4 components to consider in design of transportation systems:
  driver
  vehicle
  road
  pedestrian

Characteristics of drivers:
  Vision is the most important.

Perception/Reaction Time → the time required to perceive and react to a stimulus
  Perception- perceiving the presence of a stimulus in the field of vision
  Identification- driver identifies and understands the stimulus
  Emotion- driver decides how to react to the stimulus
  Volition- driver executes the decision

For design, a PIEV time of 2.5 seconds is used for stopping sight distance (AASHTO design value).
It is important to design according to driver expectations.

Example:
A driver with perception/reaction time of 2.5 seconds is driving at 55 mph when he observes an accident has blocked the road. How far would the vehicle travel, in feet, before being able to apply the brakes?
Characteristics of pedestrians:
Walking characteristics are very important. Typical rates 3.0-8.0 ft/sec
For design, a walk rate of 4 ft/sec is used.

Characteristics of vehicles:
For geometric design of highways, three types of characteristics are considered:
Static-
Kinematic-
Dynamic-

Figure 2.1 Forces acting on a road vehicle. (From your Mannering textbook).
Power Requirements:
\[
P = \frac{R \times v}{550}
\]

where:
\(P\) = horsepower delivered
\(R\) = sum of resistance to motion (lb)
\(v\) = speed (ft/sec) **notice units

Braking distance: (does not include PIEV time)

Theoretical: \[
S = \frac{\gamma \left( V_1^2 - V_2^2 \right)}{2g(\eta \mu + f \pm \sin \theta)}
\]

Practical: \[
S = \frac{V_1^2 - V_2^2}{30(\frac{a}{32.2} \pm G)}
\]

Where:
\(V_1\) = initial velocity (in mph)
\(V_2\) = final velocity (in mph)
\(a\) = 11.2 ft/s\(^2\) or 3.4 m/s\(^2\)
\(G\) = percent grade divided by 100
\(S\) = distance in feet

Stopping Sight Distance:
\[
SSD = \frac{V_1^2}{30(\frac{a}{32.2} \pm G)} + 1.47PIEV \times V_1
\]

where:
\(PIEV\) = perception/reaction time (seconds)
\(V_1\) = initial velocity (mph)
\(SSD\) = stopping sight distance in feet

*Pay attention to units!!!
Examples – Driver and Vehicle Characteristics  
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1. A motorist is traveling at 55 mph down a 5% grade when he observes an accident ahead. If the motorist was able to stop his vehicle 30 ft from the overturned truck, what distance away from the truck was he when he first observed the accident? Assume PIEV = 2.5 sec.

2. How much farther does it take a car traveling 45 mph on a 4% downgrade to stop on poor, wet pavement than on poor, dry pavement? Assume anti-lock system does not fail, and braking efficiency is 90%.

3. A driver traveling 55 mph in an unfamiliar area rounds a curve whereupon he sees a 25 mph speed zone sign. He is 300 feet from the sign when it comes into view, and he tries to decelerate as fast as he thinks is safely possible ($a=16.1$ ft/sec$^2$). Assuming level terrain and a perception/reaction time of 2.0 seconds, what is his speed when he reaches the sign?

4. A car is traveling at 75 mi/hr down a 3% grade on poor, wet pavement. The car’s braking efficiency is 90%. The brakes were applied 300 ft before impacting an object. The car had an antilock braking system, but the system failed 200 ft after the brakes had been applied (wheels locked). What speed was the car traveling at just before it impacted the object? (Assume theoretical stopping distance, ignore air resistance, and let $f_r = 0.015$.) (This is 2.23 in your textbook.)

5. A driver is traveling 55 mi/hr on a wet road. An object is spotted on the road 450 ft ahead and the driver is able to come to a stop just before hitting the object. Assuming standard perception/reaction time and practical stopping distance, determine the grade of the road.