36.2 A normal shock wave in air has a Mach number of 3. The pressure upstream is $1atm$, what is the pressure downsteam?

A. 2 psi

B. 10 psi

C. 60 psi

D. 150 psi

There are two possible approaches for this problem, the first using the Normal Shock Relationships table and the second using equations relating downstream flow conditions to upstream flow conditions for a normal shock wave. In both cases, the subscript 1 is used to represent the upstream conditions and the subscript 2 is used to represent the downstream conditions.

Using the table, for $M_1 = 3$, find the corresponding pressure ratio.

$$\frac{P_2}{P_1} = 10.3333$$

Since the upstream pressure is known, substitute for P_1 and convert from atm to psi.

$$P_2 = 10.3333\,(P_1) = 10.3333\,(1atm)\left(\frac{14.7psi}{atm}\right) = 152psi$$

Alternatively, since the table values have been generated for convenience, it is also valid to use the underlying formulas to solve for the pressure ratio. The ratio of specific heats, k, is assumed to be 1.4.

$$\frac{P_2}{P_1} = \left(\frac{1}{k+1}\right)\left[2kM_1^2 - (k-1)\right]$$

$$\frac{P_2}{P_1} = \left(\frac{1}{1.4+1}\right)\left[2\,(1.4)\,(3)^{\,2} - (1.4-1)\right] = 10.3333$$

The rest of the solution follows from the first approach.

Answer D