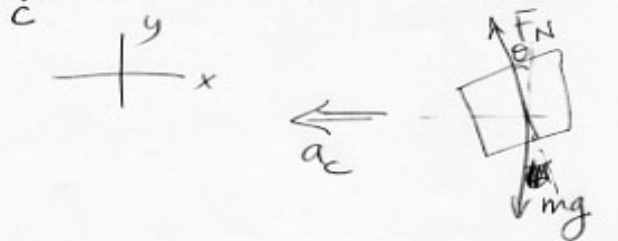9. [pts] A jeep is traveling around a banked circular curve of radius R = 140 m with the center of the circle at C. The road is covered rain (i.e. frictionless), and the jeep (m = 1500 kg traveling with a constant speed v = 19.5 m/s shows the front of the jeep coming tow.

(a) Draw the free-body diagram.

(b) Determine the minimum angle θ at which the road must be banked in order that the jeep not slide off the road.

$$\sum F_x = ma_x \qquad\qquad \sum F_y = ma_y$$

$$F_N \sin\theta = \frac{mv^2}{R} \quad ① \qquad\qquad F_N\cos\theta - mg\cos\theta = 0$$

$$F_N \cos\theta = mg \quad ②$$

divide ① by ②

$$\tan\theta = \frac{F_N\sin\theta}{F_N\cos\theta} = \frac{\frac{mv^2}{R}}{mg} = \frac{v^2}{Rg} = \frac{(19.5\frac{m}{s})^2}{140m(9.8\frac{m}{s^2})} = 0.277$$
$$\rightarrow \theta = 15.5°$$

(c) As the jeep is rounding the curve, it travels 110 m. What is the work done by the normal force as it travels that distance?

$$0 \qquad\qquad \vec{F_N} \perp \vec{v} \quad \text{so no motion parallel to force}$$

(d) After rounding the curve, the jeep travels along a straight stretch of road and accelerates from its original speed to 28.0 m/s in 30.0 sec. Calculate the work done by the engine during this acceleration. Ignore air resistance.

$$K_i + W_{eng} = K_f$$
$$W_{eng} = K_f - K_i = \frac{1}{2}m(v_f^2 - v_i^2) = \frac{1}{2}(1500\,kg)\left[(28\tfrac{m}{s})^2 - (19.5\tfrac{m}{s})^2\right]$$
$$= 3.03 \times 10^5\,J$$