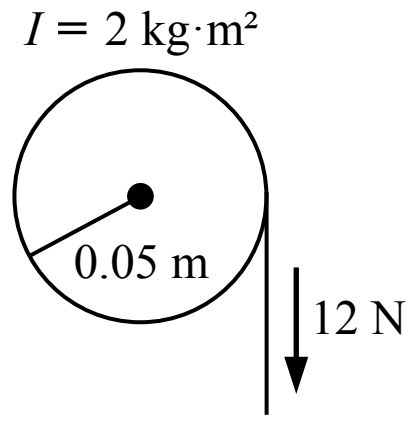
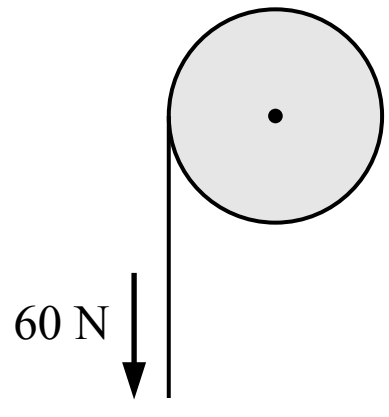
ANGULAR MOMENTUM



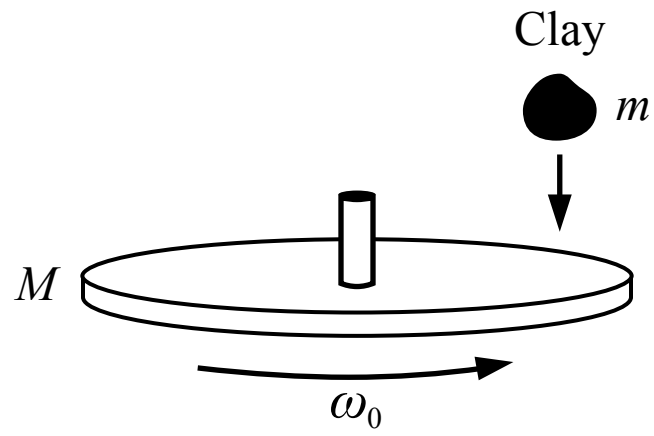
1. A string with negligible mass is wrapped around the outside of a pulley with a rotational inertia of 2 kg·m² and a radius of 0.05 m as shown in the figure above. The pulley is initially at rest when a constant 12 N force is applied to the string. The angular momentum of the pulley after a period of 3 seconds is most nearly

   (A) 3.6 kg·m²/s
   (B) 0.9 kg·m²/s
   (C) 0.6 kg·m²/s
   (D) 1.8 kg·m²/s



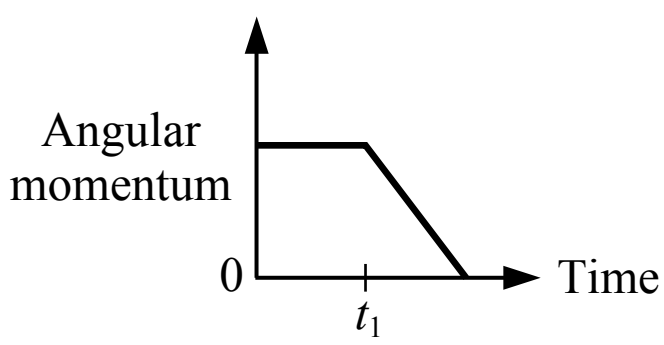
2. A string with negligible mass is wrapped around the outside of a pulley which has a radius of 0.1 m. The pulley is initially at rest when a constant 60 N force is applied to the string. The angular momentum of the pulley after a period of 2 s is most nearly

   (A) 0
   (B) 12 kg·m²/s
   (C) 6 kg·m²/s
   (D) Cannot be determined

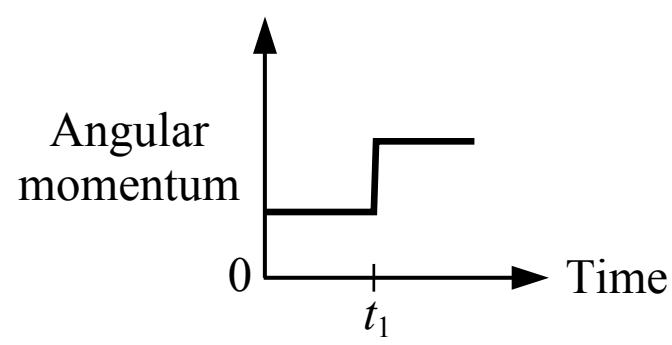


3. A large wheel is free to spin about an axle passing through its center without friction. The wheel is rotating with a constant angular speed of ω_0 when a ball of clay is dropped from rest onto the wheel from above and the clay immediately sticks to the wheel at time t_1. Which of the following graphs show the angular momentum of the wheel-clay system about an axis passing through the axle?

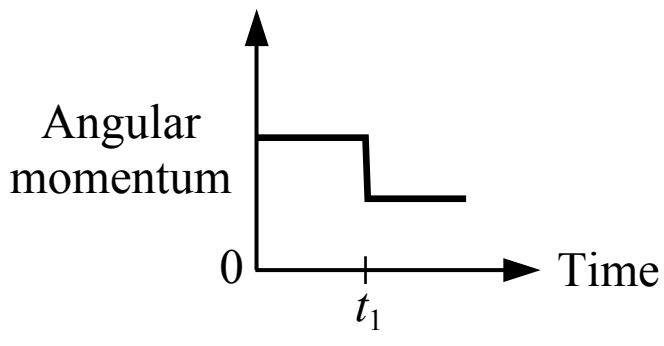
(A)



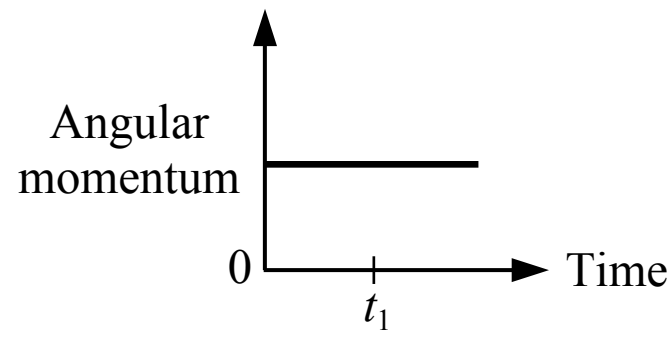
(B)

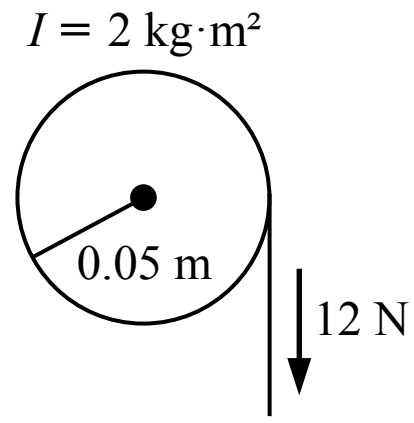


(C)



(D)





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   (A) 3.6 kg·m²/s

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   (D) 1.8 kg·m²/s

A Incorrect

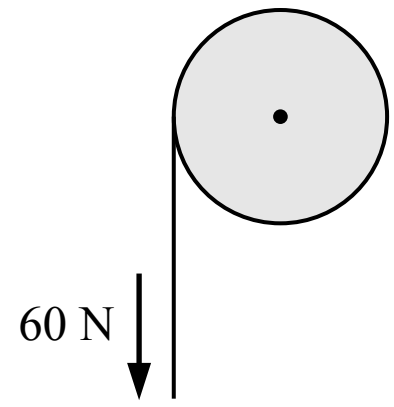
B Incorrect

C Incorrect

D Correct

The initial angular momentum is zero and the change in angular momentum is equal to the torque applied multiplied by the period of time.

$\Delta L = \tau \Delta t \qquad L_f - L_i = rF_\perp \Delta t \qquad L_f - (0) = (0.05\ \text{m})(12\ \text{N})(3\ \text{s}) \qquad L_f = 1.8\ \text{kg}\cdot\text{m}^2/\text{s}$



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(A) 0

(B) 12 kg·m²/s

(C) 6 kg·m²/s

(D) Cannot be determined

A Incorrect

B Correct

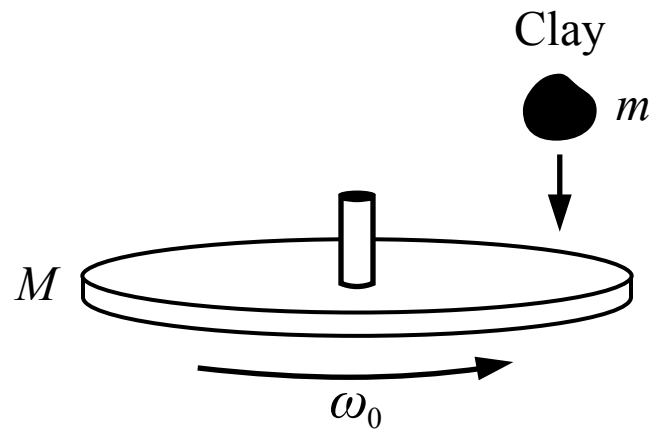
The change in angular momentum of the pulley is equal to the net torque exerted on the pulley multiplied by the period of time that the torque is applied. The net torque on the pulley is due to the tension in the string which is 60 N. The force acts at the outer edge of the pulley, perpendicular to the radius, so the full force contributes to the torque. The pulley starts at rest with zero angular momentum.

$\Delta L = \tau \Delta t = rF_{\perp} \Delta t = (0.1 \text{ m})(60 \text{ N})(2 \text{ s}) = 12 \text{ kg·m}^2/\text{s}$

C Incorrect

This answer is the torque exerted on the pulley by the tension force with the unit of angular momentum.

D Incorrect



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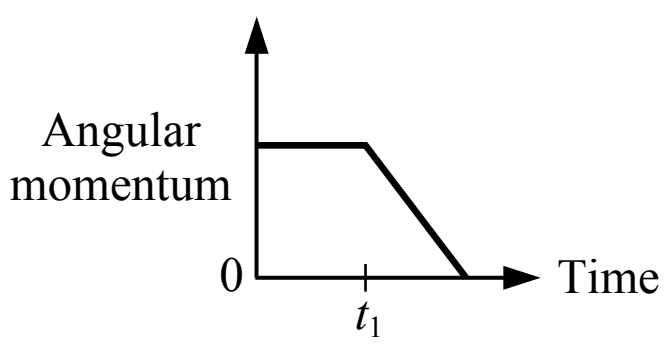
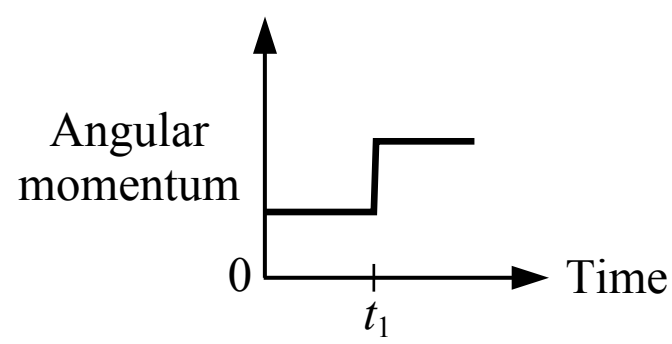
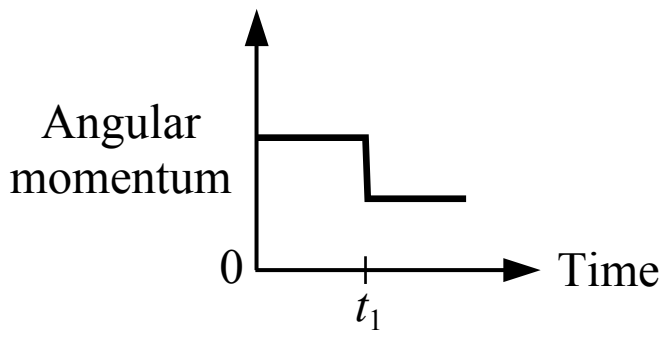


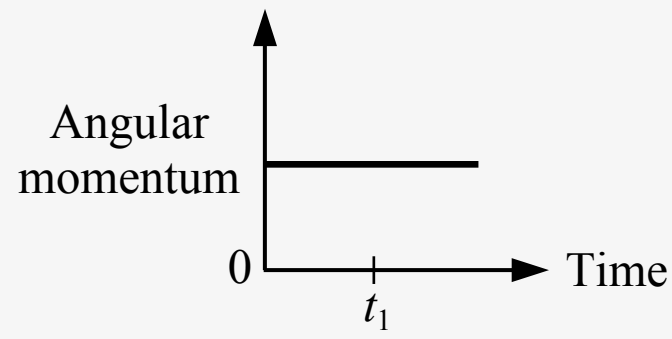
(B)



(C)



(D)



A Incorrect

B Incorrect

C Incorrect

D Correct

There is no external torque acting on the wheel-clay system about the axis passing through the axle so the angular momentum about that axis is conserved (there is no change in angular momentum). The gravitational forces are parallel to that axis and do not produce a torque. There is no friction from the axle producing a torque. The forces between the wheel and the clay are internal so they do not change the angular momentum of the system.