

Rotational energy, rolling and angular momentum

AP Physics 1 (algebra-based) · Test

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

This test covers rotational kinetic energy, rolling motion and conservation of angular momentum. Show all working, give units and justify your reasoning. A calculator is allowed.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 6

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

Question 1 Definitions (2 marks)

- State the equation for the angular momentum of a rigid object rotating about a fixed axis. (1 mark)
- State the condition under which the angular momentum of a system is conserved. (1 mark)

Question 2 Flywheel (2 marks)

A flywheel has rotational inertia 0.80 kg m^2 and angular speed 25 rad/s .

- Calculate its rotational kinetic energy. (1 mark)
- Calculate its angular momentum. (1 mark)

Question 3 Spinning skater (3 marks)

A skater with $I = 3.0 \text{ kg m}^2$ spins at 2.4 rad/s , then draws in her arms so that $I = 1.2 \text{ kg m}^2$. There is no external torque.

- Calculate her final angular speed. (2 marks)
- State and explain what happens to her kinetic energy. (1 mark)

Question 4 Rolling cylinder (3 marks)

A solid cylinder of mass 2.0 kg rolls without slipping at 4.0 m/s . Its rotational inertia is $\frac{1}{2}MR^2$.

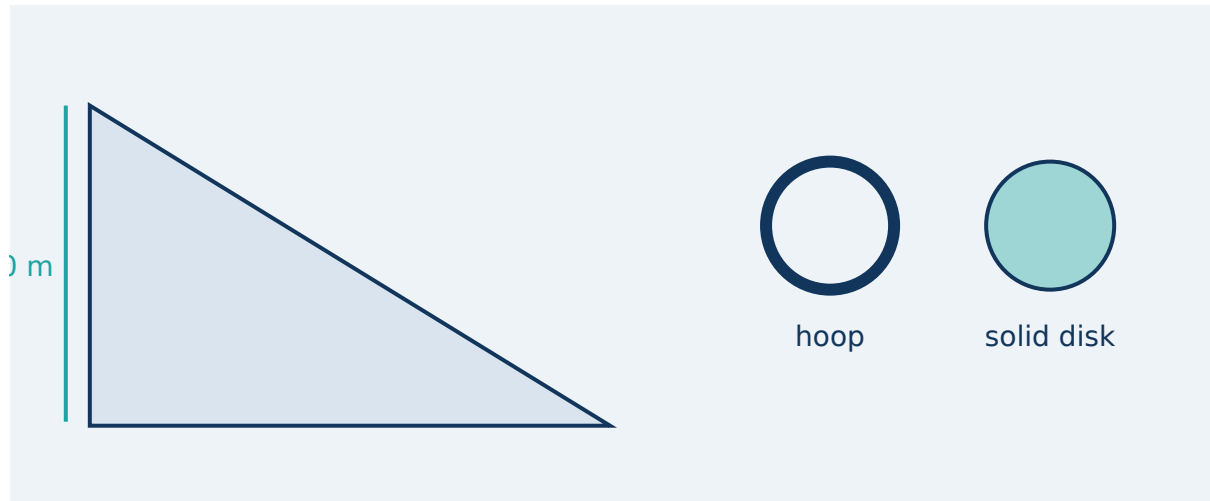
- Calculate its translational kinetic energy. (1 mark)
- Calculate its rotational kinetic energy. (1 mark)

- c. Calculate its total kinetic energy. (1 mark)

Question 5 Racing down a ramp (3 marks)

A hoop and a solid disk of equal mass and radius are released together from rest at the top of the ramp shown. Both roll without slipping.

- State which reaches the bottom first. (1 mark)
- Use energy ideas to explain your answer. (2 marks)



Both objects have mass M and radius R and are released from rest at the top of the ramp.

Question 6 Clay lump on a turntable (3 marks)

A turntable with $I = 0.20 \text{ kg m}^2$ spins at 6.0 rad/s . A clay lump adds 0.050 kg m^2 to the rotational inertia when it sticks to the turntable.

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

Question 7 Work by a torque (2 marks)

A constant torque of 3.0 N m turns a wheel through 8.0 rad . The wheel starts from rest and has $I = 0.30 \text{ kg m}^2$.

- Calculate the work done by the torque. (1 mark)
- Calculate the final angular speed. (1 mark)

Question 8 Ball up a slope (2 marks)

A solid ball ($I = \frac{2}{5}mR^2$) rolls without slipping at 3.5 m/s on level ground and then up a smooth-surfaced slope. Calculate the maximum vertical height it reaches. (2 marks)