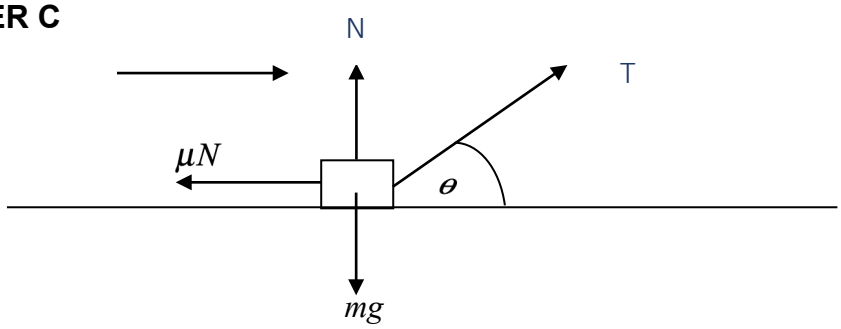
Question 46

A box of mass 10 kg is on a horizontal plane. A rope makes an angle of θ^0 with the horizontal and exerts a tension of 30 newtons. If the coefficient of friction between the block and the surface is 0.2, which one of the following values of θ produces the largest acceleration of the block?

A. $\theta = 0$
B. $\theta = 5$
C. $\theta = 10$
D. $\theta = 15$
E. $\theta = 20$

ANSWER C



resolving parallel to the plane (1) $T\cos(\theta) - \mu N = ma$

resolving perpendicular to the plane (2) $T\sin(\theta) + N - mg = 0$

to find *a* we need to eliminate *N*

from (2) $N = mg - T\sin(\theta)$ substituting into (1) gives

$$T\cos(\theta) - \mu\left(mg - T\sin(\theta)\right) = ma$$

$$ma = T\cos(\theta) - \mu mg + \mu T\sin(\theta)$$

$$ma = T\left(\cos(\theta) + \mu\sin(\theta)\right) - \mu mg$$

$$a = \frac{T}{m}\left[\cos(\theta) + \mu\sin(\theta)\right] - \mu g$$

now when $T = 30\,N$ $m = 10\,\text{kg}$ $\mu = 0.2$ $g = 9{,}8$ $a = ?$

$a = 3\left[\cos(\theta) + 0.2\sin(\theta)\right] - 1.96$, checking each alternative

A. $\theta = 0 \quad \Rightarrow a = 1.04\,\text{m/s}^2$

B. $\theta = 5 \quad \Rightarrow a = 1.08\,\text{m/s}^2$

C. $\theta = 10 \quad \Rightarrow a = 1.1\,\text{m/s}^2$

D. $\theta = 15 \quad \Rightarrow a = 1.09\,\text{m/s}^2$

E. $\theta = 20 \quad \Rightarrow a = 1.06\,\text{m/s}^2$

