Subject No 26 General Aircraft Technical knowledge - Aeroplane

(Note: This syllabus is generally based on a piston-engine GA-type aeroplane.)
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.

Sub Topic	Syllabus Item
26.2	**Engines**
26.2.2	State the basic difference between reciprocating (piston) and gas turbine (jet) engines.
26.2.4	Distinguish between the basic types of piston aircraft engine.
26.2.6	State the fundamental operating principle of the reciprocating (piston) engine.
26.2.8	With the aid of diagrams, identify the main components of a four-stroke cycle piston engine including: cylinders; pistons; cylinder heads; valves; spark plugs; connecting rods; crankshaft; camshaft and valve operating mechanism.
26.2.10	With respect to a four-stroke piston engine, state the meaning of the following terms: cycle; stroke; top dead centre (TDC) and bottom dead centre (BDC); bore; clearance and swept volumes; compression ratio; firing interval; firing order; manifolds; manifold pressure; crank angle.
26.2.12	Explain the operation of the four-stroke cycle.
26.2.14	Explain valve lag, valve lead, and the advantages of valve overlap.
26.2.16	Explain the term ignition timing and the need for spark advance.
26.2.18	Distinguish between detonation and pre-ignition, state the main causes of these conditions, and the reasons for avoiding them.
26.4	**Engine Performance**
26.4.2	Define the terms: force; work; power; energy; and engine torque.
26.4.4	Relate horsepower to kilowatts.
26.4.6	Define brake power.
26.4.8	Define rated power and explain 'rated altitude' or 'critical altitude'.
26.4.10	Explain the following in broad terms: thermal efficiency; mechanical efficiency; and volumetric efficiency.
26.4.12	With the aid of a diagram, explain the relationship between typical brake power and power available curves.
26.4.14	Explain the general conditions for the most efficient engine operation.

26.6 Carburation & Fuel Injection

26.6.2 Explain the following in relation to fuel-air mixture ratios:

(a) 'rich' and 'lean':

(b) normal workable mixture ratio limits;

(c) the 'chemically correct' or stoichiometric ratio; and

(d) the approximate ratios for maximum power output and best economy.

26.6.4 With the aid of a diagram, describe a typical carburettor mixture setting curve and show the operating area where detonation will occur.

26.6.6 With the aid of a diagram, explain the basic principle of operation of a simple float-type carburettor.

26.6.8 Explain the need for the following in an aero-engine carburettor:

(a) atomisation and diffusion;

(b) accelerating system;

(c) idling system;

(d) power enrichment (economiser) system;

(e) mixture control and cut-off system.

26.6.10 State the two main disadvantages with use of a float-type carburettor in an aero-engine.

26.6.12 State the principal difference between a fuel injection system and carburetted systems.

26.6.14 Explain the principal differences between continuous flow fuel injection, and direct fuel injection systems.

26.6.16 List the advantages and disadvantages of using fuel injection systems in aero-engines.

26.6.18 State the correct use of the mixture control.

26.6.20 Explain the consequences of operating with over-rich and over-lean mixture settings.

26.6.22 With respect to carburettor ice, explain the process and the atmospheric conditions for the formation of:

(a) refrigeration (or fuel) ice;

(b) throttle ice;

(c) impact ice.

26.6.24 Explain the normal symptoms of carburettor ice formation, and the correct use of the carburettor heat control.

26.8 Induction and Exhaust systems; Supercharging

26.8.2 With respect to carburettor air intakes, explain the correct use of ram air, filtered air, carburettor heat.

26.8.3 List the reasons for a reduction in power when carburettor heat is operated.

26.8.4 In general terms, describe the function of the inlet and exhaust manifold.

26.8.5 Explain the importance of proper sealing of the exhaust manifold.

26.8.6 Explain the advantages, and the limitations of, supercharging.

26.8.8 Explain the basic principle of operation of exhaust-driven superchargers (turbochargers).

26.10 Fuel Systems

26.10.2 Distinguish between gravity-feed and pump-feed fuel systems.

26.10.4 For a simple fuel system, explain the function, and where appropriate, the correct handling of the following:

(a) tank filler caps and drains;

(b) expansion spaces;

(c) tank vents;

(d) baffles;

(e) sumps and drains;

(f) fuel quantity detectors;

(g) fuel strainers and filters;

(h) tank selector valves;

(i) engine-driven fuel pump;

(j) boost (auxiliary) pump(s);

(k) engine primers and priming systems.

26.10.6 Describe the importance of correct management of fuel selection.

26.10.8 List the actions recommended in the case of loss of power through faulty fuel selection.

26.10.10 State the differences between aviation gasoline (AVGAS) and motor gasoline

(MOGAS).

26.10.12 Explain fuel octane ratings and performance numbers.

26.10.14 State the grades of AVGAS available in New Zealand, together with their colours.

26.10.16 Explain the likely result of using a higher grade, or a lower grade, of fuel than that recommended for a given aircraft.

26.10.18 State the caution against using automobile fuel (MOGAS) in an aircraft engine, unless specifically authorised.

26.10.20 Describe the distinguishing features of aviation turbine fuel (AVTUR) and state the difference between the decals used on AVTUR and AVGAS fuelling equipment.

26.10.22 State the precautions which can be taken to avoid fuel contamination with water and other impurities.

26.10.24 State the special precautions which must be taken when fuelling from drum stock, and the avoidance of the use of non-approved plastic containers.

26.10.26 Describe the correct procedures to be used for carrying out a fuel check.

26.10.28 Describe the general rules for refuelling an aircraft, and the correct use of fuel tank dipsticks.

26.12 Ignition Systems

26.12.2 State the reasons for fitting independent dual ignition systems to aero-engines.

26.12.4 List the essential components of an ignition system.

26.12.6 Describe, in broad terms, the operation of the following;

(a) an aircraft magneto;

(b) the distributor;

(c) ignition harness (high tension leads);

(d) spark plugs;

(e) impulse couplings.

26.12.8 Describe the operation of the ignition switch(es) in the cockpit, and outline the correct procedures to be followed during magneto checks.

26.12.10 Describe the functioning of the starter motor, and outline the correct operation of the starter switch.

26.12.12 Describe the procedures and the precautions to be taken when hand-swinging a propeller to start an engine.

26.14 Lubrication and Cooling Systems

26.14.2 Explain the main functions of the engine oil system.

26.14.4 Describe the effect of temperature on the viscosity and lubrication qualities of oil.

26.14.6 Compare the features of the ashless dispersant (AD) oils used in piston aero-engines with straight mineral oil and detergent oils.

26.14.8 With respect to oil grades, differentiate between the commercial aviation numbers and SAE ratings.

26.14.10 Differentiate between a wet sump and a dry sump oil system.

26.14.12 With the aid of a diagram, briefly describe the function of:

(a) the engine-driven oil pump and pressure relief valve;

(b) oil lines, passages and galleries;

(c) oil sumps and scavenge pumps;

(d) oil cooler;

(e) oil tank and filter.

26.14.14 Explain the need for periodic oil changes.

26.14.16 Describe the correct oil replenishment procedure.

26.14.18 Describe the likely results of operating an engine with:

(a) incorrect oil type;

(b) incorrect oil quantity.

26.14.20 Describe the likely causes of:

(a) low oil pressure;

(b) high oil pressure;

(c) high oil temperature.

26.14.22 Explain the relationship between a fluctuating or low oil pressure reading accompanied by a rise in oil temperature, and the actions which the pilot should take.

26.14.24 State the reasons why excessively high engine temperatures must be avoided.

26.14.26 List the ways in which heat from the combustion process is dispersed from a typical aero-engine.

26.14.28 For an air-cooled engine, explain the function of:

(a) cowling ducts and baffles;

(b) cooling fins;

(c) pilot-operated cowl flaps.

26.14.30 Explain the general handling requirements for maintaining engine temperatures in the proper range, for aircraft:

(a) without CHT gauge or cowl flaps;

(b) fitted with CHT gauge and cowl flaps.

26.16 Propellers

26.16.2 With the aid of a diagram, identify the following with respect to a propeller blade section:

(a) relative airflow and angle of attack;

(b) the rpm and TAS vectors;

(c) the total reaction (TR) and its components, thrust and propeller torque.

26.16.4 State the two main disadvantages of the fixed-pitch propeller, which the constant-speed (variable-pitch) propeller was designed to overcome.

26.16.8 For a constant speed propeller, differentiate between the functions of the propeller (pitch) control and the throttle (MAP) control, when the propeller is:

(a) in the constant-speed range;

(b) below the constant-speed rpm range.

26.16.10 Explain how the constant-speed unit acts to change the pitch of the blades and maintain rpm:

(a) with changes to MAP;

(b) with changes in airspeed.

26.16.12 Explain the basis for centrifugal and aerodynamic twisting moments on a propeller blade, and identify the direction in which they tend to twist the blade.

26.16.14 With the aid of diagrams, explain the method of operation of typical pitch-changing mechanisms.

26.16.16 With the aid of a diagram, explain the operation of a typical CSU governor.

26.16.18 With the aid of diagrams, show the forces acting on a feathered blade section, and with the propeller in the reverse thrust mode.

26.16.20 Explain the caution against applying power as the propeller blades are travelling from the normal thrust to the reverse thrust angle.

26.16.22 Describe the normal handling of the propeller pitch and/or manifold pressure controls:

(a) when the aircraft is on the ground;

(b) for 'exercising' the CSU;

(c) prior to take-off and landing;

(d) when increasing or decreasing power in the air.

26.16.24 Describe the types of failure which can affect the CSU, including the conditions which can lead to a 'runaway propeller' and the required remedial action.

26.18 Electricity and Magnetism

26.18.2 Explain the basis of an electrical current, and the direction of the current.

26.18.4 Describe the basic characteristics of an electrical flow the terms [amps, volts, electro magnetic force (emf) and ohms].

26.18.6 State Ohm's law.

26.18.8 With the aid of diagrams, describe simple 'two-wire' and 'single wire' grounded electrical circuits.

26.18.10 Distinguish between direct and alternating current, and explain the terms 'Hertz' and 'rectification'.

26.18.12 Describe the properties of magnetism, including polarity, attraction and repulsion.

26.18.14 Distinguish between temporary and permanent magnets, and the properties of 'soft iron' and 'hard iron'.

26.18.16 Describe the terms magnetic field, magnetic flux, and permeability.

26.18.18 Explain 'electromagnetism' and with the aid of diagrams, show the lines of magnetic force around a straight conductor and a coil.

26.18.20 With the aid of diagrams, describe the principle of operation of an electromagnetic switch (or relay) and a solenoid switch. State typical examples of their use in aircraft electrical circuits.

26.18.22 List the six ways in which an emf can be generated.

26.18.24 Explain the principle of electromagnetic induction.

26.18.26 With the aid of a diagram, describe the principle of operation of a simple alternator (a magnet rotating inside a loop conductor).

26.18.27 Show the features of a practical alternator, and explain how the a.c. output is normally rectified to provide d.c.

26.18.28 With the aid of a diagram, describe the principle of operation of a simple generator (a loop conductor rotating inside a magnet).

26.18.29 Show the features of a practical generator, and explain how the output is passed through a commutator to provide d.c.

26.18.30 Explain the need for voltage regulation for both alternators and generators, and how a generator also requires a current regulator and a reverse current relay.

26.18.32 Explain the principle of operation of a basic electric cell ('battery').

26.18.34 Distinguish between primary and secondary cells, wet-cells and dry cells, lead-acid and nickel-cadmium (and similar) types.

26.18.36 Explain the meaning of :

(a) battery capacity;

(b) thermal runaway.

26.18.40 Explain the basic features and operation of:

(a) a lead-acid battery;

(b) a nickel-cadmium (nicad) battery.

26.18.42 State the advantages of Nicad batteries.

26.20 Electrical Systems

26.20.2 State the systems which typically require electrical power in a light aircraft.

26.20.4 Explain the function(s) of the following in a typical aircraft electrical system:

(a) the battery;

(b) a ground power source;

(c) the alternator or generator;

(d) bus bar;

(e) overvoltage protection.

26.20.6 Distinguish between the functions and interpretation of left-zero and centre-zero ammeters.

26.20.8 Distinguish between the functions and correct operation of a single battery master switch and split battery/alternator switches.

26.20.10 Distinguish between the way in which fuses, circuit breakers and overload switches operate.

26.20.12 Explain airmanship points of handling the electrical system, including:

(a) avoiding overheating electrical services if operated during pre-flight;

(b) not starting or stopping the engine with unnecessary electrical equipment switched on;

(c) avoiding prolonged use of the starter motor;

(d) checking satisfactory operation of the alternator/generator after start, and periodically during flight;

(e) ensuring the battery master is switched off before vacating the aircraft after flight.

26.20.14 Explain the diagnosis and correct handling of electrical malfunctions including:

(a) an excessive charge rate;

(b) alternator/generator failure;

(c) blown fuse/popped circuit breaker.

26.22 Engine Instruments

26.22.2 Explain the underlying principle of operation of the following:

(a) tachometers (rpm gauges): centrifugal, drag cup, electrical and electronic types;

(b) manifold pressure and boost gauges;

(c) oil pressure gauges: direct reading, remote indicating and ratiometer types;

(d) fuel pressure gauges;

(e) vacuum gauges.

26.22.4 Explain the principle of operation of a simple a.c. synchro system.

26.22.6 Describe the principle of operation of the following instruments:

(a) cylinder head and exhaust gas temperature (thermocouples);

(b) oil temperature gauges;

(c) outside air temperature gauges;

(d) fuel quantity and fuel flow gauges.

26.24 Pressure Instruments

26.24.2 Define static air pressure, dynamic pressure and total (pitot) pressure.

26.24.4 State the pressure requirements of the three basic pressure instruments.

26.24.6 Describe a simple pitot-static system and distinguish between a single pitot (pressure) head and separate pitot tube and static vents.

26.24.7 State the function of pitot heat.

26.24.8 With the aid of a diagram, describe the principle of operation of an airspeed indicator (ASI).

26.24.10 State the conventional colour coding of a typical light aircraft ASI.

26.24.12 Explain the following errors affecting an ASI:

(a) density error (IAS/TAS relationship);

(b) position (pressure) error;

(c) compressibility error.

26.24.14 State the pre-flight and in-flight serviceability checks for an ASI.

26.24.16 With the aid of a diagram, explain the principle of operation of an altimeter.

26.24.18 Explain the meanings of the subscale settings QNH, QFE and QNE.

26.24.20 State the effect of pressure setting error on altimeter indication.

26.24.22 State the effect of airmass temperature at constant QNH on altimeter indication.

26.24.24 Explain the following errors affecting an altimeter:

(a) instrument;

(b) position error;

(c) lag.

26.24.26 State the serviceability checks and the accepted indication tolerances of an altimeter.

26.24.28 With aid of a diagram, explain the principle of operation of a vertical speed indicator (VSI).

26.24.30 Explain the following errors affecting a VSI;

(a) lag;

(b) position error.

26.24.32 State the serviceability checks for a VSI.

26.24.34 Explain the symptoms, effects, and possible remedies available, for blockages and leaks in the pitot-static system to each of the pressure instruments.

26.26 Gyroscopic Instruments

26.26.2 Briefly describe a typical aircraft vacuum (suction system).

26.26.3 Distinguish between suction pump, venturi, and positive pressure systems.

26.26.4 State the inherent properties of a spinning gyroscope rotor.

26.26.6 Explain what is meant by the term gimbal, and list the four types of gyroscope.

26.26.8 With the aid of a diagram, explain the principle of operation of a turn indicator.

26.26.10 Distinguish between a turn indicator (TI) and a turn coordinator (TC).

26.26.12 State the errors which a turn indicator is subject to.

26.26.14 State the principle of operation of the balance ball, and with the aid of diagrams, interpret various TI and TC indications.

26.26.16 Explain the serviceability checks for the TI/TC.

26.26.18 With the aid of a diagram, explain the principle of operation of a direction indicator (DI) [or heading indicator (HI)].

26.26.20 Explain the following errors which the DI is subject to:

(a) gimbal error;

(b) real drift (or real wander);

(c) apparent drift (or apparent wander);

(d) low rotor speed.

26.26.22 State the common operating limitations and serviceability checks for a DI.

26.26.24 State the advantages of an electrically-driven DI versus an air-driven instrument.

26.26.26 With the aid of a diagram, explain the principle of operation of an artificial horizon (AH) [or attitude indicator (AI)].

26.26.28 Briefly describe the effects of a straight-line acceleration and a turn, on the pendulous unit of an air-driven AH, and state the errors in indication arising from these effects.

26.26.30 State the general operating limitations of air-driven and electrically-driven AHs.

26.26.32 With the aid of diagrams, distinguish between the indications of the TC and AH under various conditions.

26.28 Compasses

26.28.2 With the aid of a diagram, describe the features of the earth's magnetic field (flux) and define variation.

26.28.4 Describe the angle of dip and components H and Z of the earth's magnetic flux.

26.28.6 Describe the basic features of a typical aircraft direct-reading magnetic compass, and explain the reason(s) for:

(a) pendulous suspension of the magnet system;

(b) immersing the magnet system in fluid.

26.28.8 Describe acceleration and turning errors in the southern hemisphere of a direct-reading compass, and the practical aspects of these errors.

26.28.10 Define deviation and state how it is compensated for in a direct-reading compass.

26.28.11 Given a typical deviation card, apply corrections for residual deviation.

26.28.12 State the serviceability checks for a direct-reading compass.

26.28.14 Explain what a compass swing is and give examples of the occasions on which it is required.

26.30 Airframes

26.30.2 Explain five different types of loading to which an airframe must be designed to accept.

26.30.4 Explain the effects of the application of a load to an airframe structure (stress and strain) and differentiate between bending, tensile, compression, torsional and shear loads.

26.30.6 Briefly describe the three styles of fuselage construction (truss; monocoque; and stressed skin (or semi-monocoque).

26.30.8 Briefly describe the three common types of wing construction (biplane; braced monoplane; unbraced monoplane (or cantilever).

26.30.10 Describe the function of the following wing components; spars, ribs; skin and stringers.

26.30.12 Briefly describe the construction of tailplane and fin, and control surfaces.

26.30.14 Briefly describe the layout of the primary control runs.

26.30.16 State the requirements which the undercarriage system must be able to meet.

26.30.18 Describe the features of simple light aircraft undercarriage construction, and given a diagram, explain the operation of an oleo-pneumatic shock strut.

26.30.20 Describe the pilot checks of oleo-pneumatic undercarriage legs.

26.30.22 Briefly describe the essential features of a retractable undercarriage system.

26.30.24 Briefly describe the construction of aircraft wheel assemblies and tyres.

26.30.26 State the requirements for tyre care and checks.

26.30.28 State the procedure for tie down (or picketing) a light aircraft.

Support Systems

26.32 Hydrodynamics

26.32.2 State Pascal's principle.

26.32.4 With the aid of diagrams:

(a) describe mechanical advantage;

(b) show how it can be gained hydraulically;

(c) demonstrate the principle of operation of aircraft hydraulic services.

26.34 Hydraulic systems

26.34.2 State the advantages of using hydraulics to operate aircraft services.

26.34.4 Differentiate between the three types of hydraulic oil.

26.34.6 Describe the function of common hydraulic system components; including:

(a) reservoirs;

(b) pumps;

(c) pressure regulators;

(d) accumulators;

(e) check valves and relief valves;

(f) selector valves;

(g) actuators;

(h) filters.

26.34.8 With the aid of schematic diagrams, describe the operation of the following hydraulic systems:

(a) open centre system;

(b) pressurised system.

26.36 Pneumatic systems

26.36.2 Briefly state the advantages and disadvantages of pneumatic systems versus hydraulic systems.

26.36.4 With the aid of schematic diagrams, outline the operation of the following pneumatic systems:

(a) back-up systems;

(b) low pressure systems.

26.38 Brake systems

26.38.2 State the basic principle of operation of wheel brake units.

26.38.4 Explain the operation of expander-tube and brake-shoe wheel units.

26.38.6 Explain the operation of disc brake units.

26.38.8 Outline the operation of:

(a) an independent brake system;

(b) a boosted brake system;

(c) a power brake system.

26.38.10 Explain the operation of anti-skid units.

26.40 Ice protection systems

26.40.2 Distinguish between anti-icing systems and de-icing systems.

26.40.4 Explain the operation and the proper handling of, mechanical, fluid and thermal ice protection systems.

26.40.6 Describe ice detection, windscreen heating and rain clearance systems.

26.42 Fire protection systems

26.42.2 Outline the operation of unit-type and continuous loop fire detectors.

26.42.4 List the common extinguishing agents and state any precautions when using.

26.42.6 Describe common fire extinguishing systems and the limitations with their use.

26.44 Weight and Balance

26.44.2 Define the following terms:

(a) arm;

(b) datum;

(c) moment (including the units used);

(d) centre of gravity (CG);

(e) CG range and limits;

(f) station;

(g) index units;

(h) basic empty weight (empty aircraft weight);

(i) empty weight CG position;

(j) basic operating weight (aircraft prepared for service weight);

(k) payload;

(l) zero fuel weight;

(m) ramp weight;

(n) gross weight;

(o) maximum certificated take-off weight (MCTOW);

(p) maximum certificated landing weight (MCLW);

(q) the specific gravity and the weight of AVGAS.

26.44.4 Explain the principles of aeroplane balance, and the function of the tailplane in providing the final balancing force.

26.44.6 State the effect on longitudinal stability and handling with the aeroplane loaded with the CG:

(a) well forward;

(b) outside the forward limit;

(c) CG well aft;

(d) outside the aft limit.

26.44.8 Given weights and arms, calculate moments and establish a CG position.

26.44.10 Demonstrate the use of graphs to:

(a) calculate load moment;

(b) establish CG position.

26.44.12 Given appropriate data and using a typical weight and balance work sheet, calculate the CG position at take-off and for landing.

26.44.14 Solve the following loading problems:

(a) loading or offloading weight and find new CG position;

(b) loading or offloading weight to place the CG at a given station;

(c) loading or offloading weight at a given station without exceeding CG limits;

(d) moving weight from one station to another and finding new CG position;

(e) establishing payload available given a maximum zero fuel weight.