Wed. Lab Fri.	**2.4 – .5 Momentum with Changing Force Quiz 1** L2 Measuring & Modeling 1-D Motion 2.6 – .8 Constant Force, time estimates, Models	RE 2.b bring laptop, smartphone, pad,… bring headphones if you want RE 2.c
Mon. Tues	3.1 – .5, .14-.15 Fundamental Forces, Gravitation	RE 3.a EP 2, HW2: Ch 2 Pr's 40, 57, 63, 67 & CP

Momentum Principle

& the Universal Speed limit

Predictions of Motion under the influence of Forces

Meet Gravitation – constant force

Meet Springs – changing force

Iterative Prediction of Motion

while $t < t_{max}$:

$$\vec{p}_{object} \Leftarrow \vec{p}_{object} + \vec{F}_{net \to object}\Delta t$$

$$\vec{r}_{object} \Leftarrow \vec{r}_{object} + \frac{\vec{p}_{object}}{m_{object}}\Delta t$$

$$t \Leftarrow t + \Delta t$$

Constant Force: Gravitation (near Earth)

Magnitude: $\left|\vec{F}_{Earth}\right| \approx mg$

Mass

$9.8\ m/s^2$

Direction: toward earth

(sign and component depend on your choice of coordinate systems)

Iterative Prediction of Motion

while $t < t_{max}$:

$$\vec{F}_{net\rightarrow object} = m_{object}\vec{g}$$

$$\vec{p}_{object} \Leftarrow \vec{p}_{object} + \vec{F}_{net\rightarrow object}\Delta t$$

$$\vec{r}_{object} \Leftarrow \vec{r}_{object} + \frac{\vec{p}_{object}}{m_{object}}\Delta t$$

$$t \Leftarrow t + \Delta t$$

demo

Smoothly-Varying Force: Spring

$$\vec{F}_{sp\rightarrow} = -k_s \vec{s} = -k_s s \hat{L}$$

example with the spring over here, I hang 4.9 N (0.5 kg) weight from it, and it stretches by _____m. So, what's it's stiffness?

Example From RE: A spring is 0.14 m long when it is relaxed. When a force of magnitude 325 N is applied, the spring becomes 0.22 m long.

(a) What is the stiffness of this spring?

(b) Next, this spring is compressed so that its **length** is 0.08 m. What magnitude of force is required to do this?

Q 2.5 c

A spring is 12 cm (0.12 m) long when relaxed. Its stiffness is 30 N/m. You push on the spring, compressing it so its length is now 10 cm (0.10 m).

What is the magnitude of the force the spring now exerts on your hand?

a) 0.6 N
b) 3 N
c) 3.6 N
d) 30 N

Experiment: Observe Motion

Compute: Simulate Motion (with force and momentum visualized)

Iterative Prediction – walk through

$k_{sp} = 8N/m$

$\Delta t = 0.1s$

$m = 0.06kg$

$L_{eq} = 0.2m$

$\vec{r} = \langle 0, -0.1m, 0 \rangle$

$\vec{p} = \langle 0,0,0 \rangle$

$t = 0s$

- **While t< 10s**

$\vec{F} \Leftarrow -k_s * (|r| - L_{eq})\hat{r}$

$\vec{p} \Leftarrow \vec{p} + \vec{F}\Delta t$

$\vec{r} \Leftarrow \vec{r} + (\vec{p}/m) * \Delta t$

$t \Leftarrow t + \Delta t$

- Step 1
- Step 2

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