Topic 2 – Measuring the Earth

Vocabulary

Atmosphere – layer of gases surrounding the Earth, moon and other planets.

Contour line – a line(s) on a contour map that represents equal elevation.

Contour interval – the difference between two consecutive contour lines of different value on a contour map.

Coordinate system – a grid system on Earth to locate positions using latitude and longitude.

Curst – the outer most solid portion of the Earth's lithosphere

Earth's interior – the region of the Earth extending from the crust to the inner core.

Elevation – the height above sea level, the vertical distance above sea level.

Equator – the parallel between the north and south poles on Earth, zero (0^o) latitude.

Field – something that has a measurable value of a given quantity. Examples are elevation field, temperature field, pressure field, etc.….

Gradient – the rate of change from place to place within a field; also called slope.

Hydrosphere – the liquid layer of the Earth.

Isoline – a field line that connect equal values, such as, contour lines, isotherms and isobars.

Latitude – the angular distance north or south of the equator. Also known as parallels. Minimum latitude is 0^o (equator) to 90^oN or 90^oS of the equator.

Lithosphere – Layer of rock that forms the solid outer shell of the Earth.

Longitude – angular distance east or west of the prime meridian. Also called meridians. Usually expressed in degrees, beginning at the prime meridian (0^o) to 180^oE or 180^oW of the prime meridian.

Profile – a side view of a map that shows the elevation changes of a topographic map.

Topographic map – a model of an elevation field using contour lines to show height above sea level.

Overview of Topic

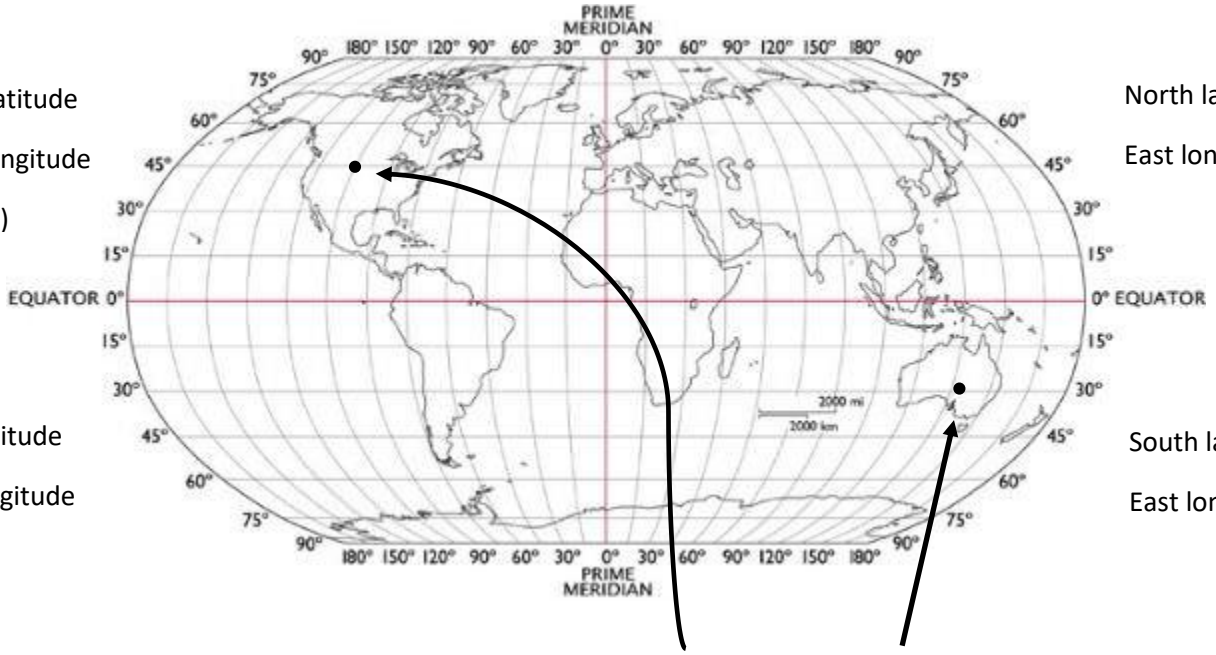
I. Shape of the Earth
   a. Sphere
   b. Evidence from
      i. Satellite photos
      ii. Ships are to sink below horizon as distance from shore increases.

II. Spheres of Earth
   a. Outer spheres
      i. Atmosphere – Page 1 ESRT – Troposphere
      ii. Hydrosphere – Page 1 ESRT – Hydrosphere
      iii. Lithosphere – Page 1 ESRT – Crust (percent mass & percent volume)
   b. Earth's Interior (geosphere)
      i. Page 10 ESRT

III. Locating positions on Earth
   - Coordinate systems
   a. Latitude
      i. Angular distance North or South of the equator
      ii. Measured as degrees ^{o}N & ^{o}S of the equator.
      iii. North Pole is 90^{o}N and South Pole is 90^{o}S.
      iv. Equator is 0^{o} (N or S) does not matter, it can be unlabeled

   b. Longitude
      i. Angular distance East or West of the Prime Meridian
      ii. Measured as degrees E^{o} & W^{o}.
      iii. Greenwich England reference point.
      iv. Prime Meridian is 0^{o} longitude
      v. International Date Line is 180^{o} longitude.

c. Measuring with latitude and longitude



d. Report latitude first, then longitude last (45°N, 105°W) or (30°S, 140°E)

IV. Fields

a. Isolines

i. Isolines are drawn at regular intervals

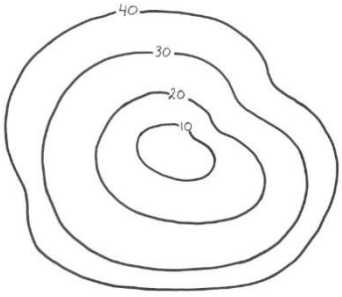
ii. Isolines NEVER cross each other

iii. Values inside a closed isoline are either higher or lower than those outside the closed isoline

iv. Always label the value of the isoline

v. Fields can represent

1. Contour maps (contour lines)
2. Temperature maps (isobars)
3. Pressure maps (isobars)



A field map

V. Mapping

a. Contour lines

i. Closed circles mean an increase in elevation

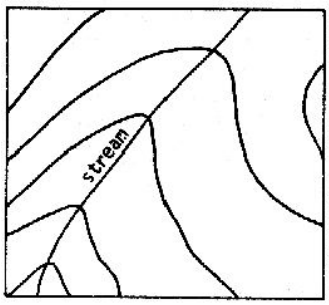
ii. Contour interval

1. Distance in meters (m) or feet (ft) between adjacent lines
2. Sometimes you need to calculate it

iii. Map scale
    1. Provided with any map
    2. Measures distances on ground in kilometers (km) or miles (mi)

iv. Map direction
    1. Compass rose shows North
    2. If no compass rose then North is to the top of the diagram

v. Stream flow
    1. Contour lines make **"V"** shape as they cross stream
    2. Tip of **"V"** points up stream, opposite the flow.
    3. Represented as a directions (N, S, E, or W)



Stream flows S or SW

vi. Profiles (find a YouTube video)
    1. https://www.youtube.com/watch?v=dA1J9kpi1nM
    2. Use a straight edge of clean sheet of paper.
    3. Mark off every contour line that intersects the edge of the paper.
    4. Use the scrap paper to transfer each mark onto elevation grids
    5. Connect points
    6. Top of hills should be humped and not touch next grid line.
    7. Streams should go below the grid line, but not touch next grid line.

vii. Gradient (slope)
    1. Formula
        a. $Gradient = \frac{change\ in\ field\ value}{distance}$
        b. Field value is the change in elevation or the isoline value between two points on the map
        c. Distance is the distance between the two points on the map using the map scale.

Earth Science Reference Table – (ESRT)

Pages from ESRT used in Topic 1.

Page 1, 3, 4, 10 & 14

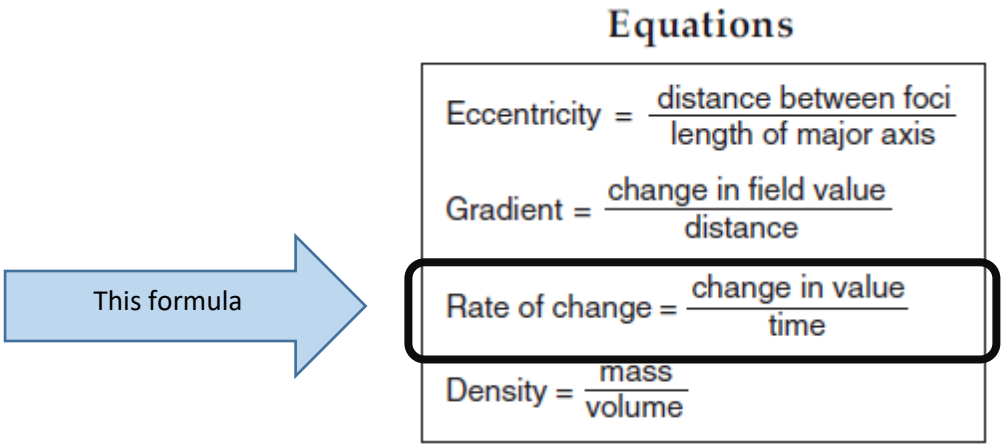
<u>Earth Composition (page 1)</u>

Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

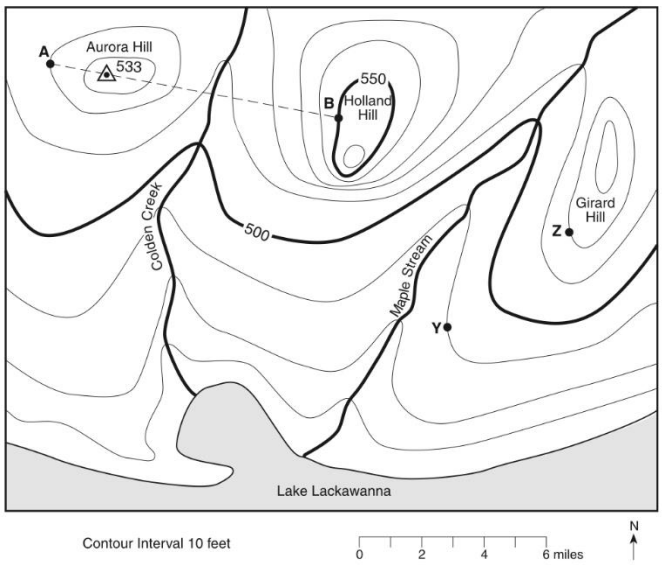
This section of the reference table can be used several units. Pay attention to the columns, the crust is the lithosphere and contains both percent by mass and percent by volume.

<u>Gradient (page 1)</u>



Example: Find the gradient between points Y and Z on the map.

- Determine the elevation for Y and for Z.
- Look for the contour interval on the map or look for labeled contour lines.
- The 500 ft contour is labeled, point Y is below and point Z is above.
- A = 490ft, Z = 520ft
- Distance must use the scale on the map, make a new scale with a clean sheet of paper, a new ruler.
- The distance is 5 miles between point Y and Z.
- Use gradient formula and include units.
- $Gradient \quad = \frac{520\ ft - 490\ ft}{5\ miles} = \mathbf{5\ \frac{ft}{mi}}$



Another example to calculate gradient maybe given as a word problem.

> The elevation between at point A is 20 meters (m) and at point B is 2 meters (m). The ground distance is 1.5 kilometers (km) between point A and point B. What is the gradient?

- Determine the change in elevation (field value) and pay attention to the units.
  - 20 m – 2 m = 18 m
- Find the distance. In this case it is stated as 1.5 km.
- Calculate gradient.
- The answer should be 12 $\frac{m}{km}$.

When performing calculations that require actual measurements on a map such as the first example, there will always going to be slight differences in accuracy based on student measurements. The answers will be close within a small margin of error that is indicated on an exam. In the second example with the given values there should be no differences in the answer based on the students' calculations.

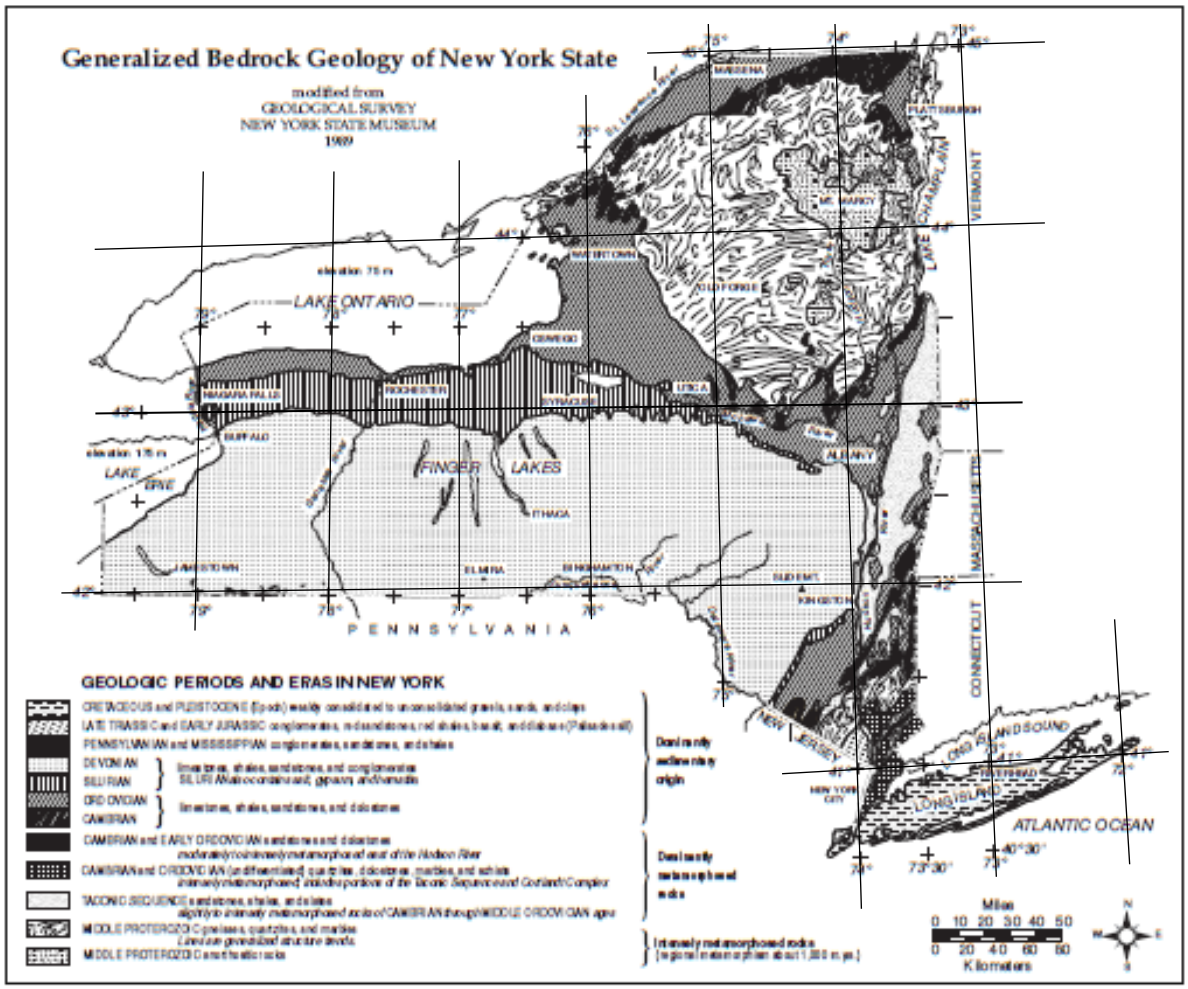
New York State map (page 3)

This map is a bedrock map, but has latitude and longitude that is used to locate places in NY.

The map also had a map scale to make measurements.

Have students draw lines east to west and north to south like the map below.

Between each degree are minutes (60 min = 1 degree)



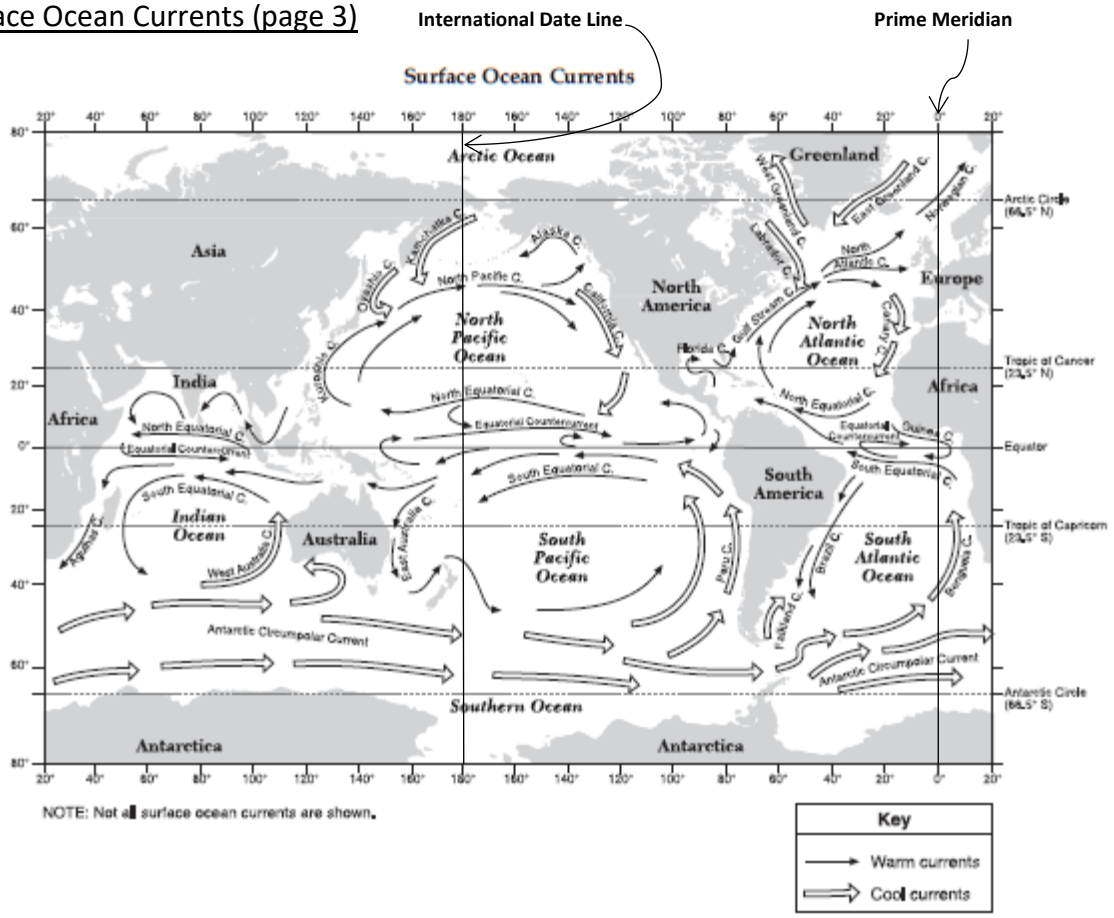
An example would ask what is the coordinates of Ithaca NY?

- 42 degree and 30 minutes N, 76 degrees and 30 minutes W. It should be written using a coordinate system (42° 30'N, 76° 30'W). If written in words the student wouldn't be wrong.

Another example might be what is the latitude of the observer if Polaris is at an altitude of 43°?

- Polaris is unique in its positon in relation to the Earth; it is directly over the North Pole.
- Polaris' altitude is equal to the latitude of an observer in the northern hemisphere.
- In this case the observer would be at 43°N latitude.
- DOES NOT WORK IN SOUTHERN HEMISPHERE!

Surface Ocean Currents (page 3)



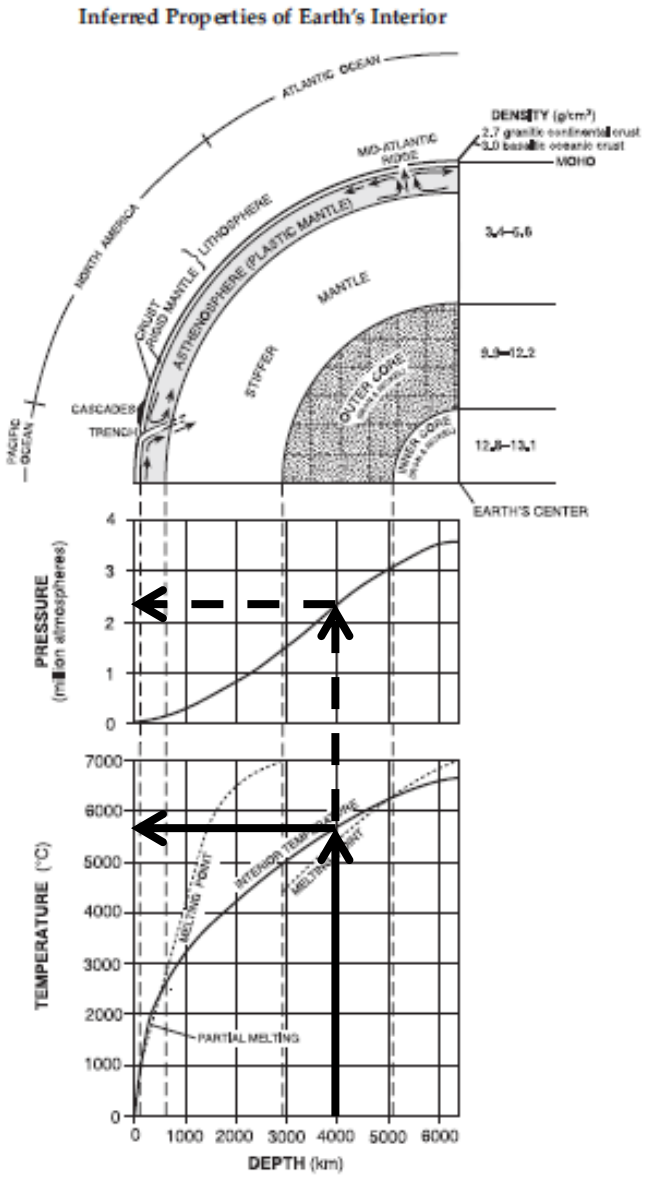
This map is used to find locations on Earth.

Notice that 180° is at the center of the map; it is to emphasize the oceans, not political boundaries.

The Prime Meridian (PM) and the International Date Line has been added. Left (west) of the PM is west and the right (east) of the PM.

There are also important reference lines of latitude that can be sued in other units.

Earth's interior (page 10)



This can be a tricky graph to use for students. There are many different Earth properties that can be gleaned from this table.

Most questions will refer the depth and either the temperature, pressure or a layer of Earth.

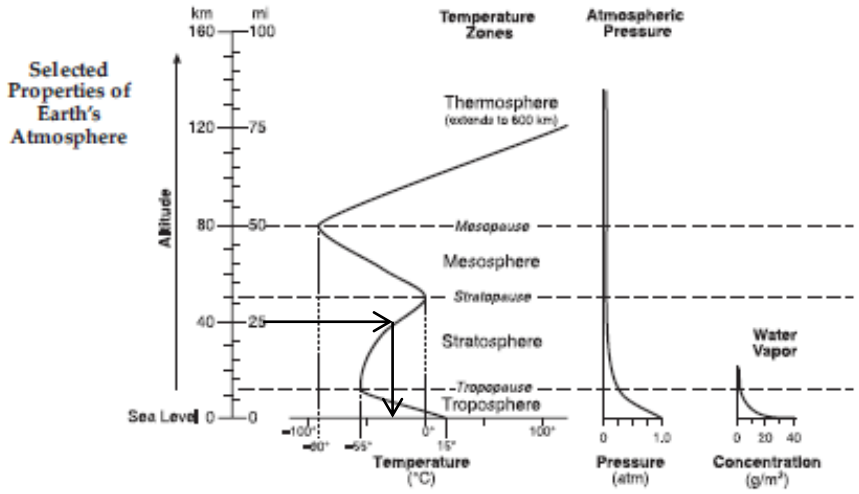
For example; what is the interior temperature of the Earth at a depth of 4000 km?

- The thick arrow shows how to complete the problem.
- The arrow intersects the interior temperature and then moves to the temperature on the y-axis.
- The temperature is 5700 °C. There will usually be some margin of error; some might indicate the temperature to be 5800 °C.

Finding pressure is done the same method. For example what is the pressure of the Earth's interior at a depth of 4000 km?

- Follow the dashed arrow to the pressure part of the graph.
- The dashed arrow intersects the pressure on the graph; now look on the y-axis to find the pressure which is about 2.2 million atmospheres.
    - An atmosphere is the average pressure the Earth exerts at the surface; the average is 1 atmosphere or 1 atm.

<u>Earth's Atmosphere (page 14)</u>



This is also a tricky table and has a lot of information. The table shows several variables based on altitude in the atmosphere.

- Altitude is the y-axis and has both miles and kilometers.
- Temperature, pressure and concentration are the x-axis.

An example that might be asked in topic 2 would be what layer of the atmosphere would be found at an altitude of 25 kilometers?

- Find 25 km on the y-axis, it should be the *stratosphere*.

Another example might be what is the temperature and layer of the atmosphere that is located at 25 miles above sea level (25 miles in altitude).

- Find 25 miles and anywhere from – 25 to – 35 ^{o}C.