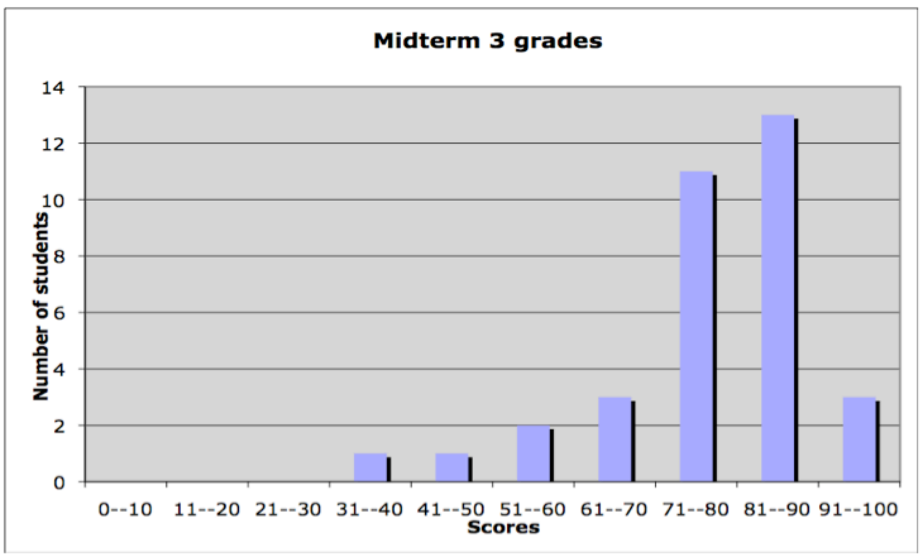
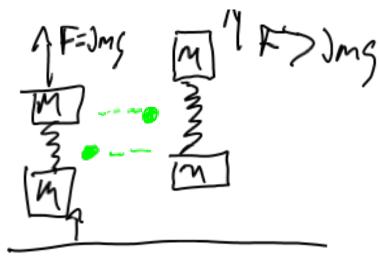
November 21

Get clickers



Mean = 76.5
Median = 79
Std Dev = 12.5

5)



$y_{1i} = 0.3m \quad y_{2i} = 0.6m$

$y_{1f} = 0.5m \quad y_{2f} = 1.2m$

a) $cm_i = 0.45m \quad cm_f = 0.85m$

$E_f = E_i + W \implies K_f = K_i + W \quad K_i = 0$

$W = F_{net} \cdot dr = (159N - 2Mg)(0.85m - 0.45m)$

$= 28.32J$

$K_{trans} = W = 28.32J$

b) $\Delta E = W + \cancel{Q}^{0} = \Delta K_{trans} + \Delta K_{vib} + \Delta U_s$

$$W_{ext} = W_F + W_{grav,b1} + W_{grav,b2}$$

$$= F(y_{2f} - y_{2i}) - mg(y_{1f} - y_{1i}) - mg(y_{2f} - y_{2i})$$

$$= 60.12\ J$$

$$\Delta U = U_f - \cancel{U_i}^{0} = \frac{1}{2} k_s s^2$$

$$= \frac{1}{2} k_s (0.7m - 0.3m)^2$$

$$= 0.4\ J$$

$$\Delta K_{vib} = W - \Delta K_{trans} - \Delta U_s$$

$$= 31.40\ J$$

7) $E_f = E_i + W$

$0 = K_i - mg\Delta y \rightarrow K_i = mg\Delta y$

$K_i = \frac{P_i^2}{2m}$

$P_i = \sqrt{2m^2 g \Delta y} = \sqrt{2(60kg)^2(9.8 m/s^2)(0.16m)} = 106\ kg\frac{m}{s}$

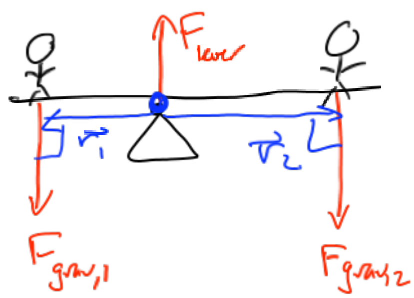
$P_{china} = 1.1 \times 10^{11}\ kg\,m/s$

$P_{china} = P_{earth} = M_{earth} V_{earth}$

$V_{earth} = \frac{P_{china}}{M_{earth}} = \frac{1.1 \times 10^{11}\ kg\,m/s}{6 \times 10^{24}\ kg} = 1.8 \times 10^{-14}\ m/s$

$\vec{\tau} = \vec{r} \times \vec{F}$

Discussion: Seesaw



$\Delta\vec{p} = 0 = \vec{F}_{net}\Delta t$

$\Rightarrow \vec{F}_{net} = 0$

$F_{lever} - F_{grav,1} - F_{grav,2} = 0$

$\Delta\vec{L} = 0 = \vec{\tau}_{net}\Delta t$

$\vec{\tau}_{net} = 0$

$r_1 F_{grav,1} - r_2 F_{grav,2} = 0$

Discussion: Angular Momentum Principle

$$\vec{\tau}_A = \frac{d\vec{L}_A}{dt} \quad \text{or} \quad \vec{L}_f = \vec{L}_i + \vec{\tau}_{net}\Delta t$$

$$\vec{F}_{net} = \frac{d\vec{p}}{dt} \quad \text{or} \quad \vec{p}_f = \vec{p}_i + \vec{F}_{net}\Delta t$$

$$\Delta E = W + Q \qquad E_f = E_i + W + Q$$

Discussion: Torque

Torque only meaningful about a location A

$$\vec{\tau} = \vec{r} \times \vec{F}$$

cross product $\Rightarrow$ vector

need know A so that know $\vec{r}$

Discussion: Conservation of Angular Momentum

Just like $\vec{p}_f = \vec{p}_i$ when $\vec{F}_{net}\Delta t \approx 0$

we have $\vec{L}_f = \vec{L}_i$ when $\vec{\tau}_{net}\Delta t \approx 0$

$L = I\omega$ $\qquad\qquad p = mv$

$\hookrightarrow \Sigma m_i r_i^2$

$\vec{\tau}_{net} = 0 \Rightarrow L_f = L_i \Rightarrow I_f\omega_f = I_i\omega_i$

$\omega_f = \frac{I_i}{I_f}\omega_i$

$$\omega_f = \frac{I_i}{I_f}\omega_i$$

$$K_{rot} = \frac{1}{2} I \omega^2 = \frac{1}{2} \frac{(I\omega)^2}{I} = \frac{L^2}{2I}$$

$$= \frac{\text{Const}^2}{2 \text{ gets smaller}} \Rightarrow \text{gets bigger}$$

Discussion: Translation vs. Rotational Angular Momentum

translational angular momentum: system center of mass moving about a point

rotational angular momentum: things rotating about center of mass

total angular momentum is sum.

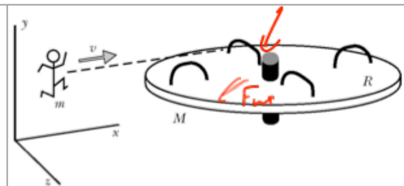
Clicker Questions: Merry-Go-Round

Q3

$\vec{r} = 0$

Child runs and jumps on playground merry-go-round. For the system of the child + disk (excluding the axle and the Earth), which statement is true from just before to just after impact?

(K = total kinetic energy,
$\vec{P}$ = total linear momentum,
$\vec{L}$ = total angular momentum about the axle)



$\tau = \vec{r} \times \vec{F}$
$= 0$

A) ~~K, $\vec{P}$,~~ and $\vec{L}$ do not change

B) ~~$\vec{P}$ and $\vec{L}$ do not change~~

C) $\vec{L}$ does not change

D) ~~K and $\vec{P}$ do not change~~

E) ~~K and $\vec{L}$ do not change~~

$\Delta\vec{p} = \vec{F}_{net}\Delta t = 0$

inelastic $\Delta K \neq 0$

$\Delta\vec{L} = \vec{\tau}\Delta t = 0$