole has a latitude of 90°N;

- the south pole has a latitude of 90°S;

- the equator has a latitude of 0° and is a great circle, in that it is formed by a plane that passes through the Earth's centre, **bisecting** the Earth's sphere.

Meridians of longitude are half great circles, **perpendicular** to the equator, which extend from pole to pole. The

meridians are identified by the angle that they subtend with the centre of the Earth (measured in degrees, minutes and seconds) east or west from the prime meridian:

- the **prime or zero meridian** (0° longitude) passes close to Greenwich, England;

- **subsequent meridians** are identified as degrees east or west around to 180°.

Each degree of latitude or longitude can be divided into **minutes**. A minute is 1/60 of a degree¹. The average length of one minute of latitude is equal to one international nautical mile (NM), or 6076.1 feet (or 1852 meters). Example: 45° 10' means 45 degrees, 10 minutes. Distance is always measured using the latitude scale. It cannot be measured horizontally along the longitude scale, because the distance would vary as the meridians converge (get closer), nearer the poles.

“In aviation, locations are generally defined in terms of latitude and longitude, while chart directions are referenced in relation to true north.”

Direction

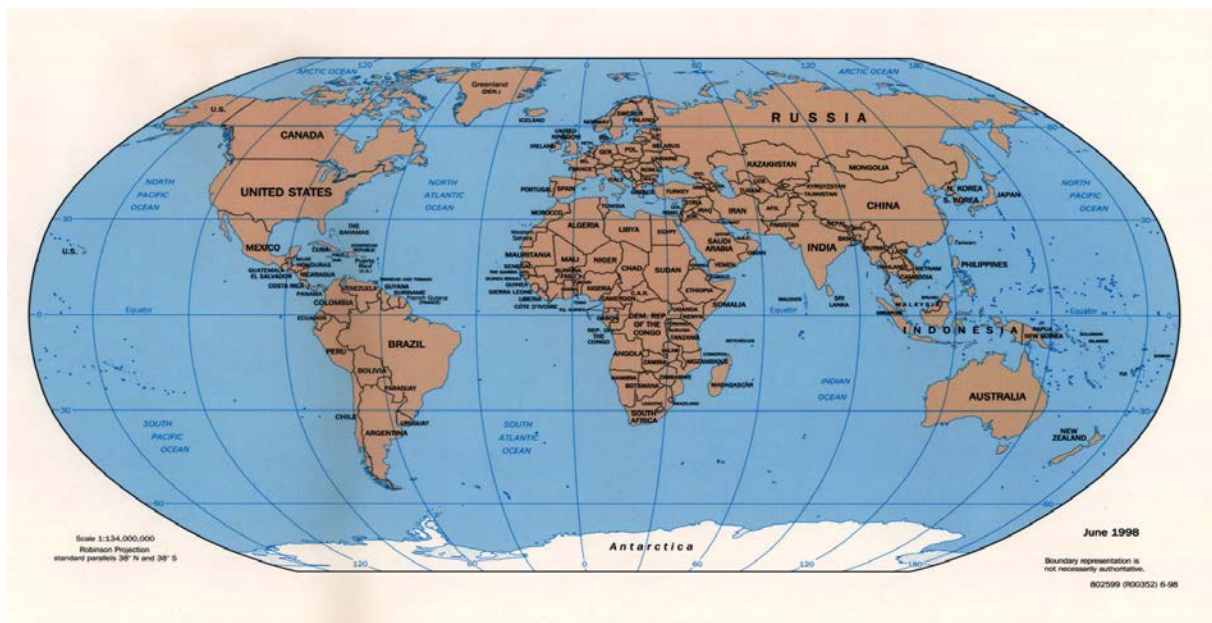
Directions are read from maps in degrees **true** (°T). They are written as groups of three numbers: 020°T 150°T. Nevertheless, as it has already been

men-tioned in Unit 5, the compass which is used to fly a heading (direction or bearing), does not point toward true north; it points toward magnetic north. A correction, known as variation, has to be

applied to a true heading to make it into a magnetic heading. Magnetic headings are written as follows: 120°M 005°M. Variation is shown on maps by dotted lines called **isogonals**. Isogonals join places of equal magnetic variation. Variation may be east (E) or west (W).

For example Mount Beauty airstrip in Victoria, Australia, is located at S36° 44.1' E147° 10.2'. It is logical to express “Lat/long” **coordinates** with the direction from the equator/prime meridian first (S and E), then a group representing the degrees (S36° and E147°) followed by a group for the minutes (S36° 44.2' E147° 10.6').

¹ For greater precision, degrees are divided into 60 minutes (') - of distance, not time. Each minute is further divided into 60 seconds ("), although it's becoming common to use tenths of a minute, or decimal minutes, instead of seconds. A tenth of a minute (or tenth of a nautical mile) is about 600 feet or 185 meters. For example, the position of Athens' Acropolis can be described as 37° 58' 12" N – 23° 43' 30" E.



World map showing major lines of latitude and longitude (scale 1:134,000,000). Maps of the Earth are covered in a series of lines, forming a grid (a series of squares). The horizontal lines are called *parallels of latitude*, and the vertical lines are called *meridians of longitude*.

Reading Activity – Comprehension Questions

Read the text again and answer the following questions.

1. Is $23^{\circ} 46' E$ a latitude or a longitude?
2. What is a line connecting places of equal magnetic variation called?
3. Is $38^{\circ} 15' N$ a latitude or a longitude?
4. What scale do we use in order to measure distance?

Word Study 1

Read the text again and choose the words in **bold** that mean the following.

1. is the boundary line of a circle.
2. The is the meridian (line of longitude) at which the longitude is defined to be 0° .
3. The imaginary great circle around the Earth's surface, equidistant from the poles and perpendicular to the Earth's axis of rotation is called the It divides the Earth into the Northern Hemisphere and the Southern Hemisphere.

4. refer to any of a set of two or more numbers used to determine the position of a point, line, curve, or plane in a space of a given dimension with respect to a system of lines or other fixed references.
5. A unit of angular measurement equal to one sixtieth of a degree, or 60 seconds, is called a
6. A is a unit of length used in sea and air navigation, based on the length of one minute of arc of a great circle, especially an international and U.S. unit equal to 1,852 meters (about 6,076 feet).

Word Study 2

Refer to the map of Australia below and write the names of the Australian cities which correspond to the coordinates given in the tables below.



	1.	2.	3.	4.	5.
City	.....	.....	.....	.....	.....
Latitude	12°24' S	23°48' S	31°56' S	27°23' S	34°56' S
Longitude	130°52' E	133°53' E	115°57' E	153°06' E	138°35' E

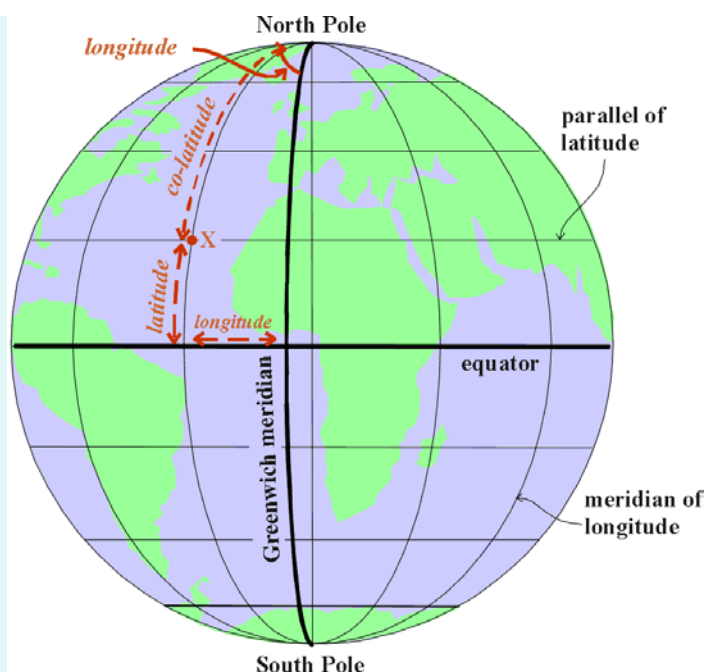
	6.	7.	8.	9.	10.
City	.....	.....	.....	.....	.....
Latitude	35°18' S	37°49' S	18°41' S	29°41' S	33°57' S
Longitude	149°11' E	144°50' E	121°46' E	121°02' E	151°11' E

Vocabulary Review 1 – Maps and Charts

Fill in the gaps of the following text using the words from the list below.

grid	aeronautical charts	equator	poles	landmarks
meridians of longitude	prime meridian	airspace	surface	compare
latitude	navigation	track	parallels of latitude	degree

Maps represent areas of the
1. of the Earth. Position on maps is often described using **2.** and longitude. Maps for aviation are referred to as **3.**, but the word map is also widely used. More specifically maps are covered in a series of lines, forming a **4.** (a series of squares). The horizontal lines are called **5.**, and the vertical lines are called **6.** The **7.** is the zero-degree (0°) parallel of latitude; the **8.** are 90°. Latitude is expressed in degrees north (°N) or degrees south (°S) of the equator. Each meridian of longitude is one **9.**



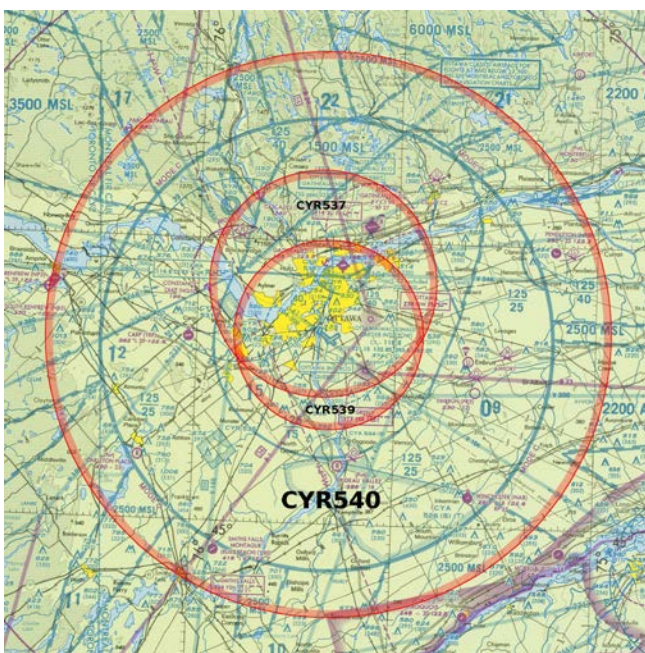
Zero degrees (0°) longitude passes through Greenwich near London in England. There are 180° of longitude east (E), and 180° west (W). Zero degrees longitude is called the **10.** Pilotage, which is **11.** by reference to **12.** or checkpoints, requires an aeronautical chart showing the surface features of the area in detail. This kind of chart allows pilots to **13.** their position. The aeronautical chart does not only show the topographic and cultural detail but also provides a lot of information on airports, navigational aids and **14.** A pilot must be able to **15.** what is shown on the chart with what is seen on the ground.

Vocabulary Review 2 – Air navigation

Fill in the gaps of the following text using the words from the list below.

mid-air	board	instruments	visual flight rules (VFR)	air traffic
breaking	fuel	lost	high	rescue
beacons	endangering	observations	awareness	piloting

The principles of air navigation are the same for all aircraft, big or small. Air navigation involves successfully **1.** an aircraft from place to place without getting **2.**, **3.** the laws applying to aircraft, or **4.** the safety of those on **5.** or on the ground. Air navigation differs from the navigation of surface craft in several ways: Aircraft travel at relatively **6.** speeds, leaving less time to calculate their position en route. Aircraft normally cannot stop in **7.** to ascertain their position at leisure. Aircraft are safety-limited by the amount of **8.** they can carry; a surface vehicle can usually get lost, run out of fuel, then simply await rescue. There is no in-flight **9.** for most aircraft. And collisions with obstructions are usually fatal. Therefore, constant **10.** of position is critical for aircraft pilots. The techniques used for navigation in the air will depend on whether the aircraft is flying under the **11.** or the instrument flight rules (IFR). In the latter case, the pilot will navigate exclusively using **12.** and radio navigation aids such as **13.**, or as directed under radar control by **14.** control. In the VFR case, a pilot will largely navigate using dead reckoning² combined with visual **15.** (known as pilotage), with reference to appropriate maps. This may be supplemented using radio navigational aids.



A NOTAM (Notice to Airmen) distributed by the Ottawa Authorities. The photo shows an expanded version of the Ottawa Terminal control space from the surface to 12,500 feet. In general, a NOTAM is a notice distributed mainly by means of telecommunications containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure, or hazard. NOTAM information could affect a pilot's decision to make a flight. It includes airport or primary runway closures, changes in the status of navigational aids, ILSs, radar service availability, and other information essential to planned en route, terminal, or landing operations.

² Navigation solely based on computations of time, airspeed and heading.

Vocabulary Review 3 – Route Planning

Skim the passage quickly and select the appropriate word for each blank from the choices provided.

The first step in navigation is deciding where one wishes to go. A private pilot planning a flight under VFR will usually use an aeronautical chart of the area which is published specifically for the use of pilots. This map will depict controlled airspace, radio **...(1)...** aids and airfields prominently, as well as hazards to flying such as mountains, tall radio masts, etc. It also includes sufficient **...(2)...** detail - towns, roads, wooded areas - to aid visual navigation. In the UK for example, the CAA³ publishes a series of maps covering the whole of the UK at various scales, updated annually. The information is also updated in the notices to airmen, or NOTAMs.

The pilot will choose a route, taking care to avoid controlled airspace that is not permitted for the flight, **...(3)...** areas, danger areas and so on. The chosen route is **...(4)...** on the map, and the lines drawn are called the track. The aim of all subsequent navigation is to follow the chosen track as accurately as possible. Occasionally, the pilot may elect on one leg⁴ to follow a clearly **...(5)...** feature on the ground such as a railway track, river, highway, or coast.

When an aircraft is **...(6)...**, it is moving relative to the body of air through which it is flying; therefore maintaining an accurate ground **...(7)...** is not as easy as it might appear, unless there is no wind at all — a very rare occurrence. The pilot must adjust heading to compensate for the wind, in order to follow the ground track. Initially the pilot will calculate **...(8)...** to fly for each leg of the trip prior to departure, using the forecast wind directions and speeds supplied by the meteorological authorities for the purpose. These figures are generally

accurate and updated several times per day, but the unpredictable nature of the weather means that the pilot must be prepared to make further **...(9)...** in flight. A general aviation (GA) pilot will often make use of either the E6B flight computer - a type of slide rule - or a purpose-designed **...(10)...** navigational computer to calculate initial headings.

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| 1. | a. power
c. navigation | b. broadcast |
| 2. | a. air
c. space | b. ground |
| 3. | a. allowed
c. obstacle free | b. restricted |
| 4. | a. plotted
c. carved | b. written |
| 5. | a. hidden
c. visible | b. blurry |
| 6. | a. in flight
c. on the ground | b. in service |
| 7. | a. highway
c. airway | b. track |
| 8. | a. headings
c. plans | b. destinations |
| 9. | a. additions
c. adjustments | b. transformations |
| 10. | a. electronic
c. electrical | b. mechanical |

³ Civil Aviation Authority.

⁴ One segment or part of an entire flight or trip by air.

