1. A cylinder contains 2.0 moles of an ideal gas at a temperature of 300 K. The gas is compressed isothermally from a volume of 5.0 L to 2.0 L. Calculate the work done on the gas during the compression.
2. A solid sphere of mass 5.0 kg and radius 0.20 m is rolling without slipping down an inclined plane. The plane makes an angle of 30° with the horizontal. Determine the linear acceleration of the sphere as it rolls down.
3. A flywheel with a moment of inertia of 0.50 kg·m² is rotating at 300 rpm. How much energy is required to bring the flywheel to rest?
4. A gas is allowed to expand adiabatically, performing 250 J of work. If the internal energy of the gas decreases by 400 J, how much heat is added to or removed from the system?
5. A disk with a mass of 2.0 kg and a radius of 0.15 m is subjected to a torque of 1.5 N·m. Calculate the angular acceleration of the disk.
6. A car engine absorbs 1200 J of heat from a high-temperature reservoir and expels 800 J of heat to a low-temperature reservoir during one cycle. Determine the efficiency of the engine.
7. A wheel rotates with an angular velocity of 10 rad/s. A constant torque is applied, causing the wheel to accelerate uniformly to 30 rad/s in 5 seconds. Find the angular displacement of the wheel during this time.
8. A steel rod expands by 0.20 mm when heated from 20°C to 80°C. If the original length of the rod is 1.5 m, calculate the coefficient of linear expansion of the steel.
9. A pendulum with a length of 1.2 m swings with small oscillations. Calculate its rotational kinetic energy at the lowest point of its swing if its angular velocity at that point is 2.5 rad/s.
10. A gas is heated at constant volume, causing its pressure to double. If the initial temperature was 300 K, find the final temperature of the gas.
11. A 4.0 kg wheel with a radius of 0.30 m is spinning at 20 rad/s. What is the total kinetic energy of the wheel if its moment of inertia is I=0.5MR2I = 0.5 M R^2I=0.5MR2?
12. A reversible Carnot engine operates between two reservoirs at temperatures of 600 K and 300 K. What is the maximum theoretical efficiency of the engine?
13. A particle moves in a circular path of radius 2.0 m with a constant speed of 4.0 m/s. Calculate its angular velocity and the centripetal force acting on the particle if its mass is 0.50 kg.
14. A block slides down a frictionless incline of height 5.0 m, then collides elastically with a stationary ball at the bottom. Describe the energy transformations in the system and explain how energy conservation applies.
15. A gas expands at constant pressure from a volume of 1.0 L to 3.0 L. The pressure is $1.5 \times 10^5$ Pa. How much work is done by the gas during the expansion?