TODAY

2 or more particles in space

ODE45

Thms.

Constraints in 1D

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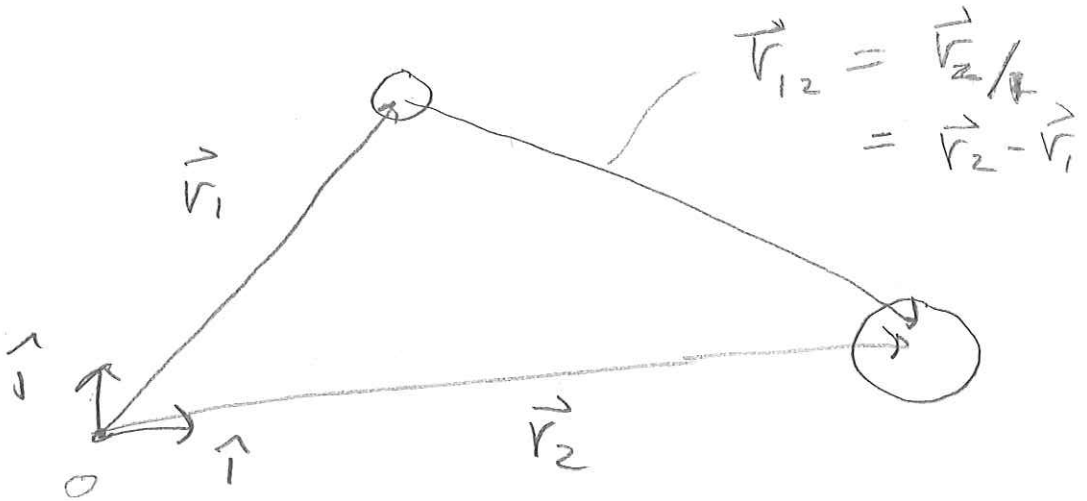
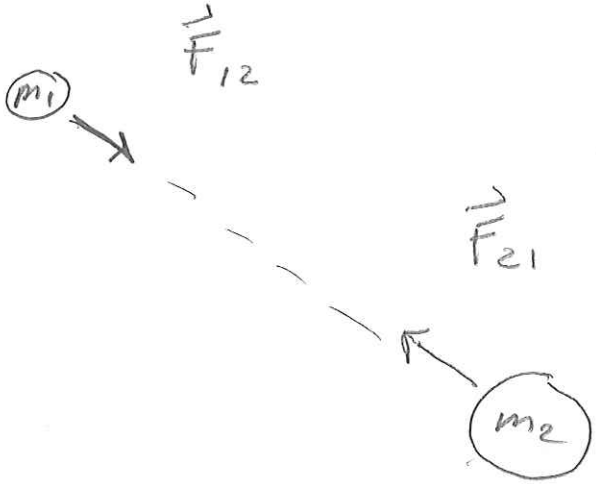
ex) 2 particles, Newtonian Gravity



FBDs



$$\vec{F}_{12} = F\,\hat{a}$$

$$= \frac{G m_1 m_2}{r_{12}^2}\,\hat{a}_{12}$$

$\hat{a}_{12} = \vec{r}_{12} / r_{12}$

$\vec{r}_{12} = \vec{r}_2 - \vec{r}_1$

Know position & vel

$\Rightarrow$ Know force

$$\dot{z} = f(t, z)$$

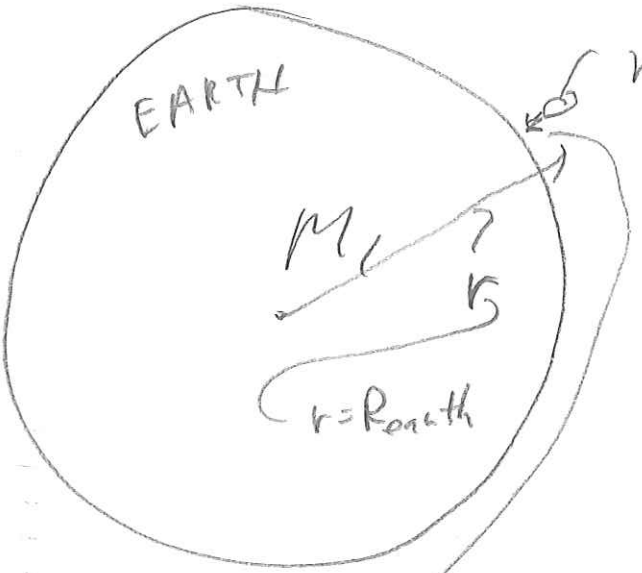
$$z = \begin{bmatrix} \vec{r}_1 \\ \vec{r}_2 \\ \vec{v}_1 \\ \vec{v}_2 \end{bmatrix}$$

ICs: $\vec{r}_1(0) = \vec{0}$, $\vec{r}_2(0) = 1\,\hat{i}$

$\vec{v}_1(0) = \vec{0}$, $\vec{v}_2(0) = 1\,\hat{j}$

$G = 1$, $m_1 = 1$, $m_2 = 2$

ASIDE! little g (vs) big G



$$F = \frac{m_1 m_2 G}{r^2} = m_1 g \quad \text{(if } r = R_e\text{)}$$

$$g = \frac{m_2 G}{R_{earth}^2}$$

$$G = \frac{g R_{earth}^2}{m_2}$$

For System

Lin. Mom : $\vec{L} = m_1 \vec{v}_1 + m_2 \vec{v}_2$

Ang. Mom/O $\vec{H}_{/O} = \vec{r}_{1/O} \times m_1 \vec{v}_1 + \vec{r}_{2/O} \times m_1 \vec{v}_2$

E_K : $E_K = \frac{1}{2} m_1 \vec{v}_1 \cdot \vec{v}_1 + \frac{1}{2} m_2 \vec{v}_2 \cdot \vec{v}_2$

E_p : $E_p \equiv -\frac{m_1 m_2 G}{r_{12}}$

E_{TOT} : $E_{TOT} = E_p + E_K$

Quiz

Conserved or Not? (for system just defined)

A = yes
B = No
C = depends on ICs

$\vec{L}$? A

$\vec{H}_{/O}$? A

E_K? C (const. for circ. motion)

E_p? C (const for circ motion)

E_{TOT} = A

⇒ MATLAB

100

* Simple motion rel. to C.o.M.
* Watch tolerances
  (Don't trust anything unless it stays there when you increase accuracy.)

* ODE 45

```
f = @(t,z) myrhs(t,z,P)
options = odeset('AbsTol',1e-6,
                 'RelTol',1e-6)
[tarray,zarray] = ode45(f,tarray,
                        z0,options)
```

(Note tarray has no effect on accuracy.),