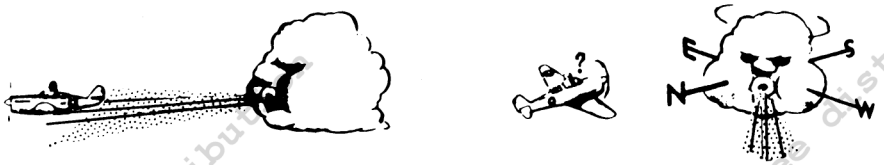
Department of Transportation

FEDERAL AVIATION ADMINISTRATION

VFR PILOT EXAM-O-GRAM* NO. 27

THE EFFECT OF WIND ON AN AIRPLANE



While acquiring aeronautical knowledge, we sometimes neglect, or do not thoroughly understand some of the fundamental principles involved in flying an airplane. One of the basic facts of flight which is involved in the safety of almost every flight, and yet in FAA Airman Written Examinations seems to be one of the least understood is THE RELATIONSHIP BETWEEN THE AIRPLANE AND THE AIR SURROUNDING IT.

DOES WIND AFFECT THE AIRPLANE'S AIRSPEED? With the possible exception of wind shear, severe gusts, sudden lulls, etc., NO. Remember, the airspeed is the speed at which the airplane is traveling through the air. Even though the air mass might also be moving (wind), the relationship of the airplane's movement to the mass of air remains unchanged. This may be explained by assuming a person is walking forward at 5 mph inside a railroad train which is traveling 60 mph. Regardless of the train's speed, the person is walking 5 mph in relation to the train. If the person turns around and walks toward the rear of the train, or if the train slows to a stop, he is still walking 5 mph in relation to the train. Similarly, the direction and speed of the movement of the air mass (wind) through which the airplane flies, has no effect on its speed through the air (airspeed). It follows then that stalling speed is also unaffected by a steady normal wind (Exam-O-Gram #17).

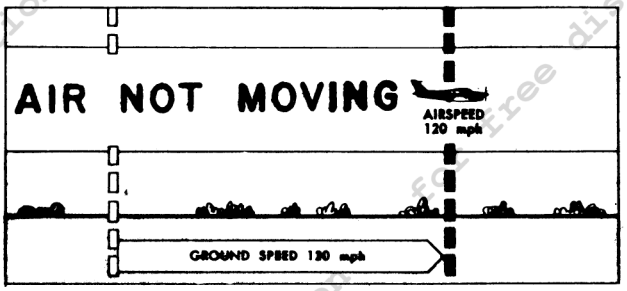


Figure 1

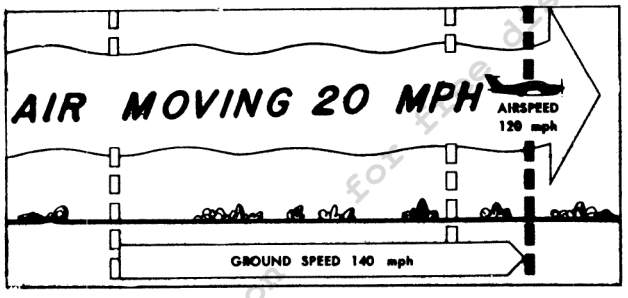


Figure 2

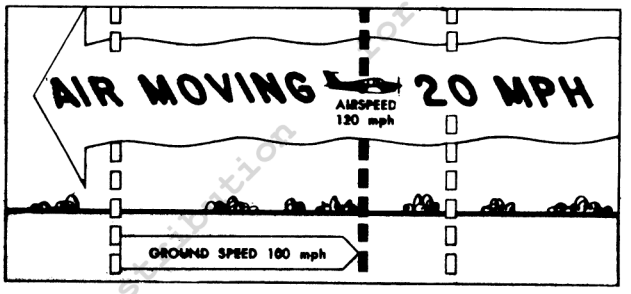


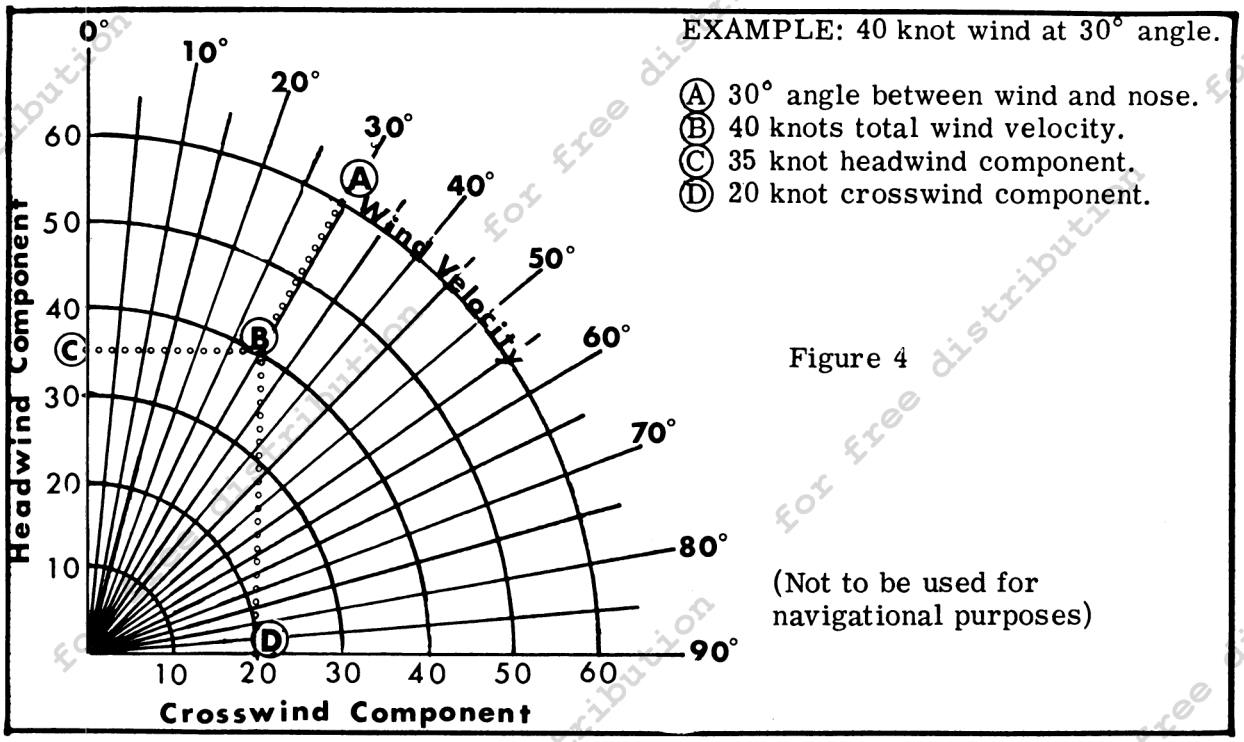
Figure 3

*Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

Rev. 1/74

DOES WIND AFFECT THE AIRPLANE'S GROUNDSPEED? Definitely yes! Again consider the case of a person walking inside a railroad train. Since the train is moving 60 mph in relation to the ground and the person is walking forward 5 mph in relation to the train, he is actually traveling 65 mph in relation to the ground (groundspeed). Conversely, if he walks toward the rear of the train at a rate of 5 mph and the train is moving 60 mph, he is actually traveling at a rate of 55 mph in relation to the ground. Similarly, an airplane flying at an airspeed of 120 mph with a tailwind of 20 mph is traveling at a groundspeed of 140 mph (Figure 2). After turning around so the wind is now a headwind of 20 mph, the airplane would be traveling 100 mph in relation to the ground, or with a 40 mph reduction in groundspeed (Figure 3). Since groundspeed is not a factor in stalling speed, the airplane is no closer to a stall flying into the wind than flying with the wind.

IS THE GROUNDSPEED CHANGED BY AN AMOUNT EQUAL TO THE WINDSPEED? Not always! The groundspeed is increased or decreased by the full amount of the windspeed only when a direct headwind or direct tailwind exists. As the angle between the nose of the airplane and the wind direction increases (up to approximately 90° on either side) the headwind component decreases, resulting in a gradual reduction in the effect of wind on the airplane's groundspeed (see Figure 4). As the angle increases from approximately a 90° crosswind to 180°, the tailwind component increases with a corresponding increase in groundspeed.



EXAMPLE: 40 knot wind at 30° angle.

(A) 30° angle between wind and nose.
(B) 40 knots total wind velocity.
(C) 35 knot headwind component.
(D) 20 knot crosswind component.

Figure 4

(Not to be used for navigational purposes)

CAN A ROUND-TRIP FLIGHT WITH WIND CONDITIONS BE MADE IN THE SAME TIME AS ONE WITH NO WIND? No! It would seem that a headwind one way and a tailwind the other way would average the same as making the round-trip under no wind conditions, but it will not. The airplane flies longer in the headwind condition than it does in the tailwind condition and therefore the total time increases.

	20 mph Wind	No Wind
True Airspeed (TAS)	100 mph	100 mph
Flight Out 200 Miles	120 mph GS = 1 hr. 40 min.	100 mph GS = 2 hrs.
Flight Back 200 Miles	80 mph GS = 2 hr. 30 min.	100 mph GS = 2 hrs.
Total Time	4 hr. 10 min.	4 hrs.
Average GS	96 mph	100 mph

DOES AN AIRPLANE IN FLIGHT TRAVEL IN THE DIRECTION IT IS HEADED? Not always! The airplane moves forward because of engine thrust pulling in the direction it is headed. However, if the mass of air surrounding the airplane is also moving (wind) the airplane, in addition to its forward movement, is carried in the same direction and at the same speed as the air mass. Thus, we have two directional forces acting on the airplane--the thrust component and the wind component. If the thrust is moving the airplane forward toward the east and the wind is moving it sideward toward the south, then the resultant path over the ground will be east-southeasterly. (See Figure 5.) This sideward movement of the airplane caused by the wind is called "drift."

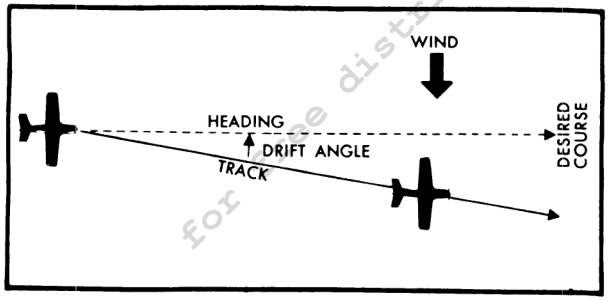


Figure 5

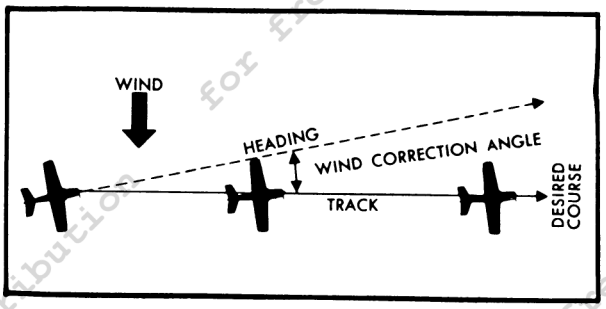
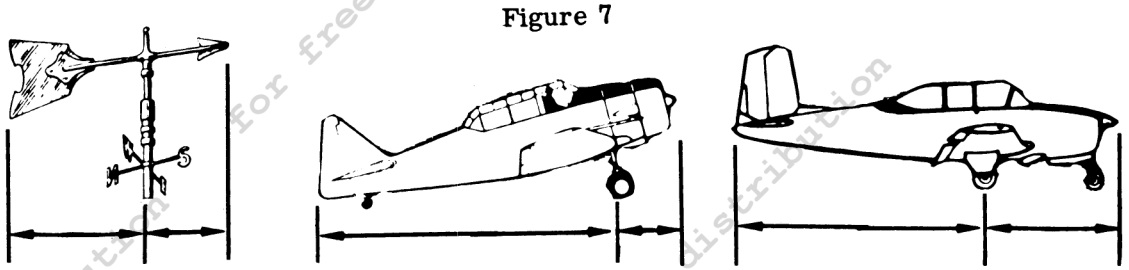


Figure 6

HOW CAN WE COMPENSATE FOR DRIFT IN ORDER TO MAKE GOOD A DESIRED COURSE OVER THE GROUND? We must head the airplane into the wind at an angle at which the direction of the thrust component will compensate for the wind component. This correction angle or "crab" should be sufficient to make the resultant path over the ground (ground track) coincide with the desired course over the ground. (See Figure 6.) The necessary heading can be determined by trial and error, or by wind triangle computations based on true airspeed, true course, and wind direction and speed.

DOES WIND AFFECT AN AIRPLANE ON THE GROUND THE SAME AS IN THE AIR? In certain respects, no! In addition to being moved forward through the air by its own power, an airplane in flight is carried in the same direction and at the same speed as the movement of the air mass surrounding it. Since it is free to move with the air mass, the airplane in flight does not "feel" this movement of the mass of air (except when wind-shear, or sudden lulls or gusts are encountered). Therefore, after the proper correction for drift is established, control pressure need not be maintained for directional control. However, during ground operation, the friction of the airplane's wheels in contact with the ground resists drifting, creating a pivot point at the main wheels. Since a greater portion of the airplane's surface is presented to the crosswind aft of the wheels than is presented forward of the wheels, the airplane tends to "weathervane" or turn into any crosswind. In this case corrective control pressures must be applied and maintained for directional control on the ground. This weathervaning occurs even in tricycle (nose wheel) gear airplanes, unless the wheels are located well aft in relation to the side surface of the airplane.

Figure 7



WHAT EFFECT DO CROSSWINDS HAVE ON TAKEOFF AND LANDING? While the airplane is free of the ground, the wind has the same effect as explained in preceding paragraphs for an airplane in flight. However, on takeoff and landings, an airplane should never be allowed to contact the ground while drifting or while headed in a direction other than that in which it is moving over the ground. Unless proper action is taken to prevent this from occurring, severe side stresses will be imposed on the landing gear, and a sudden swerve or ground loop may occur. When this develops, we have an almost uncontrollable situation and consequently, a serious accident potential.

CAN TAKEOFFS AND LANDINGS BE SAFELY MADE IN ALL CROSSWIND CONDITIONS? Not always! Takeoffs and landings in certain crosswind conditions are inadvisable or even dangerous. If the crosswind is great enough to warrant an extreme drift correction, a hazardous landing condition may result. Therefore, always consider the takeoff or landing capabilities with respect to the reported surface wind conditions and the available landing directions. The absence of proper crosswind techniques, or the disregard for adequate consideration of the airplane's characteristics and capabilities with respect to crosswind conditions, are reflected by the continual rise in accidents involving ground control.

WHAT IS THE MAXIMUM SAFE CROSSWIND CONDITION? Before an airplane is type certificated by the FAA, it must be flight tested to meet certain requirements. Among these is the demonstration of being satisfactorily controllable with no exceptional degree of skill or alertness on the part of the pilot in 90° crosswinds up to a velocity equal to 0.2 V_{SO}. This means a windspeed of two-tenths of the airplane's stalling speed with power off and gear and flaps down. (If the stalling speed is 60 MPH, then the airplane must be capable of being landed in a 12 MPH 90° crosswind.) To inform the pilot of the airplane's capability, Regulations require that the demonstrated crosswind velocity be made available. Certain Airplane Owner's Manuals provide a chart for determining the maximum safe wind velocities for various degrees of crosswind for that particular airplane.

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