Visual Tutorial

Pitot Static System Simulator

Adobe (formerly Macromedia) Flash Requirements

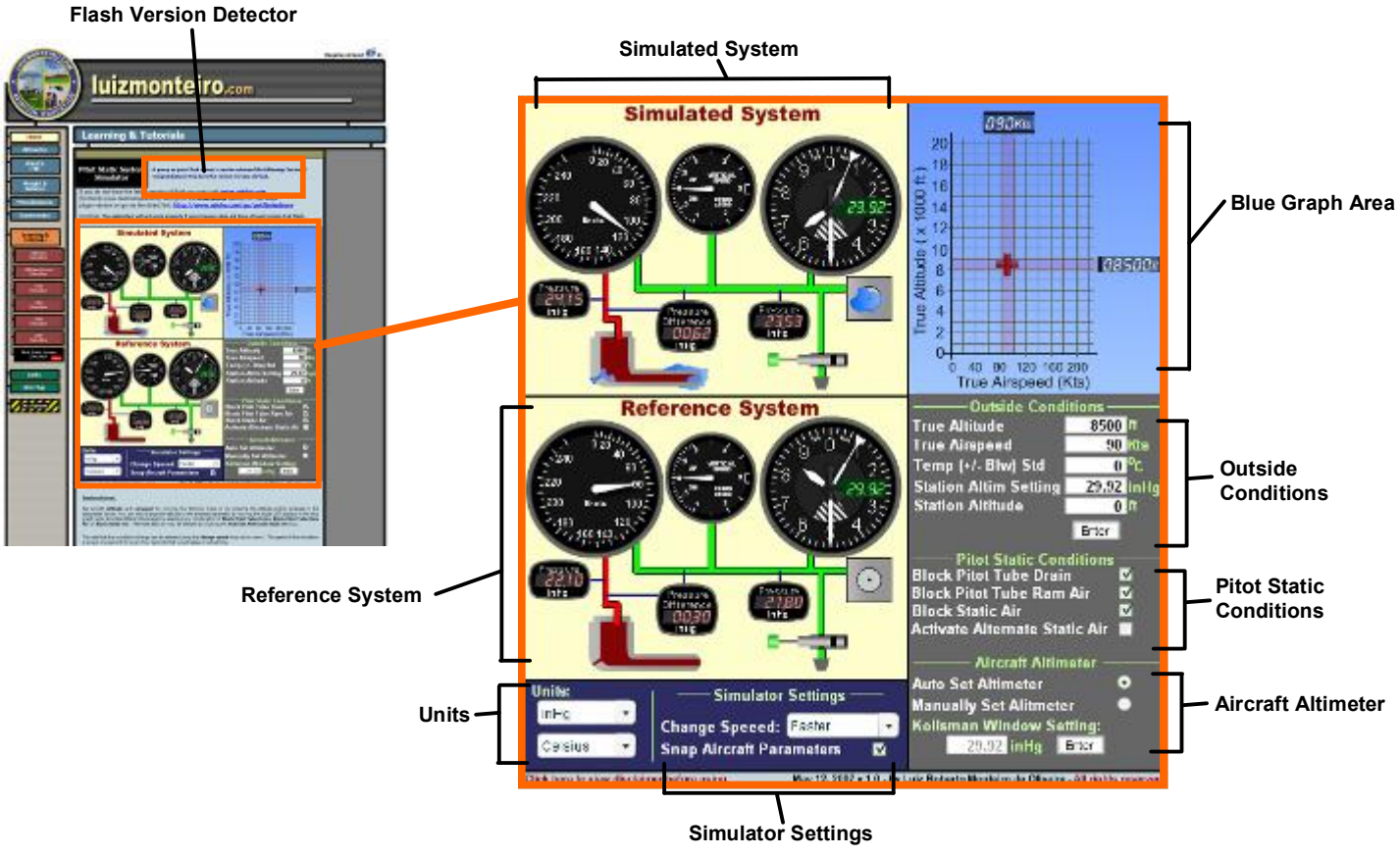
Thank you for using the Pitot Static System Simulator from luizmonteiro.com. Please note that this tutorial is designed to help you understand how to use the simulator. Note that the results are only approximations and should never be used in real flight.

Before you begin using the simulator, please make sure that your browser has the Adobe (formerly Macromedia) Flash version 8 or higher. If you do not have this you may go to the Adobe website at: http://www.adobe.com and go to the downloads section where you will be able to download and install the latest version.

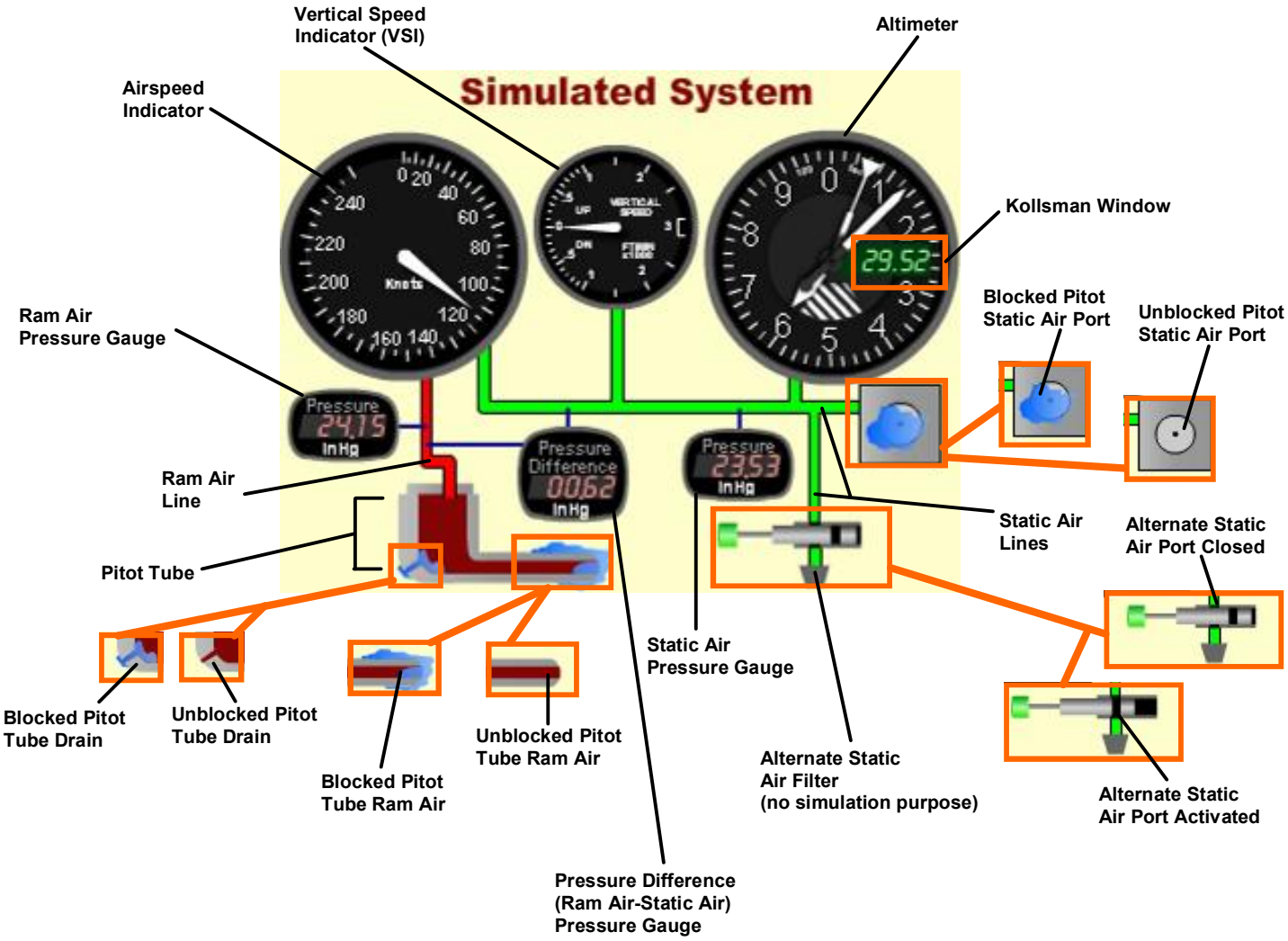
The Pitot Static System Simulator web page will also run a test (Flash Version Detector) to check which version is installed in your browser. If you have at least version 8 installed the following message will appear on the page right before the simulator section:

If your browser has an older version which will not allow the simulator to function correctly the following message will appear:

Pitot Static System Simulator Application Parts

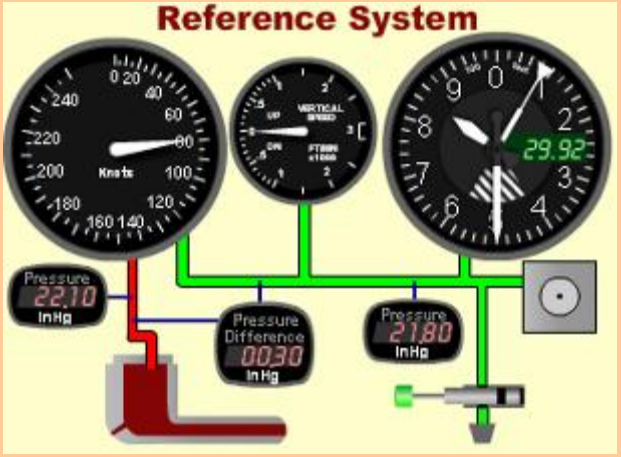


Pitot Static System Simulator Application Parts (cont.)



Note that the **Reference System** has the same parts as the **Simulated System** except that you cannot block the **Ram Air**, **Drain Hole** or **Static Air Port**. Also the **Kollsman Window** is always set to the **Station** **Altimeter Setting** even if the **Aircraft** **Altimeter Setting (Kollsman Window in the Simulated System)** is manually set to a different setting. In addition to the **Alternate Static Air Port** does not engage in the **Reference System**.

The reason for this is that the **Reference System** is used to compare the readings with the **Simulated System** when these variables are introduced.



Pitot Static System Simulator Application Parts (cont.)

Simulated System
This is the Pitot Static System that applies blockages and the manually set altimeter setting.

Reference System
This is the Pitot Static System that can be used as a reference to compare results from the Simulated System. The Reference System always has the correct Altimeter Setting and is not affected by blockages selected by the user.

Outside Conditions

True Altitude
The actual altitude that the aircraft, and therefore the Pitot Static System is placed.

True Airspeed
The actual airspeed that the aircraft, and therefore the Pitot Static System is moving in the air.

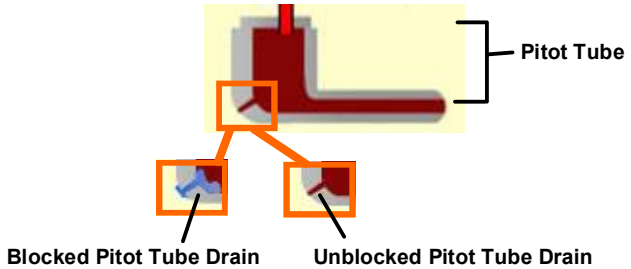
Temp (+/- Blw) Std
The variation in temperature above or below the temperature in standard atmosphere.

Station Altim Setting
The Altimeter Setting for a particular airport or station. This is the same Altimeter Setting that would be obtained on the ATIS (Airport Terminal Information Service). Note that unless **Auto Set Altimeter** is selected, the Kollsman window (i.e. the altimeter in the aircraft) will not be adjusted automatically in the **Simulated System**, simulating either the pilot forgetting to set the altimeter or the altimeter setting not being available. The Kollsman window in the **Reference System** will be set to the station altimeter setting regardless if **Auto Set Altimeter** is selected or not.

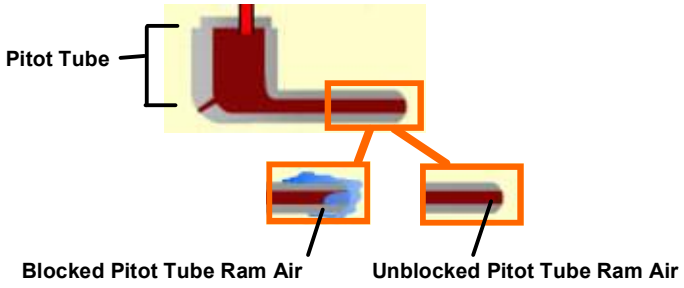
Station Altitude - The altitude of the airport or station where the Altimeter Setting was obtained.

Pitot Static Conditions

Block Pitot Tube Drain
Simulates the blockage of the Pitot Tube Drain.

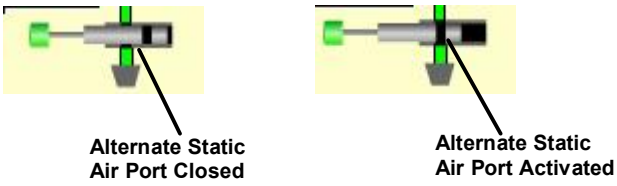


Block Pitot Tube Ram Air
Simulates the blockage of the Pitot Tube Ram Air.



Block Static Air
Simulates the blockage of the Static Air Port.

Activate Alternate Static Air
Simulates the activation of the Alternate Static Air Port. Typically as the aircraft increases in speed the static pressure using the Alternate Static Ports is typically slightly less than that of the actual Static Port outside the aircraft for non-pressurized aircraft.



Aircraft Altimeter

Auto Set Altimeter/Manually Set Altimeter
Determines whether the Kollsman Window Setting is automatically adjusted if a different station altimeter setting is entered.

Kollsman Window Setting
This setting is made by the pilot on the aircraft's altimeter.

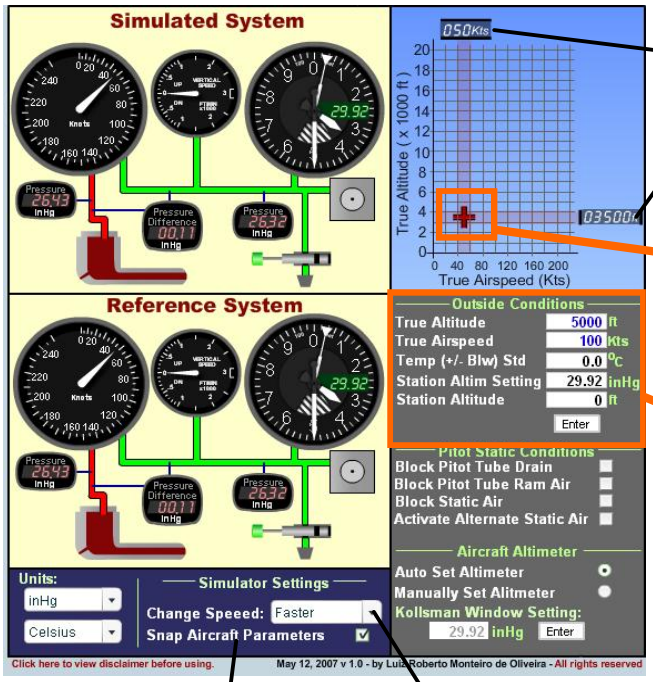
Units
This section allows the user to change pressure units from inHg (inches of mercury) to HPa (Hecto Pascal) or temperature from Celsius to Fahrenheit.

Change Speed
The rate that the conditions change can be selected using the change speed drop down menu.

Snapped Aircraft Parameters
If the Snapped Aircraft Parameters check box is selected, then altitude will be rounded to the nearest 500 feet and airspeed will be rounded to the next 5 knots. If this is not selected then altitude will be rounded to the nearest 100 feet and airspeed will be rounded to the nearest 1 knot. This happens regardless if the altitude and airspeed were entered manually or by dragging them using the cross in the blue graph.

Setting Aircraft Climb and Speed Profile

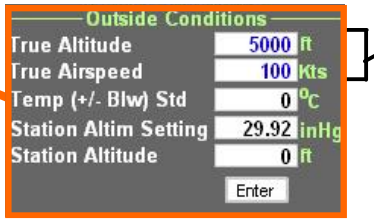
Set aircraft altitude and airspeed by moving the blinking cross or by entering the altitude and/or airspeed in the designated boxes. You can also change the altitude or the airspeed separately by moving the digital LCD displays in the blue graph area.



True Airspeed Digital LCD Display

Altitude Digital LCD Display

Blinking Cross

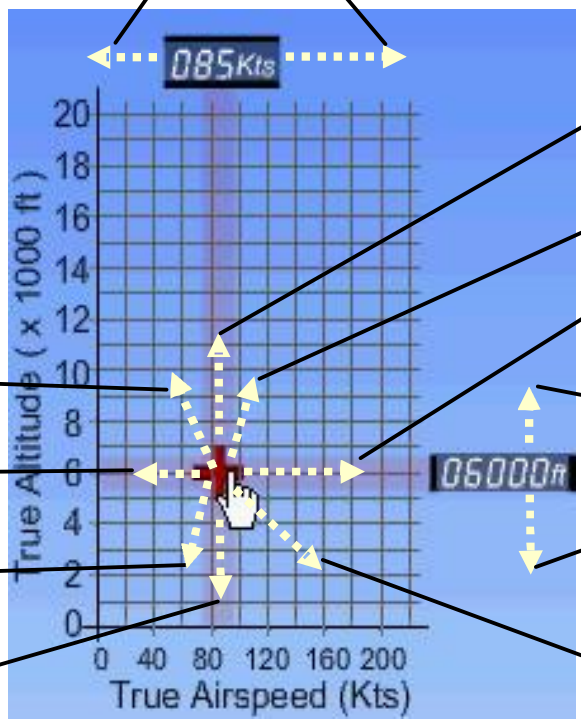


True Altitude and **True Airspeed** can be entered here as well. Values remain in blue color and are only effective once you click <Enter>. Once entered the values turn black

The rate that the conditions change can be selected using the **Change Speed** drop down menu. The speed of the simulation is always one second for every four seconds that would elapse in actual time.

If the **Snap Aircraft Parameters** check box is selected, then altitude will be rounded to the nearest 500 feet and airspeed will be rounded to the next 5 knots. If this is not selected then altitude will be rounded to the nearest 100 feet and airspeed will be rounded to the nearest 1 knot. This happens regardless if the altitude and airspeed were entered manually or by dragging them using the cross in the blue graph.

Level with decreasing or increasing speed
(Drag Airspeed LCD left or right)



Constant speed climb
(Drag Blinking Cross in this direction)

Climb with increasing speed
(Drag Blinking Cross in this direction)

Level with increasing speed
(Drag Blinking Cross in this direction)

Climb with decaying speed
(Drag Blinking Cross in this direction)

Level with decreasing speed
(Drag Blinking Cross in this direction)

Descent with decreasing speed
(Drag Blinking Cross in this direction)

Constant speed descent
(Drag Blinking Cross in this direction)

Constant speed climb or descent
(Drag Altitude LCD in up or down)

Descent with increasing speed
(Drag Blinking Cross in this direction)

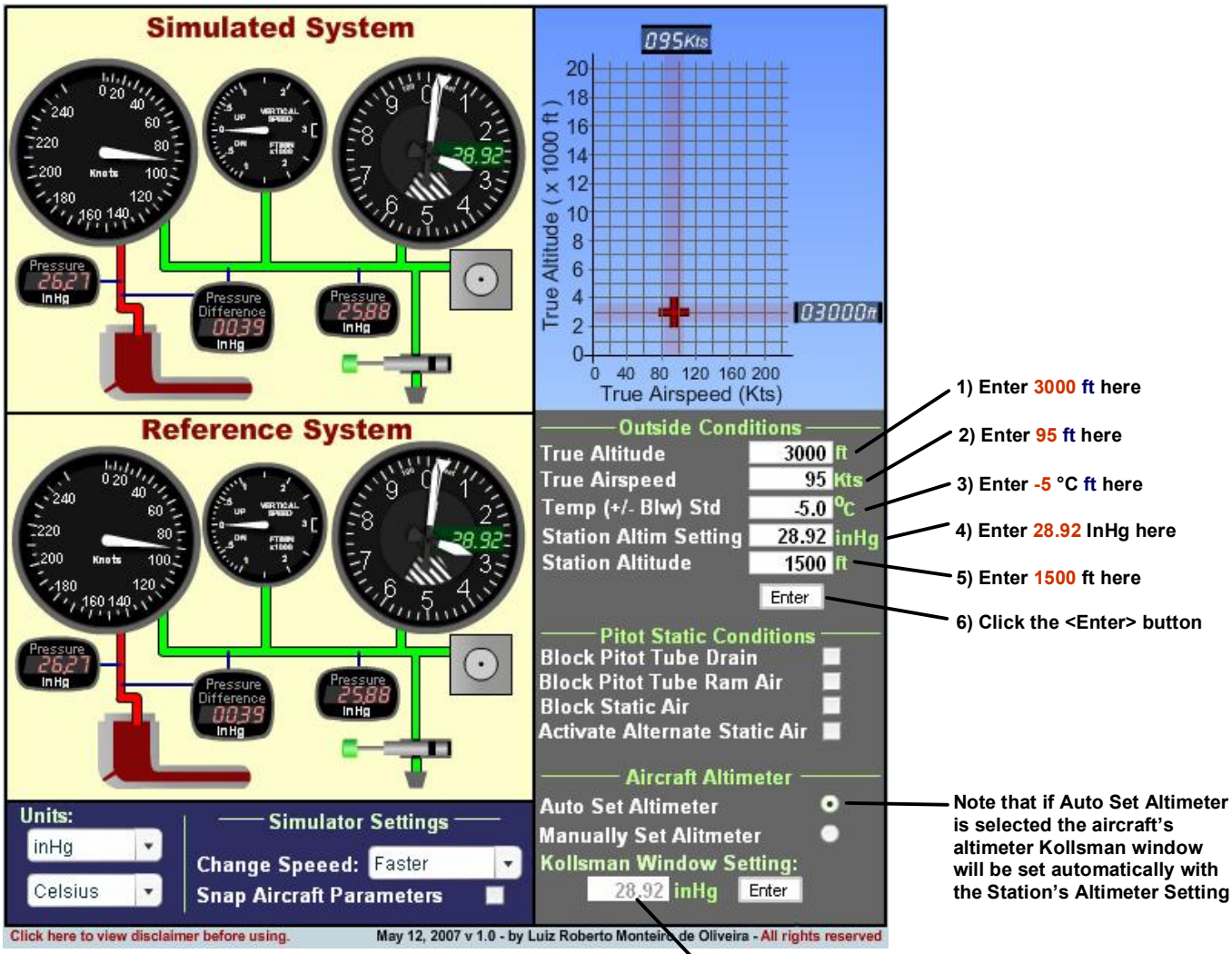
Example 1

An aircraft is flying at a True Altitude of 3000ft and at 95 Kts True Airspeed. According to the ATIS at a nearby airport located at 1500ft MSL the altimeter setting is 29.82 InHg. The pilot has entered that setting of 29.82 InHg in the aircraft's altimeter Kollsman window. The outside temperature is 5°C below standard. The pilot is flying through icing conditions and the static port freezes. If a vertical gust blows the aircraft 200ft up so that the true altitude is now 3200ft (True Altitude).

1) What happens to the pitot static instruments?

2) Can this condition cause an unwary pilot to get disoriented?

Step One: Set Initial Conditions

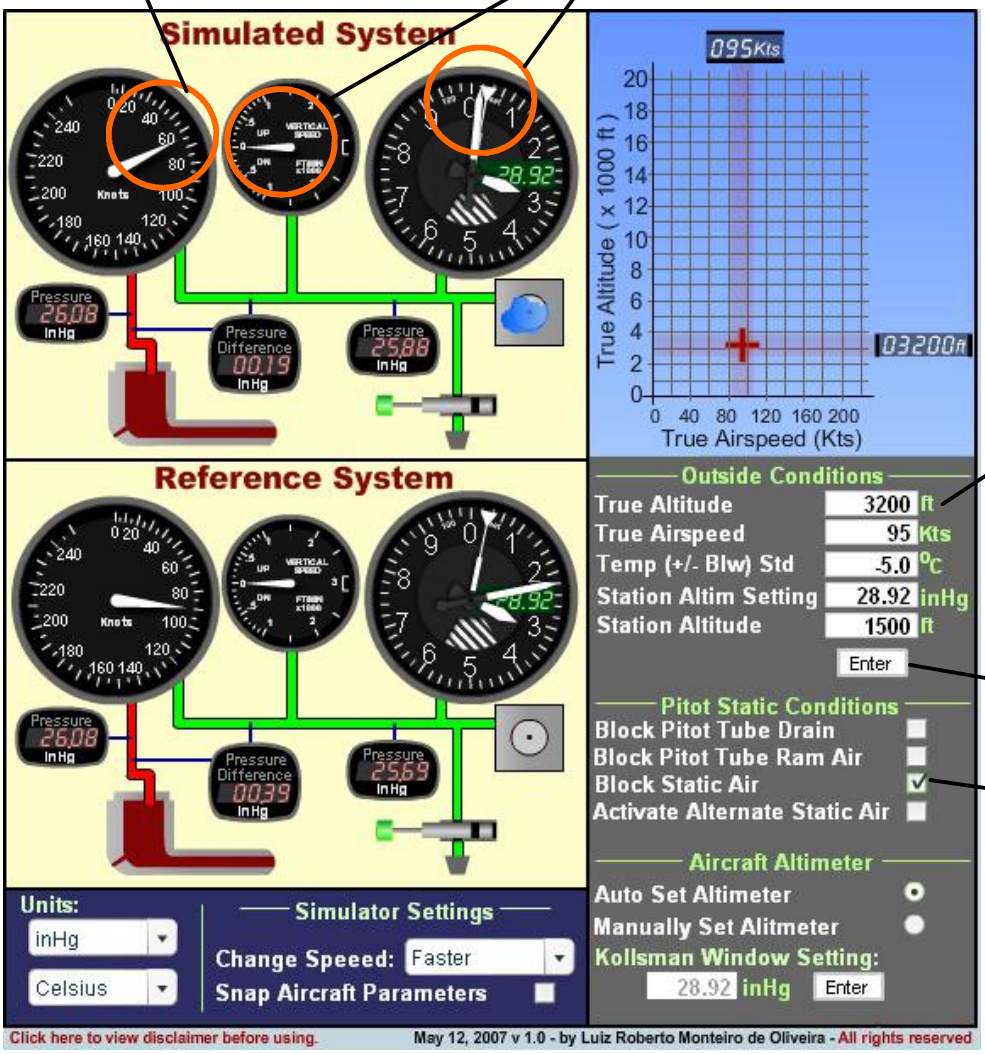


Example 1 (continued)

Step Two: Set Pitot Static Conditions and New Conditions

4) Notice that the Indicated Airspeed dropped about 25 Kts in just 200 ft even though the True Airspeed has not changed!

5) Notice that the VSI and Altimeter froze at the altitude that the blockage occurred, which makes sense since they depend solely on the Static Pressure



2) Enter 3200 ft here

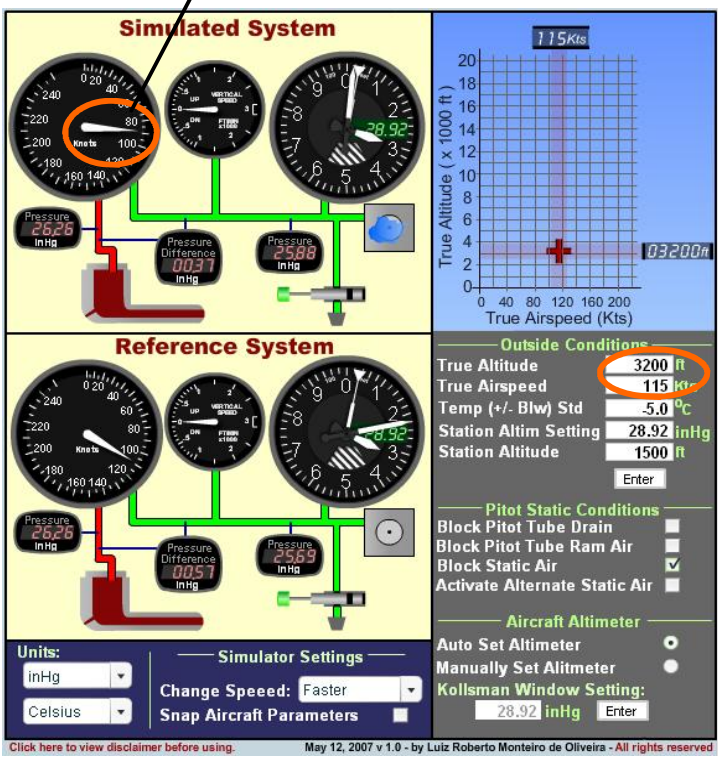
3) Click the <Enter> button

1) Apply blockage to Static Air Port

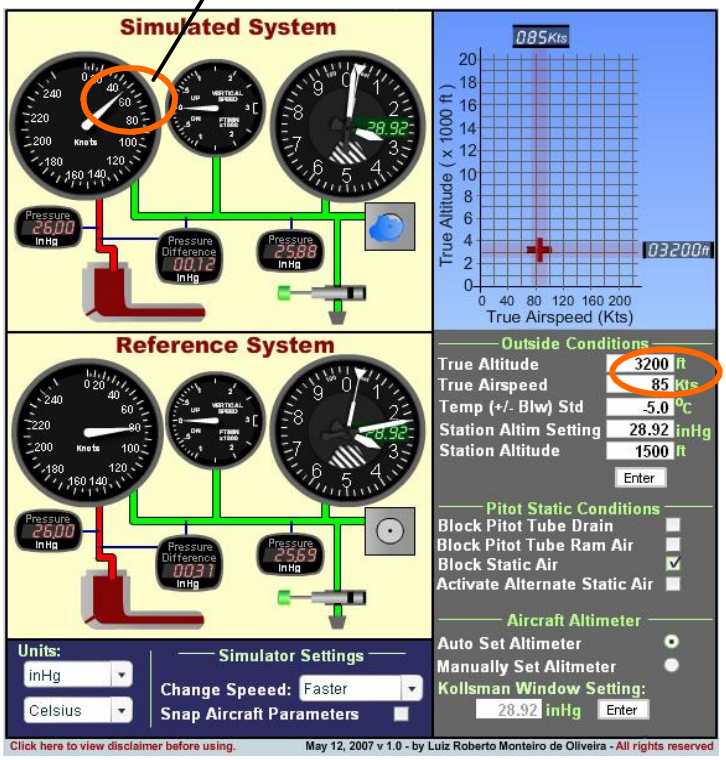
Conclusion
If the Static Air is blocked while the Pitot Tube Ram Air and Drain Hole are unobstructed, the Airspeed indicator will indicate lower than the correct airspeed as altitude increases and greater as altitude decreases. The VSI and Altimeter stop at the altitude that the blockage occurred. The pilot can be disoriented quickly since the airspeed varies a lot with small changes in altitude.

Example 1 (further investigation part 1)

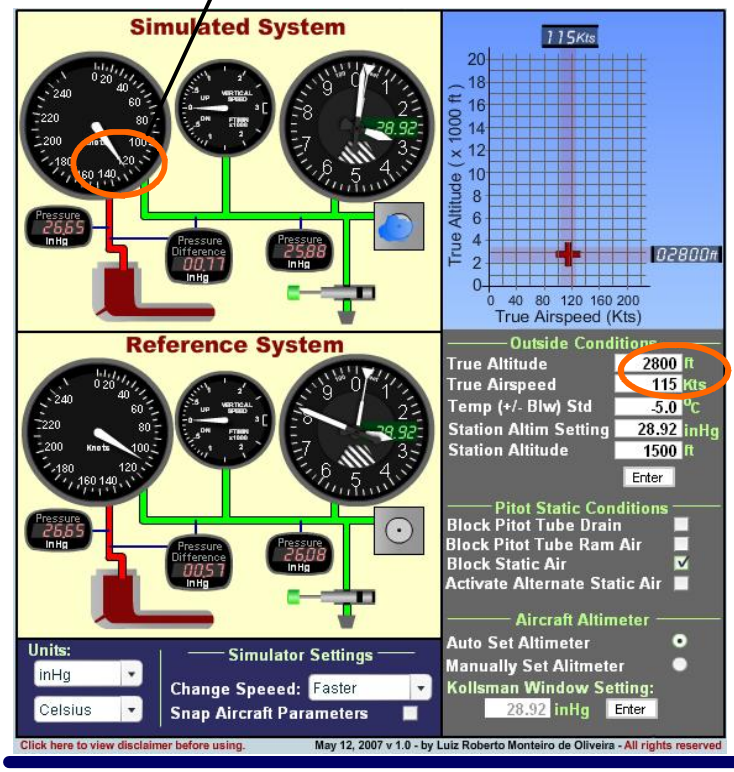
Increasing speed to 115 shows that the Indicated Airspeed will increase but the value will be below the correct Indicated Airspeed value when above the altitude that the pitot static system froze.



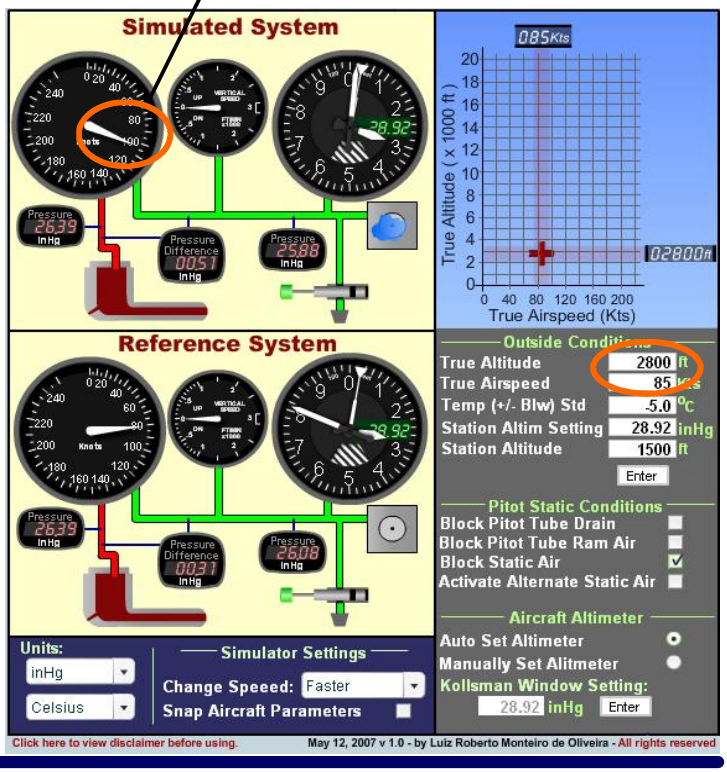
Decreasing speed to 85 shows that the Indicated Airspeed will decrease but the value will be below the correct Indicated Airspeed value when above the altitude that the pitot static system froze.



Increasing speed to 115 shows that the Indicated Airspeed will increase but the value will be above the correct Indicated Airspeed value when below the altitude that the pitot static system froze.

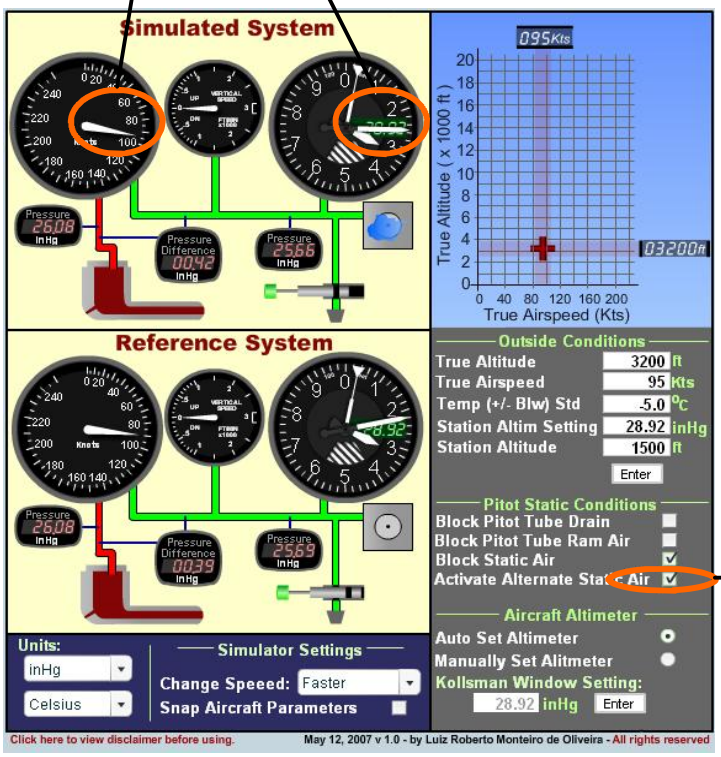


Decreasing speed to 85 shows that the Indicated Airspeed will decrease but the value will be above the correct Indicated Airspeed value when below the altitude that the pitot static system froze.

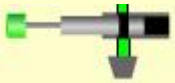


Example 1 (further investigation part 2)

When activating the Alternate Static Source the readings of Indicated Airspeed read only slightly higher as well as the Altimeter



Remember: To correct for blocked Static Source activate the Alternate Static Air! Try it now on the Simulator and see the results.



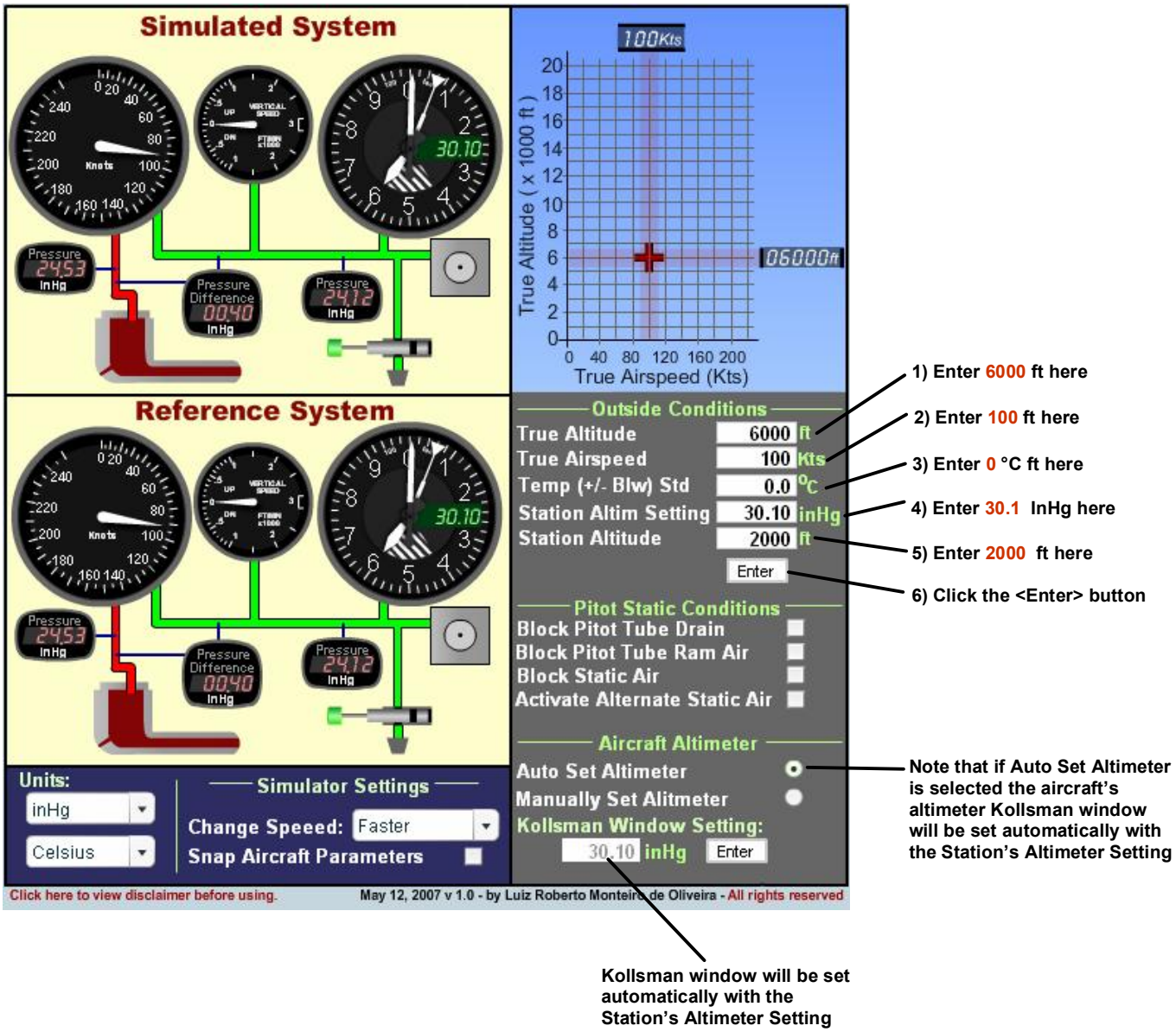
Example 2

An aircraft is flying at a True Altitude of 6000ft and at 100 Kts True Airspeed. According to the ATIS at a nearby airport located at 2000 ft MSL the altimeter setting is 30.1 InHg. The pilot has entered that setting of 30.1 InHg in the aircraft's altimeter Kollsman window. The outside temperature is standard. The pilot is flying through icing conditions and the Pitot Drain Hole freezes followed by the Pitot Ram Air freezing as well. If a vertical gust blows the aircraft 200ft up so that the true altitude is now 6200ft (True Altitude).

1) What happens to the pitot static instruments?

2) Can this condition cause an unwary pilot to get disoriented?

Step One: Set Initial Conditions

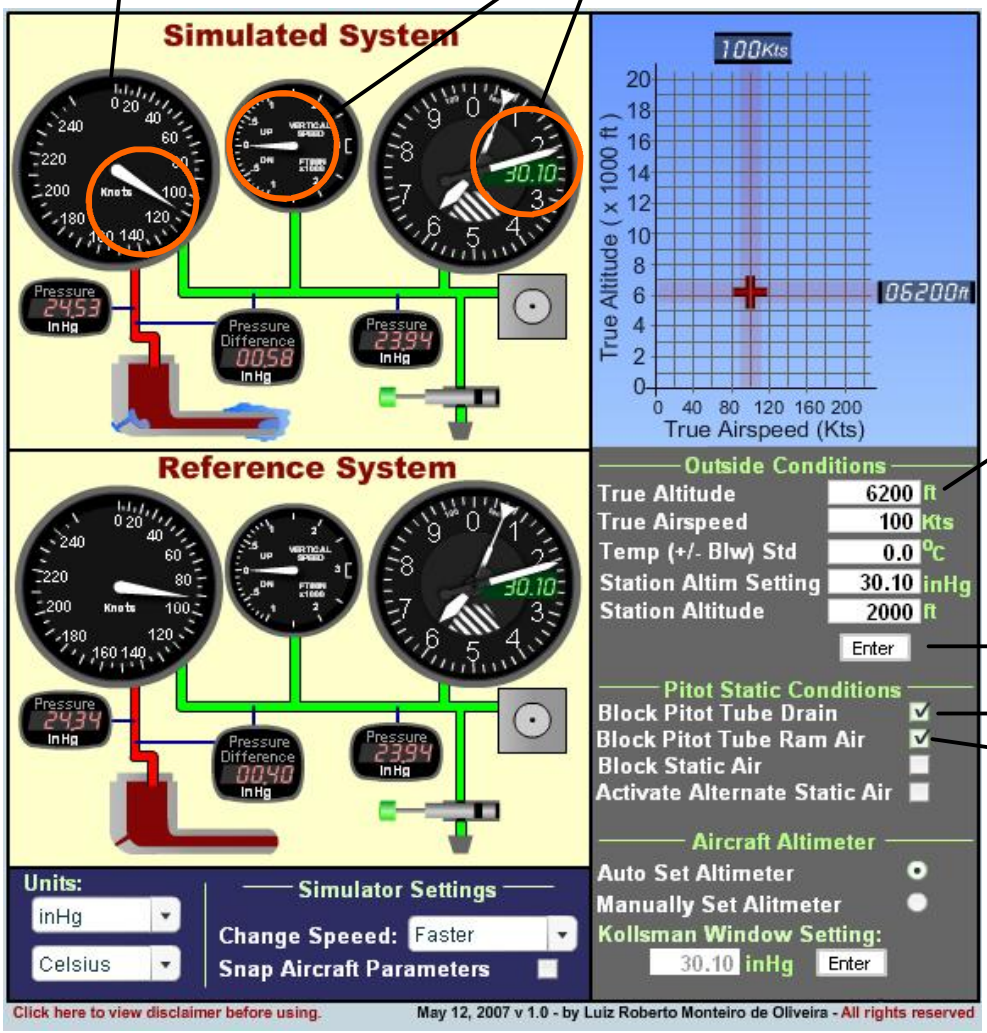


Example 2 (continued)

Step Two: Set Pitot Static Conditions and New Conditions

5) Notice that the Indicated Airspeed raised about 20 Kts in just 200 ft even though the True Airspeed has not changed!

6) Notice that the VSI and Altimeter are normal since they are not affected by the Ram Air Pressure



3) Enter 6200 ft here

4) Click the <Enter> button

1) Apply blockage to Pitot Tube Drain

2) Apply blockage to Static Air Port

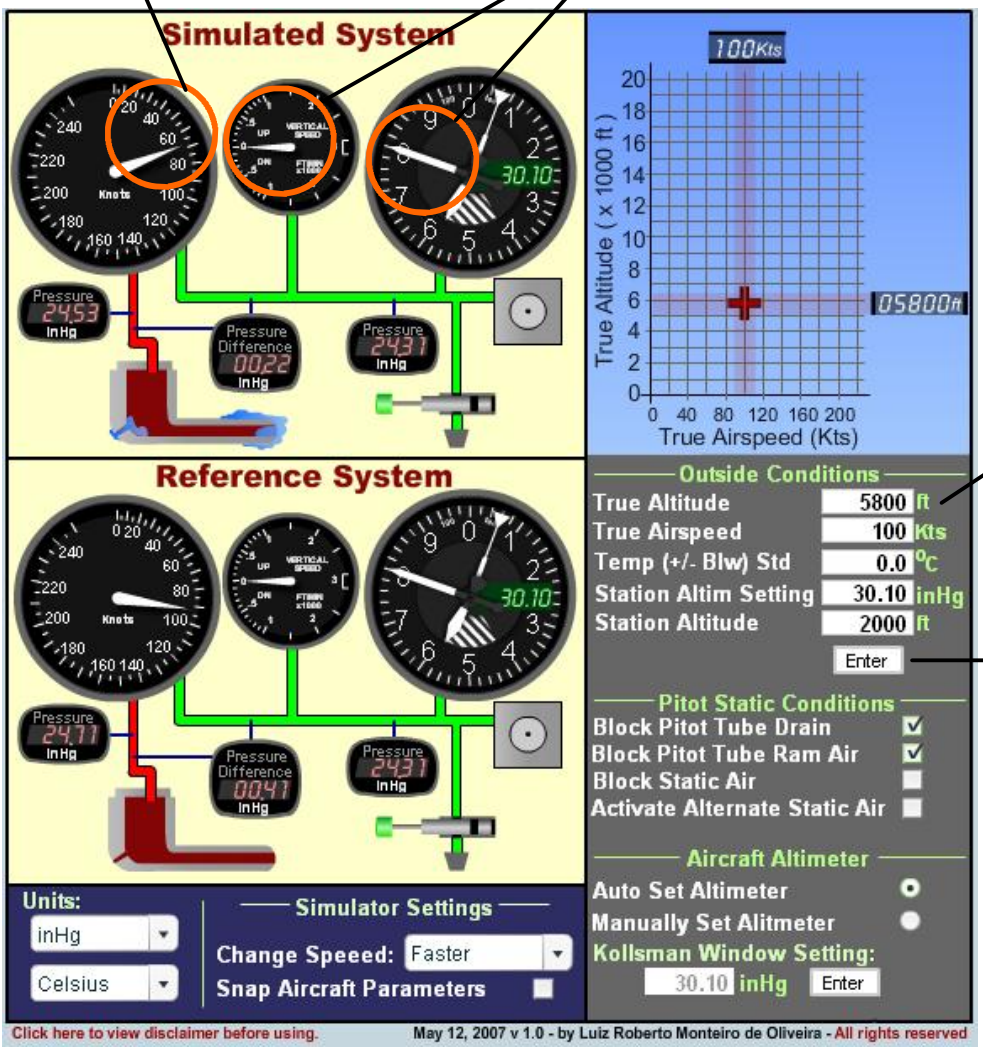
Note that if the Ram Air Port is blocked before the Pitot Tube Drain the results will be quite different since the Ram Air pressure will escape through the Pitot Tube Drain and not get trapped. The result is the Indicated Airspeed dropping to zero at that altitude.

Example 2 (continued)

Step Three: Let's see what happens now if the aircraft descends 200 ft

5) Notice that the Indicated Airspeed dropped about 20 Kts in just 200 ft even though the True Airspeed has not changed!

6) Notice that the VSI and Altimeter are normal since they are not affected by the Ram Air Pressure



3) Enter 5800 ft here

4) Click the <Enter> button

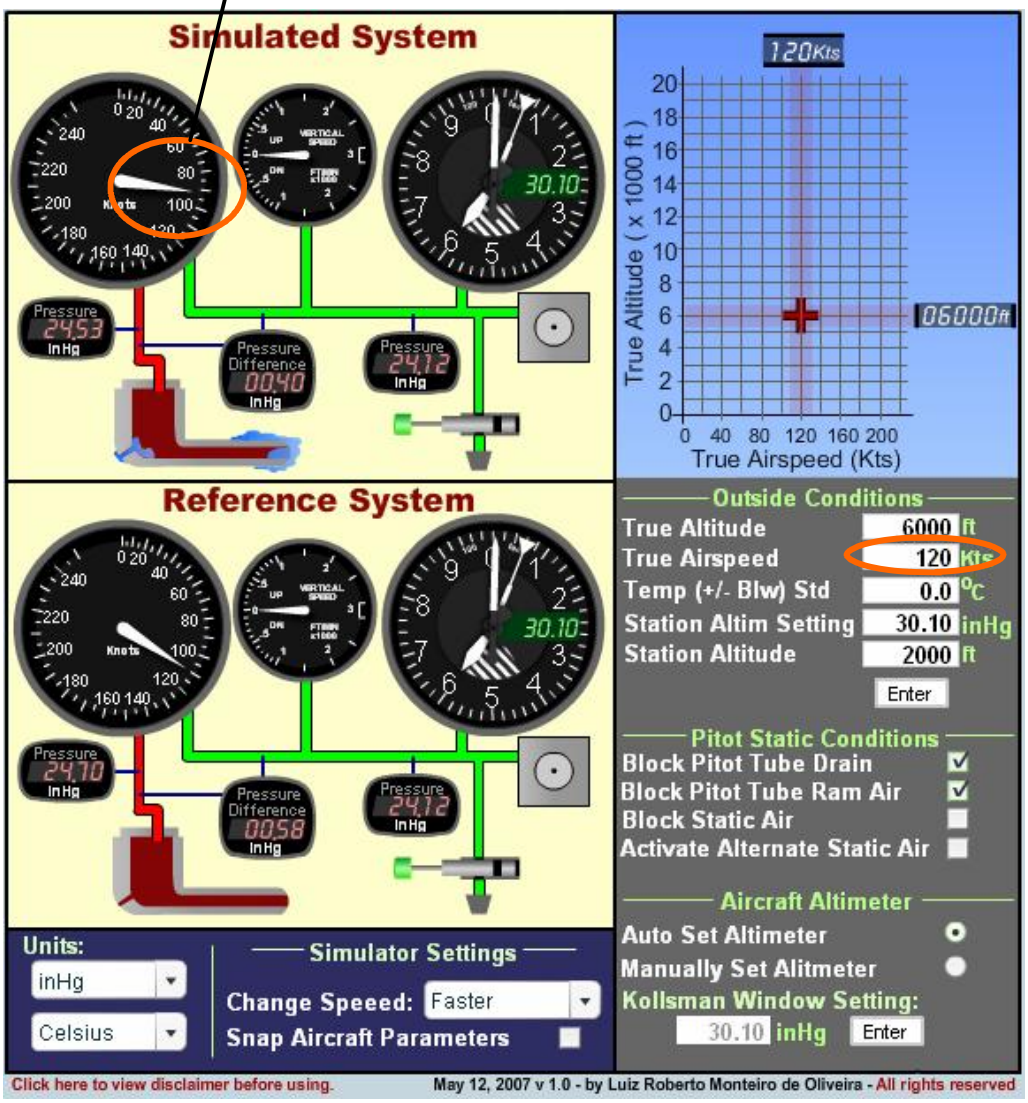
Conclusion

If the Pitot Drain Hole freezes followed by the Pitot Ram Air while the Static Air Port remains unobstructed, the Airspeed Indicator will not respond to changes in Airspeed (since the Ram Air is blocked) and the Airspeed Indicator will freeze at the current indication at the altitude it blockage occurred, however if the aircraft climbs the Airspeed Indicator will increase and decrease if the aircraft descents. This makes it behave similarly to an Altimeter. Note that this is the opposite behavior that happens when the Static Port froze in the previous example.

As the altitude decreases and thus the Indicated Airspeed the disoriented pilot may be inclined to lower the nose into a dive to try to "regain airspeed". This in actuality will cause the aircraft's speed to increase possibly beyond the limits and the pilot may dive into the ground. In this case the pilot must recognize that the Altimeter is still working and should use a power setting for airspeed control and disregard any Indicated Airspeed value.

Example 2 (further investigation)

Increasing speed to 120 shows that the Indicated Airspeed will not change. This makes sense since the Ram Air is blocked.



Final Considerations

There are many more scenarios that can be simulated. These include placing the Pitot Static System at different altitudes and changing parameters such as Temperature, Station Altitudes, Station Altimeter Settings, and seeing how this affects the readings of the Altimeter and Airspeed Indicator. The Altitudes selected in the simulation are True Altitudes even though pilots don't fly True Altitudes so that it is possible to compare the indicated results with something more concrete and real. This is the same reason why airspeeds selected are True Airspeeds.

Pressure gauges also allow users to study the effects that placing the Pitot Static System in a certain airflow and altitudes have on the pressures being sensed by the instruments. The Airspeed Indicator, for example, basically measures the difference between Ram Air and Static Air calibrated to show True Airspeed in Standard Atmosphere Conditions and at Sea level. The Altimeter measures the Static Pressure and is calibrated to show True Altitude in Standard Atmospheric Conditions. When conditions depart from standard, corrections must be made or instrument interpretation will be erroneous.

End