2. We define the direction of motion of the car as the $+x$ direction. The velocity of the car is a constant $\vec{v} = +(80)(1000/3600) = +22$ m/s, and the radius of the wheel is $r = 0.66/2 = 0.33$ m.

   (a) In the car's reference frame (where the lady perceives herself to be at rest) the road is moving towards the rear at $\vec{v}_{\text{road}} = -v = -22$ m/s, and the motion of the tire is purely rotational. In this frame, the center of the tire is "fixed" so $v_{\text{center}} = 0$.

   (b) This frame of reference is not accelerating, so "fixed" points within it have zero acceleration; thus, $a_{\text{center}} = 0$.

   (c) Since the tire's motion is only rotational (not translational) in this frame, Eq. 11-18 gives $\vec{v}_{\text{top}} = +v = +22$ m/s.

   (d) Not only is the motion purely rotational in this frame, but we also have $\omega =$ constant, which means the only acceleration for points on the rim is radial (centripetal). Therefore, the magnitude of the acceleration is

   $$a_{\text{top}} = \frac{v^2}{r} = \frac{22^2}{0.33} = 1.5 \times 10^3 \text{ m/s}^2 \ .$$

   (e) The bottom-most point of the tire is (momentarily) in firm contact with the road (not skidding) and has the same velocity as the road: $\vec{v}_{\text{bottom}} = -22$ m/s. This also follows from Eq. 11-18.

   (f) The magnitude of the acceleration is the same as in part (d): $a_{\text{bottom}} = 1.5 \times 10^3 \text{ m/s}^2$.

   (g) Now we examine the situation in the road's frame of reference (where the road is "fixed" and it is the car that appears to be moving). The center of the tire undergoes purely translational motion while points at the rim undergo a combination of translational and rotational motions. The velocity of the center of the tire is $\vec{v} = +v = +22$ m/s.

   (h) The translational motion of the center is constant; it does not accelerate.

   (i) In part (c), we found $\vec{v}_{\text{top,car}} = +v$ and we use Eq. 4-39:

   $$\begin{aligned} \vec{v}_{\text{top,ground}} &= \vec{v}_{\text{top,car}} + \vec{v}_{\text{car,ground}} \\ &= v + v \end{aligned}$$

   which yields $2v = +44$ m/s. This is consistent with Fig. 12-3(c).

   (j) Since we are transforming between constant-velocity frames of reference, the accelerations are unaffected. The answer is as it was in part (d): $1.5 \times 10^3 \text{ m/s}^2$.

   (k) We can proceed as in part (i) or simply recall that the bottom-most point is in firm contact with the (zero-velocity) road. Either way – the answer is zero.

   (l) As explained in part (j), $a = 1.5 \times 10^3 \text{ m/s}^2$.