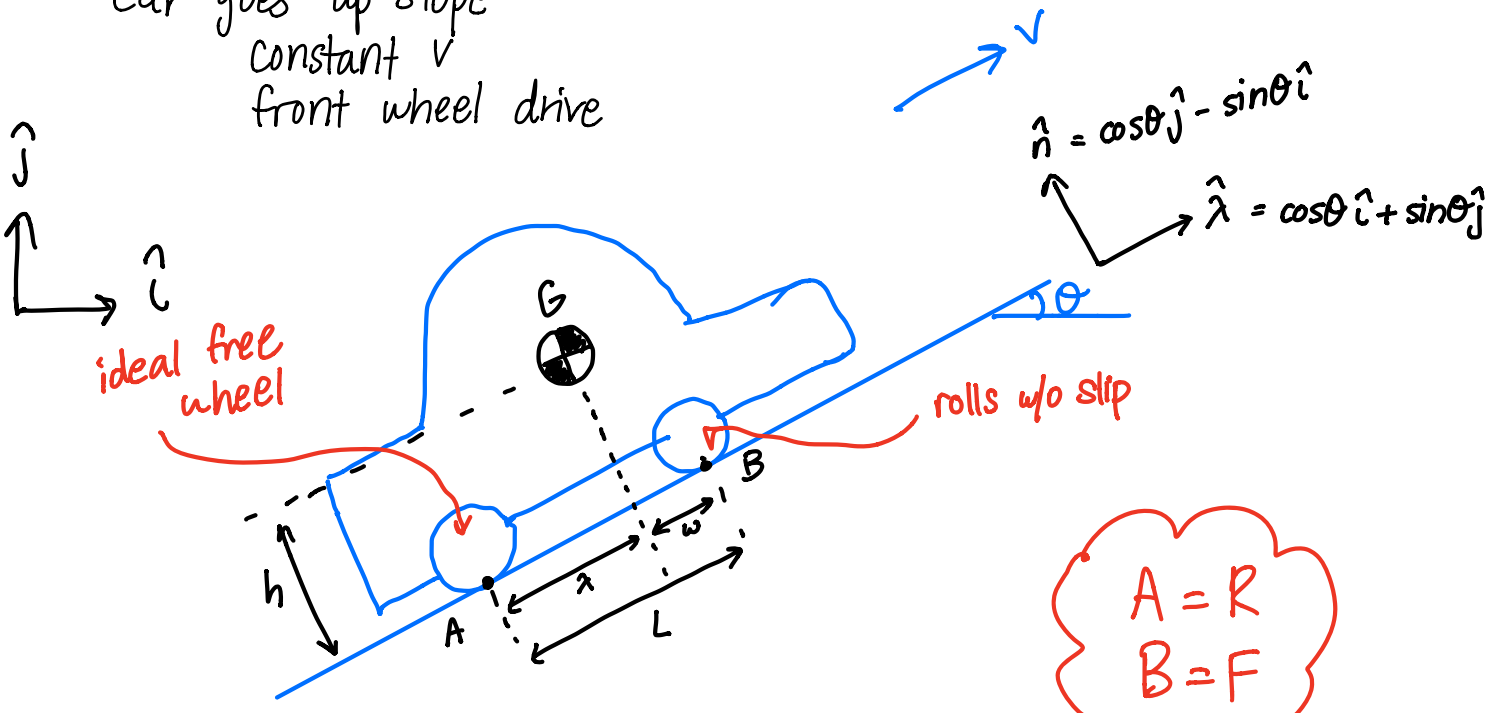
MAE 2030 Lecture #2:

2/10/21

Today: ① Statics example
② Symbolic math

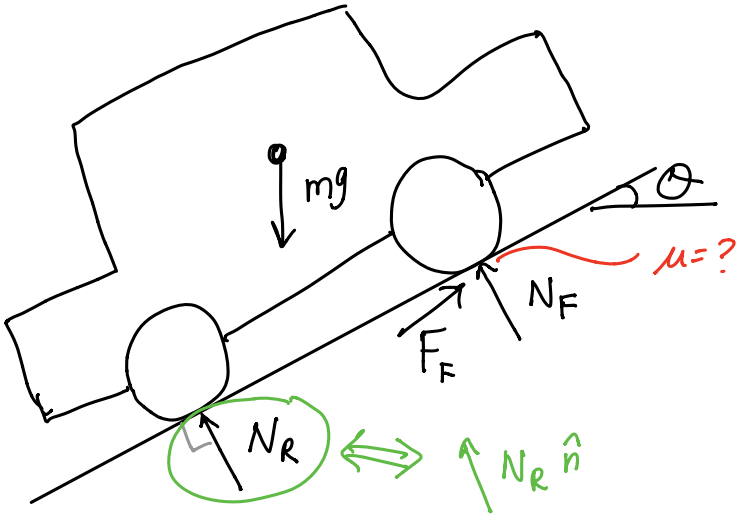
Front wheel drive:

Car goes up slope
constant V
front wheel drive



A = R
B = F

FBD:



Method I: LMB ⇒ Force Balance: $\sum \vec{F} = \vec{0}$

Forces: $N_R \hat{n} + N_F \hat{n} + F_F \hat{\lambda} - mg\hat{j} = \vec{0}$ } 2 scalar eqns (dot with both $\hat{i}$ and $\hat{j}$)

AMB ⇒ Moment Balance $\sum \vec{M}_{/G} = \vec{0}$

$\vec{r}_{F/G} \times (N_F \hat{\lambda} + F_F \hat{n}) + \vec{r}_{R/G} \times N_R \hat{n} = \vec{0}$ } 1 scalar eqn

3 eqns & 3 unknowns: N_R, N_F, F_F

vector from G to F

$[\vec{r}_{GF} = \vec{r}_{F/G}]$

Solve eqns ⇒ F_F, N_F, N_R

MATLAB: demo: Freke & Saskya's age problem

Symbolic demo:

Editor - /Users/Andy/--Andy-Stuff-misc/MATLAB_Andy/aCourses/2030/2030Spring2021/SaskyaFreke.m

```
1   %Symbolic Demo, a "word" problem.
2   % How old is Freke?
3   % Eight years ago Saskya was half as old as Freke
4   % In 46 years Saskya will be Freke's present age.
5   % Let x = Saskya's age
6   %     y = Freke's age
7
8   syms    x y   real
9
10  eqn1  = x-8  = (y-8)/2;
11  eqn2  = x + 46  = y;
12
13
14
15  [x, y] = solve([eqn1,eqn2],[x,y]);
16
17  y = double(y);
18
19  disp(['Freke is ' num2str(y) ' years old.'])
20
21
22
23
```

} expressions! not eqns

Command Window

New to MATLAB? See resources for Getting Started.

```
Unable to convert expression containing symbolic variable
substitute values for variables.

Error in sym/double (line 702)
        Xstr = mupadmex('symobj::double', S.s, 0);

Error in SaskyaFreke (line 13)
y = double(y);

>> SaskyaFreke
Freke is 100 years old.
>>
```

😱

demo: see braked car MATLAB demo & posted code

output: $\mu = \dfrac{L\sin\theta}{d\cos\theta - h\sin\theta}$

important built-in commands: syms, solve( ), pretty( ), cross( ), dot( ), simplify( )

for more info on these commands, google it!

MATLAB tips: ① MATLAB likes expressions, not eqns
② when in doubt, represent vectors in columns
e.g. i = [1 0 0]'

Method II: look for 1 eqn & 1 unknown

$$\sum \vec{M}_{/A} = \vec{0}$$

$$\left\{ \vec{r}_{G/A} \times (-mg\hat{i}) + \vec{r}_{B/A} \times (N_F \hat{n}) = \vec{0} \right\} \cdot \hat{k}$$

$\vec{r}_{G/A} = d\hat{\lambda} + h\hat{n}$ $\qquad$ $\vec{r}_{B/A} = L\hat{\lambda}$

$\Rightarrow$ 1 scalar eqn for N_F

$$\{\sum \vec{F} = \vec{0}\} \cdot \hat{\lambda}$$

$$\Rightarrow F_F + -mg\hat{j} \cdot \hat{\lambda} = 0$$

$$\Rightarrow F_F \text{ (1 scalar eqn)}$$

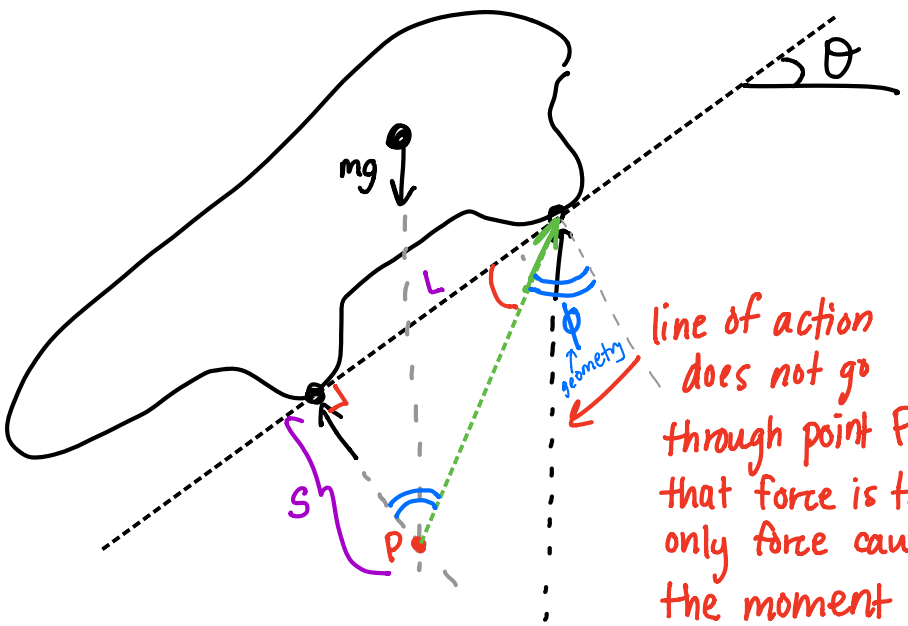
needed

$$\mu = \frac{F_F}{N_F}$$

Method III:

3-force body → if you have an object that's in equilibrium, and it only has 3 forces acting on it, those 3 forces all have to have lines of action that intersect at one point

Conceptual FBD:



line of action does not go through point P, that force is the only force causing the moment

BUT it has to add to zero

$$\mu = \tan\phi = \frac{L}{S}$$

∴ the force has to be zero (which it's not)

OR it's line of action passes through point P (seen in green)