Subject No 8 - PPL Meteorology

Notes: This syllabus is principally based on the meteorology as applicable to flying a single piston-engine General Aviation type aeroplane or helicopter, within New Zealand at altitudes at or below 13,000 feet.

Detailed acronyms and service provider titles (e.g. SKC, MetService) are indicative of the area of knowledge required and do not limit this syllabus to those specifically listed.

Each subject has been given a subject number and each topic within that subject a topic number. These reference numbers will be used on 'knowledge deficiency reports' and will provide valuable feed back to the examination candidate. These reference numbers are common across the subject levels and therefore may not be consecutive.

Sub Topic	Syllabus Item
	Fundamentals of the atmosphere
8.2	**The atmosphere**
8.2.2	State the composition and structure of the atmosphere.
8.2.4	Describe the presence and importance of the following in the atmosphere: (a) carbon dioxide (b) ozone (c) water vapour.
8.2.6	Explain how temperature influences the ability of air to hold water vapour.
8.4	**Atmospheric Pressure**
8.4.2	Describe the source of atmospheric pressure.
8.4.4	Explain the basic principle of operation of the barometer.
8.4.6	Define pressure lapse rate.
8.4.8	State the average pressure lapse rate in the lower atmosphere.
8.4.10	Explain the effect of temperature on pressure lapse rate.
8.4.12	Define and describe: (a) isobar; (b) wind velocity; (c) anticyclone ("high"); (d) depression ("low"); (e) ridge of high pressure; (f) trough of low pressure; (g) col; (h) pressure gradient.
8.4.14	Explain the relationship between pressure gradient, isobars and wind velocity (airflow around pressure systems).
8.4.16	State the concept of convergence and divergence and describe how the associated subsidence or ascent of air influences the type of weather commonly associated with pressure systems.
8.4.18	State the unit of pressure commonly used in meteorology.
8.4.20	List the assumed conditions on which the International Standard Atmosphere (ISA) is based.

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8.4.22	Explain how deviation from ISA values influences performance of aircraft and their engines.
8.4.24	Define: (a) QNH; (b) QFE; (c) altitude; (d) height; (e) pressure altitude.
8.4.26	Explain why an altimeter requires a subscale adjustment.
8.4.28	Explain the importance of correct subscale setting.
8.6	**Temperature and Heat Exchange Processes**
8.6.2	Explain what is meant by solar radiation.
8.6.4	Describe the elements that influence the amount of incoming solar radiation.
8.6.6	Explain what is meant by terrestrial radiation.
8.6.8	Describe the elements that influence the escape of terrestrial radiation.
8.6.10	Explain the effect of solar and terrestrial radiation on the air temperature.
8.6.12	Describe the effect of latitude on the distribution of incoming solar radiation.
8.6.14	Describe the process of: (a) conduction; (b) convection.
8.6.16	Define albedo.
8.6.18	Describe the diurnal variation of surface air temperature and explain the effect of different types of surface on this variation.
8.8	**Atmospheric Moisture**
8.8.2	Define: (a) condensation; (b) evaporation; (c) deposition; (d) sublimation; (e) melting; (f) freezing; (g) latent heat.
8.8.4	Explain the function of condensation nuclei during condensation.
8.8.6	State the effect of the following on the rate of evaporation: (a) air temperature; (b) moisture content of air; (c) atmospheric pressure; (d) the wind.
8.8.8	Describe the processes that change the physical state of moisture and explain how latent heat is involved in each transformation.

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8.8.10	Explain what is meant by relative humidity.
8.8.12	Explain the effect of changes in temperature and moisture content of air on relative humidity.
8.8.14	Explain what is meant by dew point.
8.8.16	Explain the effect of moisture content of air on the value of the dew point.
8.8.18	Explain the effects on aircraft and engine performance of: (a) air density (b) air moisture content.
8.8.20	Explain how temperature, relative humidity and dew point values can be used to indicate differences in water content of air.
8.10	**Wind**
8.10.2	State the direction in which the following two forces act: (a) pressure gradient; (b) Coriolis force.
8.10.4	State the effect of wind speed on the strength of the coriolis force.
8.10.6	Explain how the inter-relation between pressure gradient and coriolis force determine the circulation around pressure systems.
8.10.8	Explain what is meant by the “friction layer”, and describe the elements that influence the depth of the layer.
8.10.10	Explain how the friction layer affects the surface wind velocity.
8.10.12	Define the following terms: (a) gust; (b) lull; (c) squall; (d) veering; (e) backing.
8.10.14	Describe the diurnal variation of the surface wind over the: (a) land; (b) sea.
8.10.16	Describe the changes in wind velocity when climbing out of, or descending into, the friction layer.
8.10.18	Describe how an approximate wind velocity can be determined from a 25-knot windsock when at an angle of 30°, 45°, 75° and 90° from the vertical.
8.10.20	Describe how an approximate wind direction can be determined from: (a) ripples on water; (b) wind lanes on water; (c) wind shadow on bodies of water.
8.10.22	State Buys Ballot’s Law.
8.10.24	Explain how applying Buys Ballot’s Law can: (a) determine the location of high and low pressure areas; (b) establish possible errors in altimeter reading.

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8.10.26	Define wind shear.
8.10.28	Describe the effects of vertical and horizontal wind shear on aircraft operations.
8.12	**Stability of Air**
8.12.2	Explain what is meant by: (a) stable air; (b) unstable air; (c) neutrally stable air.
8.12.4	State the two factors that determine the stability of air.
8.12.6	Describe what is meant by “environment lapse rate” (ELR).
8.12.8	Explain the adiabatic process.
8.12.10	Interpret graphs of steep and shallow environment lapse rates including inversions and isothermal layers.
8.12.12	State the dry adiabatic lapse rate (DALR).
8.12.14	Explain how the relationship between the ELR and DALR can be used to determine the stability or instability of unsaturated air.
8.12.16	State the saturated adiabatic lapse rate (SALR).
8.12.18	Explain how the relationship between the ELR and SALR can be used to determine the stability or instability of saturated air.
8.12.20	Explain the factors involved in thermal rising of air.
8.12.22	Explain how different dew point values determine the cloud base.
8.12.24	Explain the effect of increasing surface temperature on the base of convective cloud, given a constant moisture content.
8.12.26	Describe the types of cloud that could be expected in: (a) stable saturated air; (b) unstable saturated air.
8.12.28	Describe weather conditions and degrees of visibility in: (a) stable air; (b) unstable air.
8.12.30	Describe how stable and unstable air affect flying conditions.
8.14	**Local winds – New Zealand**
8.14.2	Describe the sea breeze process, including typical: (a) timing of the occurrence; (b) average strength of the sea breeze; (c) horizontal and vertical limits; (d) associated cloud development; (e) associated turbulence.
8.14.4	Describe the land breeze process, and state: (a) typical timing of the occurrence; (b) average speed of the wind; (c) most likely season for the occurrence.

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8.14.6	Describe the katabatic and anabatic wind processes, and state the: (a) typical timing of the occurrence; (b) average strength of the winds; (c) effect of moist valley air on cloud/fog formation; (d) effect of gravity on Katabatic winds; (e) effect of adiabatic cooling and warming.
8.14.8	Describe the fohn wind process.
8.14.10	Given environment temperatures, dew points and mountain heights, determine the: (a) cloud base on the windward side; (b) cloud base on the lee side; (c) temperature at stated datum level on the lee side.
8.14.12	Describe the flight conditions associated with fohn wind conditions.
8.14.14	Describe the mountain wave (standing, or lee wave) process.
8.14.16	Explain the wind and weather conditions, and associated main dangers to aircraft operations, in mountain wave conditions.
8.14.18	Describe the rotor zones process and explain the associated dangers to aircraft operations.
8.14.20	Describe the effect of local obstructions on wind flow.
8.16	**Inversions**
8.16.2	Define: (a) inversion; (b) isothermal layer.
8.16.4	Explain the effect of inversions on: (a) the formation and development of cloud; (b) visibility; (c) turbulence; (d) the relative humidity and dew point; (e) the increased risk of carburettor icing; (f) the presence of wind shear.
8.16.6	Explain the factors involved in a: (a) radiation inversion; (b) turbulence inversion; (c) subsidence inversion; (d) frontal inversion.
8.16.8	Describe the flight conditions in the presence of inversions.
8.18	**Cloud**
8.18.2	Describe the basic cloud formation process.
8.18.4	Explain the most common method through which cloud is formed and how air is cooled to produce cloud.

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8.18.6	Explain what is meant by “buoyancy” of air.
8.18.8	Differentiate between cloud droplets and rain/shower drops.
8.18.10	State the approximate altitude limits (in NZ latitudes) of: (a) high cloud; (b) middle cloud; (c) low cloud.
8.18.12	Describe the following types of cloud and include a description of likely icing, turbulence and precipitation: (a) cirrostratus; (b) cirrocumulus; (c) cirrus; (d) altostratus; (e) altocumulus; (f) stratocumulus; (g) stratus; (h) cumulus; (i) cumulonimbus/towering cumulus; (j) nimbostratus.
8.18.14	Describe the terms used for describing the characteristics of cloud.
8.18.16	Describe the following methods whereby air is lifted, and include the effect of stability/instability on the type of cloud formed: (a) orographic lifting; (b) mechanical lifting; (c) convective lifting; (d) slow widespread ascent; (e) frontal lifting.
8.18.18	Explain the processes that contribute to cloud dispersal.
8.20	**Precipitation**
8.20.2	Define: (a) precipitation; (b) virga.
8.20.4	Explain how cloud drops can grow through: (a) the presence of ice crystals (Bergeron process); (b) coalescence.
8.20.6	Describe the following types of precipitation: (a) rain; (b) drizzle; (c) snow; (d) sleet; (e) hail.

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8.20.8	Describe the characteristics of the following types of precipitation: (a) continuous; (b) intermittent; (c) showers.
8.20.10	Describe the rate of precipitation: (a) light; (b) moderate; (c) heavy.
8.22	**Visibility**
8.22.2	Define meteorological visibility.
8.22.4	Explain what is meant by transparency of air.
8.22.6	Explain how illumination from the sun or moon have an effect on visibility.
8.22.8	Differentiate between visibility distance and visibility range.
8.22.10	Describe the characteristics and the effect on visibility distance, of the following: (a) precipitation; (b) fog or mist; (c) haze; (d) smoke; (e) sea spray; (f) snow; (g) whiteout.
8.22.12	Explain the factors involved in slant range.
8.24	**Fog**
8.24.2	Define fog.
8.24.4	Describe the principles of formation, required meteorological conditions, factors affecting extent of, and dispersal of: (a) radiation fog; (b) advection fog; (c) valley fog; (d) sea fog; (e) steaming fog; (f) frontal fog.
8.24.6	Describe the operational problems associated with fog.
8.26	**Fronts and Depressions**
8.26.2	Define air mass.
8.26.4	List the different types of air masses.
8.26.6	Define source region and state the typical areas where New Zealand’s source regions are found.
8.26.8	Describe what is meant by: (a) cold advection;

Sub Topic	Syllabus Item
	(b) warm advection.
8.26.10	Explain the typical weather conditions in New Zealand when affected by cold and warm advection.
8.26.12	Describe how divergence aloft affects the atmospheric pressure near sea level.
8.26.14	Describe the characteristics of the: (a) mid-latitude depression; (b) orographic depression; (c) thermal (heat type) depression.
8.26.16	State the symbols, and colour codes, used to describe the following fronts on weather charts: (a) cold front; (b) warm front; (c) occluded front; (d) stationary front.
8.26.18	Describe the cross section of the typical cold front including cloud, temperature and freezing level changes, precipitation, and typical width.
8.26.20	State the events before, at, and after, an idealised cold front in terms of: (a) pressure; (b) temperature; (c) wind velocity; (d) cloud; (e) precipitation; (f) visibility.
8.26.22	Describe a cross section of the typical warm front including cloud, temperature and freezing level changes, precipitation, and typical width.
8.26.24	State the events before, at, and after, an idealised warm front in terms of: (a) pressure; (b) temperature; (c) wind velocity; (d) cloud; (e) precipitation; (f) visibility.
8.26.26	Describe a cross section of the following occlusions and explain how each type develops: (a) cold occlusion; (b) warm occlusion.
8.26.28	Describe the potential dangers to VFR flight through fronts.
8.26.30	Describe the techniques, and precautions that can be taken to manage the risks of VFR flight through fronts.
8.28	**Thunderstorms**
8.28.2	Explain the conditions to be met for the development of thunderstorms.

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8.28.4	Describe the three stages of thunderstorm development.
8.28.6	Explain the development, and describe the characteristics of: (a) orographic thunderstorms; (b) heat type thunderstorms; (c) frontal thunderstorms.
8.28.8	Describe the hazards associated with thunderstorms and explain why light aircraft should avoid them.
8.28.10	Explain the origin and development of tornadoes and state the main hazards.
8.30	**Icing**
8.30.2	Explain what is meant by supercooled water, and describe the influence of latent heat on the formation of ice.
8.30.4	Explain the process of freezing and melting.
8.30.6	With regard to airframe icing, explain the processes involved in the formation of: (a) clear ice; (b) rime ice; (c) hoar frost; (d) freezing rain.
8.30.8	State the types of cloud, and cloud drop size, that are conducive to the formation of each type of ice.
8.30.10	State the altitudes relative to the freezing level where rime ice or clear ice can be expected in cloud.
8.30.12	Give examples of conditions that could cause: (a) freezing rain; (b) hoar frost.
8.30.14	State the hazards for light aircraft from: (a) snow; (b) sleet; (c) hail.
8.30.16	Explain the influence of the following on the rate of ice accretion: (a) water content of cloud; (b) aircraft characteristics, components and airspeed.
8.30.18	State the dangers of icing to aircraft in flight and on the ground.
8.30.20	Explain the methods that can be used to manage the risks of aircraft icing.
8.30.22	Explain the environmental factors involved in carburettor icing, including; (a) moisture content; (b) temperature; (c) temperature gradient (inversions).
8.30.24	State the temperature range in which carburettor ice typically can form.
8.30.26	Explain how the accretion rate of carburettor ice is influenced by the throttle setting.
8.30.28	Explain the conditions that can cause carburettor icing while on the ground.

Sub Topic	Syllabus Item
8.32	**Turbulence**
8.32.2	Describe the cause(s), factors involved, dangers, and techniques commonly used to avoid or minimise: (a) thermal (convective) turbulence; (b) mechanical turbulence – small scale and large scale; (c) wind shear turbulence; (d) wake turbulence.
	New Zealand Meteorology
8.36	**New Zealand Meteorology**
8.36.2	Describe how the following items govern the NZ climate: (a) latitude; (b) oceanic surroundings; (c) topography.
8.36.4	In general terms, describe cloudiness, gustiness, visibility and turbulence at various locations within New Zealand during typical: (a) northwest wind regimes; (b) northeast wind regimes; (c) southwest wind regimes; (d) southeast wind regimes.
8.36.6	With regard to VFR flight in a light aircraft over the Southern Alps, for typical weather scenarios, describe the meteorological considerations during flight planning and enroute including: (a) cloud base; (b) turbulence; (c) adverse and favourable winds; (d) visibility; (e) selection of tracks; (f) anticipated in-flight conditions; (g) the time frame of any weather change.
	Meteorological Services to Aviation
8.44	**Domestic Meteorological Services for Aviation**
8.44.2	With reference to cloud amount, explain the meaning of: (a) SKC; (b) NSC; (c) FEW; (d) SCT; (e) BKN; (f) OVC; (g) CAVOK.
8.44.4	Describe how cloud and cloud base are reported.

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8.44.6	Describe the principle of operation, and operational effectiveness of the automated visibility sensor.
8.44.8	With respect to NZ FIR VFR operations, interpret, understand and assess information of all the descriptions contained in: (a) area forecast (ARFOR); (b) meteorological reports (METAR/SPECI/ METAR AUTO); (c) trend forecasts (TREND); (d) aerodrome forecasts (TAF); (e) SIGMET; (f) Automatic terminal information service (ATIS); (g) Aerodrome and weather information broadcasts (AWIB); (h) Basic weather reports (BWR); (i) Pilot reports; (j) Radar and Satellite imagery.
8.44.10	Interpret and assess weather information made available by: Internet, newspapers television, and radio.
8.44.12	Describe the limitations of non-aviation specific weather information.