Exam answers posted on class website

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Homework #7 due tonight at midnight

Homework #8 due next Wed (Nov 21) at midnight

HW #7 – ball and loop problem: Ignore ball’s r compared to h and loop’s R. (Thanks to Jennifer Beers).

A solid cylinder, a hollow cylinder, and a square block of equal masses are released at the top of an inclined plane. The cylinders roll down and the block slides down, all with negligible frictional losses. In what order will they arrive at the bottom?

A. hollow c., solid c., block

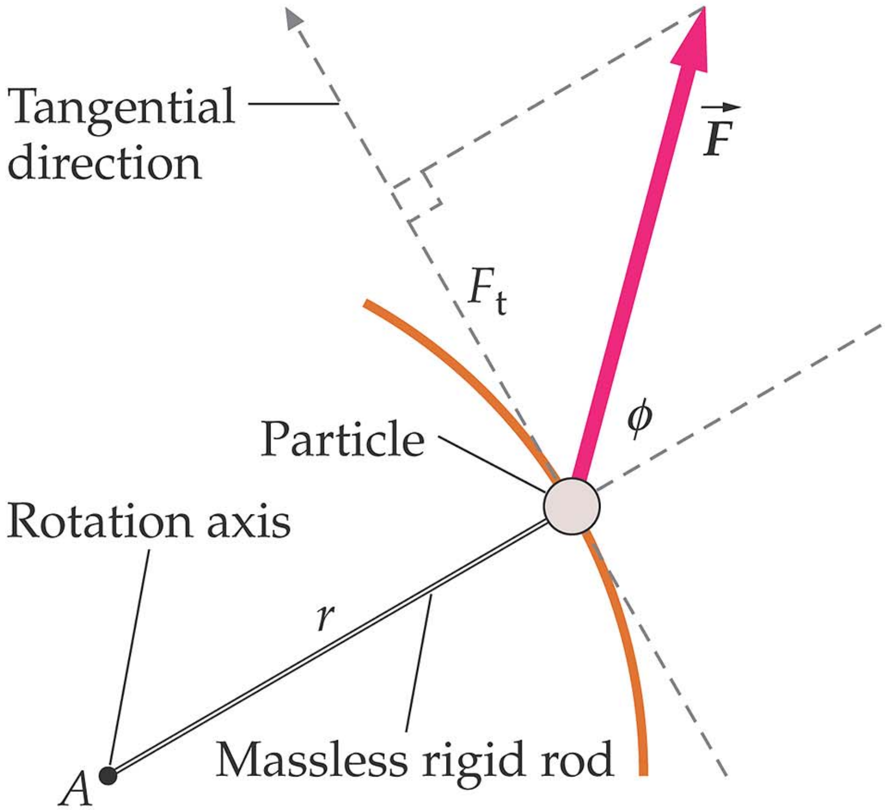
B. block, hollow c., solid c.

C. solid c., hollow c., block

D. block, solid c., hollow c.

E. all at the same instant

Chapter 9.4 Rotational dynamics



Particle of mass M pivots about axis thru A perp to the rod attaching it.

$\vec{F}$ **component perpendicular to rod provides a_t**

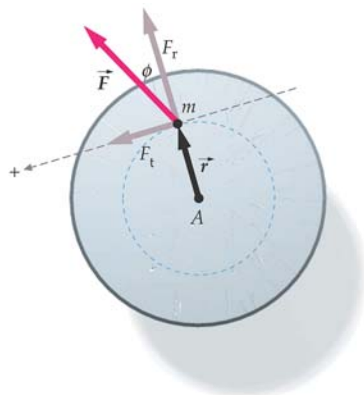
(other component is balanced by tension in rod)

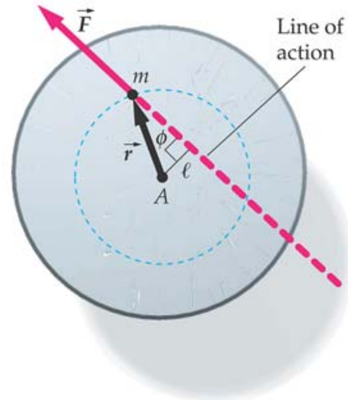
$$F_t = Ma_t \to rF_t = rMa_t\left(\frac{r}{r}\right) = Mr^2\alpha = I\alpha$$

define torque $\tau = F_t r$ about axis thru A.

In summary, Newton's 2nd becomes $\tau = I\alpha$
(This is shown true for general I in text) and if several torques and internal connections, then

$$\tau_{\text{net,external}} = \sum \tau_{\text{ext}} = I\alpha$$





$$\tau = F_t r = F\sin(\phi) r = F\ell$$

Lever arm – perpendicular distance from line of action of the force to axis

Note that ϕ is complement of usual angle for component.

And note if $\vec{F} \perp \vec{r}$, torque is Max,

and if $\vec{F} \parallel \vec{r}$, torque is 0.

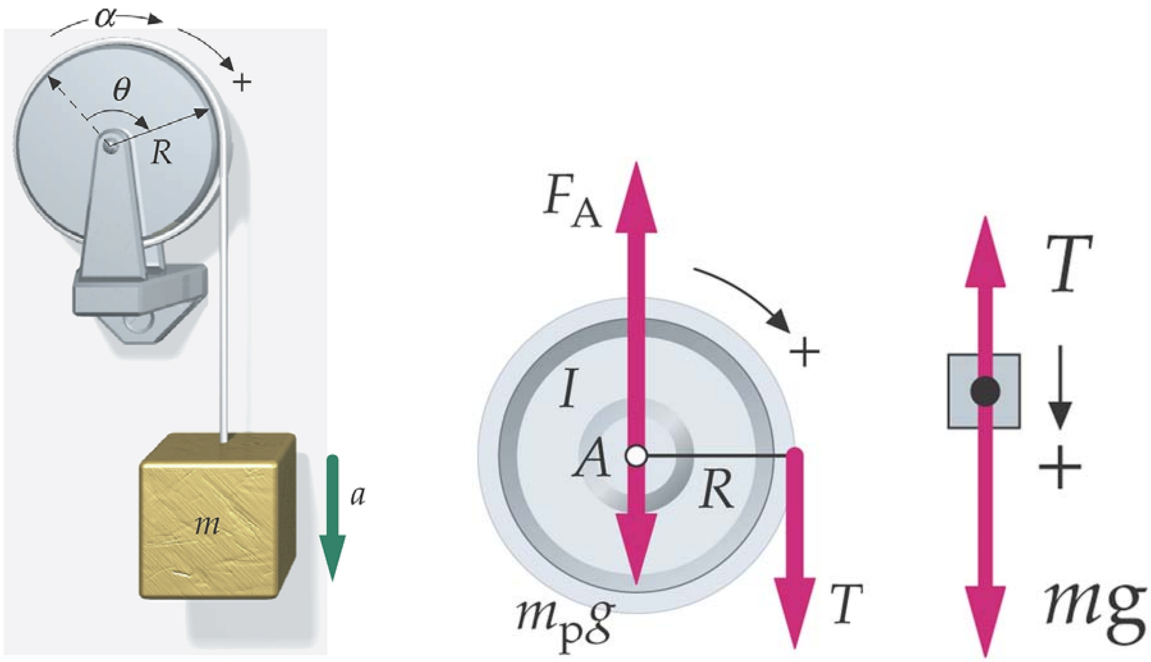
If force is from (uniform) gravity, it is mg acting at the C.M. and pointing down.

Work and Power: Work: $\vec{F} \cdot \Delta\vec{s} \rightarrow \tau\theta$ (put in *r*/*r*)

***P* = *W*/*t* so *P* = $\tau\,\omega$**

Solving Problems (Sec 9.5 and 9.6)

Free body diagrams for rotation (show how torques are developed):



Enumerate torques: ($T\,R$ in this case) and write Newton's 2nd : $\tau = T\,R = I\alpha$

Deal with mass: (F.B. Diagram and Newton's 2nd)

$$mg - T = ma = m\,R\alpha$$

noting a for mass = a_t for string/wheel = $R\alpha$ since the string is not slipping.

2 eqns in 2 unknowns, solve first for α and substitute into second:

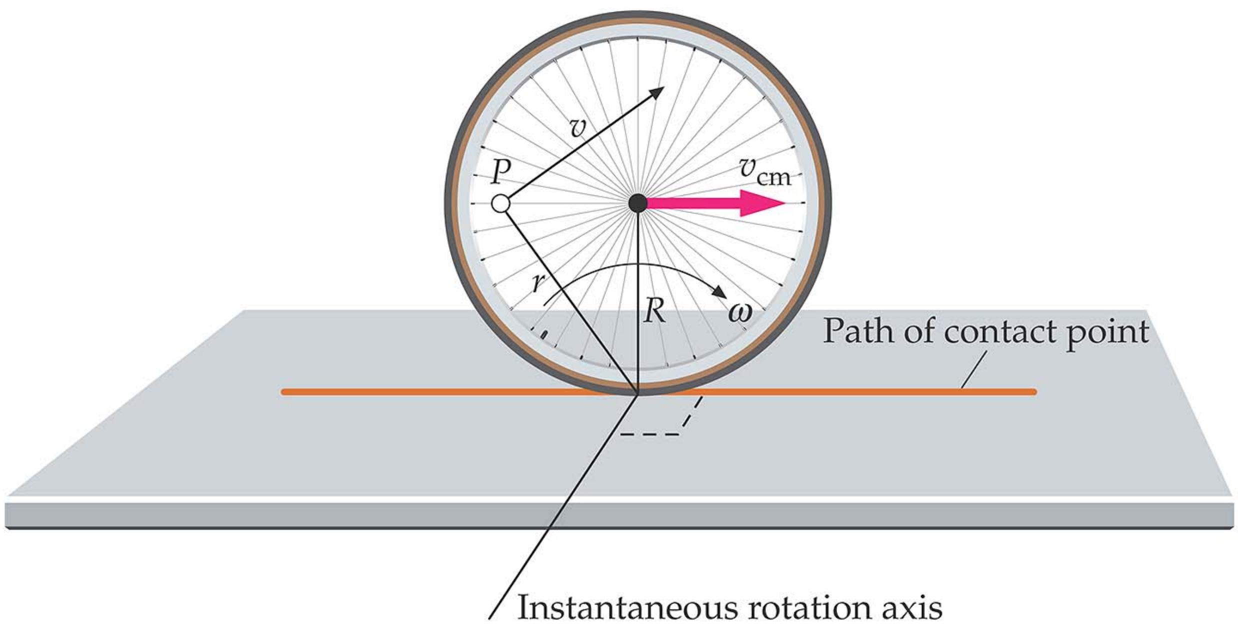
$$mg - T = m\,R\,(T\,R/I)$$

so $mg = T(m R^2 / I + 1)$ and $T = \dfrac{mg}{mR^2 / I + 1}$

Then get a. Check units.

Knowing a, which is constant, can get v, ω, time for mass to fall some distance from rest, and so on.

Choosing axis for torque:



Wheel rotates about axel – a good choice. Wheel also rotates (instantaneously) about contact point. Another good choice.

Demo