CONSERVATION OF ENERGY / ROLLING MOTION

● Remember**:** If an object moves while rotating **(**Rolling Motion**)** on a surface without slipping → **$v_{,CM}$ = __________**

- **-** In order for an object to start rotating, or to rotate faster **(___),** there needs to be ___________________ **(_____).**
- **-** The role of _________ in Rolling Motion is to **"**convert**"** some _____ into _____ **(** ______ into ______ **).**
- **-** Unless otherwise stated**,** _________ does this without dissipating any energy → **W____ = _____**
- **-** To summarize**:** If **α ≠ 0** → there is ___________ but _____________**.**

  If **"**without slipping**"** → there is ___________**.**

EXAMPLE**:** A solid cylinder of mass M and radius R is released from rest from the top of an inclined plane of length L that makes an angle of **Θ** with the horizontal. The cylinder rolls without slipping**.** Derive expressions for the linear and angular speeds that the cylinder will have at the bottom of the plane**.**

PRACTICE: SPHERE GOING UP A HILL / MAX HEIGHT

PRACTICE**:** A solid sphere of mass M = 10 kg and radius R = 2 is rolling without slipping with speed V = 5 m/s on a flat surface when it reaches the bottom of an inclined plane that makes an angle of **Θ =** 37° with the horizontal. The plane has just enough friction to cause the sphere to roll without slipping while going up. What maximum height will the sphere attain**?**

EXAMPLE: ROLLING SPHERE / ROUGH AND SMOOTH HILLS

EXAMPLE**:** A solid sphere of mass M and radius R is initially at rest at the top of a rough hill of height H_1.The sphere rolls down the rough hill, then rides on a smooth horizontal surface, then goes up a long, smooth hill. The first hill (rough) has enough friction to cause the sphere to roll without slipping. What maximum height H_2, in terms of H_1 and other variables, will the sphere attain on the second hill (smooth)**?**

→ BONUS**:** Why are the two heights different**?**

PRACTICE: SPHERE ON LOOP-THE-LOOP / SPEED AT BOTTOM

PRACTICE**:** You may remember that the lowest speed that an object may have at the top of a loop-the-loop of radius **R**, so that it completes the loop without falling, is $\sqrt{\mathbf{gR}}$ **.** Calculate the lowest speed that a solid sphere must have at the bottom of a loop-the-loop, so that it reaches the top with enough speed to complete the loop. Assume the sphere rolls without slipping**.**