




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670	12-9E Steam flows through a device with a stagnation pressure of 120 psia, a stagnation temperature of 700°F, and a velocity of 900 ft/s. Assuming ideal-gas behavior, determine the static pressure and temperature of the steam at this state.	12-9 Steam flows through a device with a stagnation pressure of 820kPa, a stagnation temperature of 370°F, and a velocity of 270m/s. Assuming ideal-gas behavior, determine the static pressure and temperature of the steam at this state.
670	12-24E Steam flows through a device with a pressure of 120 psia, a temperature of 700°F, and a velocity of 900 ft/s. Determine the Mach number of the steam at this state by assuming ideal-gas behavior with $k = 1.3$ . <i>Answer: 0.441</i>	12-24 Steam flows through a device with a pressure of 820kPa, a temperature of 370°C, and velocity of 270m/s. Determine the Mach number of the steam at this state by assuming ideal-gas behavior with $k = 1.3$ .
670	12-25E  Reconsider Prob. 12-24E. Using EES (or other) software, compare the Mach number of steam flow over the temperature range 350 to 700°F. Plot the Mach number as a function of temperature.	12-25 Reconsider Prob. 12-24. Using EES (or other) software, compare the Mach number of steam flow over the temperature range 175°C to 370°C. Plot the Mach number as a function of temperature.
670	12-29E Air expands isentropically from 170 psia and 200°F to 60 psia. Calculate the ratio of the initial to final speed of sound. <i>Answer: 1.16</i>	12-29 Air expands isentropically from 1150kPa and 93°C to 410kPa. Calculate the ratio of the initial to final speed of sound.
671	12-43E Air at 30 psia, 212°F, and Mach number $Ma = 0.8$ flows through a duct. Calculate the velocity and the stagnation pressure, temperature, and density of air. <i>Answers: 1016 ft/s, 758 R, 45.7 psia, 0.163 lbm/ft<sup>3</sup></i>	12-43 Air at 200kPa, 100°C, and Mach number $Ma = 0.8$ flows through a duct. Calculate the velocity and the stagnation pressure, temperature, and density of air.
671	12-60E Air enters a nozzle at 30 psia, 630 R, and a velocity of 450 ft/s. Assuming isentropic flow, determine the pressure	Air enters a nozzle at 200kPa, 350K, and a velocity of 135 m/s. Assuming isentropic flow, determine the pressure
672	and temperature of air at a location where the air velocity equals the speed of sound. What is the ratio of the area at this location to the entrance area? <i>Answers: 539 K, 17.4 psia, 0.574</i>	and temperature of air at a location where the air velocity equals the speed of sound. What is the ratio of the area at this location to the entrance area?

672	<p><b>12-67E</b> Air enters a converging–diverging nozzle of a supersonic wind tunnel at 150 psia and 100°F with a low velocity. The flow area of the test section is equal to the exit area of the nozzle, which is 5 ft<sup>2</sup>. Calculate the pressure, temperature, velocity, and mass flow rate in the test section for a Mach number <math>Ma = 2</math>. Explain why the air must be very dry for this application. <i>Answers: 19.1 psia, 311 R, 1729 ft/s, 1435 lbm/s</i></p>	<p><b>12-67</b> Air enters a converging–diverging nozzle of a supersonic wind tunnel at 1000kPa and 38°C with a low velocity. The flow area of the test section is equal to the exit area of the nozzle, which is 0.45m<sup>2</sup>. Calculate the pressure, temperature, velocity, and mass flow rate in the test section for a Mach number <math>Ma = 2</math>. Explain why the air must be very dry for this application.</p>
672	<p><b>12-84E</b>  Air flowing steadily in a nozzle experiences a normal shock at a Mach number of <math>Ma = 2.5</math>. If the pressure and temperature of air are 10.0 psia and 440.5 R, respectively, upstream of the shock, calculate the pressure, temperature, velocity, Mach number, and stagnation pressure downstream of the shock. Compare these results to those for helium undergoing a normal shock under the same conditions.</p>	<p><b>12-84</b> Air flowing steadily in a nozzle experiences a normal shock at a Mach number of <math>Ma = 2.5</math>. If the pressure and temperature of air are 68kPa and 244.7K, respectively, upstream of the shock, calculate the pressure, temperature, velocity, Mach number, and stagnation pressure downstream of the shock. Compare these results to those for helium undergoing a normal shock under the same conditions.</p>
673	<p><b>12-85E</b>  Reconsider Prob. 12-84E. Using EES (or other) software, study the effects of both air and helium flowing steadily in a nozzle when there is a normal shock at a Mach number in the range <math>2 &lt; Ma_1 &lt; 3.5</math>. In addition to the required information, calculate the entropy change of the air and helium across the normal shock. Tabulate the results in a parametric table.</p>	<p><b>12-85</b> Reconsider Prob. 12-84. Using EES (or other) software, study the effects of both air and helium flowing steadily in a nozzle when there is a normal shock at a Mach number in the range <math>2 &lt; Ma_1 &lt; 3.5</math>. In addition to the required information, calculate the entropy change of the air and helium across the normal shock. Tabulate the results in a parametric table.</p>
673	<p><b>12-93E</b> Air at 8 psia, 20°F, and a Mach number of 2.0 is forced to turn upward by a ramp that makes an 8° angle off</p>	<p><b>12-93</b> Air at 55kPa, -6.7°C, and a Mach number of 2.0 is forced to turn upward by a ramp that makes an 8° angle off</p>

673	<b>12-95E</b> Air flowing at $P_1 = 6$ psia, $T_1 = 480$ R, and $Ma_1 = 2.0$ is forced to undergo a compression turn of $15^\circ$ . Determine the Mach number, pressure, and temperature of air after the compression.	<b>12-95</b> Air flowing at $P_1 = 40$ kPa, $T_1 = 266.67$ K, and $Ma_1 = 2.0$ is forced to undergo a compression turn of $15^\circ$ . Determine the Mach number, pressure, and temperature of air after the compression.
674	<b>12-106E</b> Air flows with negligible friction through a 4-in-diameter duct at a rate of 5 lbm/s. The temperature and pressure at the inlet are $T_1 = 800$ R and $P_1 = 30$ psia, and the Mach number at the exit is $Ma_2 = 1$ . Determine the rate of heat transfer and the pressure drop for this section of the duct.	<b>12-106</b> Air flows with negligible friction through a 10cm diameter duct at a rate of 2.25 kg/s. The temperature and pressure at the inlet are $T_1 = 444.44$ K and $P_1 = 200$ kPa, and the Mach number at the exit is $Ma_2 = 1$ . Determine the rate of heat transfer and the pressure drop for this section of the duct.
674	<b>12-108E</b> Air is heated as it flows through a 4 in $\times$ 4 in square duct with negligible friction. At the inlet, air is at $T_1 = 700$ R, $P_1 = 80$ psia, and $V_1 = 260$ ft/s. Determine the rate at which heat must be transferred to the air to choke the flow at the duct exit, and the entropy change of air during this process.	<b>12-108</b> Air is heated as it flows through a 10cm x 10cm square duct with negligible friction. At the inlet, air is at $T_1 = 388.89$ K, $P_1 = 550$ kPa, and $V_1 = 80$ m/s. Determine the rate at which heat must be transferred to the air to choke the flow at the duct exit, and the entropy change of air during this process.
675	<b>12-126E</b> Helium gas with $k = 1.667$ enters a 6-in-diameter duct at $Ma_1 = 0.2$ , $P_1 = 60$ psia, and $T_1 = 600$ R. For an average friction factor of 0.025, determine the maximum duct length that will not cause the mass flow rate of helium to be reduced. <i>Answer: 291 ft</i>	<b>12-126</b> Helium gas with $k = 1.667$ enters a 15cm-diameter duct at $Ma_1 = 0.2$ , $P_1 = 400$ kPa, and $T_1 = 333.33$ K. For an average friction factor of 0.025, determine the maximum duct length that will not cause the mass flow rate of helium to be reduced.
675	<b>12-128E</b> Air flows through a 6-in-diameter, 50-ft-long adiabatic duct with inlet conditions of $V_1 = 500$ ft/s, $T_{01} = 650$ R, and $P_1 = 50$ psia. For an average friction factor of 0.02, determine the velocity, temperature, and pressure at the exit of the duct.	<b>12-128</b> Air flows through a 15cm-diameter, 15-m-long adiabatic duct with inlet conditions of $V_1 = 150$ m/s, $T_{01} = 361.11$ K, and $P_1 = 340$ kPa. For an average friction factor of 0.02, determine the velocity, temperature, and pressure at the exit of the duct.

676	<p><b>12-149E</b> Helium expands in a nozzle from 150 psia, 900 R, and negligible velocity to 15 psia. Calculate the throat and exit areas for a mass flow rate of 0.2 lbm/s, assuming the nozzle is isentropic. Why must this nozzle be converging-diverging?</p>	<p><b>12-149</b> Helium expands in a nozzle from 1000 kPa, 500K, and negligible velocity to 100 kPa. Calculate the throat and exit areas for a mass flow rate of 0.09 kg/s, assuming the nozzle is isentropic. Why must this nozzle be converging-diverging?</p>