Engine Operation

From hot- and cold-start procedures to power settings, leaning, and temperature management, aircraft engine operation can be surprisingly complicated. Test your knowledge with this safety quiz.

1. Operating “over-square” in cruise flight (i.e., with a manifold pressure higher than engine rpm in hundreds) can harm the engine, and should be avoided.

   False

   Despite assertions to the contrary, in modern engines there’s no particular risk involved in running “over-square” (for example, with more than 25 inches of manifold pressure at 2,500 rpm). Of course, there are limits. Excessively high manifold pressures and/or abrupt power changes coupled with low engine speeds can cause damage; but so long as a given power setting is allowed by the POH, it should be fine.

2. Which of the following actions can help prevent fouling of spark plugs? (Select all that apply)

   - Leaning the mixture on the ground
   - Avoiding prolonged idling below 1,000 rpm
   - Swapping top and bottom spark plugs periodically
   - Leaning the mixture in flight
   - Increasing engine speed just prior to shutdown

   All the items listed help prevent lead fouling of spark plugs, which is generally a result of low engine operating temperatures and overly rich mixtures. Leaning the mixture on the ground (and in flight) helps considerably, as does avoiding prolonged idling below 1,000 rpm. Bottom spark plugs are more prone to fouling than top plugs, hence the recommendation to swap them at maintenance intervals. Lastly, running the engine briefly to 1500-1700 rpm, then reducing it to 1,000 rpm before shutting down with the mixture, will also help.

3. While taxiing on grass at a fly-in, your nosewheel drops into a shallow hole and the propeller briefly strikes soft mud and grass. The engine slows momentarily but doesn’t stop. Upon inspection, the prop appears undamaged. You should:

   Consult a mechanic: The engine, prop, and accessories could all be damaged

   Most pilots know that sudden engine stoppage is a bad thing—but what many don’t realize is that a drop in rpm (due to the prop hitting something soft) can also cause significant damage. Engines aren’t designed to tolerate forces applied in this way: Internal parts can be overstressed, and attached accessories (such as vacuum pumps) have delicate parts that can be damaged. Likewise, a propeller that looks fine to the naked eye may still have sustained internal damage. Recommendations vary—Lycoming, for example, suggests an engine tear-down after
any such incident—but whatever the situation you should always consult a mechanic before further operation.

4. Which of the following steps will help extend the service life of a piston aircraft engine? (Select all that apply)

   Flying frequently
   “Avoiding rapid throttle movements
   Preheating in cold weather

Preheating the engine in cold weather, using smooth, gradual throttle inputs, and flying frequently are all good ways to maximize the life of an engine. The other items listed may sound reasonable, but they can lead to problems. “Babying” the engine during break-in can interfere with the cylinder wear-in process and lead to excessive oil consumption, among other things. Partial-power takeoffs won’t do anything to extend engine life, but they can have safety consequences. Finally, when it comes to cylinder head temperatures, lower isn’t always better: Lean properly, and use power settings that keep temps in the normal range.

5. The FBO mistakenly fuels your turbine-powered TBM-850 with avgas, rather than Jet A. Not realizing this, you climb aboard and prepare to start the engine. What’s the most likely result?

   The engine will perform normally

Unlike gasoline engines, which can be damaged or destroyed by jet fuel, most turbine engines can be safely operated on avgas (within the limitations specified by the POH). In the situation described, it’s doubtful that the pilot would notice any difference in engine operation. Turbine or not, though, it’s always a good idea to sump the tanks after refueling.

6. It’s 90 degrees F, and you’re preparing to take off from Tucumcari, New Mexico (4,051 msl). Assuming you’re flying behind a non-turbocharged engine with a fixed-pitch propeller, you should:

   Lean for maximum rpm at full-throttle

Consult your POH for specific guidance, but for non-turbocharged engines it’s generally recommended to lean the mixture for any takeoff at or above 5,000 feet density altitude. With a fixed-pitch propeller, the correct procedure is to run the engine up to full power, then lean the mixture until maximum rpm is achieved.

7. On most single-engine piston airplanes with constant speed propellers, a total loss of oil pressure will cause the propeller to:

   Go to high rpm
The constant speed propellers on most single-engine airplanes are held at coarse pitch (low rpm) by oil pressure. Thus, if the engine loses oil pressure, the propeller will automatically go to high rpm.

8. You’re flying an airplane with a constant speed propeller. During cruise flight, you decide to climb to smoother air several thousand feet above. In which order should you perform the following actions? (Drag the items into the proper order)

1. Mixture - enrich
2. Propeller - increase rpm
3. Throttle - increase manifold pressure

Assuming that the engine has already been leaned for cruise, it’s best to begin a significant power increase by richening the mixture somewhat. After that, bring the propeller to the desired climb rpm, and then increase the manifold pressure. For a power decrease the opposite is true: Reduce manifold pressure first, then adjust the propeller.

9. Which of the following actions could help prevent damage to your engine from shock cooling?

- Richen the mixture gradually during descents
- Avoid descents faster than roughly 1,000 fpm
- Maintain at least 15" manifold pressure (or low-cruise RPM)
- Keep cowl flaps closed during descent
- Install winterization kits for cold weather ops

Shock cooling is typically more of a problem on high performance engines, but all of the items above are good general operating procedures for piston-engine aircraft. The main thing is to avoid rapid descents (particularly at low power settings), but it’s also wise to richen the mixture gradually, make sure cowl flaps are closed, and install winterization kits for cold weather ops.

10. Just for fun: Aircraft piston engine types are commonly referred to by an alphabetic prefix, followed by displacement in cubic inches. Match the engines below with the aircraft they powered.

IO-360  (Cessna 337)
R-3350  (Lockheed L-1049)
R-4360  (Boeing 377)
GO-300  (Cessna 175)
LO-360  (Piper Seminole)

A pair of six-cylinder Continental IO-360s pulled/pushed the Cessna 337. The 18-cylinder Wright R-3350 powered the Lockheed L-1049 Super Constellation, while the larger 28-cylinder Pratt & Whitney R-4360 pulled the Boeing 377 Stratocruiser. The six-cylinder, geared GO-300 was used on the Cessna 175. The LO-360, which turns counter-clockwise when viewed from the cockpit, was used on the right wing of the Piper Seminole (a regular O-360 went on the left).