Ottawa Flying Club

PROFESSIONAL PILOT PROGRAM

Meteorology

Reference Material: - From The Ground Up
- Air Command weather manual
- Supplemental references at your discretion.

Questions:

Subsection 1: ATMOSPHERE

1) From the standpoint of weather, what is the most important constituent of the lower levels of the atmosphere? Explain.

2) On the basis of temperature changes with height, name the four divisions of the atmosphere. Include the defining characteristics for each.

3) List two ways minute solid particles found in the lower levels of the troposphere affect flying conditions.

4) The ICAO standard atmosphere assumes which conditions?

5) Give two reasons why clouds are more common in the troposphere than in the stratosphere.

6) Contrast general flight conditions of bumpiness and clouds in the lower levels of the troposphere with those in the stratosphere.

Subsection 2: CLOUDS

1) Write the abbreviation of the cloud type, which best fits the description, several descriptions may apply to one cloud.
    a) Causes a halo to appear about the sun.
    b) Precipitation may be in the form of hail.
    c) A tufted form is known as "mares' tails".
    d) Lightning and thunder.
    e) A low uniform layer of cloud resembling fog from which drizzle may fall
    f) A layer or series of patches of rather flattened rounded masses of cloud based above 6500 ft but below 20000ft
    g) Clouds of vertical development with almost flat bases and hard clear-cut rounded tops.
    h) Small rounded masses or white flakes with slight or no shadows, arranged in groups or lines like sand on the seashore.
    i) Gives the sky a "ground glass" appearance.
    j) A layer of rounded masses which show considerable shading; usually based 2000 to 4000 ft above ground.
    k) A layer of cloud with relatively flat top usually based above 6500 ft and often topped above 20000 ft.
    l) Precipitation may be in the form of continuous rain.

2) What significance would you attach to a report of ACC in the early morning?

3) You are climbing through a layer of stratocumulus. Describe the conditions of bumpiness you would expect during ascent to an altitude well above the top of the cloud.

4) You are flying through a layer of stratocumulus and experience sudden turbulence. What significance would you attach to this phenomenon?

5) You are preparing for an instrument approach to land. A ceiling of 200 ft and precipitation in the form of drizzle is reported. What conditions of visibility and turbulence would you expect?

6) An active warm front is approaching from the west. Name the clouds you would expect to see as it approaches.

7) Explain 'coalescence' and give the conditions favourable for the process to take place.

8) Explain how ice affects the formation of precipitation.

9) Give all the associated clouds, weather and conditions of stable air and then unstable air:

Subsection 3: MOISTURE & TEMPERATURE

1) Give the definition of lapse rate.

2) Give the following lapse rates:
   a) DALR
   b) SALR
   c) ICAO

3) Temperature normally decreases with height because...

4) Why is it colder on a cloudy day than on a clear day?

5) Why is it warmer on a cloudy night than on a clear night?

6) Describe the three conditions that are favourable for maximum nighttime cooling.

7) When Surface temperatures rise due to daytime heating, how is the heating effect transmitted aloft?

8) Mechanical turbulence is caused by?

9) How does advection cooling occur? How does it spread?

10) The cooling process responsible for most cloud formation is _____, which occurs whenever the air is _____.

11) When dry or saturated air sinks, its temperature increases adiabatically at the rate of _____. Why does this happen?.

12) The maximum amount of water vapour that can be present in the air depends upon which factor?

13) When air is holding all the moisture it can, it is said to be _____, the temperature/dewpoint spread is _____, and the relative humidity is _____.

14) The 1200Z weather report gives the temp/dew point as 15/10. If the afternoon temperature is expected to rise to 25 C by daytime heating, how will the dew point temperature and the relative humidity be affected?

15) It is now late afternoon, the surface temperature is as expected (Quest. #14), and cumulus clouds have formed. Show, by means of a diagram, the base of clouds and the height above the surface, giving the temperatures, lapse rates and the

cause of the cloud formation. Include the dew point temperature in the cloud at a height of 4000 ft above the base of the cloud.

Subsection 4: STABILITY AND INSTABILITY - VERTICAL MOTION

1) Describe the flight characteristics of stable and unstable air.

2) Unstable air is indicated by a _____ lapse rate, whereas stable air is indicated by a _____ lapse rate.

3) Describe the effect on the stability and the lapse rate when warm air is cooled from below. Give an example.

4) List the atmospheric conditions favouring the development of vertical motion. Describe each one.

5) The table shows an example of the temperature aloft as observed at an airport at sea level. The surface temperature at 0900 hrs is 15 C.

Height	Temp C	Levels from	Lapse rate
20000	-12	18000 to 20000	
18000	-11	16000 to 18000	
16000	-10	14000 to 16000	
14000	-10	12000 to 14000	
12000	-6	10000 to 12000	
10000	-2	8000 to 10000	
8000	2	6000 to 8000	
6000	6	4000 to 6000	
4000	12	2000 to 4000	
2000	18	0 to 2000	
surface	15		

a) Complete the table by inserting the environmental lapse rate (ELR) between the various altitudes.

b) What is the height of the freezing level over the station?

c) Compare the temperature at 10000 ft over the station with that at the same altitude in the ICAO Standard Atmosphere.

d) Between what levels is there an
I) inversion?
ii) isothermal layer?

e) The forecaster says that by 1700 hrs the surface temperature will rise to 25 C and that cumulus cloud based at 5000 ft will begin to form.

I) What will the temperature be at the base of the cloud?

ii) What will the dew-point temperature be at the base of the cloud?

iii) Compare the temperature within the developing cumulus at 5000 ft with that of the surrounding air.

iv) Plot the ELR temperatures versus the rising column of air temperatures (DALR,SALR). Draw the cloud formation in pencil.

v) To what level can this cloud be expected to develop?

vi) What name can be given to a cloud of this thickness?

vii) What type of precipitation do you expect to fall from this cloud?

viii) What will prevent this cloud from continuing to grow into a major storm cloud?

ix) What will the dew-point temperature be at the top of the cloud?

Subsection 5: ATMOSPHERIC PRESSURE and ALTIMETER PROBLEMS

1) Atmospheric pressure is defined as...

2) Explain why pressure decreases with height.

3) Low pressure zones are often associated with _____ weather, whereas high-pressure zones are usually associated with _____ weather.

4) The altitude (height above ground) of a pressure level aloft is usually _____ towards the north pole than towards the equator because...

5) The station pressure at Brandon, Man. (elev.1337 ft), is generally higher than the station pressure at Calgary, Alb. (elev 3540 ft). Explain with the aid of a labelled diagram.

6) How does the rate of decrease of pressure with height in the lower levels of the atmosphere compare with that at higher levels? Explain.

7) You had landed at the City Centre airport in Toronto (CYTZ) at 1800Z and your altimeter read the correct elevation of the airport when you landed. Twelve hours later you climbed into the aircraft in order to take off and note that the indicated altitude has increased.
   a) Explain what has happened.
   b) If the indicated altitude has increased by 250 ft and your altimeter setting is reading 29.93 "Hg. What is the probable current altimeter setting?

8) Complete the table below.

Current Alt. Setting	Field Elevation	Old Alt. Setting	Error is…	Alt. Reading Before Correct
30.10	650	29.90		
29.85	650	30.15		
29.91	650			850
	650	29.96		430

Subsection 6: WINDS

1) Name and explain 3 main forces acting on the air.

2) Explain the 'diurnal effect' on winds.

3) Explain how 'anabatic' and 'katabatic' winds develop.

4) Winds rotate _____ around a High pressure system.

5) During a climb from the earth's surface to 3000 ft the wind will (veer/back), and (gain speed/lose speed).

6) Explain how to asses upper level wind speed and direction from charts.

7) Explain what causes the pressure differential in the upper levels.

Subsection 7: AIR MASSES

1) Define "air mass" and state the reasons for this definition.

2) Name and describe the four main air masses over North America in winter.

3) Give the three factors that determine the weather in an air mass.

4) Name the two cooling processes that may affect the extreme lower layers of an air mass.

5) After several days of low stratus, fog and drizzle, a colder air mass produces a clear sky, with the exception of a few cumulus based at 4000 ft in the afternoon.
    a) Compare the stability of the two air masses.
    b) Compare their moisture contents. Explain

6) Explain how and why the dense fog often occurs on the east coast.

Subsection 8: FRONTS & FRONTAL WEATHER

1) A front as it appears on the weather map is a.....between..... at the surface.

2) Name and describe three of the main types of fronts.(i.e. cold front, etc)

3) a) If part of a front is coloured blue, it means that along this part...
b) If part of this front is coloured alternately red and blue, it means that...

4) Explain the occluding process.

5) A trowal is...

6) Complete the vertical cross sections diagrams (from the figure), making sure that the base line is proportional to the chart distance. Label the air masses and wind direction. (complete: A B; K L; E F; G H; I J using the diagram on the following page)

7) Give the 3 main factors that determine the weather at fronts.

8) Explain why the cloud cover may be very wide and extend hundreds of miles ahead of an active warm front, and yet at the cold front, with the same air masses, the cloud is a narrow horizontal band.

9) Draw a vertical cross-section of a warm front that is causing clear ice. Label the air masses and the different forms of precipitation that should evolve from the front. Include the freezing level and the winds.

10) Name and explain the typical weather changes (at the surface) associated with the passing of a) a cold front b) a warm front

Subsection 9: THUNDERSTORMS

1) Name three prerequisite conditions for the formation of a thunderstorm.

2) Name and describe the stages of development of the thunderstorm.

3) Name and explain the two main types of thunderstorms.

4) How is the "gust front" created?

5) Name and discuss the dangers of flying in or close to a thunderstorm.

6) List and describe at least 5 rules of thunderstorm avoidance. Also list and describe at least 5 rules to follow if you are unable to avoid a thunderstorm.

Subsection 10: TURBULENCE

1) Name and describe the four main classes of turbulence. Include the resulting inboard sensations to the occupants of the aircraft.

2) List and describe in detail four causes of turbulence.
For each cause, include the situation that develops the worst turbulence.

3) Describe the mountain wave.

4) What are some of the precautions that should be taken when flying near these waves?

Subsection 11: ICING

1) A droplet is said to be supercooled when it:

2) List and briefly describe 5 possible effects of icing on aircraft.

3) The seriousness of icing depends on what 3 factors.

4) Describe in detail the airframe freezing process. (i.e. How does ice form on the aircraft?)

5) Name the 3 main types of ice accretion. How can a pilot tell them apart?

6) What type of icing is the most serious? why?

7) a) Which type of cloud presents the greatest risk of icing? Why?
b) In which part of this cloud is the possibility of the greatest icing? What would be the temperature range that is conducive to this icing?

Subsection 12: SURFACE BASED LAYERS

1) What is fog and how does it form?

2) Name and discuss the 5 main types of fog.

3) Describe the effect of a cloud layer on the dissipation of advection fog over:
    a) land
    b) sea

4) Why does radiation fog usually dissipate during the morning?

5) Why does radiation fog sometimes thicken at sunrise?

6) What is "haze" and describe some of the factors that influence it.