76. (a) It is clear from the problem that $\vec{v}_{\text{air,plane}} = -180\,\hat{\text{i}}$ m/s where $+\hat{\text{i}}$ is the plane's direction of motion (relative to the ground).

(b) Let ΔM_a be the mass of air taken in and ejected and let ΔM_f be the mass of fuel ejected in time Δt. From the viewpoint of ground-based observers, the initial velocity of the air is zero and its final velocity is $v - u$, where u is the exhaust speed (labeled v_{rel} in the textbook) and v is the velocity of the plane. The initial velocity of the fuel is v and its final velocity is $v - u$. The velocity of the plane changes from v to $v + \Delta v$ over this time interval. The change in the total momentum of the plane-fuel-air system is $\Delta P = M_p \Delta v + \Delta M_f(u) + \Delta M_a(u - v)$ so the net external force is

$$\frac{\Delta P}{\Delta t} = M_p \frac{\Delta v}{\Delta t} - u \frac{\Delta M_f}{\Delta t} + (v - u)\frac{\Delta M_a}{\Delta t} \ .$$

We examine some of these terms individually. The $v\,\Delta M_a/\Delta t$ term gives the magnitude of the force on the plane due to air intake (most easily seen from the point of view of observers on the plane) and is equal to $(180)(70) = 1.3 \times 10^4$ N.

(c) We interpret the question as asking for the force due to ejection of both the air and the combustion products due to consuming the fuel. This corresponds then to the $u\,\Delta M_a/\Delta t$ and $u\,\Delta M_f/\Delta t$ terms above, and is equal to $(490)(70 + 2.9) = 3.6 \times 10^4$ N.

(d) We require $\Delta P/\Delta t = 0$ since this (the air, plane and fuel) forms an isolated system (Eq. 9-29). Therefore, our equation above leads to

$$M_p \frac{\Delta v}{\Delta t} = u \frac{\Delta M_f}{\Delta t} + (u - v)\frac{\Delta M_a}{\Delta t}$$

with all the terms on the right hand side constituting the net thrust (compare Eq. 9-42). These are the values (with appropriate signs) found in parts (b) and (c), so we obtain $3.6 \times 10^4 - 1.3 \times 10^4 = 2.3 \times 10^4$ N.

(e) Using Eq. 7-48, we multiply the net thrust by the plane speed and obtain $\left(2.3 \times 10^4\right)(180) = 4.2 \times 10^6$ W.