Highway Capacity

1. A traffic stream is carrying 4500 veh/hr in three lanes in one direction. What is the average headway per lane?

2. With the 4500 veh/hr in three lanes;
   a. What is the density per lane if the operating speed is 60 mi/hr?
   b. What is the spacing between vehicles in each lane for these conditions?

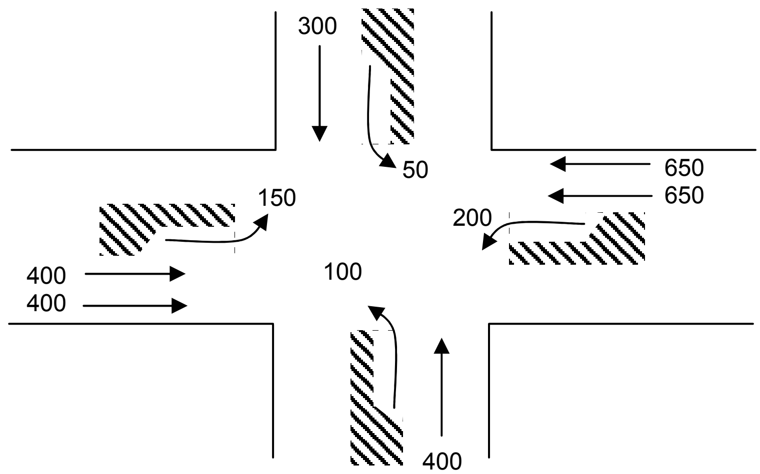
3. What is the capacity of a 4-lane freeway in one direction if the density at capacity is 45 veh/mi/lane, and the speed at capacity is 53 mi/hr?

4. A multi-lane highway is operating in a high mountain valley on a typical grade of about 1%, or grades representing level terrain conditions. It is carrying 10% trucks. The passenger car equivalent is 1.5 for level terrain, and 2.5 for rolling terrain and 4.0 for mountainous terrain. What is the heavy vehicle factor, f_{HV}, for this location?

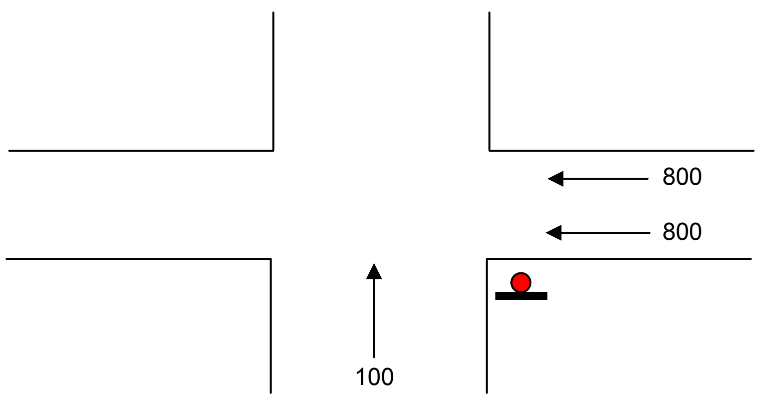
5. For a 6-lane freeway the operating speed is 57 mph and the demand volume is 4800 vph with a peak hour factor of 0.9. Assuming this is for the peak period on a commuter route when no trucks are present, what is the level of service based on the following criteria?

Level of Service	Density, $\frac{\text{pass. cars}}{\text{mile / lane}}$
A	10
B	18
C	25
D	35
E	≤45
F	>45

6. For the intersection shown below;
   a. What is the sum of the critical movements?
   b. Are those volumes likely to exceed the capacity of a signalized intersection?



7. A stop controlled intersection of one way streets carries 800 veh/hr/lane in 2-lanes on the major street and has a demand to cross the major street from the stop-controlled minor street of 100 vehicles. Assuming a critical gap of 6 seconds for entering vehicles, is it likely that the 100 vehicles could cross?



1. A traffic stream is carrying 4500 veh/hr in three lanes in one direction. What is the average headway per lane?

$$h = \frac{3600 \text{ sec/hr}}{\text{volume/lane}}$$

$$h = \frac{3600 \text{ sec/hr}}{4500 \text{ vph/3 lanes}}$$

h = 2.4 sec/veh

2. With the 4500 veh/hr in three lanes;

a. Density (veh/mi) = $\frac{\text{volume (veh/hr)}}{\text{speed (mi/hr)}}$

Density (veh/mi/ln) = $\frac{[4500/3]\text{vph/ln}}{60\ (\text{mi/hr})}$

Density = 25 veh/mi/ln

b. Spacing (ft/veh) = $\frac{5280\ (\text{ft/mi})}{\text{Density (veh/mi)}}$

Spacing (ft/veh) = $\frac{5280\ (\text{ft/mi})}{25\ (\text{veh/mi})}$

Spacing (ft/veh) = 211 ft/ veh

3. What is the capacity of a 4-lane freeway in one direction if the density at capacity is 45 veh/mi/lane, and the speed at capacity is 53 mi/hr?

Volume (veh/hr) = speed (mi/hr) x density (veh/hr)

Volume $\left(\frac{\text{veh/hr}}{\text{lane}}\right)$ = 53 mph x 45 vpm/ln

Volume $\left(\frac{\text{vph}}{\text{lane}}\right)$ = 2385 vph/ln

Capacity = 2385 vph/ln x 3 ln = 4770 vph

4. A multi-lane highway is operating in a high mountain valley on a typical grade of about 1%, or grades representing level terrain conditions. It is carrying 10% trucks. The passenger car equivalent is 1.5 for level terrain, and 2.5 for rolling terrain and 4.0 for mountainous terrain. What is the heavy vehicle factor, f_{HV}, for this location?

$$f_{HV} = \frac{\text{mixed vehicles}}{\text{equivalent passenger cars}}$$

$$f_{HV} = \frac{100\%}{P_{PC} + P_T E_T + P_{RV} E_{RV}}$$

where

P_{PC} = % passenger cars, trucks, RVs

E_T, E_{RV} = passenger car equivalent for trucks, RVs

$$f_{HV} = \frac{100\%}{90\% + (10\%)\,1.5} = \underline{\underline{0.95}}$$

ALTERNATIVE METHOD:

$$f_{HV} = \frac{1}{1 + P_T\ (E_T - 1) + P_{RV}\ (E_{RV} - 1)}$$

where P_T, P_{RV} = decimal % trucks, RVs

$$f_{HV} = \frac{1}{1 + 0.10\ \ (1.5 - 1)} = \underline{\underline{0.95}}$$

5. For a 6-lane freeway the operating speed is 57 mph and the demand volume is 4800 vph with a peak hour factor of 0.9. Assuming this is for the peak period on a commuter route when no trucks are present, what is the level of service based on the following criteria?

Level of Service		Density, $\frac{\text{pass. cars}}{\text{mile/lane}}$
A		10
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$$v_p = \frac{\text{demand volume}}{\text{PHF x N x } f_{HV} \text{ x } f_p}$$

Note:

f_{HV} = 1 since there are no trucks

f_P = 1 for commuter traffic

$$V_P = \frac{4800 \text{ vph}}{0.9 \text{ x } 3 \text{ x } 1 \text{ x } 1} = 1778 \frac{\text{Pass Cars}}{\text{Hr}}$$ per lane as peak 15 min. flow

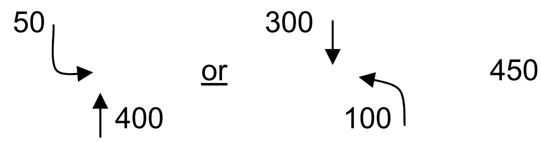
$$\text{Density } \frac{PC}{Mi} = \frac{\text{Volume}\left(\frac{PC}{Hr}\right)}{\text{Speed}\left(\frac{Mi}{Hr}\right)}$$

$$\text{Density } \frac{PC}{Mi} = \frac{1778 \text{ PCPH}}{57 \text{ mph}} = 31.2 \, {}^{PC}\!/_{MI}$$

since $31.2 \le 35$ PC/Mi $\therefore$ LOS "D"

6. For the intersection shown below;
   a. Critical movements

N – S



E – W

Σ critical movements = 1250 vph

b. Capacity of intersection

Rule of thumb: Capacity = 1450 veh/hr

1250 vph ≤ 1450 vph ∴ under capacity

7. A stop controlled intersection of one way streets carries 800 veh/hr/lane in 2-lanes on the major street and has a demand to cross the major street from the stop-controlled minor street of 100 vehicles. Assuming a critical gap of 6 seconds for entering vehicles, is it likely that the 100 vehicles could cross?

$$P_R\left(h \geq t_c\right) = e^{-qt}$$

where

$\left(h \geq t_c\right)$ = probability of headway ≥ critical gap

q = flow rate, veh/sec

t = critical gap, sec

$$q = \frac{Veh/Hr}{3600\ {}^{sec}\!/_{hr}}$$

q = 0.444 veh/sec

$$P_R\left(h \geq t_c\right) = e^{-qt}$$

$$= e^{-0.444(6)} = 0.0695$$

= 111 gaps > 100 veh

Yes, gaps exceed number of vehicles