

050

METEOROLOGY

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
<p>050 01 00 00</p> <p>050 01 01 00</p> <p>050 01 01 01</p>	<p><u>THE ATMOSPHERE</u></p> <p><u>Composition, Extent, Vertical Division</u></p> <p>Describe the vertical division of the atmosphere, based on the temperature variations with height:</p> <ul style="list-style-type: none"> – List the different layers and their main qualitative characteristics – Describe the troposphere <ul style="list-style-type: none"> – Define tropopause – Mention the main values of the standard (ISA) atmosphere up to the tropopause – Describe the proportions of the most important gases in the air in the troposphere – Describe the variations of the height and temperature of the tropopause from the poles to the equator – Describe the breaks in the tropopause along the limits of the main air masses – Indicate the variations of the tropopause height with the seasons and the variations of atmospheric pressure – Define stratosphere <ul style="list-style-type: none"> – Describe the main variations with height of the composition of the air in the stratosphere – Mention the vertical extent of the stratosphere up to the stratopause. – Describe the reason for the temperature increase in the ozone layer. 	
<p>050 01 02 00</p>	<p><u>Temperature</u></p> <ul style="list-style-type: none"> – Define air temperature – List the units of measurement of air temperature used in aviation meteorology 	

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050 01 02 01	<p>Describe the mean vertical distribution of temperature up to 50 km.</p> <ul style="list-style-type: none"> – Mention general causes of the cooling of the air in the troposphere with increasing altitude, and of the warming of the air in the stratosphere 	
050 01 02 02	<p>Explain how local cooling or warming processes result in transfer of heat.</p> <ul style="list-style-type: none"> – Define radiation <ul style="list-style-type: none"> – Describe qualitatively solar radiation reaching the atmosphere – Describe qualitatively the filtering effect of the atmosphere on solar radiation – Describe qualitatively terrestrial radiation <ul style="list-style-type: none"> – Explain how terrestrial radiation is absorbed by some components of the atmosphere – Explain the greenhouse effect due to clouds and some gases in the atmosphere – Define and explain the process of conduction <ul style="list-style-type: none"> – Explain the role of conduction in the cooling and warming of the atmosphere – Define and explain the process of convection <ul style="list-style-type: none"> – Name situations in which convection occurs – Define and explain the process of advection <ul style="list-style-type: none"> – Name situations in which advection occurs – Describe transfer of heat by turbulence 	
050 01 02 03	<p>Lapse rates, stability and instability</p> <ul style="list-style-type: none"> – Describe qualitatively and quantitatively the temperature lapse rates of the troposphere and the meaning of thermal stability and instability and the environmental lapse rate (refer to 03 03 01) <p>Note: Dry adiabatic lapse rate = 1°C/100m or 3°C/1000 FT; average value at lower levels for saturated adiabatic lapse rate = 0.6°C/100m or 1.8°C/1000 FT</p>	

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050 01 02 04	<p>Describe development and types of inversions</p> <ul style="list-style-type: none"> - Explain the characteristics of inversions and of an isothermal layer. - Explain the reasons for the formation of the following inversions: <ul style="list-style-type: none"> - Ground inversion due to ground radiation (nocturnal radiation) - Subsidence inversion - Frontal inversion - Inversion above friction layer - Valley inversion - Tropopause inversion 	
050 01 02 05	<p>Temperature near the earth's surface, surface effects, diurnal variation, effect of clouds, effect of wind</p> <ul style="list-style-type: none"> - Describe how the temperature near the earth's surface is influenced by the nature of surface, diurnal and seasonal variations, the effect of clouds and of wind. - Explain the cooling and the warming of the air on the earth or sea surfaces - Sketch the diurnal variation of the temperature of the air in relation to the radiation of the sun and of the earth - Describe qualitatively the influence of the clouds on the warming and the cooling of the surface and the air near the surface <ul style="list-style-type: none"> - Distinguish between the influence of low or high clouds, thick or thin clouds - Explain the influence of the wind on the cooling and warming of the surfaces 	
050 01 03 00	<p><u>Atmospheric Pressure</u></p>	
050 01 03 01	<p>Barometric pressure, isobars</p> <ul style="list-style-type: none"> - Define atmospheric pressure 	

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	<ul style="list-style-type: none"> – List the units of measurement of the atmospheric pressure used in aviation – Describe the principle of the barometers: <ul style="list-style-type: none"> – mercury barometer – aneroid barometer – Describe isobars on the surface weather charts <ul style="list-style-type: none"> – Define H, L, trough, ridge, col 	
050 01 03 02	<p>Explain the pressure variation with height, contours</p> <ul style="list-style-type: none"> – Describe qualitatively the variation of the barometric lapse rate <p>Note: The average value for the barometric lapse rate near mean sea level is 27 FT (8m) per 1 hPa, at about 5500m/AMSL is 50 FT (15m) per 1 hPa</p> <ul style="list-style-type: none"> – For contours refer to 10 02 03 	
050 01 03 03	<p>Explain the reduction of measured pressure to mean sea level, QFF</p> <ul style="list-style-type: none"> – Describe the principle of calculation for QNH – Define QFF – Mention the use of QFF for surface weather charts 	
050 01 03 04	<p>Illustrate with a vertical cross section of isobaric surfaces a surface low pressure system, an upper air low pressure system, a surface high pressure system and an upper air high pressure system</p>	
050 01 04 00	<p><u>Atmospheric Density</u></p>	
050 01 04 01	<p>Describe the interrelationship between pressure, temperature and density</p> <ul style="list-style-type: none"> – Describe the distribution of the air density in the atmosphere. – Describe the effect of humidity on the density of air 	
050 01 05 00	<p><u>International Standard Atmosphere (ISA)</u></p>	

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050 01 05 01	<p>Explain the use of standardised values for the atmosphere</p> <ul style="list-style-type: none"> – List the main values of the ISA: <ul style="list-style-type: none"> – Mean sea level pressure, – Mean sea level temperature – The vertical temperature lapse rate up to 20km – Height and temperature of the tropopause – The composition of dry air within the troposphere, – List the standard pressure levels and equivalent standard flight levels – Calculate the standard temperature in degree Celsius for a given flight level – Determine a standard temperature deviation by the difference between the given outside air temperature and the standard temperature 	
050 01 06 00	<p><u>Altimetry</u></p>	
050 01 06 01	<p>Define ‘pressure altitude’ and ‘true altitude’</p> <ul style="list-style-type: none"> – Explain qualitatively the influence of the air temperature on the distance between: <ul style="list-style-type: none"> – The ground and the level read on the altimeter – Two flight levels – Determine by rule of thumb the true altitude for a given flight level and a given ISA temperature deviation 	

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	<p>Rule of thumb for altimetry calculations</p> <p>a. The elevation of the airport has to be taken into account. The temperature correction has to be considered for the layer between ground and the position of the aircraft.</p> <p>b. The deviation of outside air temperature from ISA is considered to be constantly the same given value in the whole layer.</p> <p>c. The correction of temperature and pressure deviation may be treated independently of each other.</p> <p>d. All calculations are based on rounded pressure values to the nearest lower hPa.</p> <p>e. "4%-rule": The change of height is 4% when ISA temperature deviation is 10°C (per 1°C → 4%)</p>	
050 01 06 02	<p>Define height, altitude and flight level</p> <ul style="list-style-type: none"> – Name the altimeter settings associated to height, altitude, pressure altitude and flight level – Calculate the different values with given QNH and temperature <ul style="list-style-type: none"> – Flight level to true altitude – True altitude to flight level 	
050 01 06 03	<p>Give the ICAO definition of QNH, QFE and 1013.25 hPa</p> <ul style="list-style-type: none"> – Calculate the different readings on the altimeter when the pilot changes the altimeter setting – Illustrate with a numbered example the changes of altimeter setting and the associated changes in reading when the pilot climbs through the transition altitude or descend through the transition level – Derive the reading of the altimeter on the ground when the pilot uses the different settings 	
050 01 06 05	<p>Effect of accelerated airflow due to topography</p> <ul style="list-style-type: none"> – Describe qualitatively how the effect of accelerated airflow due to topography affects altimetry 	
050 02 00 00	WIND	
050 02 01 00	Definition and measurement of wind	
050 02 01 01	Define wind and state how it is measured	

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050 02 02 00 050 02 02 01	<ul style="list-style-type: none"> – Define wind – State the meteorological units of measurement for wind <ul style="list-style-type: none"> – Explain how wind velocity is measured in meteorology <p>State how wind data is indicated in the surface and upper level charts and in the TAF and METAR messages (Refer to 050 10 01 01)</p> <p>The primary cause of wind</p> <p>Primary cause of wind, pressure gradient, coriolis force, gradient wind</p> <p>Define the term horizontal pressure gradient</p> <ul style="list-style-type: none"> – Explain how the pressure gradient force acts in relation to the pressure gradient – Explain how the coriolis force acts in relation to the wind – State the conditions necessary for the development of a geostrophic wind – Explain the development of a geostrophic wind <ul style="list-style-type: none"> – Indicate how the geostrophic wind flows in relation to the isobars and to the pressure gradient in the Northern and Southern hemispheres – Analyse the effect of changing latitude or air density on the geostrophic wind speed – Explain the gradient wind effect and indicate how the gradient wind differs from the geostrophic wind in cyclonic and anticyclonic circulation 	
050 02 02 02	<p>Explain the relationship between isobars and wind</p> <p>Explain the relationship between isobars and wind speed and direction</p>	
050 02 03 00 050 02 03 01	<p>The general global circulation</p> <p>Describe and explain the general global circulation</p> <p>Sketch or indicate on a map the general global wind pattern for all latitudes at low level in January and July</p> <ul style="list-style-type: none"> – Name major low level wind systems in the polar regions 	

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050 02 04 00	<ul style="list-style-type: none"> - Name major low level wind systems in the mid latitudes - Name major low level wind systems in the tropics Sketch or indicate on a map the general global wind pattern at high level	
050 02 04 01	<ul style="list-style-type: none"> - Sketch or indicate on a map the westerly and easterly tropospheric winds Turbulence Define turbulence and gustiness. List types of turbulence State the ICAO definition of turbulence	
050 02 04 02	List common types of turbulence (convective, mechanical, orographic, frontal, clear air turbulence) Explain the origins of turbulence. State where turbulence is usually found Explain the formation of atmospheric turbulence <ul style="list-style-type: none"> - Explain the formation of convective turbulence - Explain the formation of mechanical and orographic turbulence - Explain the formation of frontal turbulence - Explain the formation of clear air turbulence State where turbulence will normally be found	
050 02 05 00	Variation of wind with height	
050 02 05 01	Describe the variation of wind in the friction layer Describe how the wind changes speed and direction descending through the friction layer in the northern and southern hemispheres (rule of thumb) <ul style="list-style-type: none"> - Describe the airflow in the friction layer Describe how wind changes with height in the friction layer State the surface and airmass conditions that influence the turbulence in the friction layer	

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050 02 06 00	<p>Name the factors that influence the vertical extent of the friction layer</p> <p>Note: Approximate value for variation of wind in the friction layer (values to be used in the examination)</p> <p>Variations between the geostrophic wind and the wind in the friction layer:</p> <table border="0"> <tr> <td>Type of landscape</td> <td>Wind speed in friction layer in % of the geostrophic wind</td> <td>The wind in the friction layer blows slightly across the isobars towards the low pressure. Angle between wind direction and isobars</td> </tr> <tr> <td>over water</td> <td>ca. 70%</td> <td>ca. 10°</td> </tr> <tr> <td>over land</td> <td>ca. 50%</td> <td>ca. 30°</td> </tr> </table> <p>Local winds</p>	Type of landscape	Wind speed in friction layer in % of the geostrophic wind	The wind in the friction layer blows slightly across the isobars towards the low pressure. Angle between wind direction and isobars	over water	ca. 70%	ca. 10°	over land	ca. 50%	ca. 30°	WMO – No. 266
Type of landscape	Wind speed in friction layer in % of the geostrophic wind	The wind in the friction layer blows slightly across the isobars towards the low pressure. Angle between wind direction and isobars									
over water	ca. 70%	ca. 10°									
over land	ca. 50%	ca. 30°									
050 02 06 01	<p>Describe and explain anabatic and katabatic winds, land and sea breezes and venturi effects</p> <p>Describe and explain anabatic winds</p> <p>Describe and explain katabatic winds</p> <p>Describe and explain land and sea breezes</p> <p>Describe and explain the venturi effect, convergence in valleys and mountain areas</p>										
050 02 08 00	<p>Standing waves</p>										
050 02 08 01	<p>Describe and explain the origin and formation of standing waves</p> <p>State the conditions necessary for the formation of standing waves</p> <p>Describe the structure and properties of standing waves</p> <p>Explain how standing waves may be identified by their associated meteorological phenomena</p> <p>State the aviation hazards associated with standing waves</p>										
050 03 00 00	THERMODYNAMICS										
050 03 01 00	Humidity										

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050 03 01 01	<p>Describe water vapour in the atmosphere</p> <ul style="list-style-type: none"> - Define humid air <p>Describe the significance for meteorology of water vapour in the atmosphere</p> <ul style="list-style-type: none"> - Indicate the sources of atmospheric humidity - Describe the influence of water vapour on atmospheric processes 	
050 03 01 02	<p>Define the temperature/dew point relationship, the mixing ratio and the relative humidity</p> <ul style="list-style-type: none"> - Define mixing ratio <ul style="list-style-type: none"> - Name the unit used in meteorology to express the mixing ratio - Explain the factors influencing the mixing ratio - Recognise the lines of equal mixing ratio on a simplified diagram (T,P) - Define saturation mixing ratio <p>Note: A simplified diagram (T,P) contains:</p> <ul style="list-style-type: none"> - on the x-axis temperature (T) - on the y-axis height corresponding to pressure (P); <p>The degree of saturation / mixing ratio, stability / instability are shown as functions of temperature change with height (as lines or curves in the diagram)</p> <ul style="list-style-type: none"> - Define saturation of air by water vapour <ul style="list-style-type: none"> - Illustrate with a diagram (T, mixing ratio) the influence of the temperature on the saturation mixing ratio, at constant pressure - Explain the influence of the pressure on the saturated mixing ratio - Define dew point 	

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050 04 02 00	<ul style="list-style-type: none"> - Explain the influence of an inversion on the formation of stratus clouds - Explain the influence of ground inversion on the formation of fog - Determine the top of a cumulus cloud caused by an inversion on a simplified diagram - Deduce the role of the tropopause inversion in the formation of clouds 	
050 04 02 01	<p>Fog, Mist, Haze</p> <p> Explain the formation of fog, mist, and haze in general</p> <ul style="list-style-type: none"> - Define fog, mist and haze with reference to WMO standards of visibility range and relative humidity - Name the factors contributing in general to the formation of fog and mist - Name the factors contributing to the formation of haze 	
050 04 02 02	<p> Explain the formation of radiation fog</p> <ul style="list-style-type: none"> - Explain the conditions for the development of radiation fog - Describe the significant characteristics of radiation fog, and its vertical extent - Summarise the conditions of the dissipation of radiation fog 	
050 04 02 03	<p> Explain the formation of advection fog</p> <ul style="list-style-type: none"> - Explain the conditions for the development of advection fog - Describe the different possibilities of advection fog formation over land, sea and coastal regions - Describe significant characteristics of advection fog - Explain the causes for dissipation of advection fog <p> Explain the formation of steaming fog</p> <ul style="list-style-type: none"> - Explain the conditions for the development of steaming fog - Describe significant characteristics of steaming fog 	

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050 04 02 04	<ul style="list-style-type: none"> – Summarise the condition for the dissipation of steaming fog <li style="padding-left: 20px;">Explain the formation of frontal fog – Explain the conditions for the development of frontal fog – Deduce significant characteristics of frontal fog – Summarise the conditions for the dissipation of frontal fog 	
050 04 02 05	<ul style="list-style-type: none"> <li style="padding-left: 20px;">Summarize the features of orographic fog – Explain the conditions for the development of orographic fog – Deduce significant characteristics of orographic fog – Summarise the conditions of the dissipation of orographic fog 	
050 05 00 00	<u>PRECIPITATION</u>	
050 05 01 00	<u>Development of precipitation</u>	
050 05 01 01	<p>Describe the development of precipitation</p> <ul style="list-style-type: none"> – Summarise the outlines of the “ice particle” (Bergeron-Findeisen) process – Summarise the outlines of the coalescence process – Distinguish between the two processes <li style="padding-left: 20px;">Distinguish between the two processes by which precipitation is formed <li style="padding-left: 20px;">Describe the atmospheric conditions that favor either process – Explain the development of rain and drizzle – Explain the development of snow – Explain the development of hail 	
050 05 02 00	<u>Types of precipitation</u>	

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050 05 02 01	<p>Describe the types of precipitation and their relationship with cloud types</p> <ul style="list-style-type: none"> – List and describe the types of precipitation given in the TAF and METAR codes – Describe drizzle (DZ) and rain (RA) – State ICAO/WMO approximate diameters for cloud, drizzle and rain drops – Describe snow grains (SG) and snow (SN) – Describe ice pellets – Describe the precipitation type ice crystals – Describe hail, small hail, snow pellets <ul style="list-style-type: none"> State approximate maximum recorded weights and diameters for hailstones – Describe freezing precipitation (FZRA, FZDZ) <ul style="list-style-type: none"> Explain the mechanism for the formation of freezing precipitation Describe the weather conditions that give rise to freezing precipitation – Distinguish between the types of precipitation generated in convective and stratiform cloud – Assign typical precipitation types and intensities to different clouds 	
050 06 00 00	<u>AIRMASSES AND FRONTS</u>	
050 06 01 00	<u>Types of Airmasses</u>	
050 06 01 01	<p>Summarise and describe the factors affecting the properties of an airmass</p> <ul style="list-style-type: none"> Define an airmass List the environmental factors that affect the final properties of an air mass <ul style="list-style-type: none"> Explain the effect of land or sea source areas Explain the effect of land or sea tracks Explain the effect of passage over cold or warm surfaces 	

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050 06 01 02	<p>Summarise the classification of airmasses by areas of origin and by modification on track</p> <p>State the classifications of air masses by temperature and humidity at source</p> <p>Name the three areas of origin of the main airmasses that affect Europe</p> <p>Explain how maritime and continental tracks modify these air masses</p> <p>State the characteristics weather brought by each of these air masses</p> <p>Summarise European airmass weather</p> <p>Explain how air mass weather is affected by the season, the airmass track and by orographic and thermal effects over land</p>	
050 06 02 00	<p><u>Fronts</u></p>	
050 06 02 01	<p>Define and describe the boundaries between air masses (fronts), general situation and geographic differentiation</p> <p>Define a frontal surface and give a general and practical description of a front</p> <p>Name the global frontal systems</p> <p>State the approximate latitudes and geographic positions of the global frontal systems</p> <p>State the different types of fronts</p>	
050 06 02 02	<p>Describe the warm front, with the associated clouds and weather</p> <p>Define a warm front</p> <p>Describe the cloud, weather, ground visibility and aviation hazards at a warm front depending on the stability of the warm air</p> <p>Explain the seasonal differences in the weather at warm fronts</p> <p>Describe the structure, slope and width of a warm front</p> <p>Sketch a cross-section of a warm front, showing weather, cloud, tropopause heights, jet streams and aviation hazards</p>	

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050 06 02 03	<p>Describe the cold front, with the associated clouds and weather</p> <p>Define a cold front</p> <p>Describe the cloud, weather, ground visibility and aviation hazards at a cold front depending on the stability of the warm air</p> <p>Explain the seasonal differences in the weather at cold fronts</p> <p>Describe the structure, slope and width of a cold front</p> <p>Sketch a cross-section of a cold front, showing weather, cloud, tropopause heights, jet streams and aviation hazards</p>	
050 06 02 04	<p>Describe the warm sector of a polar front depression, with the associated clouds and weather</p> <p>Define fronts and air masses associated with the warm sector of a polar front depression</p> <p>Describe the cloud, weather, surface visibility and aviation hazards in a warm sector</p> <p>Explain the seasonal differences in the weather in the warm sector</p> <p>Sketch a cross-section of a warm sector, showing weather, cloud, tropopause heights, jet streams and aviation hazards</p> <p>Sketch a plan of a warm sector and the cold and warm fronts and illustrate the changes of pressure, temperature and wind as the sector passes</p>	
050 06 02 05	<p>Describe the weather immediately behind the cold front</p> <p>Describe the weather and the development of the surface pressure systems immediately behind the cold front of a polar front depression</p> <p>Explain the seasonal differences in the weather behind a cold front</p>	
050 06 02 06	<p>Describe occluded fronts, with the associated clouds and weather</p> <p>Define an occlusion</p> <p style="padding-left: 20px;">Define a cold occlusion</p> <p style="padding-left: 20px;">Define a warm occlusion</p>	

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	<p>Describe the cloud, weather, surface visibility and aviation hazards in a cold occlusion</p> <p>Describe the cloud, weather, surface visibility and aviation hazards in a warm occlusion</p> <p>Explain the seasonal differences in the weather at occlusions</p> <p>Sketch a cross-section of cold and warm occlusions, showing weather, cloud, tropopause heights, jet streams and aviation hazards</p> <p>In a sketch plan illustrate the development of an occlusion in a typical polar front depression, and the movement of the triple point</p>	
050 06 02 07	<p>Describe stationary fronts with the associated clouds and weather</p> <p>Define a stationary or quasi-stationary front</p> <p>Describe the cloud, weather, surface visibility and aviation hazards in a stationary or quasi-stationary front</p>	
050 06 02 08	<p>Describe the movements of fronts and pressure systems and the life cycle of a mid latitude low</p> <p>State the qualitative rules for predicting the direction of movement and the speed of movement fronts</p> <p>Explain the difference between the speed of movement of cold and warm fronts</p> <p>State the qualitative rules for predicting the direction of movement and the speed of movement of polar front depressions</p> <p>Describe qualitatively, with a sketch if required, the genesis, development and life cycle of a polar front depression</p> <p>Sketch and describe the initial stage</p> <p>Sketch and describe the mature stage</p> <p>Sketch a plan of the mature stage showing the position of the jet streams, the cloud masses and rain belts, linking this to Sections 02 02 to 02 07</p> <p>Sketch and describe the occluded or dying stage</p>	
050 07 00 00	<u>PRESSURE SYSTEMS</u>	
050 07 01 00	<u>Location of the principal pressure areas.</u>	

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050 07 01 01	<p>Define or identify the location of the principal pressure areas.</p> <p>Identify or indicate on a map the principal global high pressure areas in January and July</p> <p>Identify or indicate on a map the principal global low pressure areas in January and July</p> <p>Explain how these pressure areas are formed</p> <p>Explain how the pressure areas move with the seasons</p>	
050 07 02 00	<p><u>Anticyclone</u></p>	
050 07 02 01	<p>Describe anticyclones (high pressure areas), types, general properties, cold and warm anticyclones, ridges and wedges, subsidence</p> <p>List the different types of anticyclones (high pressure areas)</p> <p>Describe airmass subsidence, its effect on the environmental lapse rate, and the associated weather</p> <p>Describe the formation of the different types of anticyclones</p> <p>Describe the formation of warm anticyclones</p> <p>Describe the formation of cold anticyclones</p> <p>Describe the formation of temporary cold anticyclones, ridges and wedges of high pressure</p> <p>Describe the properties of the different forms of anticyclones</p> <p>Describe the properties of and weather associated with warm anticyclones</p> <p>Describe the properties of and weather associated with cold anticyclones</p> <p>Describe the properties of and weather associated with ridges and wedges</p> <p>Describe the effects of blocking anticyclones</p>	
050 07 03 00	<p><u>Non frontal depressions</u></p>	
050 07 03 01	<p>Describe the formation and properties of thermal, orographic and secondary depressions, cold air pools and troughs.</p>	

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	<p>Describe the effect of low level convergence and divergence in producing areas of low and high pressure</p> <p>Describe the formation and properties of thermal depressions</p> <p>Describe the formation and properties of orographic depressions (lee lows)</p> <p>Describe the formation and properties of secondary depressions</p> <p>Describe the formation and properties of cold air pools</p> <p>Describe the formation and properties of troughs of low pressure</p>	
050 08 00 00	<u>CLIMATOLOGY</u>	
050 08 03 00	<u>Typical weather situations in the mid-latitudes</u>	
050 08 03 01	<p>Describe the formation of westerly waves and their effect on the climate zones</p> <p>Describe and explain the formation of westerly waves</p> <p>Describe and explain the global distribution of westerly waves</p> <p>Explain the effect of westerly waves on the positions of the mid latitude weather systems</p>	
050 08 03 02	<p>Describe the main mid latitude high pressure zones</p> <p>Identify or sketch on a map the mid latitude high pressure regions</p> <p>Name the two main winter mid latitude cold high pressure regions</p> <p>Describe the weather associated with cold ridges in the polar air (Refer to 050 07 02 01)</p>	
050 08 03 03	<p>Describe the weather associated with a uniform pressure pattern</p> <p>Describe the weather associated with a uniform pressure pattern over continental Europe</p>	
050 08 03 04	<p>Describe the weather associated with a cold pool</p> <p>Describe the weather associated with a cold pool over continental Europe (Refer to 050 07 03 01)</p>	
050 08 04 00	<u>Local seasonal weather and wind</u>	
050 08 04 01	Describe the formation of, and weather associated with some well-known winds	

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JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	<p>Describe the classical mechanism for the development of Foehn winds (including “Chinook”)</p> <ul style="list-style-type: none"> – Describe the weather associated with Foehn winds <p>Describe the characteristics of and weather associated with the “Mistral”</p> <p>Describe the characteristics of and weather associated with the “Bora”</p> <p>Describe the characteristics of and weather associated with the “Sirocco”</p>	
050 09 00 00	<u>FLIGHT HAZARDS</u>	
050 09 01 00	<u>Icing</u>	
050 09 01 01	<p>Explain the weather conditions for ice accretion, and the topographical effect</p> <p>Summarise the general conditions under which ice accretion occurs on aircraft</p> <ul style="list-style-type: none"> temperatures of outside air temperature of the cell presence of supercooled water in clouds, fog and rain possibility of sublimation <p>Indicate the general weather conditions under which ice accretion in venturi carburetor occurs</p> <p>Explain the general weather conditions under which ice accretion on aircraft cell occurs</p> <ul style="list-style-type: none"> Explain the formation of supercooled water in clouds and in rain Explain qualitatively the relationship between the air temperature and the amount of supercooled water <p>Explain qualitatively the relationship between the type of cloud and the size and number of the droplets, in cumuliform and stratiform clouds</p> <p>Indicate in which circumstances ice can form on an aircraft on the ground</p> <ul style="list-style-type: none"> Temperature Humidity 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 09 02 00 050 09 02 01	<p>Precipitation</p> <p>Explain in which circumstances ice can form on an aircraft in flight</p> <ul style="list-style-type: none"> inside clouds in precipitation outside clouds and precipitation <p>Describe the different factors influencing the intensity of icing</p> <ul style="list-style-type: none"> the temperature the amount of supercooled water in a cloud or in precipitation the speed of the aircraft the shape (thickness) of the aircraft cell parts (wings, antennas, a.s.o.) <p>Explain the effects of topography on icing</p> <p>Explain the formation of larger water drops in stratiform orographic clouds</p> <p><u>Turbulence</u></p> <p>Describe the effects on flight and turbulence avoidance</p> <p>Define light, moderate and severe turbulence according to ICAO RAC 4444 APP 1</p> <p>Describe the effects in flight of turbulence and wind shear</p> <p>Describe avoidance of turbulence</p> <ul style="list-style-type: none"> Indicate how the pilot prepares his flight in order to avoid turbulant zones, with the information received in the weather briefing Indicate how the pilot can select his track and level to avoid the following turbulent zones: <ul style="list-style-type: none"> rough ground surfaces relief inversion layers 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	<p>CB, TS zones</p> <p>unstable air</p> <p>Describe how the pilot can avoid turbulence during flight execution:</p> <p style="padding-left: 40px;">recognition of the position and risk of the turbulent zones, including turbulence caused by aircraft: (wake turbulence)</p> <p style="padding-left: 40px;">adjustment of airspeed, track and altitude</p>	
050 09 03 00	<u>Wind shear</u>	
050 09 03 01	Define wind shear	
	Define vertical and horizontal wind shear	
050 09 03 02	Define weather conditions for wind shear	
	Describe weather conditions where wind shear can form (for vertical and horizontal wind shear, mostly in combination)	
	Describe wind shear formation in and around thunderstorms	
	Describe wind shear in and around active cold fronts and squall lines	
	Describe wind shear caused by relief	
	Describe wind shear near inversions	
	Describe wind shear near frontal surfaces	
	Describe wind shear near the top of the boundary layer	
	Describe wind shear caused by sea breeze	
050 09 03 03	Explain the effects of wind shear on flight.	
	Describe qualitatively the effects of different types of wind shear on flights	
	Describe wind shear effect on the true airspeed,	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 09 04 00 050 09 04 01	<p>Describe wind shear effect on the angle of incidence,.</p> <p>Describe cross wind shear effect</p> <p><u>Thunderstorms</u></p> <p>Describe the structure of thunderstorm, squall lines, life history, storm cells, electricity in the atmosphere, static charges.</p> <p>Assess the average duration of a thunderstorm and its different stages</p> <p>Describe and sketch the structure of thunderstorms during their most active stage</p> <p>Define the squall line</p> <ul style="list-style-type: none"> weather situation where squall line can be formed weather conditions in squall lines occurrence <p>Define the stages of the life history of a thunderstorm</p> <ul style="list-style-type: none"> initial, mature and dissipating stage <p>Describe supercell storm: initial, supercell, tornado and dissipating stage</p> <p>Describe the electricity in the atmosphere, and static generated by thunderstorms</p> <ul style="list-style-type: none"> Describe the basic outline of the electric field in the atmosphere, Describe the generation of electrical potential differences in and around a thunderstorms cloud Describe "St. Elmo's fire", the phenomenon caused by the static charge of the aircraft, and the discharge of static 	
050 09 04 02	<p>Summarise the conditions and the process of development, the forecast, locations and type specifications</p> <p>Describe the different types of thunderstorms, their location, conditions and process of development:</p> <ul style="list-style-type: none"> air mass thunderstorms 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 09 04 03	<p>frontal thunderstorms</p> <p>squall lines</p> <p>supercell storm</p> <p>orographic thunderstorms</p> <p>Name the main meteorological signs used to forecast the development of thunderstorms</p> <p>Clouds</p> <p>vertical temperature lapse rate</p> <p>Describe thunderstorm avoidance , ground/airborne radar, stormscope</p> <p>Explain how the pilot can anticipate each type of thunderstorms</p> <p>preflight weather briefing</p> <p>observation in flight</p> <p>use of specific meteorological information, and information given by ground weather radar</p> <p>use of airborne radar</p> <p>use of the stormscope (lightning detector)</p> <p>Explain avoidance of thunderstorms</p> <p>Summarise the flight hazards of a fully developed thunderstorms,</p> <p>Indicate on a sketch the most dangerous zones in and around a thunderstorm</p> <p>Recommend a general 'philosophy' of pilots in relation with thunderstorms,</p> <p>Describe practical examples of flight techniques used to avoid the hazards of thunderstorms</p>	
050 09 04 04	<p>Describe the development and effects of downbursts.</p> <p>Define the downburst</p> <p>Distinguish between macroburst and microburst.</p>	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 09 04 05	<p>Explain the appearance of a downburst</p> <p>Give the typical duration of a downburst</p> <p>Describe the effect of downburst</p> <p style="padding-left: 40px;">Describe the process of development of a downburst in thunderstorms</p> <p style="padding-left: 40px;">Describe the different types of wind shear which occur if penetrating a downburst</p> <p>Describe the development of lightning discharges and the effect of lightning strike on aircraft and flight execution.</p> <p>Describe the effect of lightning strike on aircraft and flight execution</p>	
050 09 06 00	<u>Low and high level inversions</u>	
050 09 06 01	<p>Explain the influence of inversions on the aircraft performance.</p> <p>Compare the flight hazards during take-off and approach associated to a strong inversion alone and to a strong inversion combined with marked wind shear.</p>	
050 09 08 00	<u>Hazards in mountainous areas</u>	
050 09 08 01	<p>Describe the influence of a mountainous terrain on cloud and precipitation and fronts.</p> <p>Describe the Foehn effect</p> <p>Describe the influence of mountainous area on a frontal passage</p>	
050 09 08 02	<p>Describe the vertical movements, mountain waves, wind shear, turbulence and ice accretion typical of mountain areas</p> <p>Describe the formation of an inversion associated with a wind shear behind a chain of mountains</p> <p>Indicate in a sketch of a chain of mountains the turbulent zones:</p> <p style="padding-left: 40px;">the mountain waves (lee waves)</p> <p style="padding-left: 40px;">the rotor</p> <p>Explain the influence of relief on ice accretion</p>	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 09 08 03	<p>Describe the development and effect of valley inversions.</p> <p>Describe the formation of valley inversion due to the katabatic winds</p> <p>Describe the valley inversion formed by warm winds aloft</p> <p>Describe the effects of a valley inversion for an aircraft in flight</p>	
050 09 09 00	<p><u>Visibility reducing phenomena</u></p>	
050 09 09 01	<p>Describe the reduction of ground (meteorological) visibility and flight visibility caused by fog, mist, smoke, dust, sand and precipitation</p> <p>Describe the appearance of the phenomena reducing visibility</p> <p style="padding-left: 20px;">Fog</p> <p style="padding-left: 20px;">mist or haze</p> <p style="padding-left: 20px;">smoke</p> <p style="padding-left: 20px;">dust</p> <p style="padding-left: 20px;">precipitation</p> <p style="padding-left: 20px;">sandstorms and low drifting sand</p>	
050 09 09 02	<p>Describe the reduction of visibility caused by low drifting and blowing snow.</p>	
050 10 00 00	<p><u>METEOROLOGICAL INFORMATION</u></p>	
050 10 01 00	<p><u>Observation</u></p>	
050 10 01 01	<p>Describe the meteorological measurement on the ground of: surface wind, meteorological visibility and runway visual range (transmissometers)</p> <p>Define surface wind</p> <p>List the ICAO units for the wind direction and speed used in the METAR</p> <ul style="list-style-type: none"> – Define gusts, as given in the METARS – Distinguish wind given in the METAR and wind given by the control tower for take-off and landing 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	<p>Define visibility</p> <ul style="list-style-type: none"> - Define ground and meteorological visibility - List the units used for meteorological visibility <p>Define runway visual range</p> <ul style="list-style-type: none"> - Define RVR and the units of measurement - List the different possibilities to transmit information about RVR to pilots - Compare the meteorological visibility and RVR <p>Define vertical visibility</p> <ul style="list-style-type: none"> - Explain briefly how and when it is measured - State how it is transmitted to pilots <p>Explain the principle of the transmissiometer measurements</p> <ul style="list-style-type: none"> - Indicate where they are placed on the airport <p>Indicate the means of observing clouds: type, amount, height of base and top, movements</p> <ul style="list-style-type: none"> - List the clouds considered in met reports, and how they are indicated in METARs - Define "octas" - Define "ceiling" - Define "cloud base" - List the units used for information about cloud base <p>Indicate the means of observation of the present weather, including all types of precipitation, air temperature, relative humidity, dewpoint, atmospheric pressure</p> <ul style="list-style-type: none"> - Describe the precipitations to be found in TAFs ans METARs - Describe the principle of the most common hygrometer and psychrometer 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 10 01 05	<ul style="list-style-type: none"> – Describe the principle of the two main types of barometer <p>Aircraft observations and reporting, data link systems, PIREPS.</p> <p>Describe, in general, the data link system</p> <p>Define AIREP or PIREP and PIREP SPECIAL</p> <p>State the use of AIREP and PIREP in aviation meteorology</p>	
050 10 02 00	<p><u>Weather charts</u></p>	
050 10 02 01	<p>Interpret significant weather charts</p> <p>List the different SWC</p> <p>Decode the symbols and abbreviations used in the SWC,</p> <ul style="list-style-type: none"> – front types with direction and speed of movement, – position and direction and speed of movement of pressure centres, – distribution, vertical extent and hazards of cloud formations, – significant weather phenomena, – freezing level, – position, direction, speed and height of jet streams, – distribution, height and degree of Clear Air Turbulence, – height of the tropopause, local tropopause minima and maxima, <p>Describe from a SWC the flight conditions along a defined flight route at a given flight level.</p> <p>Decode significant weather charts:</p> <ul style="list-style-type: none"> – High Level – Medium level – Low level 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 10 02 02	<p>Describe and interpret surface weather charts.</p> <p>Recognize weather systems on a surface weather chart,</p> <ul style="list-style-type: none"> – axis of ridges and troughs, – fronts, – frontal side, warm sector and rear side of midlatitude lows, – high pressure areas. <p>Recognize in surface weather charts areas with cloudiness, precipitation and fog.</p> <p>Determine from surface weather charts the wind direction and speed.</p>	
050 10 02 03	<p>Describe and interpret upper air charts.</p> <p>Define 'constant pressure charts'</p> <ul style="list-style-type: none"> – Define isohypse (contourlines) on constant pressure air charts – Define isotherms on constant pressure charts – Recognize the following weather systems on constant pressure charts: ridges and troughs, low and high pressure systems. areas of cold and warm air, areas with jet streams, <p>Describe forecast upper wind and temperature charts</p> <ul style="list-style-type: none"> – Determine from forecast wind and temperature charts and designated locations, if necessary by interpolation the outside air temperature, the ISA temperature deviation, 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 10 02 04	<p style="text-align: center;">the wind direction and wind speed</p> <ul style="list-style-type: none"> – Name the most common flight level corresponding to the constant pressure charts <p>Decode and interpret symbols and signs on analysed (synoptic) and prognostic charts.</p> <p>CB, thunderstorms</p> <p>Precipitations</p> <p>different kind of fronts, squall line</p> <p>isobars, trough axis</p> <p>convergence line, intertropical convergence zone.</p> <p>tropical revolving storm</p> <p>standing waves</p> <p>fog, mist, haze, smokes</p> <p>Decode and interpret symbols and signs on prognostic charts:</p> <ul style="list-style-type: none"> – SWC (refer to 050 10 02 01) – Forecast upper wind and temperature charts (refer to 050 10 02 02) 	
050 10 03 00	<p><u>Information for flight planning</u></p>	
050 10 03 01	<p>Describe and interpret aeronautical codes: METAR, TAF, SPECI, SIGMET, SNOWTAM, Runway State Message.</p> <p>Describe and interpret METAR and SPECI</p> <ul style="list-style-type: none"> – Name the meaning of the abbreviation 'METAR' and 'SPECI' – List, in general, the cases when SPECI is issued – Describe the structure of a METAR and SPECI – Decode all the abbreviations used in the METAR and SPECI 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 10 03 02	<p style="text-align: center;">Describe from a METAR flight hazards and their prognosted development.</p> <ul style="list-style-type: none"> – Name the meaning of a TREND forecast – Describe the structure of a TREND forecast – Decode a TREND forecast <p>Describe and interpret TAF</p> <ul style="list-style-type: none"> – Name the meaning of the abbreviation 'TAF' – Describe the structure of a TAF – Decode the time groups of a TAF – Decode all the abbreviations used in the TAF <p style="text-align: center;">Describe from a given TAF flight hazards and their forecast development.</p> <p>Define and interpret SIGMET</p> <ul style="list-style-type: none"> – Name the meaning of the term SIGMET – List, in general, the cases when a SIGMET is issued – Decode an issued SIGMET written in abbreviated plain language according to ICAO Annex 3, Meteorology, Chapter 7 <p>Describe the SNOWTAM and the Runway State Message</p> <ul style="list-style-type: none"> – Decode, in general, the content of a Runway State Message as written at the end of a METAR <p>Describe, in general, the meteorological broadcasts for aviation: VOLMET, ATIS, HF-VOLMET, ACARS</p> <p>Summarize the content of a heard VOLMET report.</p> <ul style="list-style-type: none"> – Decode and interpret the content of a VOLMET report <p>Summarize the content of a heard ATIS report.</p>	<p>Ref: Air Navigation Plan European Region Attach. B to Part III – Aerodrome Operations</p>

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 10 03 03	<ul style="list-style-type: none"> – Decode and interpret the content of a ATIS report – State the meaning of ACARS <p>Compare, generally, the three weather broadcasts for aviation VOLMET, ATIS and ACARS.</p> <p>Apply the content and use of pre-flight meteorological documents on a designated flight route.</p> <p>List the most important pre-flight meteorological documents to be used for pre-flight planning.</p> <ul style="list-style-type: none"> – Name the importance of the different flight informations for the safety and efficiency of the flight – Describe from a compilation of pre-flight documents the useful weather information along a designated flight route at a designated flight altitude <ul style="list-style-type: none"> – icing and turbulence zones, – CAT – thunderstorms, – jet streams, – significant clouds fields, – height of tropopause, with maxima and minima – fronts and their movement 	
050 10 03 04	<p>Describe meteorological briefing and advice.</p> <p>List, in general, the information that a flight crew can receive from meteorological services</p> <ul style="list-style-type: none"> – for preflight planning – during flight. 	
050 10 03 05	<p>Describe measuring and warning systems for low level wind shear, inversion.</p> <p>Name two ground warning systems for low level wind shear</p> <ul style="list-style-type: none"> – Describe the Low Level Wind Shear Alert System (LLWAS) 	

**COMMERCIAL PILOT LICENCE (A)
(METEOROLOGY)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
050 10 03 06	– Describe the basic outlines of terminal doppler weather radar. Describe special meteorological warnings (airport specific; e.g. lightning warnings)	