

Angular momentum and rolling motion

AP Physics C (Mechanics and E&M, calculus-based) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers angular momentum, conservation and rolling in the style of AP Physics C: Mechanics. Show every step of your working, give units and state any assumption. You may use a calculator and $g = 9.81 \text{ m/s}^2$. Marks are shown for each part and the total is 20.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:M Unit 6

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Rolling relation (2 marks)

A wheel of radius 0.25 m rolls without slipping at 6.0 m/s.

- Calculate its angular speed. (1 mark)
- State the speed of the top of the wheel relative to the ground. (1 mark)

Question 2 Skater (3 marks)

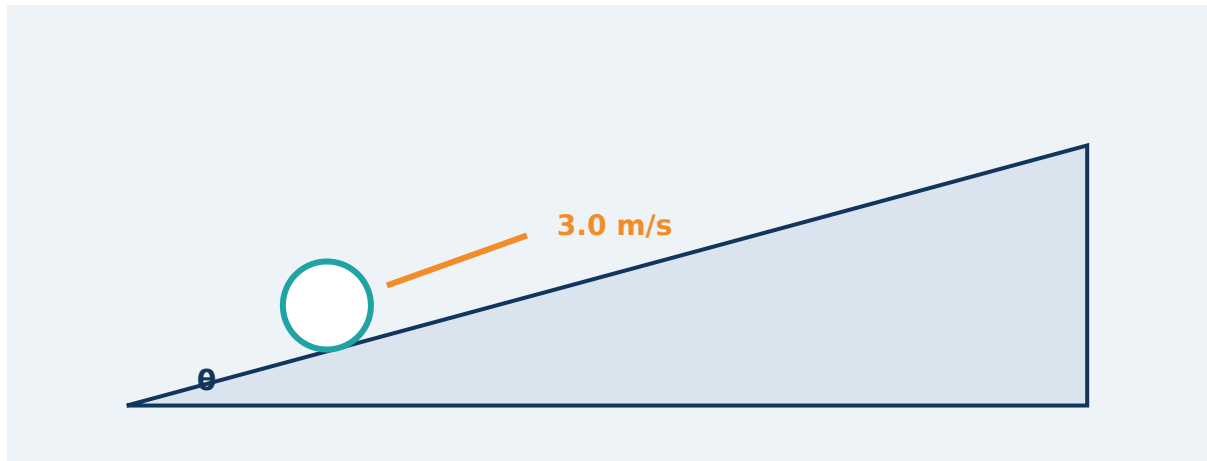
A skater spins at 3.0 rad/s with $I = 2.4 \text{ kg m}^2$. She pulls her arms in so that $I = 1.2 \text{ kg m}^2$.

- Calculate her new angular speed. (1 mark)
- Calculate the change in her kinetic energy. (1 mark)
- Explain where the extra energy comes from. (1 mark)

Question 3 Hollow against solid (2 marks)

Explain why a solid cylinder reaches the bottom of a slope before a hollow cylinder of the same mass and radius when both roll without slipping.

Question 4 Rolling up a slope (3 marks)



Question 4: the disc moves up the slope.

The disc in the figure rolls without slipping up the slope. Calculate the maximum vertical height it reaches. Use $g = 9.81 \text{ m/s}^2$.

Question 5 Friction and work (2 marks)

A ball rolls without slipping down a rough slope. Explain why static friction does no work on it even though it exerts a torque.

Question 6 Two discs (3 marks)

A disc with $I = 0.40 \text{ kg m}^2$ rotates at 10 rad/s . A second disc with $I = 0.60 \text{ kg m}^2$, at rest, is dropped onto it on the same axis and they stick.

- Calculate the final angular speed. (1 mark)
- Calculate the kinetic energy lost. (2 marks)

Question 7 Orbiting satellite (2 marks)

A satellite moves in an elliptical orbit around Earth. Explain why it moves fastest at its closest point.

Question 8 Torque from $L(t)$ (3 marks)

The angular momentum of a rotor is $L = 4.0t^3 \text{ kg m}^2/\text{s}$, with t in seconds, and its moment of inertia is 6.0 kg m^2 .

- Calculate the net torque at $t = 2.0 \text{ s}$. (1 mark)
- Calculate the angular speed at $t = 2.0 \text{ s}$. (1 mark)
- State what the net torque is doing to L . (1 mark)