1. A dumbbell is made of two equal masses, *m*, connected by a massless rod of length *r.* If I_1 is the moment of inertia with respect to an axis passing through the center of the rod and perpendicular to it and I_2 is the moment of inertia with respect to an axis passing through one of the masses we can say that

(A) $I_1 = I_2$ (B) $I_1 < I_2$ (C) $I_1 > I_2$ (D) needs more info

$I_1 = m(\frac{1}{2} r)^2 + m(\frac{1}{2} r)^2 = \frac{1}{2} m r^2$ $I_2 = mr^2$ → **Correct answer is B**

2. Consider a solid sphere of radius *R* and mass *M* rolling without slipping. Which form of kinetic energy is larger, translational (K_T) or rotational (K_R)? (For a sphere rotating around its axis, $I=2/5\ MR^2$)

(A) K_R (B) K_T (C) They are equal (D) Depends on the linear speed

$K_R = \frac{1}{2} I \omega^2 = \frac{1}{2} (2/5\ M R^2) (v^2/R^2) = 2/5 (\frac{1}{2} M v^2) = 2/5\ K_T$ → **Correct answer is B**

3. Two balls, one of radius *R* and mass *M*, the other of radius 2*R* and mass 8*M,* roll down an incline. They start together from rest at the top. Which one will reach the bottom first? (I is given in question 2)

(A) The small one (B) The bigger one (C) They arrive at the same time

Small one: $K_R = 2/5 (\frac{1}{2} M v^2)$ → $K=K_R+K_T = 7/10\ M v^2$ But $K = U = Mgh$ → $v^2=10/7\ gh$

Big one: $K_R = \frac{1}{2}(2/5\ 8M\ 4R^2)(v^2/(4R^2)) = 8/5Mv^2$ →

$K=K_R+K_T = 8/5Mv^2 + \frac{1}{2} (8M) v^2 = 28/5Mv^2$

But $K = U = 8Mgh$ → $v^2=40/28=10/7\ gh$ (same velocity as small ball)

→ They arrive at the same time → **Correct answer is C**

4. Two points are on a disk that rotates about an axis perpendicular to the plane of the disk at its center. Point B is 3 times as far from the axis as point A. If the linear speed of point B is V, the linear speed of point A is:

(A) 9V (B) 3V (C) V (D) V/3 (E) V/9

$V=\omega r$ → **Correct answer is D**

5. For the two points A and B in the previous question, if the angular speed of point B is ω, then the angular speed of point A is:

(a) 9ω (b) 3ω (c) ω (d) $\omega/3$ (e) $\omega/9$

Angular speed is the same for all points → **Correct answer is C**