

### Tutorial # 4

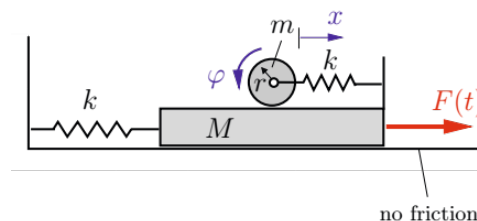
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PH 101: PHYSICS I (2019)

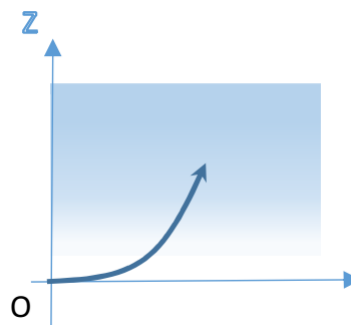
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1. Refer to the adjacent figure. The system consists of a block of mass  $M$ , a homogeneous disk of mass  $m$  and radius  $r$ , and two springs of spring constant  $k$ . The block is free to move on the frictionless surface and the disk rolls without slipping on the block. A non-conservative force  $F(t)$  acts on the block. Obtain the equation of motion using Lagrange's formalism.



2. Using Fermat's principle, find the path of a ray of light traveling on the  $xz$ -plane in a medium whose refractive index varies as,  $n(z) = n_0\sqrt{1 + (z/a)}$ , where  $n_0$  and  $a$  are positive constants and  $z$  is the depth of the medium. Assume that the light ray enters the medium at the origin, directed along the positive  $x$ -axis, and proceeds to the 1<sup>st</sup> quadrant.



3. Quiz - I solutions will be discussed.
4. Quiz - I answer copy will be returned.