Seating for PHYS 1020 Term Test, 2007
Tuesday, October 23, 7-9 pm

Student numbers		Room
From	To	
6504394	6842355	200 Fletcher-Argue
6842547	6852067	200 Armes
6852080	6852939	206 Tier
6852942	6855233	306 Tier
6855256	7607350	223 Wallace

GENERAL PHYSICS I: PHYS 10

Schedule - Fall 2007
(lecture schedule is approximate)

8	M	22	19	Chapter 7	Impulse and momentum	No lab or tutorial
	Tue	23	MID-TERM TEST, Ch 1-5, Tuesday, October 23, 7-9 pm			
	W	24	20	Chapter 7	Impulse and momentum	
	F	26	21	Chapter 8, sections 1-3 only	Rotational kinematics	
9	M	29	22			Experiment 3: Forces in Equilibrium
	W	31	23	Chapter 9 sections 1 - 3, 6	Rotational dynamics	
	F	Nov 2	24			
10	M	5	25	Chapter 10 exclude 10.7 and 10.8	Simple harmonic motion, sections 10.5 and 10.6, for self study only	Tutorial and Test 3 (chapters 7, 8)
	W	7	26			
	F	9	27	Chapter 11 exclude 11.11	Fluids	

Tuesday, October 23, 7-9 pm, midterm: ch. 1-5
(20 multiple-choice questions)

Mastering Physics Assignment 3

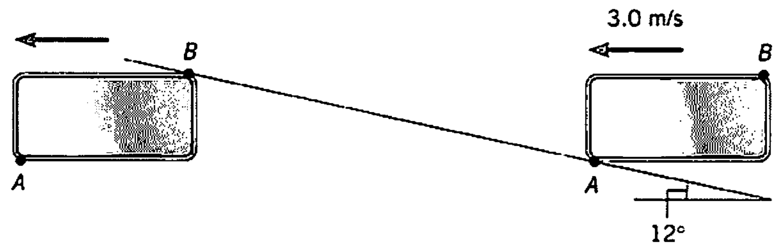
Assignment 3 is available on the Mastering Physics website

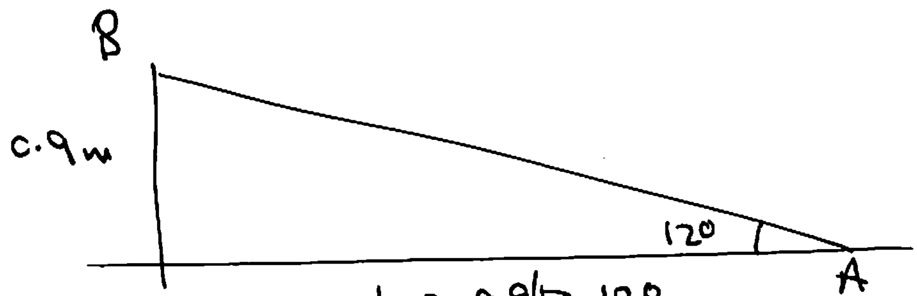
It is due Friday, October 26 at 11 pm

It covers material from chapters 4 and 5 as preparation for the term test on Tuesday

There are 8 questions for practice and 6 for credit

2.11: You are in a train that is travelling at 3 m/s along a level straight track. Very near and parallel to the track is a wall that slopes upward at 12^0 with the horizontal. As you face the window (0.9 m high, 2 m wide) the train is moving to the left. The top edge of the wall first appears at window corner A and eventually disappears at window corner B. How much time passes between the appearance and disappearance of upper edge of the wall?





$L = 0.9/\tan 12^0$

$L = 4.23\,m$

Train travels an additional 2m (width of window).

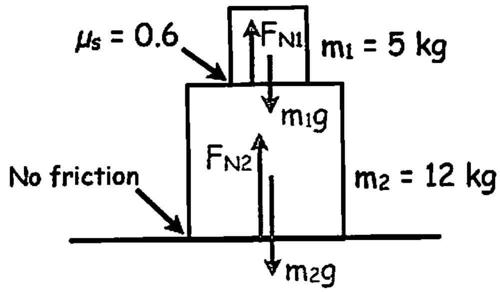
So total distance train travels $= 4.23 + 2 = 6.23\,m$

@ 3 m/s, so time's $\frac{6.23}{3} = \underline{2.08\,s}$

4.86: A 5 kg block is placed on top of a 12 kg block that rests on a frictionless table. The coefficient of static friction between the two blocks is 0.6.

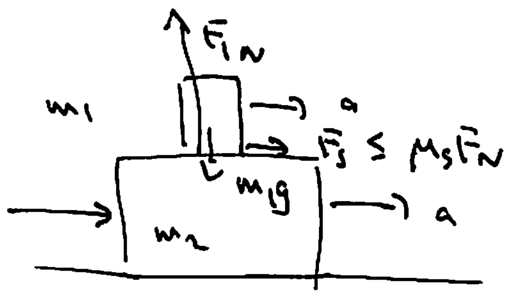
What is the maximum horizontal force that can be applied before the 5 kg block begins to slip relative to the 12 kg block, if the force is applied:

a) to the more massive block, and,
b) to the less massive block?



- The applied force accelerates both blocks if they stick together
- The friction force accelerates the block that is not pushed

a)



F accelerates m_1 and m_2:

$$F = (m_1 + m_2)a \quad (1)$$

F_s accelerates m_1: $\quad F_s = m_1 a \quad (2)$

and $\quad F_s = \mu_s F_N = \mu_s m_1 g \quad (3)$ max. value

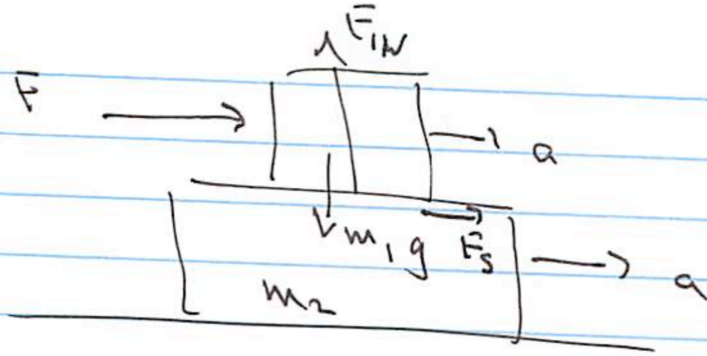
So, (2) and (3) $\quad F_s = m_1 a = \mu_s m_1 g$

$$a = \mu_s g$$

Sub. into (1): $\quad F = (m_1 + m_2)\mu_s g = (5+12) \times 0.6 g$

$$F = 100\text{ N}$$

b)



If blocks stick together, F accelerates them both:-

$$F = (m_1 + m_2)a \quad \text{as before.}$$

F_s accelerate lower block:

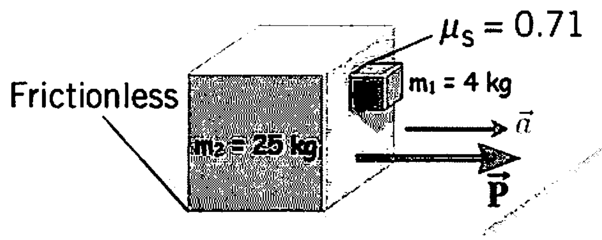
$$F_s = m_2 a = \mu_s F_{1N} = \mu_s m_1 g \quad \text{(max. value)}$$

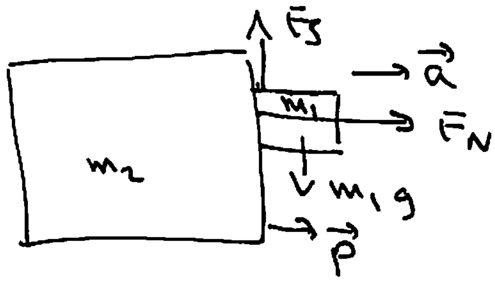
so $a = \mu_s \frac{m_1}{m_2} g$

Substitute: $F = (m_1 + m_2)\mu_s \frac{m_1}{m_2} g = 17 \times 0.6 \times \frac{5}{12} g$ N

$F = 41.6$ N

4.43/44: What is the smallest magnitude of the force P so that the small cube is held in place by friction as the blocks are accelerated?





m_1 is held in place by friction, F_s,

so $F_s = m_1 g$ and $F_s = \mu_s F_N$ (max. value)

so $\underline{\mu_s F_N = m_1 g}$ (1)

F_N accelerates m_1 $\therefore$ $F_N = m_1 a$

so $\mu_s F_N = \mu_s m_1 a = m_1 g$ (from (1))

$\underline{\mu_s a = g}$ (2)

P accelerates $(m_1 + m_2)$:

$P = (m_1 + m_2) a = (m_1 + m_2) \frac{g}{\mu_s}$ (from (2))

so $P = (4 + 25) \frac{g}{0.71} = \underline{400 \text{ N}}$

2.33/30: A speedboat starts from rest and accelerates at 2.01 m/s^2 for 7 s. At the end of this time, the boat continues for an additional 6 s with an acceleration of 0.518 m/s^2. Following this, the boat accelerates at -1.49 m/s^2 for 8 s.

a) What is the velocity at t = 21 s?
b) Find the total displacement of the boat.

1) $v_0 = 0$, $a_1 = 2.01\ m/s^2$, $t_1 = 7s$

$v_1 = v_0 + a_1 t_1 = 0 + 2.01 \times 7 = \underline{14.07 m/s}$

$x_1 = x_0 + v_0 t_1 + \frac{1}{2} a_1 t_1^2 = 0 + 0 + \frac{1}{2} \times 2.01 \times 7^2 = \underline{49.25 m}$

2) $v_1 = 14.07 m/s$, $a_2 = 0.518\ m/s^2$, $t_2 = 6s$

$v_2 = v_1 + a_2 t_2 = 14.07 + 0.518 \times 6 = \underline{17.18 m/s}$

$x_2 = x_1 + v_1 t_2 + \frac{1}{2} a_2 t_2^2 = 49.25 + 14.07 \times 6 + \frac{1}{2} \times 0.518 \times 6^2$

Monday, October 22, 2007

$x_2 = \underline{142.99 m}$

3) $v_2 = 17.18 m/s$, $a_3 = -1.49\ m/s^2$, $t_3 = 8s$

$v_3 = v_2 + a_3 t_3 = 17.18 - 1.49 \times 8 = \underline{5.26 m/s}$

$x_3 = x_2 + v_2 t_3 + \frac{1}{2} a_3 t_3^2 = 142.99 + 17.18 \times 8 + \frac{1}{2}(-1.49) 8^2$

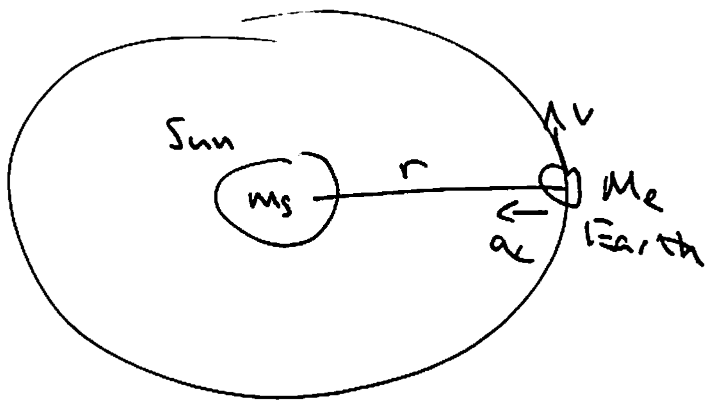
$x_3 = \underline{232.8 m}$

$\underline{5.26 m/s,\ 233 m}$

Question #7, MID TERM TEST, 2004

Calculate the mass of the sun from the radius of the earth's orbit, R_E, the earth's period in its orbit, and the gravitational constant. ($G = 6.67 \times 10^{-11}$ N.m^2/kg^2, $M_{earth} = 5.98 \times 10^{24}$ kg, $R_E = 1.5 \times 10^{11}$ m)

A) 1.34×10^{19} kg B) 5.98×10^{24} kg C) 2.00×10^{30} kg
D) 1.15×10^{33} kg E) 2.67×10^{35} kg



Force between earth and sun: $F = \frac{G m_s m_e}{r^2} = \frac{m_e v^2}{r}$

so $v^2 = \frac{G m_s}{r}$

1 year is $T = \frac{2\pi r}{v} = 2\pi r \sqrt{\frac{r}{G m_s}}$

so $m_s = \left[\frac{2\pi r}{T}\right]^2 \frac{r^3}{G}$ $\boxed{T^2 \propto r^3}$

$m_s = \left[\frac{2\pi \times 1.5 \times 10^{11}}{365 \times 24 \times 3600\,s}\right]^2 \frac{(1.5 \times 10^{11})^3}{6.67 \times 10^{-11}}$ kg

$m_s = 2.01 \times 10^{30}$ kg (C)

Q15, 2005 Midterm: The orbital radius about the sun of Saturn is about 10 times that of Earth. The period of Saturn is about:

a) 6 y, b) 30 y, c) 40 y, d) 90 y, e) 160 y.

Previous question: $T^2 \propto r^3$ Kepler's 2nd law

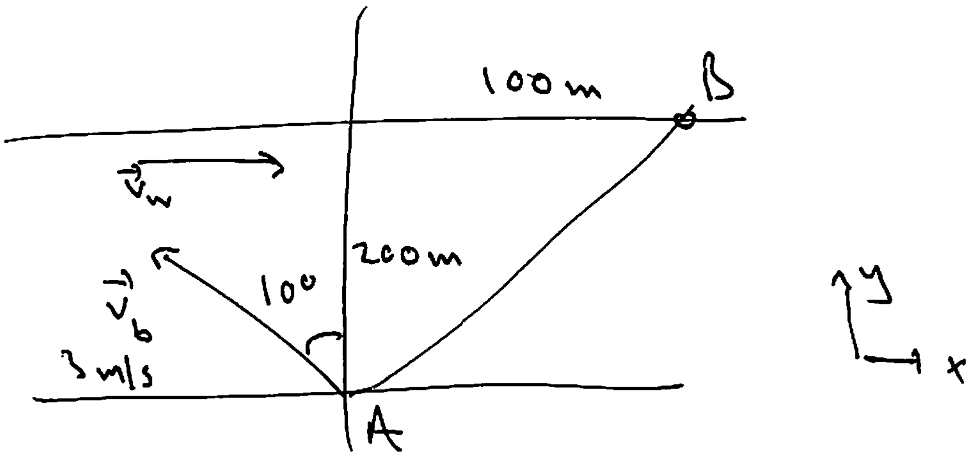
so $\left(\frac{T_S}{T_E}\right)^2 = \left(\frac{r_S}{r_E}\right)^2$

$$\frac{T_S^2}{(1y)^2} = [10]^3$$

$$T_S^2 = [1000]\ y^2$$

$$T_S = \sqrt{1000} = 32\ y$$

Q4, 2006 Midterm: A boat pilot must cross a river that is 200 m wide and arrive at the dock that is 100 m downstream. To do so, he must steer the boat at an angle of 10^0 upstream. The boat's speed in the water (at rest) is 3 m/s. What is the speed of the current of the river?



In time t boat travels 200 m in y and 100 m in x.

y: $200 = [v_b \cos 10°]\, t$ (1)

x: $100 = [v_w - v_b \sin 10°]\, t$ (2)

so, $\dfrac{200}{100} = \dfrac{[v_b \cos 10°]\, t}{[v_w - v_b \sin 10°]\, t}$

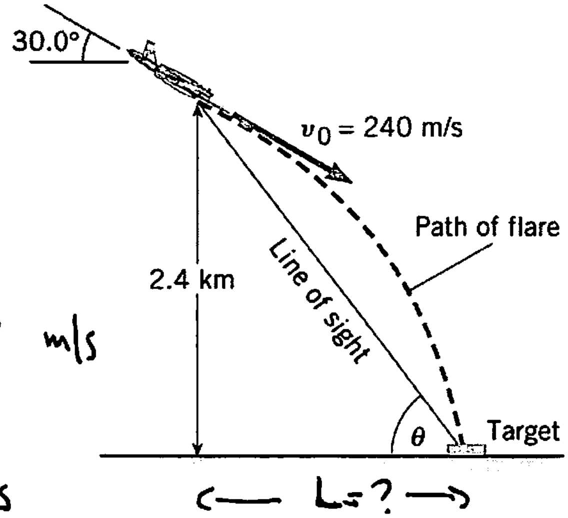
$2[v_w - v_b \sin 10°] = v_b \cos 10°$

~~$v_b = \dfrac{2v_w}{\cos 10° + 2\sin 10°}$~~ $v_w =$

$v_w = \dfrac{v_b \cos 10° + 2 v_b \sin 10°}{2}$, $v_b = 3$ m/s

$v_w = 2$ m/s

3.37/71: An airplane is flying with a velocity of 240 m/s at an angle of 30^0 with the horizontal. When the altitude of the plane is 2.4 km, a flare is released from the plane. The flare hits the target on the ground. What is the angle θ?



$v_x = v_0 \cos 30^\circ = 240 \cos 30^\circ$ m/s

$v_x = 207.8$ m/s (constant)

$v_{y0} = -240 \sin 30^\circ = -120$ m/s

Time for flare to reach ground? $L = v_x t$

$$y = y_0 + v_{0y} t - \frac{1}{2} g t^2$$

$$0 = 2400 - 120t - \frac{1}{2} g t^2$$

So, $g t^2 + 240t - 4800 = 0$

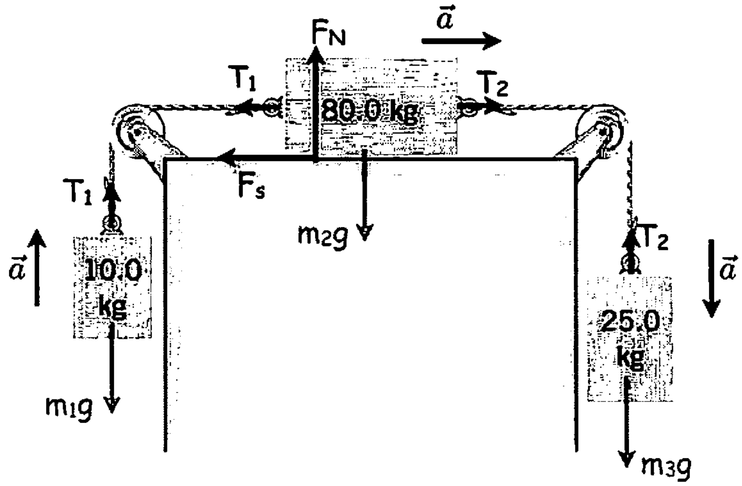
$$t = \frac{-240 \pm [240^2 + 4g \times 4800]^{1/2}}{2g} = 13.05 \text{ s}$$

Then $L = v_x t = 207.8 \times 13.05 = 2711$ m

$$\tan\theta = \frac{2400}{2711} \rightarrow \theta = 41.5^0$$

4.109: The coefficient of kinetic friction between the block and the table is 0.1.

a) What is the acceleration of the three blocks?
b) Find the tension in the two strings.



Block 1: $T_1 - m_1 g = m_1 a$ (1)

Block 2: $T_2 - T_1 - F_s = m_2 a$ (2)

Block 3: $m_3 g - T_2 = m_3 a$ (3)

$F_s = \mu_s m_2 g$ (4)

as $F_N = m_2 g$

Substitute for T_1, T_2 into (2)

(2) $\underbrace{m_3(g-a)}_{T_2} - \underbrace{m_1(a+g)}_{T_1} - F_s = m_2 a$, where $F_s = \mu_s m_2 g$

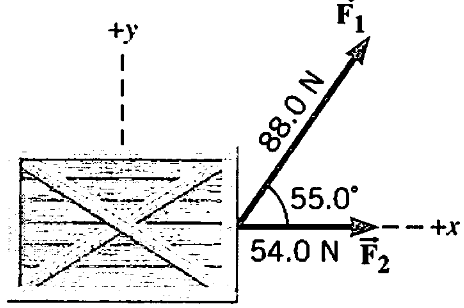
$$g[m_3 - m_1] - F_s = a[m_2 + m_3 + m_1]$$

$$a = \frac{g[m_3 - m_1] - \mu_s m_2 g}{m_1 + m_2 + m_3} = \underline{0.597 \text{ m/s}^2}$$

(1) $T_1 = m_1(a+g) = \underline{104 \text{ N}}$

(3) $T_2 = m_3(g-a) = \underline{230 \text{ N}}$

4.45/110: A 25 kg crate is initially at rest. The view in the diagram is from above. Forces F_1 and F_2 are applied to the crate and it begins to move. The coefficient of kinetic friction between the crate and the floor is $\mu_k = 0.35$. Determine the magnitude and direction of the acceleration.

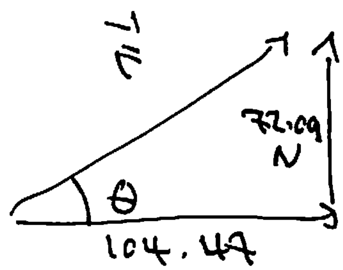


Top view

The acceleration is in the direction of the resultant force.

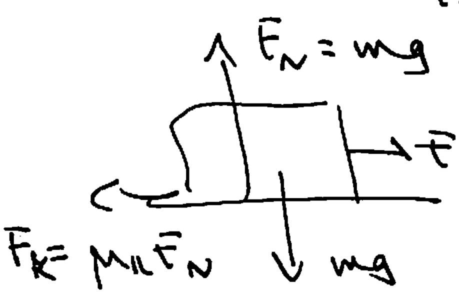
x: $F_x = 54 + 88\cos 55^\circ = 104.47\text{ N}$

y: $F_y = 88\sin 55^\circ = 72.09\text{ N}$



$F = \sqrt{F_x^2 + F_y^2} = 126.9\text{ N}$

$\tan\theta = \dfrac{F_y}{F_x}$, $\theta = 34.61^\circ$



$F_k = \mu_k F_N = \mu_k mg$

$F_k = 0.35 \times 25g = 85.75\text{ N}$

Net force in direction of displacement $= F - F_k = 126.9 - 85.8\text{ N}$

$F_{net} = 41.2\text{ N}$

$a = \dfrac{F_{net}}{m} = \dfrac{41.2\text{ N}}{25\text{ kg}} = 1.65\text{ m/s}^2$ at 34.6° above +x-axis

Q6, Dec 2006 Final: Two cars approach each other on a straight level road. Car A is travelling at 75 km/h north and car B is travelling south at 45 km/h. What is the velocity of car A relative to car B?

$\uparrow \vec{v}_A$ 75 km/h $\quad\quad \downarrow \vec{v}_B$ 45 km/h

$$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$$

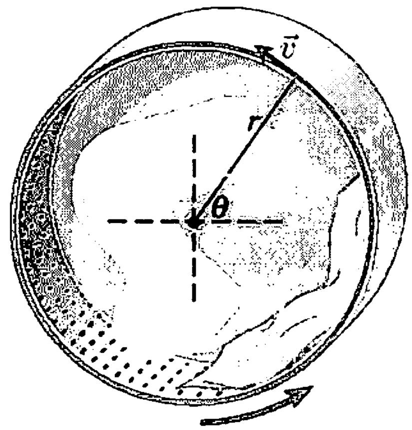
$$= 75 + 45 = 120 \text{ km/h}$$

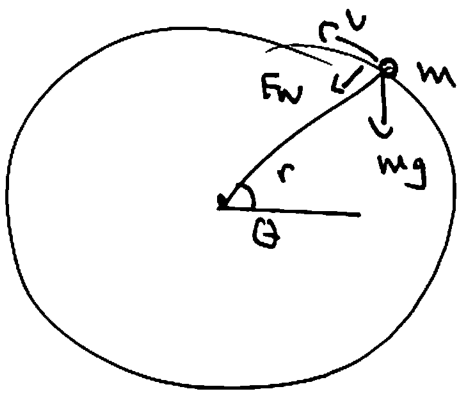
to N

$\uparrow \vec{v}_A$

$\uparrow -\vec{v}_B$

5.42: In an automatic clothes dryer, a hollow cylinder moves the clothes on a vertical circle of radius r = 0.32 m. When a piece of clothing reaches an angle θ above the horizontal, it loses contact with the wall of the cylinder and falls onto clothes below. How many revolutions per second should the cylinder make so that the clothes lose contact with the wall when θ = 70⁰?





Force toward centre of drum:–

$$F_N + mg\sin\theta = \frac{mv^2}{r}$$

If $F_N = 0$: $mg\sin\theta = \frac{mv^2}{r}$

So $v = \sqrt{rg\sin\theta}$

$v = [0.32 \times 9.8\sin 70^0]^{1/2}$

$v = 1.717$ m/s

No. of revs/s $= \frac{vt}{2\pi r} = \frac{1.717 \times 1}{2\pi \times 0.32} = 0.854$ rev/s