

2. (a) The speed parameter  $\beta$  is  $v/c$ . Thus,

$$\beta = \frac{(3 \text{ cm/y})(0.01 \text{ m/cm})(1 \text{ y}/3.15 \times 10^7 \text{ s})}{3.0 \times 10^8 \text{ m/s}} = 3 \times 10^{-18} .$$

- (b) For the highway speed limit, we find

$$\beta = \frac{(90 \text{ km/h})(1000 \text{ m/km})(1 \text{ h}/3600 \text{ s})}{3.0 \times 10^8 \text{ m/s}} = 8.3 \times 10^{-8} .$$

- (c) Mach 2.5 corresponds to

$$\beta = \frac{(1200 \text{ km/h})(1000 \text{ m/km})(1 \text{ h}/3600 \text{ s})}{3.0 \times 10^8 \text{ m/s}} = 1.1 \times 10^{-6} .$$

- (d) We refer to Table 14-2:

$$\beta = \frac{(11.2 \text{ km/s})(1000 \text{ m/km})}{3.0 \times 10^8 \text{ m/s}} = 3.7 \times 10^{-5} .$$

- (e) For the quasar recession speed, we obtain

$$\beta = \frac{(3.0 \times 10^4 \text{ km/s})(1000 \text{ m/km})}{3.0 \times 10^8 \text{ m/s}} = 0.10 .$$