

MOMENT OF INERTIA LAB
 SEE EXAMPLE 10.3 OF TEXTBOOK
 FROM EXAMPLE REFERENCED ABOVE AND FROM CHAPTER 2, IT CAN BE SHOWN

$$I = m \left(\frac{gt^2}{2h} - 1 \right) \cdot r^2$$
 We will use this formula to find the moment of inertia I of a disk and ring and then compare with the theoretical values. Here h is the vertical distance fallen by hanging mass m in time t, and r = radius of axle and I is the moment of inertia for horizontally spinning disk and/or ring of demonstration equipment used in class for the past few weeks. You will measure r with vernier calipers, t with a digital timer, and m is from the weight sets and sits on a 50 g hanger. The data sheet below suggests we must eliminate I for the spindle (SP) to find the ring (RING) and disk (DISK) I's. We will get these I's by subtracting various results given below in data sheet.

DATA SHEET:

r =	m =	h =
SPINDLE + RING		
TIME t	$I_{SP} + I_{RING}$	
1 time1	Blank	
2 time2	Blank	
3 time3	Blank	
4 time4	Blank	
Average t t_{AV}	average $I_{SP} + I_{RING} = m \left[\frac{g t_{AV}^2}{2h} - 1 \right] r^2$	
SPINDLE + DISK		
TIME t	$I_{SP} + I_{DISK}$	
1 time1	Blank	
2 time2	Blank	
3 time3	Blank	
4 time4	Blank	
Average t t_{AV}	average $I_{SP} + I_{DISK} = m \left[\frac{g t_{AV}^2}{2h} - 1 \right] r^2$	

SPINDLE + DISK + RING	
TIME t	$I_{SP} + I_{DISK} + I_{RING}$
1 t1	Blank
2 t2	Blank
3 t3	Blank
4 t4	Blank
Average t t t_{AV}	average $I_{SP} + I_{DISK} + I_{RING} = 11$
1. COMPUTE I_{DISK} USING APPROPRIATE SUBTRACTION.	
2. COMPUTE I_{RING} USING APPROPRIATE SUBTRACTION.	
COMPARE DYNAMIC MEASUREMENTS WITH THEORETICAL I-VALUES.	
RING MASS $M_{RING} =$	
RING RADIUS $R_{RING} =$	
THEORETICAL $I_{RING} =$	
PERCENT DIFFERENCE	
DISK MASS $M_{DISK} =$	
DISK RADIUS $R_{DISK} =$	
THEORETICAL $I_{DISK} =$	
PERCENT DIFFERENCE	

$$\left[\frac{I_{AV}}{t_{AV}} - I \right] \cdot r^2$$

ENTER RAW DATA IN THE ABOVE TABLE. SHOW CALCULATIONAL WORK IN SPACE BELOW AND ATTACHED WHITE SHEETS.

CH10

$$ma = mg - T$$

$$T = I \frac{a}{r^2}$$

$$\begin{cases} ma = mg - T \\ I \frac{a}{r^2} = T \end{cases}$$

$$\rightarrow a \left(m + \frac{I}{r^2} \right) = mg$$

$$\frac{mg}{a} = m + \frac{I}{r^2}$$

$$m \left(\frac{g}{a} - 1 \right) r^2 = I$$

$$\frac{1}{2} a t^2 = h \quad a = \frac{2h}{t^2}$$

$$m \left(\frac{g}{2h} - 1 \right) \cdot r^2 = I$$

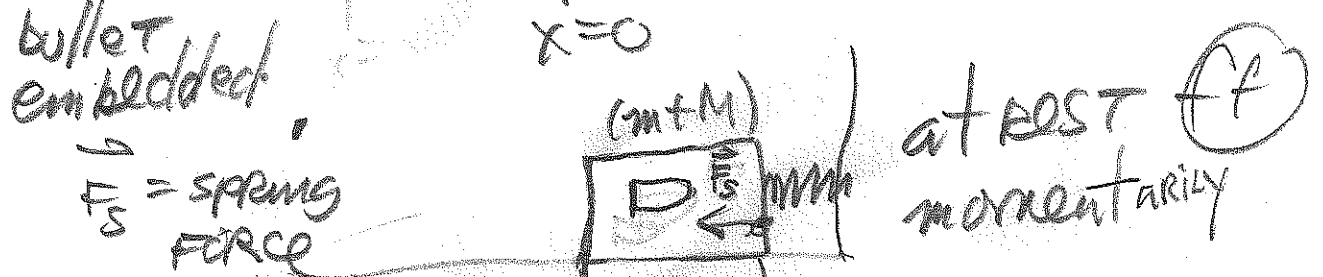
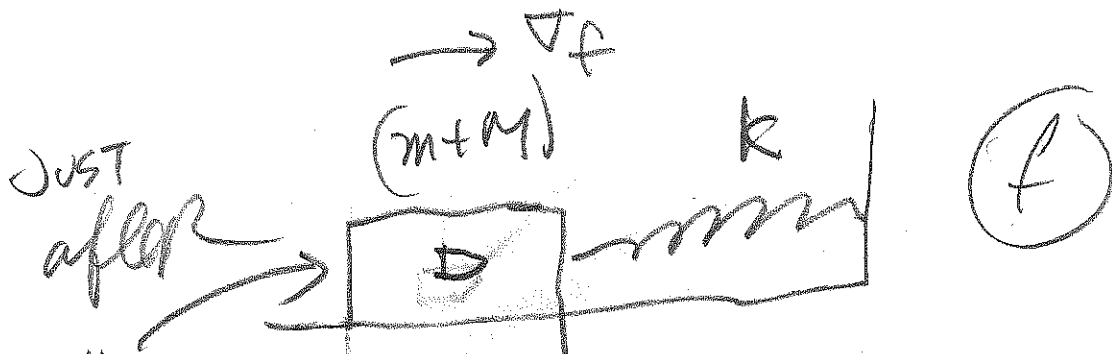
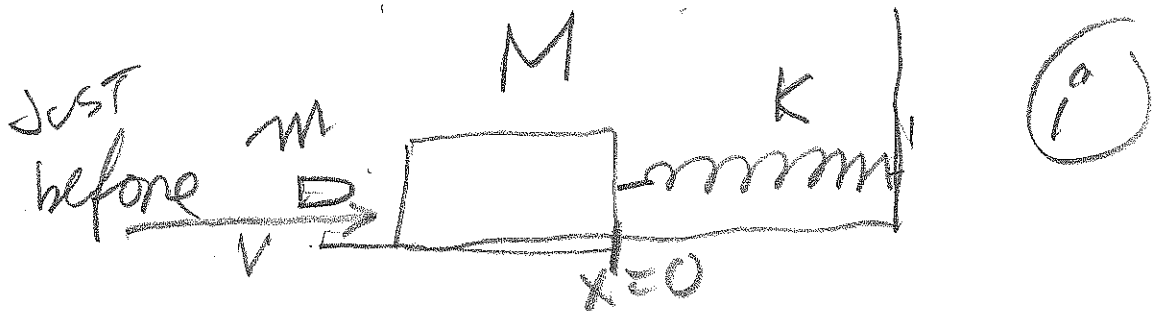
$$I = m \left(\frac{gt^2}{2h} - 1 \right) \cdot r^2$$

5-1-13

CLASS CN8 REVIEW

(43) see example 8.8

(83) → 86, 93, 85, 24



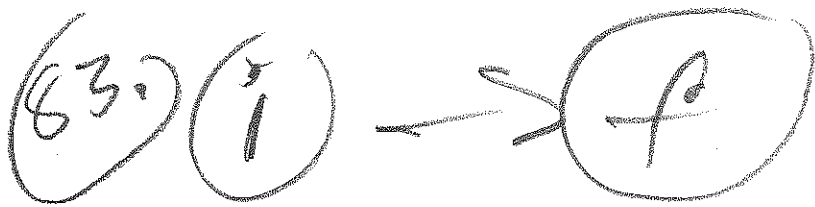
(i) → (f)

(f) → (f)

momentum

ENERGY

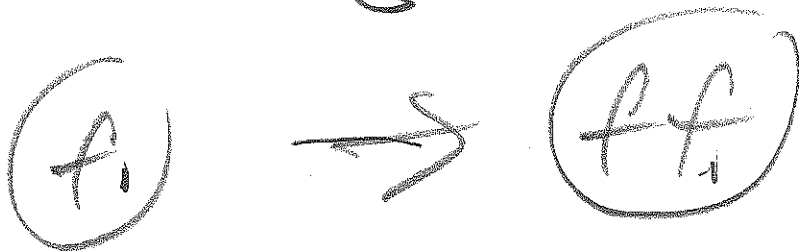
conservation
LAW
USED.



$$\sum_i P_x = \sum_f P_x$$

$mV + 0 = (m+M) \cdot V_f$


WOODEN
BLOCK
@ REST



$$KE_f + U_f = KE_{ff} + U_{ff}$$

$$\frac{1}{2} (m+M) V_f^2 + 0 = 0 + \frac{1}{2} KD^2$$

≥ EQUATIONS! (1) $mV = (m+M) \cdot V_f$

(2) $\frac{1}{2} (m+M) V_f^2 = \frac{1}{2} KD^2$

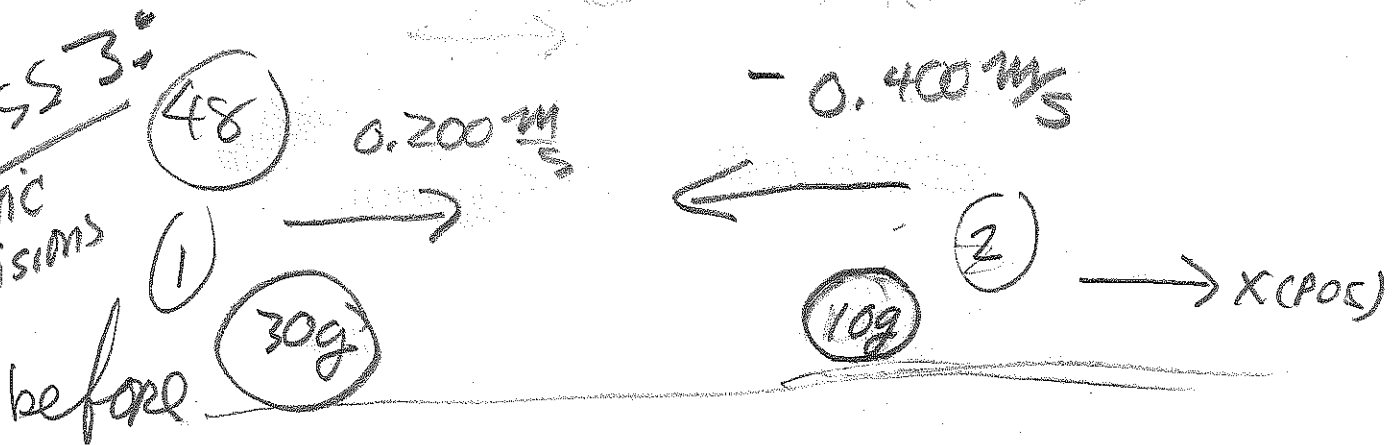
OR $V_f = \frac{mV}{(m+M)}$

#83 OPTIONS:

(i) given v and find D .

(ii) given D and find v

CLASS 3:
ELASTIC
COLLISIONS



$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$(30)(0.2) + (10)(-0.4)$$

$$= (30)v_{1f} + (10)v_{2f}$$

$$v_{1i} - v_{2i} = v_{2f} - v_{1f}$$

$$0.20 - (-0.4) = v_{2f} - v_{1f}$$

$$0.60 = v_{2f} - v_{1f}$$

$$6 - 4 = 30V_{if} + 10V_{zf}$$

$$2 = 30V_{if} + 10V_{zf}$$

$$0.60 = V_{zf} - V_{if}$$

$$V_{zf} = 0.60 + V_{if}$$

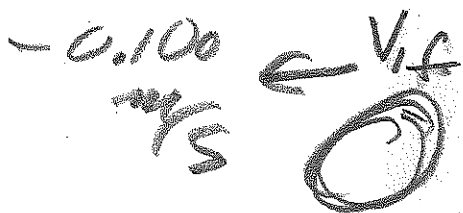
$$2 = 30V_{if} + 10(0.60 + V_{if})$$

$$2 = 30V_{if} + 6 + 10V_{if}$$

$$-4 = 40V_{if}$$

$$-0.100 \frac{m}{s} = V_{if}$$

$$\Rightarrow V_{zf} = 0.60 + (-0.10)$$
$$= 0.500 \frac{m}{s}$$



AFTER COLLISION

HW

We did: 12 and by implication 11.

(12) review:

$$\frac{1}{2}(2)(-4)^2 + \frac{1}{2}(300)(0.2)^2 = \frac{1}{2}(300)A^2$$

~

$$16J + 6J = 150A^2$$

$$A = \sqrt{\frac{22}{150}} = 0.383(\text{cm})$$

✓ check $A > x_0 = 0.200(\text{cm})$

$$x = A \cos(\omega t + \phi)$$

$$x(0) = A \cos \phi = x_0 \rightarrow A \cos \phi = 0.2$$

$$\frac{dx}{dt}(0) = v(0) = -\omega A \sin \phi = v_0 \rightarrow -\omega A \sin \phi = -4$$

$$\cos \phi > 0 \text{ and } \sin \phi > 0$$
$$\rightarrow \phi = \cos^{-1}\left(\frac{0.200}{0.383}\right) = 58.5^\circ$$

(12.) CH14

$$x = 0.383 \cdot \cos(\omega t + 58.5^\circ)$$



$$\omega = \sqrt{\frac{k}{m}}$$

CONVERT
TO RAD*

$$= \sqrt{\frac{300}{2}} = \sqrt{150} = 12.25 \frac{\text{RAD}}{\text{s}} \quad **$$

$$x = 0.383 \cdot \cos(12.25t + 58.4^\circ)$$

$$** \frac{\text{RAD}}{\text{s}} = \text{s}^{-1}$$

CH14:

(11)

comparison

(#11)

$$x = A \cos(\omega t + \phi)$$

$$x_0 = A \cos \phi$$

$$v_0 = -\omega A \sin \phi$$

$$\text{at } t=0: v_0 = -12.0 \frac{\text{m}}{\text{s}}$$

$$x_0 = 0$$

GOOD GUESS: $x = -A \sin \omega t$

$$\frac{1}{2} m v_0^2 + \frac{1}{2} k x_0^2 = \frac{1}{2} k A^2$$

$$\frac{1}{2} (2)(-12)^2 + 0 = \frac{1}{2} (300) A^2$$

$$144 = 150 A^2$$

$$A = \sqrt{\frac{144}{150}} = 0.98 \text{ (m)}$$

#11

-CHIF

$$A \cos \phi = x_0$$

$$-\omega A \sin \phi = v_0$$

$$\rightarrow 0.98 \cos \phi = 0$$

$$\rightarrow -\omega (0.98) \sin \phi = -12$$

$$\left. \begin{array}{l} \cos \phi = 0 \\ \text{und } \sin \phi > 0 \end{array} \right\} \phi = \frac{\pi}{2}$$

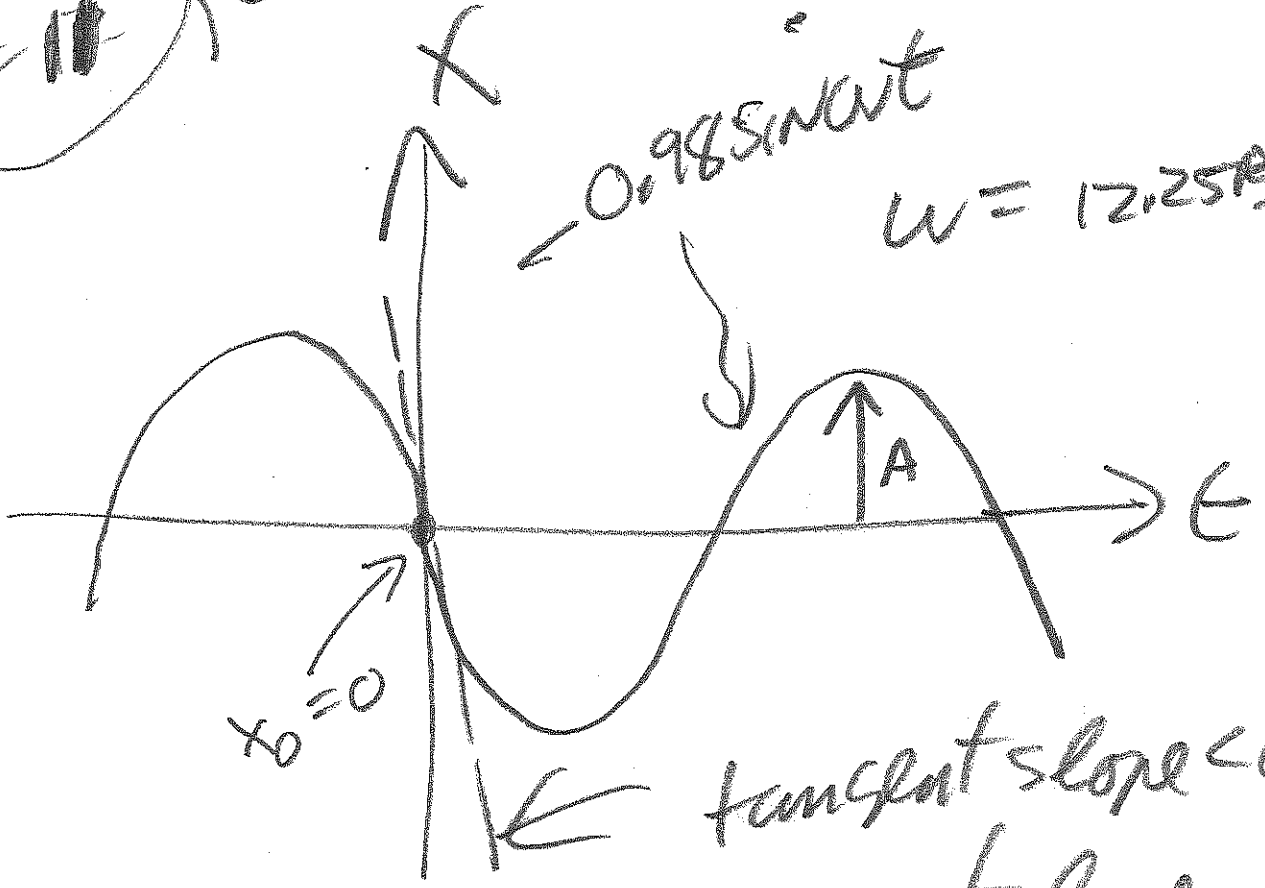
$$x = 0.98 A \cos \left(\omega t + \frac{\pi}{2} \right)$$

$$\cos \omega t \cdot \cos \frac{\pi}{2} - \sin \omega t \cdot \sin \frac{\pi}{2}$$

$$= -\sin \omega t$$

TRUE SOLUTION: $x = -0.98 \sin \omega t$

11
CH 14



$$\omega = 12.25 \frac{\text{RAD}}{\text{S}}$$

tangent slope < 0

tangent slope

$$= -12 \frac{\text{m}}{\text{s}} = v_0$$

and $x_0 = 0$

$$x = -0.98 \sin 12.25t$$