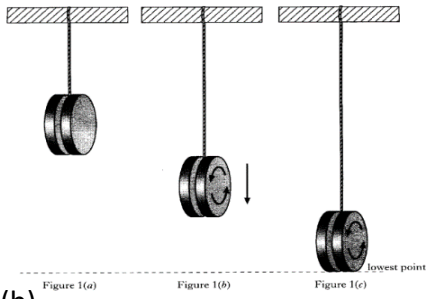
A. Key Concepts

1. Define the term torque and write down the equation.
2. Explain what an unbalanced torque can cause an object to do.
3. Define the term moment of inertia and write down the equation.
4. Explain why there are many different equations to find the inertia of an object.
5. Write down the equation for angular momentum.
6. State the law of conservation of angular momentum.
7. Write down the equation for rotational energy.
8. Explain the different between translational kinetic energy and rotational kinetic energy.

B. Past Paper Practice



1. A yo-yo consists of two discs mounted on an axle.

   A length of string is attached to the axle and wound round the axle.

   With the string fully wound, the yo-yo is suspended from a horizontal support as shown in Figure 1(a).

   The yo-yo is released from rest and rotates as it falls, as shown in Figure 1(b).

   The string is fully unwound at the yo-yo's lowest point, as shown in Figure 1(c).

   The yo-yo then rises, rewinding the string.

   a) State the type(s) of energy which the yo-yo has when it is at the position shown in:
      i. Figure 1(b);
      ii. Figure 1(c) **2**

   b) Each disc has a mass m of $0 \cdot 100\ kg$ and a radius r of $0 \cdot 050\ m$.
      The moment of inertia of a disc is given by $\frac{1}{2}mr^2$.
      The moment of inertia of the axle is negligible.
      Calculate the moment of inertia of the yo-yo. **3**

   c) When the yo-yo is at the position show in Figure 1(c) it has an angular velocity of $120\ rad\ s^{-1}$.
      Calculate the maximum height to which the yo-yo could rise as it rewinds the string. **3**

   d) One type of yo-yo has four friction pads inside each disc. Each friction pad is half in place by a spring which exerts a force of $5 \cdot 00\ N$. At low angular velocities the friction pads grip the axle as shown in Figure 2.

      At higher angular velocities, the pads move away from the axle and compress the springs. This releases the axle and allows the discs to spin freely.

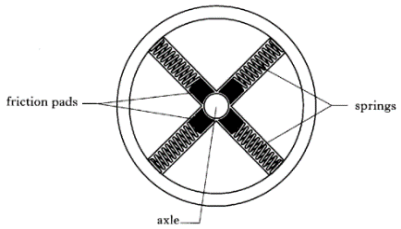


Figure 2

      i. Explain why the friction pads move away from the axle. **1**

      ii. Each friction pad can be considered as a point mass of $12 \cdot 0\ g$ at a radius of $10 \cdot 00\ mm$ from the centre of the axle.
      Calculate the minimum angular velocity at which the axle is released from the friction pads. **3**