Answer on Question #58068-Physics-Mechanics-Relativity

A track consists of two circular parts ABC and CDE of equal radius 100 m and joined smoothly as shown in figure (7-E1). Each part subtends a right angle at its centre. A cycle weighing 100 kg together with the rider travels at a constant speed of 18 km/h on the track.

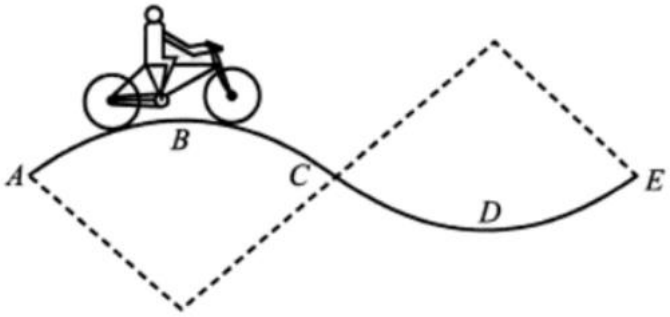
(a) Find the normal contact force by the road on the cycle when it is at B and at D.

(b) Find the force of friction exerted by the track on the tyres when the cycle is at B, C and D.

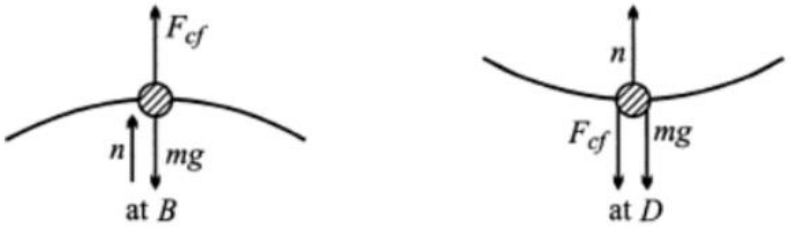
(c) Find the normal force between the road and the cycle just before and just after the cycle crosses C.

(d) What should be the minimum friction coefficient between the road and the tyre, which will ensure that the cyclist can move with constant speed? Take g= 10 m/s^2

Solution



(a) Force diagrams at B and D are shown below.



For B:

$$v = 18\frac{km}{h} = 5\frac{m}{s}.$$

$$F_{cf} = \frac{mv^2}{R}.$$

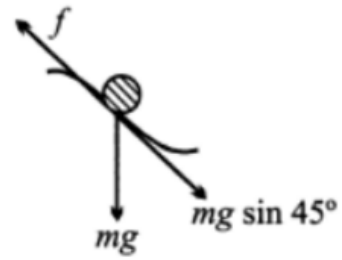
$$n = mg - F_{cf} = 100 \cdot 10 - 100 \cdot \frac{5^2}{100} = 975\ N$$

For D:

$$n = mg + F_{cf} = 100 \cdot 10 + 100 \cdot \frac{5^2}{100} = 1025\ N$$

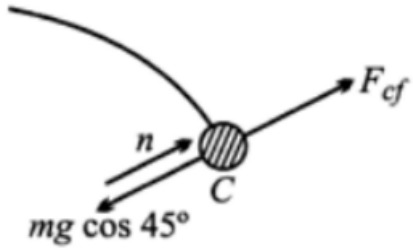
(b) At B and D; no friction acts. Because there is no additional tangential force acting on the bicycle.

At C, A component of mg acts along the track. This component is counterbalanced by friction. Thus,



$$f = mg \sin 45 = 100 \cdot 10 \cdot \sin 45 = 707\ N.$$

(c) Force on bicycle just before C is shown in figure.



$$n + F_{cf} = mg \cos\theta$$

$$n = mg \cos\theta - F_{cf} = 100 \cdot 10 \cdot \cos 45 - 100 \cdot \frac{5^2}{100} = 682\ N$$

Similarly it can be shown

$$n_D = mg \cos\theta + F_{cf} = 100 \cdot 10 \cdot \cos 45 + 100 \cdot \frac{5^2}{100} = 732\ N$$

(d) The minimum frictional force is

$$\mu n_{min} = \mu \cdot 682$$

This force must balance the tangential component of force.

$$\mu \cdot 682 = 702 \rightarrow \mu = 1.037$$