

ATTACHMENT 1

Abbreviations, Table of Equivalents, Terms, and Formulas

GREEK LETTER ABBREVIATIONS

α (Alpha)	Angle of attack in degrees
β (Beta)	Blade angle of propeller in degrees
γ (Gamma)	Ratio of specific heats of gas at constant pressure and volume
δ (Delta)	Increment of change in weight, drag, airspeed, etc.
Δ (Delta)	Relative absolute pressure
Δ (Delta)	Cowl flap setting (degrees)
Δ (Delta)	Wing flap deflection (degrees)
η (Eta)	Propeller efficiency in percent
θ (Theta)	Relative absolute temperature
μ (Mu)	Coefficient of friction
π (Pi)	3.1416
ρ_0 (Rho)	Air density at some specific altitude
ρ (Rho)	Air density at sea level
σ (Sigma)	Density ratio or relative density equals $\frac{P}{P_0}$ or $\frac{1}{\sqrt{\sigma}}$ (smoe), the reciprocal of the square root of sigma; the proportional amount that true airspeed must change with a change in H_a to maintain an equivalent airspeed.

GENERAL ABBREVIATIONS

a	Acceleration (rate of change of velocity)
A	Area, or arm
ADI	Anti-detonant Injection
A_j	Area of jet nozzle
alt	Altitude
ARCP	Air refueling control point
ATO	Assisted takeoff units
BAS or V_1	Basic airspeed in miles per hour
BASK	Basic airspeed in knots
bhp	Brake horsepower: equals $\text{rpm} \times T_p \times k$ (horsepower available at propeller shaft)

bmep	Brake mean effective pressure; equals $792,000 \text{ bhp/rpm} \times 1/\text{PD}$
BSFC	Brake specific fuel consumption
BTE	Brake thermal efficiency
BTU	British thermal unit (one BTU equals 778 foot-pounds of work)
C	Degrees centigrade (Celsius)
CAS or V_c	Calibrated airspeed in miles per hour
CASK	Calibrated airspeed in knots
cat	Carburetor air temperature ($^{\circ}\text{C}$)
C_D	Coefficient of drag (D/qS)
CFL	Critical field length
CG	Center of gravity
CHT	Cylinder head temperature
C_L	Coefficient of lift (L/qS)
C_w	Correction for wind
d	Distance
D	Drag
E	Energy
EAS or V_e	Equivalent airspeed in miles per hour
EASK	Equivalent airspeed in knots
EBP	Exhaust back pressure
EDP	Equidistance point
EGT	Exhaust gas temperature
EPR	Engine pressure ratio (The ratio of engine turbine exit pressure to compressor inlet pressure)
EPW	Equivalent performance weight
F	Degrees Fahrenheit, or friction, or force
f	Change in flat plate area
F/A	Fuel/air ratio
FF	Fuel flow
fhp	Friction horsepower
fmep	Friction mean effective pressure
fpm	Feet per minute
g	Acceleration of gravity
gal	Gallon
GNMPP	Ground nautical miles per pound
gpm	Gallons per minute

GS	Ground speed	psi	Pounds per square inch
GW	Gross weight	q	Dynamic pressure
H	Absolute altitude (Tapeline)	r	Radius
H _d	Density altitude	R	Number of engines or cylinders
h _g	Mercury	Rankine (R)	Absolute temperature scale, with each unit of measurement being equal to one Fahrenheit degree.
H _o	Optimum altitude	R/C	Rate of climb (feet per minute)
H _p	Pressure altitude	RCR	Runway Condition Reading
hp	Horsepower	R·D	Rate of Descent (feet per minute)
IAS or V _i	Indicated airspeed in miles per hour	rd	Reference datum (line)
IASK	Indicated airspeed in knots	rpm	Revolutions per minute
ICAO	International Civil Aviation Organization	RS	Refusal speed (knots CAS)
ihp	Indicated horsepower (total amount of horsepower developed by an engine)	RSC	Runway surface covering
imep	Indicated mean effective pressure	S	Projected area of a wing in square feet
K	Constant	SFC	Specific fuel consumption (pounds of fuel per hour per brake horsepower or pounds of fuel per hour per pound of thrust)
k (or K)	Knot (also kn)	shp	Shaft horsepower
Kt	Torque constant	SL	Sea level
KE	Kinetic energy	SL	Unit of measurement of mass
Kelvin	Absolute temperature scale (Celsius)	SM	Statute mile
L	Lift	smoe	Reciprocal of the square root of density ratio; used in converting indicated airspeed to true airspeed at altitude
lb	Pound	Spec H	Specific humidity
lb/gal	Pounds per gallon	T	Temperature, or thrust
lb/min	Pounds per minute	t	Time
L/D	Lift-drag ratio	T _R	Gross thrust (gas turbine)
LEMAC	Leading edge mean aerodynamic chord	T _n	Net thrust (gas turbine)
M	Mach number (Also Moment)	TAS or T	True airspeed in miles per hour
m	Mass	TASK	True airspeed in knots
MAC	Mean aerodynamic chord (a reference length to which aerodynamic characteristics are referred)	thp	Thrust horsepower (550 ft. lb/sec)
MAP	Manifold absolute pressure	TOLD	Takeoff and Landing Data (Card)
max	Maximum	TOP	Torquemeter oil pressure
METO	Maximum except takeoff	T _n or P _{tor}	Torque pressure (Torque = lb-ft)
MP	Manifold pressure	TPSI	Torque pressure in pounds per square inch
mph	Miles per hour	TRT(wet)	Takeoff rated thrust with water
MRT	Maximum rated thrust—maximum allowable thrust (no water) determined by EPR setting	TRT(dry)	Takeoff rated thrust no water
NAM	Nautical air miles	V	Velocity
No	Number	V	Volume
NM	Nautical miles	V _{ave}	Average velocity
NMPP	Nautical miles per pound	V _{crit}	Critical engine failure speed
NRT	Normal rated thrust—maximum allowable thrust for continuous operation determined by EPR setting	V _f	Final velocity
OAT	Outside air temperature	V _h	Structurally limited maximum
OAT _a	Actual outside air temperature (true)	V _j	Exhaust gas velocity in ft/sec
OAT _o	Observed outside air temperature (gage)	V _{mc}	Minimum control speed
P	Pressure, or power	V _{mea}	Air minimum control speed
P _j	Static pressure at jet nozzle in lbs/sq. ft.	V _{mcg}	Ground minimum control speed
P _{am}	Ambient pressure at jet nozzle in lbs sq. ft.	V _o	Original velocity
PD	Piston displacement	V _p	Plane velocity
PE	Potential energy	V _{pr}	Airspeed installation correction
PGW	Performance gross weight	V _r	Refusal speed
		V _{rot}	Rotation speed
		V _s	Stall speed

V_{10}	Takeoff speed
W	Work (ft-lbs), or weight
W_a	Airflow through engine in lbs/sec
W_f	Pounds of fuel (rate of flow)

TABLE OF EQUIVALENTS

1 NM	= 1.152 statute mile
1 mph	= 1.467 ft/sec
1 Knot	= 1.688 ft/sec
1" H_g	= 0.491 psi = 33.8 millibars
1 Atmosphere	= 14.7 psi = 29.92" H_g
Standard temperature	= 15° C or 59° F
Standard pressure	= 14.7 psi = 29.92" H_g
Standard gravity (g)	= 32.167 ft/sec ²
1 Horsepower	= 33,000 ft-lb/min = 550 ft-lb/sec
Pressure lapse rate	= 0.934" H_g /1000 ft. alt (approx.)
Temperature lapse rate	= -3.57° F/1000 ft. alt. (approx.)

GENERAL PHYSICS FORMULAS

Work	= Force × Distance
Power	= Work/Time
Torque	= Force × Distance (at right angles)
Force	= Mass × Acceleration
Kinetic energy	= Mass × Velocity ²

GENERAL PERFORMANCE FORMULAS

ihp	= bhp + fhp
imep (psi)	= $\frac{792,000}{\text{Displacement}} \times \frac{\text{ihp}}{\text{rpm}}$
f	= imep × A
bhp	= TOP × rpm × K
bmep	= $\frac{792,000}{\text{Displacement}} \times \frac{\text{bhp}}{\text{rpm}}$
bhp	= $\frac{\text{rpm} \times \text{Displacement} \times \text{bmep}}{792,000}$
bmep	= TOP × K × 792,000
D	= $\frac{\rho}{2} C_D AV^2$
F (against propeller)	= $\frac{\rho}{2} C_D A (2\pi r \times \text{rpm})^2 N$
shp	= rpm × T_p × K (Turboprop)
Torque	= $\frac{K \times \text{shp}}{\text{rpm}}$ (Turboprop)
T_n	= $\frac{W_a}{g} (V_j - V_i) = \frac{W_f}{g} V_j + A_j (P_j - P_{atm})$
SFC _t	= $\frac{W_f}{T_n}$ (gas turbine)
δ (Delta)	= $\frac{\text{Observed absolute pressure}}{29.92" H_g}$
θ (Theta)	= $\frac{\text{Observed Temperature (° Rankine)}}{519R}$
L	= $C_L \times S \times \frac{EAS^2}{391}$ or $\frac{EASK^2}{295}$

$$D = C_D \times S \times \frac{EAS^2}{391} \text{ or } \frac{EASK^2}{295}$$

$$TASK = NMPP \times FF$$

$$GW = D \times L/D \text{ ratio}$$

$$\text{Fuel used} = FF \times t(\text{hrs})$$

$$TAS = EAS \times \frac{1}{\sqrt{\sigma}}$$

$$TAS = TASK \times 1.152$$

$$V = 1.467 \times \text{mph}$$

$$\text{thp} = \frac{D \times TAS}{375}$$

$$R/C = \frac{\text{thp}_{ex} \times 33,000}{GW}$$

$$\text{bhp (gain)} = \frac{GW \times R/D}{33,000 \times \eta R}$$

POWER REQUIRED (mph)

$$\text{thp} = \frac{C_D \times S \times EAS^3 \times \text{smoe}}{391 \times 375 \times R}$$

$$\text{bhp}_{eng} = \frac{C_D \times S \times EAS^3 \times \text{smoe}}{391 \times 375 \times \eta R}$$

$$\text{bhp}_{odd} = \frac{\text{bhp}_{ch} \times \text{smoe}_{odd}}{\text{smoe}_{ch}}$$

$$\Delta \text{bhp} = \frac{\Delta F \times EAS^3 \times \text{smoe}}{391 \times 375 \times \eta R}$$

POWER REQUIRED (Knots)

$$\text{thp} = \frac{C_D \times S \times EASK^3 \times \text{smoe}}{295 \times 325}$$

$$\text{thp}_{eng} = \frac{C_D \times S \times EASK^3 \times \text{smoe}}{295 \times 325 \times R}$$

$$\text{bhp}_{eng} = \frac{C_D \times S \times EASK^3 \times \text{smoe}}{295 \times 325 \times \eta R}$$

$$\text{bhp}_{odd} = \frac{\text{bhp}_{ch} \times \text{smoe}_{odd}}{\text{smoe}_{ch}}$$

$$\Delta \text{bhp} = \frac{\Delta F \times EASK^3 \times \text{smoe}}{295 \times 325 \times \eta R}$$

WEIGHT AND BALANCE TERMS

Allowable Gross Weight

Allowable gross weight is the maximum gross weight with which the aircraft may take off under any given set of runway and atmospheric conditions. This weight must never exceed the published maximum allowable gross weight except in an extreme emergency. It can be less than the published maximum allowable gross weight for takeoff because of runway length, performance of engines, field elevation, climatic conditions, and fuel load.

Arm

An *arm* is the horizontal distance in inches from the reference datum line to the center of gravity (CG) of an item.

Average Arm

The *average arm* is the arm obtained by adding the weights and moments of a number of items and dividing the total moment by the total weight. The length of the average arm is the distance from the reference datum to the CG of the group of items.

Balance Station

A *balance station* is an imaginary plane vertical to the aircraft's horizontal axis. The numerical designation of each station is measured in inches from the reference datum. The reference datum is balance station 0 (zero).

Basic Index

The *basic index* is the location on the load adjuster index scale that represents the CG location of the aircraft in its basic weight condition. The basic index may be calculated by either the formula or the load adjuster method.

Basic Moment

The *basic moment* is the sum of the moments of all items making up the basic weight of the aircraft.

Basic Weight

The *basic weight* of an aircraft is the weight as it is equipped to fly, before crew, oil, fuel, and other items of variable load are added. The basic weight may vary from time to time due to equipment and structural changes. The basic weight record is kept on Chart C (DD Form 365C).

Center of Gravity

The *center of gravity* (CG) is the point about which an aircraft would balance if suspended. Its distance in inches from the reference datum is found by dividing the total moment by the total gross weight of the aircraft.

CG Limits

CG *limits* are the fixed points fore and aft, beyond which the CG should not be permitted to extend at any time during takeoff, flight, or landing. These are specified in the operating manual.

Center of Lift

The *center of lift* is the theoretical point at which the total lift of the airfoil is concentrated. It is usually equal to one-third of the mean aerodynamic chord and is located back from the leading edge of the mean aerodynamic chord. The relationship between the center of lift and the CG determines the balance of the aircraft.

Centroid

A *centroid* is the average arm or CG of a compartment, fuel tank, piece of equipment, and so forth.

Estimated Landing Gross Weight

The *estimated landing gross weight* is the weight of the aircraft minus the fuel to be used and other expendable weights.

Floor Loading

Floor loading is the weight of a load in pounds divided by the area of the floor upon which it is placed. Technical data will usually specify the floor loading limits and also the limits for various compartment loadings.

Gross Weight

The *gross weight* (GW) is the total weight of the aircraft and contents at any given time.

Jig Point

The *jig point* is a fixed point of known location in the aircraft from which measurements are made. Any convenient point may be used if its distance from the reference datum is known.

Mean Aerodynamic Chord

The *mean aerodynamic chord* (MAC) is the average chord (width) of the wing.

Moment

A *moment* is the weight of an item multiplied by its arm. The unit of measure used is the inch-pound. Moment divided by a constant is used to simplify balance calculations by reducing the number of digits. The simplified moment is obtained by dividing the true moment by 1,000 or 10,000 and rounding off the result to the nearest whole number.

Operating Weight

Operating weight is a term used for cargo aircraft which includes basic weight, crew, oil, crewman's baggage, and emergency equipment. This is the weight required to operate the aircraft before fuel and pay load are added.

Overloading

The addition of weight to an aircraft increases the hazards, because the lifting and turning forces must be increased in proportion to the increase in weight. Thus, the overloaded aircraft is less maneuverable, has a higher stalling speed, a lower ceiling, and requires a longer takeoff run.

Reference Datum

The *reference datum* (rd) of an aircraft is an imaginary plane perpendicular to the horizontal axis from which all arms are measured. It is located at or in front of the nose, so that all the dimensions will be positive values.

Structural Station

A *structural station* is a location in the aircraft, such as a bulkhead, labeled for reference on the blueprints. Structural stations may not be identical to the balance stations.

Takeoff Fuel Weight

Takeoff fuel weight is the weight of fuel aboard at the time of takeoff. This does not include that fuel used during runup and taxiing.

Takeoff Gross Weight

Takeoff gross weight is the maximum gross weight at which the aircraft is permitted to take off. It is based on structural limitations and engine takeoff power.

Tare Weight

Tare weight includes the weight of all extra items, such as jacks, blocks, and so forth, on the weighing scale platform, except the weight of the item being weighed.

Total Aircraft and Fuel Weight

Total aircraft and fuel weight is the operating weight plus takeoff fuel load and ADI fluid (if not included in basic weight).

FORMULAS

- (1) To find distance
Distance = rate of travel \times time
- (2) To find rate of travel
$$r = \frac{d}{t}$$
- (3) To find time of travel
$$t = \frac{d}{r}$$
- (4) To find lift when the measurement of travel is in nautical miles
$$L = C_L S \times \frac{EASK^2}{295}$$
- (5) To find speed
Speed = $\frac{\text{distance}}{\text{time}}$
- (6) To find time
Time = $\frac{\text{distance}}{\text{speed}}$
- (7) To find distance
Distance = speed \times time
- (8) To find nautical miles when statute miles is known
Nautical miles = statute miles \times 1.152
- (9) To determine statute miles when nautical miles is known
Statute miles = $\frac{\text{nautical miles}}{1.152}$
- (10) To find rate of fuel consumption in pounds per hour
Fuel lbs/hour = $\frac{\text{total pounds of fuel consumed}}{\text{total hours}}$
- (11) To find rate of fuel consumed in gallons per hour
Gallons/hour = $\frac{\text{total gallons of fuel consumed}}{\text{total hours}}$
- (12) To find total gallons of fuel consumed
Gallons consumed = gallons/hr \times time
- (13) To find the kinetic energy of a falling body
$$KE = \frac{W V^2}{2g}$$
- (14) To find density
$$\rho = \frac{m}{v} \left(\rho = \frac{m}{v} \right)$$
- (15) To find resultant force in solving vector problems
$$R^2 = A^2 + B^2$$
$$R = \sqrt{A^2 + B^2}$$
- (16) To find pressure
Pressure = $\frac{\text{force}}{\text{area}}$ or $P = \frac{F}{A}$
- (17) To find the rate of acceleration
Acceleration = $\frac{\text{change of motion}}{\text{unit of time}} = \frac{\text{final velocity} - \text{original velocity}}{\text{time}} = \frac{V_f - V_o}{t}$
- (18) To find acceleration if a body starts from rest
$$a = \frac{V_f}{t} \text{ or } V_f = at$$
- (19) To find the average speed of a uniformly accelerated body
$$V_{ave} = \frac{1}{2} at, \text{ or}$$
$$d = \frac{1}{2} at \times t, \text{ or } d = \frac{1}{2} at^2$$
- (20) To find distance of a free falling body near the surface of the earth:
$$d = \frac{1}{2} gt^2$$
- (21) To find momentum, multiply the mass of the body times its velocity
Momentum = mass \times velocity
- (22) To find the force required to accelerate a body of known weight to a given rate
$$\frac{F}{W} = \frac{a}{g}$$

- (23) To find the force required to accelerate a mass

$$F = ma$$

- (24) To find the mass when weight and gravity are known

$$m = \frac{W}{g}$$

- (25) To find the torque resulting from a force applied at a distance

Torque = force \times distance (lever arm)

To find the force required to exert a torque at a distance

$$\text{Force} = \frac{\text{torque}}{\text{distance}}$$

To find the distance through which a force can exert a torque

$$\text{Distance} = \frac{\text{torque}}{\text{force}}$$

- (26) To find the work which results from the application of a force through a distance

Work = force \times distance

- (27) To find the rate of doing work, defined as "power"

$$\text{Power} = \frac{\text{force} \times \text{distance}}{\text{time}}$$

Since "work" is the application of force \times distance, we can substitute to find

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

- (28) To find horsepower in terms of foot-pounds of work per second

$$\text{Horsepower} = \frac{\text{Power in foot-pounds per second}}{550}$$

$$\text{or hp} = \frac{P}{550}$$

- (29) To find starting friction when the weight of the object is known

Force = kF^1 or starting force equals the product of the coefficient of starting friction (k) and the force necessary to start the body moving slowly.

- (30) To find sliding friction, multiply the force exerted on or by the object on the surface over which it slides (N) times the coefficient of sliding friction μ (μ). On horizontal surfaces N is equal to the weight of the object in pounds.

$$F = \mu N$$

- (31) To find rolling friction,

$$F = \mu N$$

The value of μ is lesser in value than in sliding friction.

- (32) To determine pressure-density relationships if temperature remains constant.

$$\frac{\rho_1}{\rho_2} = \frac{P_1}{P_2}$$

- (33) To determine the density of a gas with variations in absolute temperature, if pressure remains constant.

$$\frac{\rho_1}{\rho_2} = \frac{T_2}{T_1}$$

- (34) To determine all combinations of temperature, pressure, and density of gases when initial conditions are known.

$$\frac{\rho_1 T_1}{P_1} = \frac{\rho_2 T_2}{P_2}$$

- (35) To determine Fahrenheit when Celsius is known

$$F = 1.8C + 32 \text{ or } F = 9/5C + 32$$

- (36) To determine Celsius when Fahrenheit is known

$$C = \frac{F - 32}{1.8} \text{ or } C = 5/9 (F - 32)$$

- (37) To determine the amount of aerodynamic lift force that an airfoil can derive from an airstream, determine the kinetic energy in the airstream.

$$\text{Kinetic energy} = \frac{\text{mass} \times \text{velocity}^2}{2}$$

- (38) To determine the velocity required to maintain the same kinetic energy with changes in density altitude.

$$\text{Velocity} = \sqrt{\frac{\text{KE} \times 2}{\text{Mass}}}$$

- (39) To determine true airspeed (TAS) after substituting (in the formula for Velocity) TAS for velocity, equivalent airspeed (EAS) for kinetic energy, and by introducing the σ factor to simplify airspeed calculations when density altitude is known.

$$\text{TAS} = \text{EAS} \times \frac{1}{\sqrt{\sigma}}$$

- (40) To determine equivalent airspeed (EAS) when true airspeed (TAS) and density altitude are known.

$$\text{EAS} = \frac{\text{TAS}}{\sqrt{\sigma}}$$

- (41) To determine torque in pound-inches when horsepower and rpm are known

$$\text{Torque} = \text{horsepower} \times \frac{63,024}{\text{rpm}}$$

- (42) To determine the total piston displacement of a reciprocating engine when cylinder diameter (D), stroke in inches (S) and number of cylinders (C) are known:

$$\text{Piston Displacement} = .7854D^2 \times S \times C$$

- (43) To determine the efficiency of a reciprocating engine from its relationships of indicated mean effective pressure (imep), the pressure

that produces friction horsepower (fmep), and the brake mean effective pressure applied to the propeller shaft (BMEP)

$$\text{imep} - \text{fmep} = \text{bmep}$$

- (44) To determine indicated horsepower.

$$\text{ihp} = \frac{\text{imep} \times \text{piston displacement} \times \text{rpm}}{792,000}$$

- (45) To determine friction horsepower.

$$\text{fhp} = \text{ihp} - \text{bhp}$$

- (46) To determine brake horsepower of a reciprocating engine when torque oil pressure (TOP), rpm, and the engine constant (K) is known

$$\text{bhp} = \text{TOP (psi)} \times \text{rpm} \times \text{K}$$

- (47) To determine thermal efficiency of a reciprocating engine

Thermal efficiency =

$$\frac{\text{Horsepower} \times 33,000 \text{ ft lbs/min}}{\text{fuel wt-min} \times 20,000 \text{ BTU} \times 778 \text{ ft lbs work}}$$

- (48) To determine mechanical efficiency of a reciprocating engine

$$\text{Mechanical efficiency} = \frac{\text{brake horsepower}}{\text{indicated horsepower}}$$

- (49) To determine volumetric efficiency, with volume of charge corrected to standard sea-level pressure and temperature

$$\text{Volumetric efficiency} = \frac{\text{volume of charge}}{\text{piston displacement}}$$

- (50) To determine thrust in terms of force of action

$$\text{Force of action} = \frac{\text{weight}}{\text{gravity (32.16)}}$$

- (51) To determine reaction (gross thrust) which does not reflect forward speed, with "a" representing acceleration

$$\text{Gross thrust} = \frac{W}{g} \times a$$

- (52) To determine velocity change of a jet engine aircraft caused by the engine

$$\text{Velocity change} = \text{velocity of jet nozzle minus the velocity of the aircraft}$$

or

$$V_c = V_j - V_p$$

- (53) To determine net thrust

$$\text{Net thrust} = \frac{W}{g} (V_j - V_p)$$

- (54) To determine thrust horsepower

$$\text{thp} = \frac{\text{net thrust} \times V_p}{550}$$

- (55) To determine thermal efficiency in the gas turbine engine

$$\text{Thermal efficiency} = \frac{\text{force} \times \text{velocity}}{\text{fuel flow} \times \text{heating value}}$$

- (56) To determine shaft horsepower of a gas turbine engine where T_s is in inch-pounds

$$\text{shp} = \frac{T_s \times \text{rpm}}{63,025}$$

- (57) To determine moment in weight and balance problems

$$\text{Moment} = \text{weight} \times \text{arm}$$

or

$$M = W \times A$$

- (58) To determine arm in weight and balance problems

$$\text{Arm} = \frac{\text{moment}}{\text{weight}} \text{ or } A = \frac{M}{W}$$

- (59) To determine weight in weight and balance problems

$$\text{Weight} = \frac{\text{Moment}}{\text{Arm}} \text{ or } W = \frac{M}{A}$$

- (60) To determine center of gravity along the longitudinal axis of the aircraft

$$\text{CG} = \frac{\text{basic moment} - \text{additional moment}}{\text{aircraft basic weight} - \text{additional weight}}$$

- (61) To determine moment in inch-pounds

$$\text{Moment (in-lb)} = \text{weight (lb)} \times \text{arm (in)}$$

- (62) To determine the distance from the reference datum (rd) line, otherwise known as the average arm, and the center of gravity

$$\text{Distance from rd to CG} = \frac{\text{total moment}}{\text{total weight}}$$

- (63) To determine new center of gravity after weight has been added

$$\text{New CG} = \frac{\text{original moment} + \text{added moment}}{\text{original weight} + \text{added weight}}$$

- (64) To determine new center of gravity after weight has been removed

$$\text{New CG} = \frac{\text{original moment} - \text{moment removed}}{\text{original weight} - \text{weight removed}}$$

- (65) To determine new center of gravity after weight has shifted or has been shifted

$$\text{New CG} = \frac{\text{original moment} \pm \text{moment change}}{\text{original weight}}$$

- (66) To determine center of gravity change

$$\text{CG change} = \frac{\text{change in moment}}{\text{total weight}}$$

- (67) To determine average chord length (MAC)

$$\text{Average chord length} = \frac{\text{sum of chord lengths in wing}}{\text{total number of chord lengths}}$$

- (68) To determine the drag of an aircraft in flight at a specified equivalent airspeed

$$D = C_D S \frac{(EASK)^2}{295} \text{ wherein}$$

C_D is coefficient of drag, S is square feet of wing area and 295 is the dynamic pressure constant number when problem involves knots.

- (69) To determine propeller efficiency (η , the Greek letter, eta) as reflected in the relationship between brake horsepower and thrust horsepower

$$\eta = \frac{\text{thp}}{\text{bhp}}$$

- (70) To determine required thrust horsepower

$$\text{thp} = \frac{D \times \text{TASK}^2}{325}$$

- (71) To determine the total brake horsepower required for any condition.

$$\text{bhp} = \frac{C_{D,S} \times \text{EASK}^3 \times \frac{1}{\sqrt{\sigma}}}{95,875 \eta}$$

- (72) To determine the brake horsepower in terms of the output of one engine where R is the number of engines on the aircraft.

$$\text{bhp/eng} = \frac{C_{D,S} \times \text{EASK}^3 \times \frac{1}{\sqrt{\sigma}}}{95,875 \eta \times R}$$

- (73) To determine the power which is in excess of the power required

$$P_{ex} = P_a - P_r$$

- (74) To determine the brake horsepower per engine required to overcome the drag introduced by flight configurations which differ from that used for long range airspeeds

$$\Delta F \text{ bhp/eng} = \frac{\Delta F \times \text{EASK}^3 \times \frac{1}{\sqrt{\sigma}}}{325 \times 295 \times R \times \eta}$$

- (75) To determine the effect of wind on nautical miles per pound of fuel for a given airspeed

$$\text{Ground NMPP} = \text{air NMPP} \times \frac{V - V_w}{V}$$

- (76) To determine elapsed time in descent

$$\text{Time (minutes)} = \frac{\text{change in altitude (feet)}}{\text{rate of descent (feet/min)}}$$

- (77) To determine the gain in thrust horsepower resulting from descent

$$\text{thp gain} = \frac{\text{gross weight} \times \text{rate of descent}}{33,000}$$

- (78) To determine the reduction in brake horsepower per engine in descent to maintain the airspeed

$$\text{bhp gain/engine} = \frac{\text{gross weight} \times \text{rate of descent}}{33,000 R \eta}$$

where R = number of engines and
 η = propeller efficiency

- (79) To determine a ratio of braking speed to touchdown speed

Touchdown speed	100%
Braking speed	X%

- (80) To determine the reserve of fuel required to overcome headwinds during the specified distances in which the headwinds prevail

$$\text{Wind reserve} = \frac{V \text{ of HW}_k}{(\text{Avg TASK}) - (V \text{ of HW}_k)} \times \text{pounds of fuel (no wind)}$$

ATTACHMENT 2

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