ENGINEERING MECHANICS - STATICS

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FRICTION

Session- 3

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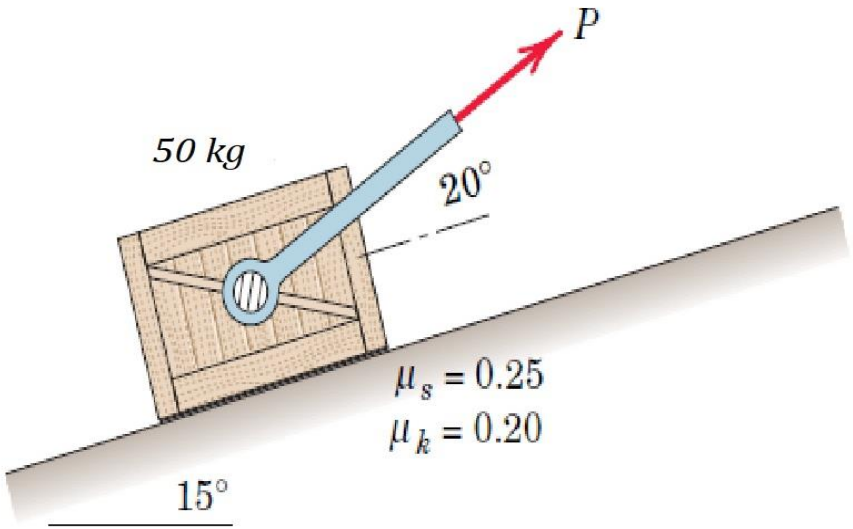
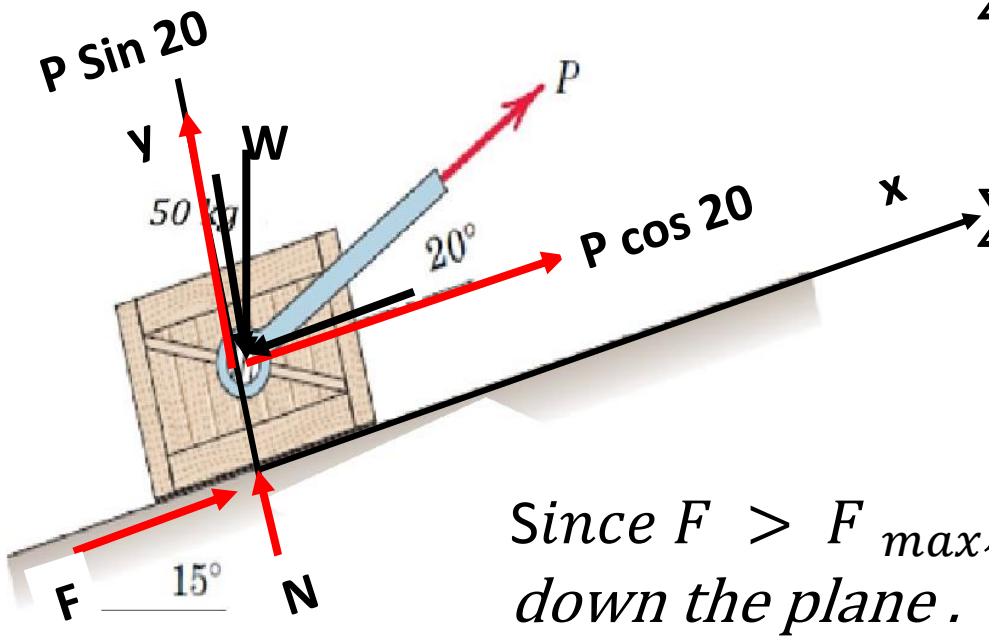
Friction- Numerical

Problem 6/3: The force *P* is applied to the 50-kg block when it is at rest. Determine the magnitude and direction of the friction force exerted by the surface on the block if (*a*) *P* = 0, (*b*) *P* = 200 N, and (*c*) *P = 250 N*. (*d*) What value of *P* is required to initiate motion up the incline? The coefficients of static and kinetic friction between the block and the incline are $\mu_s = 0.25$ and $\mu_K = 0.20$, respectively.



Problem 6/3:Solution (a) when P=0



$$\sum F_y = 0 \qquad -(50 \times 9.81)\cos(15) + N = 0$$

$$N = 473.78\ N$$

$$\sum F_x = 0 \qquad -(50 \times 9.81)\sin(15) + F = 0$$

$$F = 126.95\ N$$

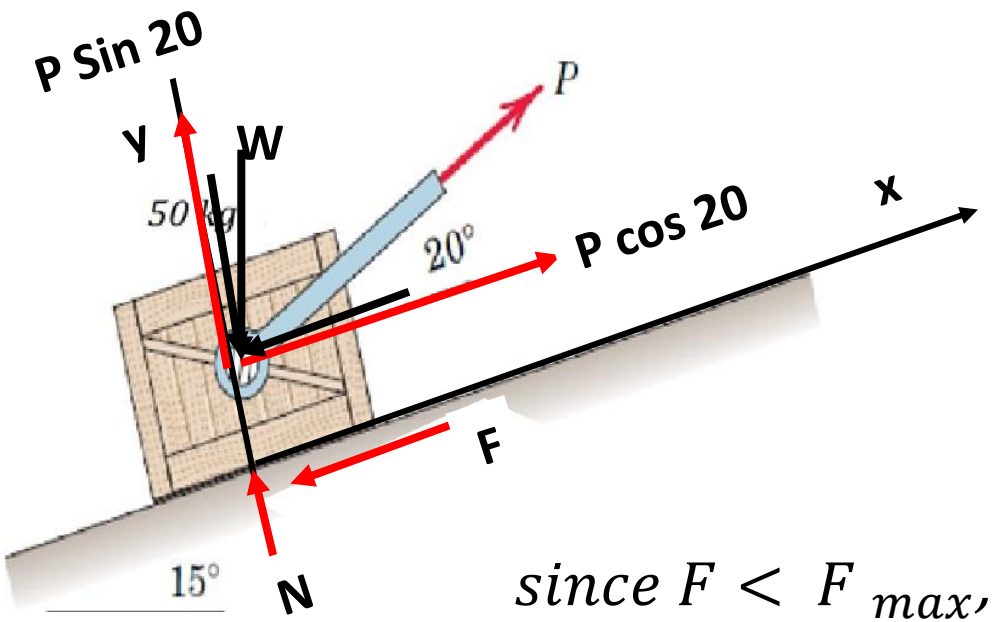
$$F_{max} = \mu_s N = 0.25\ N = 118.44\ N$$

Since $F > F_{max}$, clearly the condition is impossible , the motion occurs down the plane .

The frictional force $F = \mu_k N = 0.2(473.78)$

$F = 94.75\ N$ *up the plane*

Problem 6/3:Solution (b) when P=200 N



$$\sum F_y = 0 \quad -(50 \times 9.81)\cos(15) + N + P\sin(20) = 0$$

$$N = 542.2\ N$$

$$\sum F_x = 0 \quad -(50 \times 9.81)\sin(15) - F + P\cos(20) = 0$$

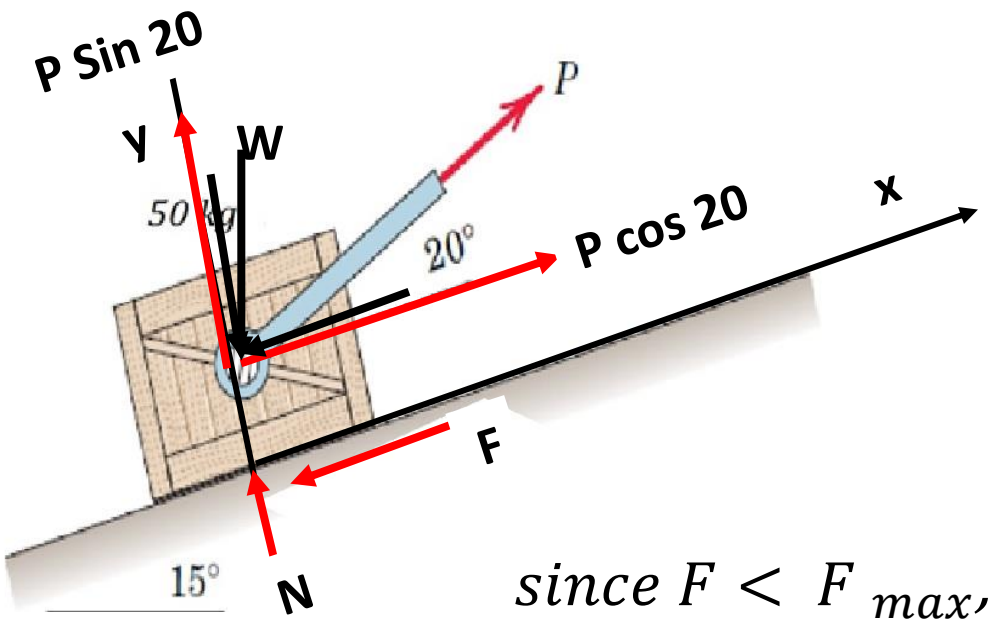
$$F = 60.99\ N$$

$$WKT, F_{max} = \mu_s N = 0.25\ N = 135.55\ N$$

since $F < F_{max}$, *body is under rest.*

$$\boldsymbol{F = 60.99\ N\ down\ the\ plane}$$

Problem 6/3:Solution (C) when P=250 N



$$\sum F_y = 0 \quad -(50 \times 9.81)\cos(15) + N + P\sin(20) = 0$$

$$N = 559.3\ N$$

$$\sum F_x = 0 \quad -(50 \times 9.81)\sin(15) - F + P\cos(20) = 0$$

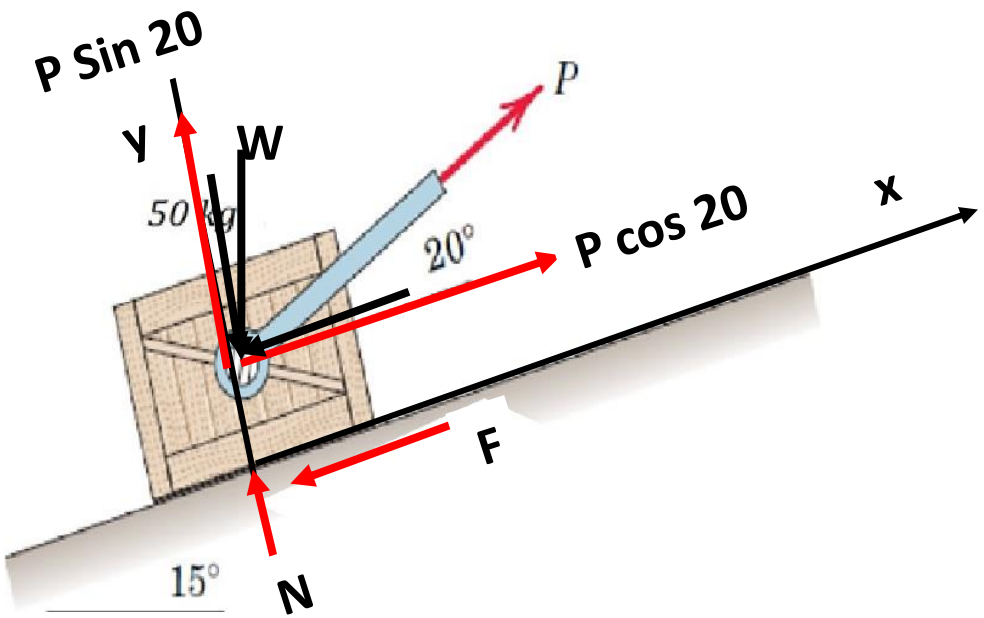
$$F = 107.97\ N$$

$$WKT, F_{max} = \mu_s N = 0.25\ N = 135.55\ N$$

since $F < F_{max}$, *body is under rest.*

$$\boldsymbol{F = 107.95\ N\ down\ the\ plane}$$

Problem 6/3:Solution (d) when P=? Motion up the incline



$$\sum F_y = 0 \; -(50 \times 9.81)\cos(15) + N + P\sin(20) = 0$$

$$N + 0.342P - 473.78 = 0 \; -- -(1)$$

$$\sum F_x = 0 \; -(50 \times 9.81)\sin(15) - F + P\cos(20) = 0$$

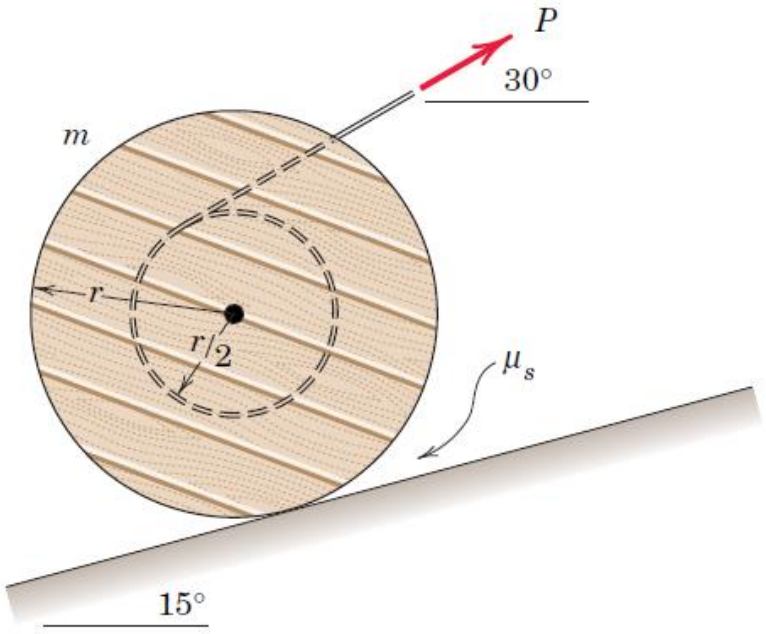
$$-0.2\,N + 0.94P - 126.95 = 0 \; -- -(2)$$

from $equation$ 1 & 2

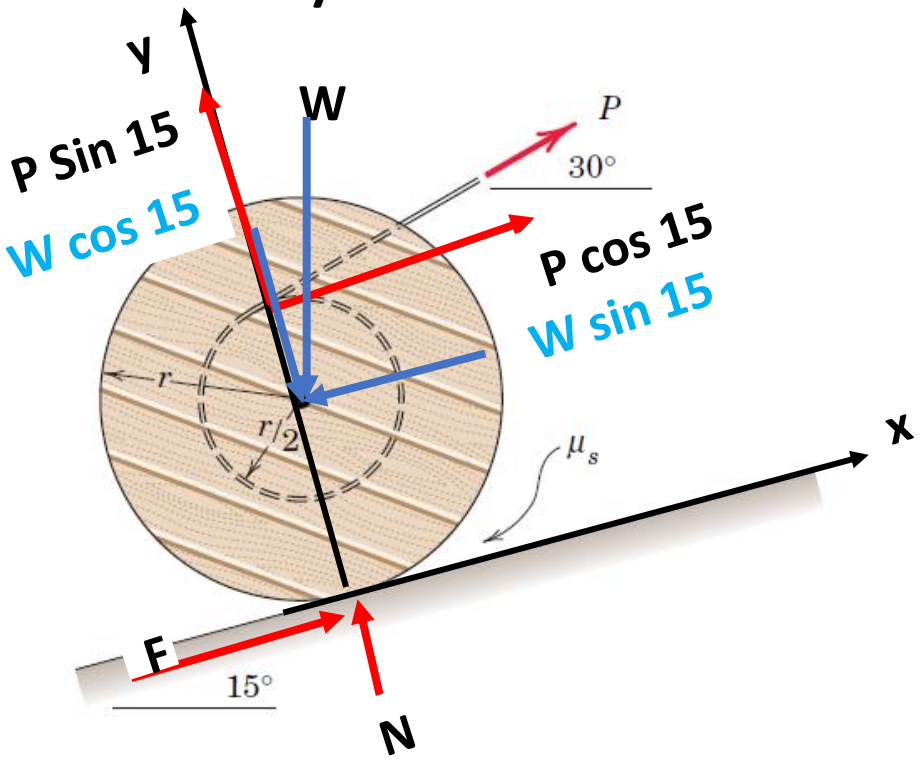
$$\boldsymbol{P = 239.3\ N}$$

Friction- Numerical

- Problem 6/6: Determine the minimum coefficient of static friction μ_s which will allow the drum with fixed inner hub to be rolled up the 15° incline at a steady speed without slipping. What are the corresponding values of the force *P* and the friction force *F*?



Problem 6/6: Solution



Applying the conditions of equilibrium

$$\sum M_o = 0 \qquad +F(r) - P\cos(15)\left(\frac{r}{2}\right) = 0$$

$$\mathrm{F} = 0.483\,P$$

$$\sum F_x = 0 \qquad +F - W\sin(15) + P\cos(15) = 0$$

$$\mathrm{P} = 0.1786\,mg$$

$$\sum F_y = 0 \qquad -\mathrm{W}\cos(15) + N + P\sin(15) = 0$$

$$N = 0.919\,mg$$

$$\boldsymbol{\mu_s = \frac{F}{N} = 0.094}$$

THANK YOU

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