

Problem 2.91

[Difficulty: 3]

2.91 An airliner is cruising at an altitude of 5.5 km with a speed of 700 km/hr. As the airliner increases its altitude, it adjusts its speed so that the Mach number remains constant. Provide a sketch of speed vs. altitude. What is the speed of the airliner at an altitude of 8 km?

Given: Data on airliner

Find: Sketch of speed versus altitude ($M = \text{const}$)

Solution:

Data on temperature versus height can be obtained from Table A.3

At 5.5 km the temperature is approximately 252 K

The speed of sound is obtained from $c = \sqrt{k \cdot R \cdot T}$

where $k = 1.4$
 $R = 286.9 \text{ J/kg}\cdot\text{K}$ (Table A.6)
 $c = 318 \text{ m/s}$

We also have

$$V = 700 \text{ km/hr}$$

or $V = 194 \text{ m/s}$

Hence $M = V/c$ or

$$M = 0.611$$

To compute V for constant M , we use $V = M \cdot c = 0.611 \cdot c$

At a height of 8 km: $V = 677 \text{ km/hr}$

NOTE: Realistically, the airplane will fly to a maximum height of about 10 km!

z (km)	T (K)	c (m/s)	V (km/hr)
4	262	325	713
5	259	322	709
5	256	320	704
6	249	316	695
7	243	312	686
8	236	308	677
9	230	304	668
10	223	299	658
11	217	295	649
12	217	295	649
13	217	295	649
14	217	295	649
15	217	295	649
16	217	295	649
17	217	295	649
18	217	295	649
19	217	295	649
20	217	295	649
22	219	296	651
24	221	298	654
26	223	299	657
28	225	300	660
30	227	302	663
40	250	317	697
50	271	330	725
60	256	321	705
70	220	297	653
80	181	269	592
90	181	269	592

