Transformations of mechanical energy on an inclined ramp

Equipment:

1. Inclined ramp
2. Set of three balls and rolls
3. Ruler
4. Caliper
5. Electronic scale

Exercise:

1. Measure the total distance *S* on the ramp between the starting and end photocells. Measure the height *H* of the starting photocell, H_1 of the middle photocell, and H_2 of the bottom photocell.
2. Determine the mass *m* and diameter *d=2R* of the body indicated by the teacher.
3. Calculate the rotational inertia I_0 of the examined body:

   a ball: $I_0 = \frac{2}{5}mR^2$,

   a roller: $I_0 = \frac{1}{2}mR^2$

4. Place examined body at the top of the ramp and measure time t_1 in which the body will reach the half length of the ramp. Repeat the measurement nine times. Calculate mean value $\overline{t_1}$.
5. Place examined body at the top of the ramp and measure time t_2 in which the body will be at the bottom of the ramp. Calculate mean value $\overline{t_2}$.
6. Calculate instantaneous linear velocities v_1 and v_2:

   $$v_1 = \frac{S}{\overline{t_1}}, v_2 = \frac{2S}{\overline{t_2}}$$

   and instantaneous angular velocities ω_1 and ω_2:

   $$\omega_1 = \frac{v_1}{R}, \omega_2 = \frac{v_2}{R}$$

   of the body in the middle and at the bottom of the ramp, respectively.
7. Calculate the potential energy

   $$E_p = mgh,$$

   and the kinetic energy of progressive movement:

   $$E_{k\,progr} = \frac{1}{2}mv^2,$$

the kinetic energy of rotational motion:

$$E_{k\,rot} = \frac{1}{2} I_0 \omega^2$$

and the total mechanical energy:

$$E_t = mgh + \frac{1}{2} mv^2 + \frac{1}{2} I_0 \omega^2$$

of the body on the top, in the middle and at the bottom of the ramp.

8. Make a graph showing the dependence of the potential energy, kinetic energy of translational motion, kinetic energy of rotational motion and total energy on the position of the examined body on the ramp.
9. Repeat steps 1-8 for one other ramp inclination indicated by the teacher
10. Repeat steps 1-9 for two different bodies indicated by the teacher
11. Note the conclusions.

Tables:

Examined body: ……
S = ……m, H = ……m, H_1 = ……m, H_2 = ……m,
d = ……m, m = ……kg, I_0 = ……kgm^2

t_1	$\bar{t}_1$	t_2	$\bar{t}_2$	υ_1	υ_2	ω_1	ω_2
[s]	[s]	[s]	[s]	[m/s]	[m/s]	[1/s]	[1/s]

Body position	E_p [J]	$E_{k\,prog}$ [J]	$E_{k\,rot}$ [J]	E_t [J]
Top of the ramp				
Middle length of the ramp				
Bottom of the ramp				

The above tables should be copied six times.