1. [10 pts.] Approximately **how many** pieces of paper can you make out of a big tree? Make an **order-of-magnitude** estimate. State very clearly the assumptions you make and the logic of your argument.

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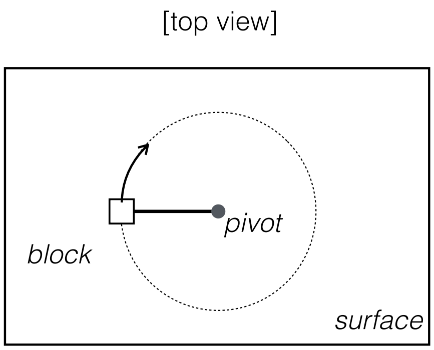
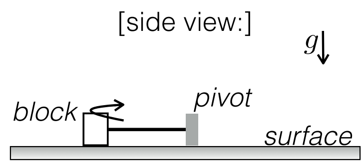
2. [15 pts.] A block connected to a pivot moves in a circle on a surface. Between the block and the surface, there is some friction, which decelerates the circular motion. Assume the angular speed is 3450 rev/min initially (at $t = 0$), after which there is constant angular deceleration. You observe that the block does 52.0 *full rotations* before coming to rest. **What was the angular acceleration**?





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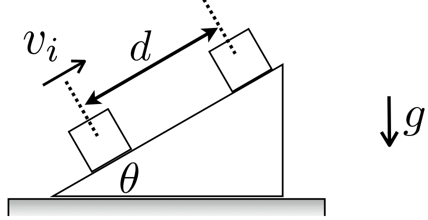
3. [20 pts.] A 4.20 kg block is set into motion up an inclined plane with an initial speed of $v_i = 8.40\,\text{m/s}$ (see figure below). The block comes to rest after traveling $d = 6.00\,\text{m}$ along the plane, which is inclined at an angle of $\theta = \pi/6$ (30.0 degrees) to the horizontal.

   (a) [5 pts.] For this motion, determine the **change in the block's kinetic energy**.

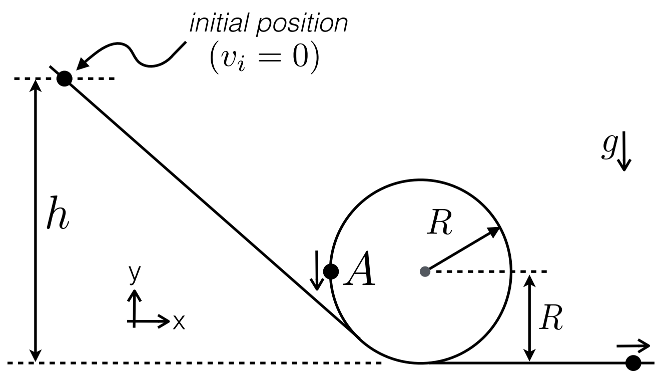
   (b) [5 pts.] For this motion, determine the **change in potential energy** of the block-Earth system.

   (c) [5 pts.] **Determine the friction force** exerted on the block (assumed to be constant).

   (d) [5 pts.] What is the **coefficient of kinetic friction**?



4. [15 pts.] A spherical bead of mass M slides on a frictionless wire from height h, and goes through a circular loop of radius R, as shown in the figure. When the bead is at the point labeled point **A** in the figure below, **what is its acceleration**? Give your answer as a vector, in terms of M, h, R, and g as necessary.



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5. [18 pts.] A single conservative force acting on a particle within a system varies as $F_x = Bx^2$, where x is position and B is a constant. (This is a 1D problem – you can ignore y and z degrees of freedom.)

   (a) [8 pts.] **How much work** is done on a particle as it moves from $x = -L$ to $x = +L$?

   (b) [7 pts.] If this is a conservative force, and we define $U(x) = 0$ at $x = 0$, **what is the $U(x)$** that gives this F_x? {*Hint: Differentiate the $U(x)$ you find, to verify that $F_x = -\frac{dU}{dx}$.*}

   (c) [3 pts.] Make a sketch (a rough plot) of F_x vs x, and of U vs x, assuming $B > 0$.

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6. [22 pts.] The motion of a particle of mass 2.00 kg is described by

$$\vec{r} = (2.00\,t^3)\,\boldsymbol{i} + (6.00\,t)\,\boldsymbol{j} - 10.0\,\boldsymbol{k},$$

   where t is time. (Assume SI units for the numerical constants given here: 2.00 m/s^3, 6.00 m/s, and -10.00 m.)

   (a) [8 pts.] What is the **kinetic energy** at time $t = 0.00$ s ?

   (b) [5 pts.] What is the **vector acceleration** of the particle at time $t = 2.00$ s ?

   (c) [9 pts.] Assume that the acceleration is due to a single external force. **What is the power** of energy transfer to the particle, as a function of time t?