REALITY PHYSICS

Calculus Based

Includes F2009 Discussion Notes

Twentieth Edition Fall 2013

By
K.W. Nicholson

Central Alabama Community College

Question Everything

CENTRAL ALABAMA COMMUNITY COLLEGE
Official Course Syllabus: PHY 213 - Cal-based PHYSICS I
Fall Semester, 2013

INSTRUCTOR: K. W. Nicholson
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Office: BS 214 **Office Hours** : Tuesday & Thursday 11:30 AM -1:00 PM, others by appoinntment

COURSE TITLE AND CREDIT:

PHY 213 - General Physics with Calculus I
2.5 Hrs Lecture 2 Hrs Lab Credit: 4 semester Hours

COURSE CO-REQUISITES: Math 125 Calculus I

I. COURSE DESCRIPTION:
This course provides a calculus based study in classical physics. Topics included are: mechanics, heat and thermodynamics.

II. COURSE OBJECTIVES: As a result of successfully completing this course the student will be able to:

1. Make measurements accurately and analyze data in lab experiments.
2. State the difference between distance and displacement, and between speed and velocity.
3. Understand and use the concept of acceleration.
4. Solve constant acceleration problems using the kinematic equations of motion.
5. Analyze and solve simple projectile motion problems involving one and two moving objects.
6. Use free body diagrams in the analysis of simple statics and motion problems.
7. Extend Newton's laws to solve rotational motion problems.
8. Use Archimedes Principle to solve simple bouancy problems.
9. Understand the difference between temperature and heat.
10. Understanding Simple Harmonic Motion
11. Solve simple applications of the first and second laws of thermodynamics.

III. CONTENT AND ORGANIZATION:

1.Serway & Jewitt's, Chapter 1: Measurement.
2.Serway & Jewitt's, Chapter 2: Distance, displacement, speed and velocity.
3.Serway & Jewitt's, Chapter 3: Vectors
4. Serway & Jewitt's, Chapter 4: Projectile and circular motion
5. Serway & Jewitt's, Chapter 5: Force and Newton's three laws of motion.
6.Serway & Jewitt's, Chapter 6: Circular Motion.
7.Serway & Jewitt's, Chapter 7 & 8: Energy
8.Serway & Jewitt's, Chapter 9: Linear Momentum & Colllisions.
9.Serway & Jewitt's, Chapter 10: Rotational Motion
10. Serway & Jewitt's, Chaper 11: Angular Momentum
11.Serway & Jewitt's, Chapter 12: Statics & Elasticity

12.Serway & Jewitt's, Chapter 14: Fluid Mechanics.
13.Serway & Jewitt's, Chapter 15: Simple Harmonic Motion
14..Serway & Jewitt's, Chapter 19 - 22: Heat and Thermodynamics

LABS:

1. Measurement
2. Intro to Motion
3. Projectile Motion
4. Force I
5. Force II
6: Force, Work & Power
7. Work & Potential Energy.
8. Momentum
9: Rotation Motion Lab
10: Torque
11: Statics
12: Archimedes Principle
13. Heat & Thermo Lab 1: Temperature
14: Heat & Thermo Lab 2: Heat Transfer I
15: Heat & Thermo Lab 5: Phase Change

IV. References: Alan Van Heuvelen's ALPS Kits, Kinetic Books text (on computers in lab)

V. Required (Graded) Assignments: 10-15 -15 pt experiments, 3 -100 point tests, 1- 200 point final, daily Reading Quizzes, 100 points

VI. EVALUATION:

Item	Discussion
10 -15 -20 pt Experiments approximately 300 pts total Thursday's 1 - 3 **Note: You will notice there are more than 15 labs. These are all suggestions. You will select your own 15 labs, or design and conduct your own experiments.** You will spend the final 15 min selecting your next lab.	Labs will be done in groups of my choosing. Data sheets and lab write-ups will be turned in individually. You must submit a copy of your data sheet on Wednesday prior to lab. You should come with most of your lab write-up completed, except for values obtained in lab, analysis, DOA, and conclusion. You may turn in labs electronically, either on flash drives, or email. Lab experiment write-ups are due at the end of the lab period. **None accepted late.** **You can do labs early, but not late.**
On time (Reading) Quizzes 100 pts total Daily	On time (Reading) quizzes cannot be made up or turned in late. (That's why we call them on time quizzes.)

3 - 100 pt tests *dates unknown*	*No make up tests will be given. First missed test will be replaced by 1/2 of your final exam score, any other missed tests will receive 0.* *If 100 % of the class agrees to take tests on Wednesdays 7:30 - 9:15, you will have more time to take tests.*
1-200 pt Final Exam date unknown	Final will be comprehensive.
50 points bonus! **Can be obtained by either:** **Doing a project (investigate something, do a really neat experiment, or build something useful.)** **Or join the science team.**	If you plan to go for the 50 point bonus, you must either join the science team or submit a prujject proposal **by Tuesday, September 10, 2013.**

Note 1: Use of communication devices such as pagers, cell phones, walkie talkies, or whatever, is prohibited in this class. If one rings, buzzes, vibrates or distracts you or the class, you may be dismissed from the course.

Note 2: Playing games on computers in the physics lab may result in your being dismissed from this course.

GRADES:

The above total, excluding bonus points, is approximately 850 points and your accumulative total will be divided by that amount to calculate your final average.

90-100% = A, 80-89% = B, 70-79% = C, 60-69% = D, 0 - 59% = F

NOTES:

l. You should keep all returned papers. You should also keep track of the ratio (your accumulative total)/(The accumulative total possible to date) as the semester progresses.

VII. TEXTBOOKS CURRENTLY BEING USED:

Physics for Scientists & Engineers by Serway & Jewitt 9th edition
<u>Reality Physics Workbook,</u> k.w.nicholson

VIII. Other Important Information:

1. Attendance: We no longer have the permission to drop students for lack of attendance.

2. If you decide to drop this course, you must do so formally before mid-term by going to student services in the Administration Building and filling out a drop form. If simply stop coming to class, you will receive an F in this course!

3. If you have a disability that may prevent you from meeting the course requirements, contact the instructor

before the end of the first week of classes to file a student disability request and to discuss a reasonable plan. Course requirements will not be waived but accommodations may be made to assist you in meeting the requirements, provided you are timely in working with the instructor to develop a reasonable accommodation plan.

Physics 213 Fall 2013
Tuesday & Thursday 1:00 - 3:15

Tuesday	Thursday is Exp & planning day
August 20 OTQ #1	August 22 OTQ 2a Experiment 1 Measurement
August 27 OTQ Orientation 2.1 - 2.4 pos, vel, acc, & motion diagrams 2.5 - 2.6 Kinematic Eq. w/constant acc	August 29 OTQ Expiment 2
September 3 3.1 - 3.4 Vectors 4.1 - 4.5 2-D motion, Projectile Motion, & Circular Motion	September 5 Expiment 3
September 10 5.1 - 5.6 Newton's 1st & 2nd Laws 5.7 Newton's 3rd Law	September 12 Expiment 4
September 17 Test 1 5.8 Friction	September 19 Expiment 5
September 24 6.1 - 6.3 Newton's Laws & Circular Motion 7.1 - 7.5 Work	September 26 Expiment 6
October 1 7.6 - 7.9 More work 8.1 - 8.6 Potential Energy	October 3 Expiment 7
October 8 9.1 - 9.4 Linear Momentum 9.5 - 9.7 Center of Mass & Rockets	October 10 Expiment 8
October 15 Test 2 10.1 - 10.3 Rotational Motion	October 17 (Mid Semester today) Expiment 9
October 22 10.4 - 10.6 Kin En, Mom of Inertia, Torque 10.7 - 10.9 Work & Power	October 24 Expiment 10
October 29 11.1 - 11.4 Angular Momentum 12.1 - 12.2 Statics I	October 31 Expiment 11

November 5 12,3 - 12.4 Statics II 14.1 - 14.4 Pressure & Bouyancy	November 7 Expiment 12
November 12 Test 3 14.5 - 14.7 Bernoulli's Principle	November 14 Expiment 13
November 19 15.1 - 15.3 Simple Harmonic Motion 15.4 - 15.5 Energy and Pendulums	November 21 Expiment 14
November 26 Happy Thanksgiving	November 28 Happy Thanksgiving
December 3 19.1 - 19.5 20.1 - 20.4 Heat & First Law of Thermo	December 5 Expiment 15
December 7 22.1 - 22.3 Heat Engines 22.4 - 22.6 Carnot Engine, Entropy	December 9 Final Exam 1 - 3 ?
December 14 Review for Final Optional	December 16 Final Exam 1 - 3 ?

Note! This pacing chart is probably incorrect and subject to change at any time.

K.W. Nicholson's Schedule for Fall 2013

Monday & Wednesday	Tuesday/Thursday	Friday
Office hours by appointment only	11:30 - 1:00 Office	Office Hours by Appointment only
	1 - 3:15 Phy 213 & 201	

Homework Note: These are suggestions only, you should be in charge of doing "enough" problems to master the concepts and techniques laid out in the Rules of Engagement.

Chapter 2 Q2, P 3,5,7,12,15,23,27,50,51, **Bonus # 1 = 70**

Chapter 3 P 7,9,27,31,35,47

Chapter 4 Q 8, P 3,5,11,17,19,27,29,**Bonus # 2 = 32**

Chapter 5 P 3,9,11,14 ans a) 181° ccw, b) 11.2 kg, c) 37.5 m/s, d) **v**= -3.75**i - .**09**j** , 15, 21,25,29,41,55

Chapter 6 5,7,9,17,19,21,25

Chapter 7 2, ans F=31.7N, W = 1590J, 4, ans a)3.28 $x10^{-2}$ J, b) - 3.28 $x10^{-2}$ J, 9,11,13,15, 24, ans 2 J, b) 5 m/s, c)6.3 J, 26, ans a&b) 60J, 31, 33, 35,37,41,45

Chapter 8 Q11, P 1,5,13,23,31,33,36,41,43,45

Chapter 9 P 1,7,9,13,15,17,19,20, ans .556 m, 24, ans $v_b=2\sqrt{gl}$, v =(4M/m)$\sqrt{gl}$, 25, 38,41, 43,49,51 **Bonus # 3 =44B**

Chapter 10 P3,5,7,13,17, 21, - 23,25,31, - 37,45,46, ans 2.36 m/s, 51,61,7179

Chapter 11 P 1,3,5,6,9, 11, 12, ans -220 kg m^2/s in z direction, 15B, 25, 27, 29, 33

Chapter 12 P 3,7,9,13, 15,43,51, 69, 27,29,31,33,35

Chapter 14 P6, ans a) P=1.01x10^7 Pa , b) 7.09 x10^5 N, 9,17,23,27,35 / 39,45,53

Chapter 15 P 1,3,5,7,2327,31

Chapter 19 P 1,3,5,7, 9,15,17,27,33,53

Chapter 20 P 3,7,15,23,35,38, ans a) -4 PV, b) 4 PV, c) -9.08 KJ

Chapter 22 P 1,3,7,11,14,23,35

Appendix 1: Rules for Exponents

(according to kwn)

1. $a^n a^m = a^{n+m}$

2. $\frac{a^n}{a^m} = a^{n-m}$

3. $(a^n)^m = a^{nm}$

4. $(ab)^n = a^n b^n$

4'. $(a^k b^p)^n = a^{kn} b^{pn}$

4". $\sqrt[n]{ab} = \sqrt[n]{a}\,\sqrt[n]{b}$

5. $\frac{a}{b}^{\,n} = \frac{a^n}{b^n}$

5'. $\frac{a^k}{b^p}^{\,n} = \frac{a^{kn}}{b^{pn}}$

5". $\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$

5.''' $\frac{a^k}{b^p}^{\,-n} = \frac{b^p}{a^k}^{\,n} = \frac{b^{pn}}{a^{kn}}$

6. $a^0 = 1$

7. $a^{-n} = \frac{1}{a^n}$

8. $\sqrt[n]{a} = a^{\frac{1}{n}}$

8'. $\sqrt[n]{a^m} = a^{\frac{m}{n}}$

9. $\sqrt[n]{a}\,\sqrt[n]{b} = \sqrt[n]{ab}$

The Rules of Engagement

These steps must be followed to the letter. Failure to apply a single step renders a problem worthless.

Kinematic Motion Problems

1. Label as Kinematic Motion Problem
2. Draw a motion diagram
3. Draw Reference Frame
4. Label Positions A, B, etc
5. Find pos, vel, time for each position
6. Find equation & solve

Force Problems

1. Label as a Force Problem
2. Draw picture
3. Draw ref. Frame
4. Draw FBD
5. **Redraw force diagram replacing the object by a dot.**
6. Resolve all force into x and y components
7. Show $\sum F_x = ma_x$, and $\sum F_y = ma_y$
8. Solve for unknown

Projectile Motion Problems

1. Label as a Projection Motion Problem
2. Draw picture
3. Draw ref. Frame
4. Mark on picture points A and B
5. Write down in neat column form values for position, velocity, acceleration and time in both x and y directions at both points A & B..
6. Remember, $x_B = v_{Ax}\Delta t + x_A$ because $a_x = 0$
7. Remember, $y_B = -.5\ g\ \Delta t^2 + v_{Ay}\ \Delta t + y_A$ because the object is just a falling body in the vertical direction.
8. Solve for the required quantity.

Circular Motion Problems

1. Label as a Circular Motion Problem
2. Show positive direction
3. Show $\sum F_c =$ ______$= mv^2/r$
4. Solve

Momentum Problems

1. Label as a Momentum Problem
2. Draw 2 pictures --- before and after
3. Indicate system!!
4. Draw the reference frame
5. Indicate on picture initial and final values of momentum
6. Solve

Work Problems

1. Label as a Work Problem
2. Draw figure
3. Circle the system
4. Draw ref. Frame and show 0 ref. Level
5. Draw bar chart
6. Write equations and solve

Equilibrium Problems

1. Label as equilibrium problem
2. Draw picture
3. Draw ref. Frame
4. Draw FBD
5. Resolve all force into x and y components
6. Show $\sum F_x =$ _____________ $= ma_x=0$, and $\sum F_y =$ ____________________ $= ma_y=0$
7. Choose a pivot point P
8. Show $\sum \tau =$ ___________________$= 0$
9. Solve system of equations for unknowns

Intel in Pierce County-a Promising Partnership

Pat Raburn, Intel, Washington Site Manager
Presented to City Club of Tacoma, March 20,1996
Notes by: Kenneth Gentili

Intel's Goals:

• Discipline and attention to detail.

• Risk taking and innovation.

• Results orientated.

• Quality.

• Customer oriented.

• Productive and challenging work environment.

To be employed at Intel an employee would find that:

• They work in teams.

• Jobs are assigned based upon skills.

• The company does not want to have injuries.

• There is a safety program.

• They are rewarded for their accomplishments.

• There is a focus on education.

• They are encouraged to volunteer in schools.

KILLER PHRASES, THE ENEMY OF IDEAS

Killer Phrases

Killer Phrases are part of culture and upbringing. One study showed that negative no-can-do statements are all around us, outweighing positive can-do statements by substantial margins. At home, on the average, parents say 18 negative statements for every positive statement. The average is 432 negative statements per day. The same study showed that teachers display a 12 to-1 ratio of negative- to-positive statements.

The rules of brainstorming are:

READY Define your problem.

FIRE Come up with as many ideas as fast as you can without criticizing them.

QUANTITY COUNTS. **WILD IDEAS ARE ENCOURAGED!**

AIM. Sift. Synthesize. Choose.

Examples of Killer Phrases:

" Gimme a break."
"Because I said so."
"You have to be kidding."
... laughter...
;** dirty looks...
'Yes, but..."
"That's so dumb"

Igniter Phrases, Phrases that Make Things Work

In one study it was reported that a good teacher makes eight positive comments for every negative comment to the students.

Examples of Phrases That Make Things Work:

• "Nice Job."

• "Wow!

* " cool"

Effective Statements for Team Members

Each of the roles has a performance criteria acts like a job description. Listed are some helpful sayings that can assist you to help make the team a positive and rewarding experience.

A **leader or team manager** should reduce stress. A leader might say:

What do you think about . ?
Goodjob!

How can we apply or use this concept?
Would this be a good approach to ?
As I understand it, our conclusion is...
Let's listen to one idea at a time.
We need to refocus and deal with

What is your idea?
Should we do ..... ?

Could this be summarized by saying ?
Have we reached this conclusion ?

A **reporter** *is* responsible for representing the team's consensus. A reporter might say:

• How could we present that?
• How can I relay that effectively?
• Can I say that our team decided...
• Does our list consists of..
• Is it correct to say that our graph shows ... How can I put that simply?
• Through a process of elimination did we ... ?

An **explorer** creates new ideas and takes risks. An explorer might say:

• Let's consider this another way.
• What about this idea?
• Let's find new methods for presenting this material.
• What would happen if we combined these ideas?
• What is this analogous to?
• How should we present this?

A **reflector** looks at things as a big picture. *A* reflector might say:

This is what it sounds like, but it could also .... So what you are saying is But let's focus on How can we improve on ... ? Do we have all of the data? Is that going to achieve our goal?

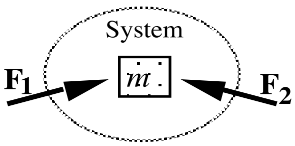
A **recorder** should be able to summarize items without editorializing. A recorder might say:

* Can we say this is ... ?
* Up to this point we gathered ...
* Where are we going with ? What data do we have to ? Can we say that more succinctly? Do we agree on this? Should it be recorded in our team journal?

Mechanics on a Sheet

CHANGING MOTION (Interactions do not add to zero)	CONSERVED MOTION (Interactions add to zero)

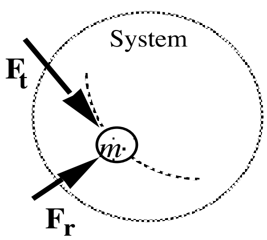
TRANSLATIONAL MOTION



Changing motion	Conserved motion
$\sum F_x = m a_x$ $\sum F_y = m a_y$	If $\sum F_x = 0$, then $\sum m v_x =$ constant. If $\sum F_y = 0$, then $\sum m v_y =$ constant.

Momentum Conserved

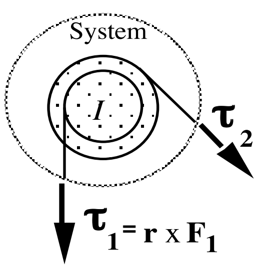
CIRCULAR MOTION



Changing motion	Conserved motion
$\sum F_{radial} = m a_{radial}$ $\sum F_{tangential} = m a_{tangential}$	If $\sum F_{tangential} = 0$, then $\sum m r v_{tangential} =$ constant.

Angular Momentum Conserved

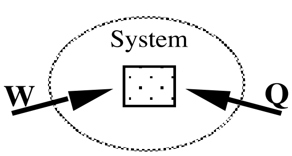
ROTATIONAL MOTION



Changing motion	Conserved motion
$\sum \tau = I \alpha$	If $\sum \tau = 0$, then $\sum I \omega =$ constant.

Angular Momentum Conserved

WORK AND ENERGY



Changing motion	Conserved motion
$W + Q = \Delta U_{system}$	If $W = Q = 0$, then $U_{system} =$ constant.

Energy Conserved

Science Team Instructions

If you choose to be on the science team as your project:

You must turn in by date noted in your course outline.

List of team members names, email addresses, phone numbers.
Name of school and teacher
Schedule of 5 dates and times when you will go visit the class.

Required deliverables from this project will be a team notebook.

You will be given a small binder in which you will put:

1. Pre-activity planning
Every member of the team taking part in this activity must attend the pre-activity planning session which must take place in the physics lab, and **sign attendance sheet**.
Pre-activity planning report. Must be submitted at least 1 day prior to doing the activity.

2. All members participating in an activity must sign a attendance sheet to be included in the

3. **Post -activity report.** Placed in your binder along with pictures.
You must include pictures in at least 3 of these reports. If you do not have a camera, we have a digital camera.

Science Team Pre - Activities Planning Template **(Before you go)**	**Science Team After Activities Report template (After return)**
Experiments 1. 2. 3. 4. Discussion of experiments and logistics Action Plan	Experiments 1. 2. 3. 4. Comments by ___________________ Comments by _____________________ Comments by _____________________ Comments by _______________________

Third Grade Teachers Names And Phone Numbers

Stephens Elementary 234 8631
Ann Goree 234-4566
Lynn Easterwood 329 3148
Lucretia Chappell cell 256 397 0180
home 256 329 1562
lchappell@alex.k12.al.us
agoree@alex.k12.al.us

Ellen Dean ?? call school and ask for her.

Dadeville: 825 6811
Elizabeth Yarbrough 825-7338 and 825 - 2483

Coosa Central Elementary
Ashley Manley 839 5687

Horseshoe Bend 329 9891 or 9110 - Lead teacher Tammy Oliver.
tammy oliver 329-2333
Linda Chambers 234-4027
Brenda White   825-4812

Chelsea Eementary: Ruth Ann Park 205 682-7220
home 205 678 8748

Kristan Barnett's gifted class from ashland 354-7564 or 215-3699

Sylacauga BB Comer   (256) 245-5302
Cecilia Wales 256 245 1460

Childersburg Elementary Pinecrest Road, Childersburg, AL 35044 (256) 378-7105

Childersburg :   Wattwood Elementary (behind WD)
Kelly Clayton : cell 256 208 0641 school number   256 315 5460

Physics 213Discussion # 1 Intro & 2.1-2.4 Monday 8-17-2009

Today's Definitions:
Chapter 2: Motion in One Dimension
D1
2-1 Define position.
2-2 Define displacement.
2-3 Define distance.
2-4 Define average speed.
2-5 Define average velocity.
2-6 Define instantaneous speed.
2-7 Define instantaneous velocity.
2-8 Define average acceleration.
2-9 Define instantaneous acceleration.

Class Procedure:
1. Reading Quiz - 10 minutes
2. Demo's & Discussion - 45 minutes
3. Conceptual Questions/Exercises - 20 minutes

Today's Agenda:
0. Reading Quiz # 1
1. Read the course syllabus very carefully please.
2. Take the Force Concepts Pre Test one day this week here in lab....
3. Demo Logger Pro using hand, constant velocity car, spring loaded car.
4. Get them to predict the shape of the x vs t curve for pasco car with initial speed up ramp.
5. Do & discuss all three curves.
6. Make sure they see and hear:
the difference between displacement and distance.
the difference between speed and velocity.
beware of acceleration.
An object that has an increase in speed of 30 mph in 10 s has an acc of 3 mph / s.
But, and object that is travelling on a circle of radius 8 m at a constant speed of 20 m/s **also** has an acceleraton.
$a = v^2 /r = 400/8 = 50\ m/s^2$. Acceleration measures either change in speed per unit time or change in direction per unit time or both.

7. Discuss Active Figures 2.3, 2.1, 2.10, 2.9, 2.11
Mention that these items are on all computers in the room.
8. Do problems 4,9,12,14 **STOP AT 10:20**
9. Do today's clickers.
Adjourn.

Physics 213Discussion # 2 2.5 & 2.6 Kinematic Motion 8-19-2009

Today's Agenda:
00. do the dollar drop.
0. Take the Force Concepts Pre Test one day this week here in lab..
1. Reading Quiz # 2
2. Do AVH - Train, car & truck, car down hill, S&J ch2 probs 21,28,52, 63, Rambo problem

1. A metro train in Washington DC starts from rest and accelerates at 2 m/s^2 for a time interval of 12 s. The train then travels at a constant speed for 60 s. The speed of the train then decreases for 12 s until it comes to a halt. Construct a pictorial diagram and find all values of position, velocity and acceleration.

2. The velocity of a car decreases as it travels down a hill that points down and to the left. Initially it travels at 9 m/s and 20 m further down the hill the car's speed is 4 m/s. Given that it is constant, determine the acceleration (magnitude and direction) of the car.

3. The Rambo Problem

Rambo parachutes onto the island. His mission is to help 20 prisoners escape from the evil island ruler. His plan is to release the prisoners, lead them to the hidden runway where a plane awaits, which, of course , he knows how to fly, load them all into the airplane and fly them to safety. All goes well until they reach the runway, and he finds the runway has been bombed. He estimates only 700m of runway remains. Being the expert in everything that he is, he knows:

- the airplane requires a speed of 90 m/s to become airborne,
- that acceleration of the empty plane is 9 m/s^2 ,
- that given the constant force of the engines, Newton's second law says acceleration is inversely proportional to mass, which means if mass of the plane doubles its acceleration halves,
- that the mass of the empty airplane is 3000kg,
- he estimates the mass of the 20 prisoners and himself to be approximately 1500 kg.

Should he attempt to takeoff or should he lead his desperate band into the jungle and hide until he thinks up another idea?

3. **STOP AT 10:20**
4. Do today's clickers.

Adjourn.

Physics 213 Discussion # 3 Chap 3 VectorsMonday 8-24-2009

Today's Agenda:
Note: Stud\ies have shown that 2 out of 3 students that failed physics did so because they failed to master the concept of a vector and resolving it into components. So get this now!

1. Reading Quiz # 3
2. Demo adding vectors graphically, begin with the dog on a walk.
   Make sure we do some that are parallel!
3. Demo subtracting vectors graphically, begin with the plane in the wind thing.
   Make sure we do some that are parallel.
4. Now demo how to do it precisely, but first, a little thing about trig.
   Maybe demo the active figures from chapter 3
5. Now get them to resolve a vector into components parallel to and perpendicular to an inclined plane.

6. Do problems from chapter 3 2,4,10,15,21,32,43
3. **STOP AT 10:20**
4. Do today's clickers.

Adjourn.

Physics 213 Discussion # 4 4.1 - 4.5 Wednesday 8-26-2009
2-D Motion & Projectile Motion

Today's Agenda:

1. Reading Quiz # 4
2. What's the difference between ordinary 2 D motion and projectile motion?
3. Do ch 4, probs 7,19,28,31 If time permits, do a couple home-made too.
4. **STOP AT 10:20**
5. Do today's clickers.

Adjourn.

Physics 213 Discussion # 5   5.1 - 5.7 Monday 8-31-2009
Intro to Force

Today's Agenda:
0. Do fists & fingers trick.
00. Do card & quarter trick.
1. Reading Quiz # 5
2. Go over selected pages in Wkb chap 5.
3. Do problems from S&J Chap 5 - 12,16,22,26,27,36,40,44,45,46,

4. **STOP AT 10:20**
5. Do today's clickers is 5a.

Workbook Chapter 5 Preview - Identifying Forces

1. Get kid up and pull and push on them and ask,
do you feel a force?
What or who is applying this force?

2. Then step back and stretch out hand toward student and ask same questions.

3. Hand him a rope and pull on other end and ask the questions.

Differentiate between **Immediate cause** and **ultimate cause**

4. Hand him a spring and pull and ask same questions.

5. Now hang the spring and attach a block and ask does the spring exert a force on the block?

6. Now hang mass from a string and ask if string exerts a force on mass.

7. Drop a block - What exerts a force on the block?

8. Block on table. What forces are being exerted on it by what?

9. Have them squeeze a spring. Does it push back?

10. Stand a spring on the table and place masses on it. Does it exert force on the object?

11. Repeat with a stiffer spring.

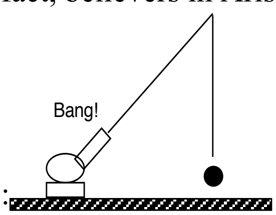
12. Repeat placing mass on thin board.
13. Now place it on table and ask is the table acting as a spring to hold up this block?
13a. Now place it on an incline and ask which way is the plane pushing on the mass?
14. Sum up. Forces are pushes or pulls between obj and some identifiable immediate cause.
They occur at a point of contact.
Can be exerted by animate or inanimate objects.
Normal forces always directed normal to surface. (means perpendicular to plane of contact.)
15. Next : Friction. Push your hand across the table. Do you feel a force? In which direction?
15a. Friction forces **are always** opposite the direction of motion.
16. Next : Action at a distance forces. Demo Mag, electrical and gravity.
17. Throw the ball up and ask what force acts at point thrown, mid way up , and at top? How do you know?
How can it keep going up if there without an upward force acting on it?
18. Next do glider on air track. And ask, is there a force on the glider?
19. The point: Whole lotta things about forces that can be counter-intuitive, which is why, in any force problem, the **FBD is the RBD,** and you will receive no credit without a correct FBD.

Workbook Chapter 5a: Force, Mass, & Newton's Laws of Motion

Overview:

Force: A push or pull that causes an object to slow down, speed up, change direction, or heat up. To put it briefly, force causes a change in velocity of either an object or the molecules it contains. The concept of force permeates every facet of physics and everyday life. If you obtain a thorough understanding of this concept you will find yourself using it from time to time to make life a little easier. It may even save your life. Mention seatbelts, babies and Hodini Buried alive in a coffin trick.

Aristotle believed that all motion required a force, or "impetus" due to a force. That is, he believed when the force stopped, or the impetus given by a force was exhausted, used up in some way, that the object stopped. In fact, believers in Aristotle believed arrows shot into the air and cannon balls fired out of cannons did this

:

in spite of visual evidence to the contrary for 2000 years!

New concepts -

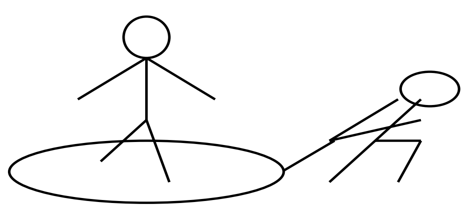
Inertia: First coined by Galileo observing objects' resistance to change in motion.

Mass : Newton's refinement, mass, is a measure of how much matter an object contains. Those that contain more matter require more force to cause the same change in velocity.

Weight: The gravitational force exerted on an object by the planet. Mass and weight are often confused because of the amazing "coincidence ?" that the force of gravity on an object at the surface of the Earth is proportional to its mass. In other words, gravitational mass turns out to be the same as inertial mass!

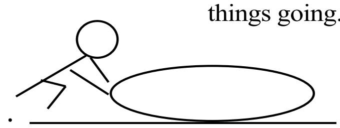
Just how force, mass, velocity and acceleration are related is the subject of these activities.

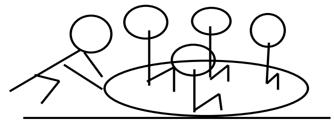
Newton's First Law. **Mass- A measure of Inertia**



Objects at rest tend to stay at rest, what happens to the rider when I jerk the hovercraft?

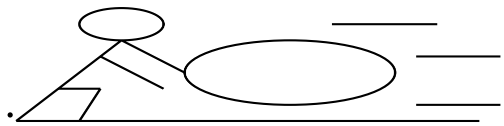
The more mass, (inertia)
the harder it is to get
things going.

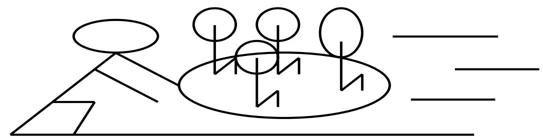


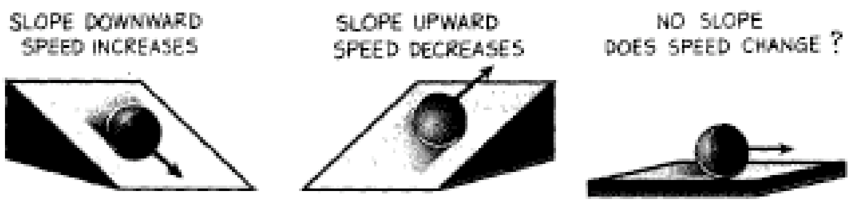


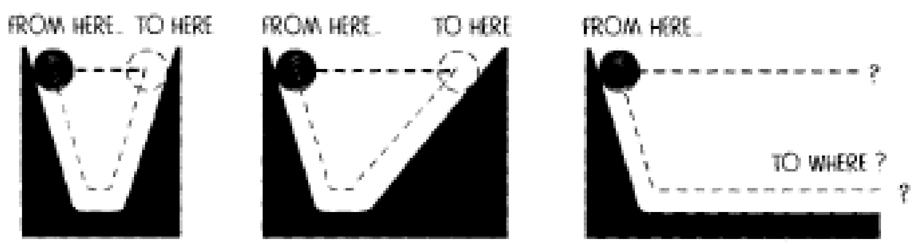
Objects in motion tend to stay in motion.

The more mass, the
harder it is to stop.







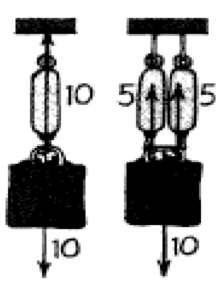


(Left) The ball rolling down the incline rolls up the opposite incline and reaches its initial height.

(Center) As the angle of the upward incline is reduced, the ball rolls a greater distance before reaching its initial height.

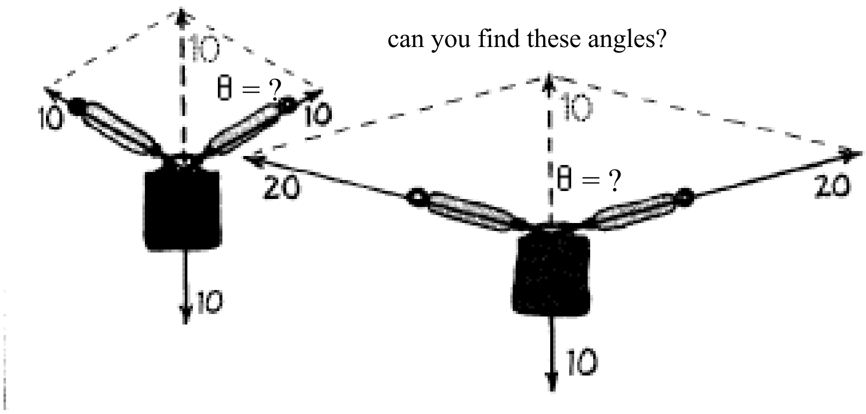
(Right) How far will the ball roll along the horizontal?

Combinations of forces, vector components of force.



(Left) When a 10-N load hangs vertically from a single spring scale, the scale pulls upward with a force of 10 N.

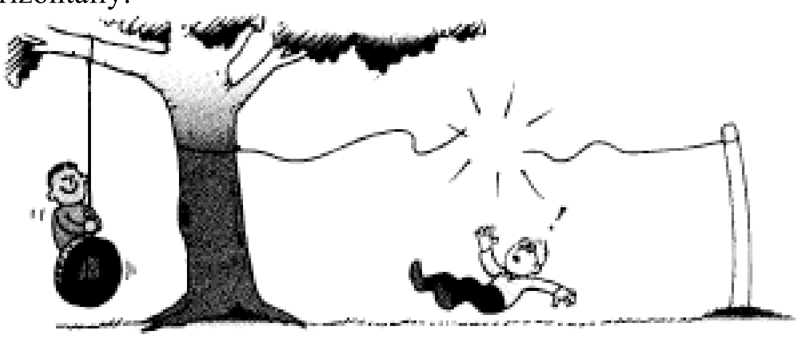
(Right) When the load hangs vertically from two spring scales, each scale pulls upward with a force equal to half of the load's weight, or 5 N.



As the angle between the spring scales increases, the scale readings increase to maintain the 10-N upward resultant.

The 10-N resultant, shown as the dashed line vector, is needed to support the 10-N load.

You can safely hang from a vertically hanging clothesline, but you'll break the clothesline if it is strung horizontally.



Activity 1. A massive ball is suspended on a string and slowly pulled by another string attached to it from below, as shown in Figure A below.

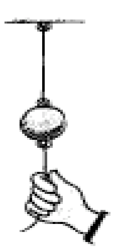
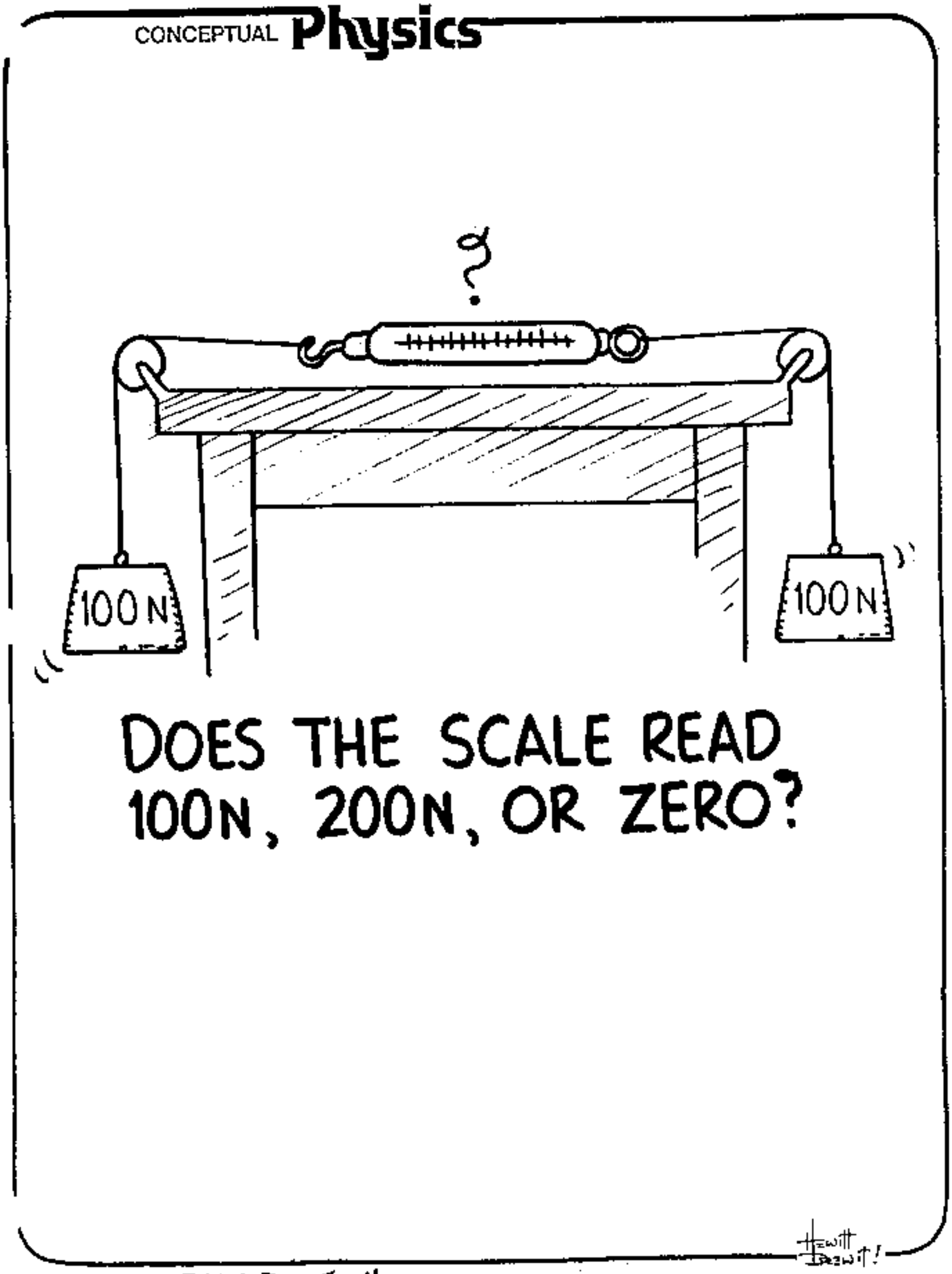


Figure A

a. Is the string tension greater in the upper or the lower string? Which string is more likely to break? Which property, mass or weight, is important here?

b. If the string is instead snapped downward, which string is more likely to break? Is mass or weight important this time?


CONCEPTUAL Physics
?
100 N
100 N
DOES THE SCALE READ
100N, 200N, OR ZERO?
CHAP. 4-11

PC 1001-Q1

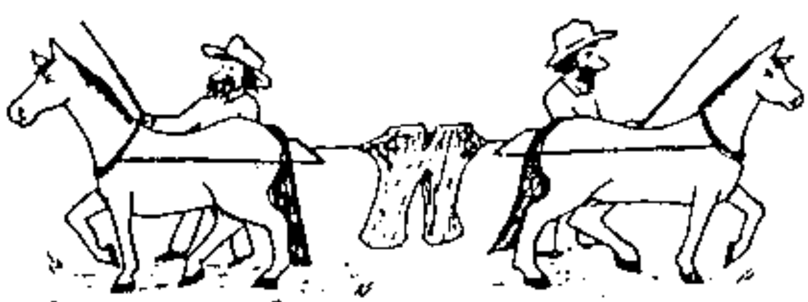
QUESTION 1:

The Levi Strauss trademark shows two horses trying to pull apart a pair of pants. Suppose Levi had only one horse and attached the other side of the pants to a fencepost.
Using only one horse would:

1. cut the tension on the pants by one-half

2. not change the tension at all

3. double the tension on the pants



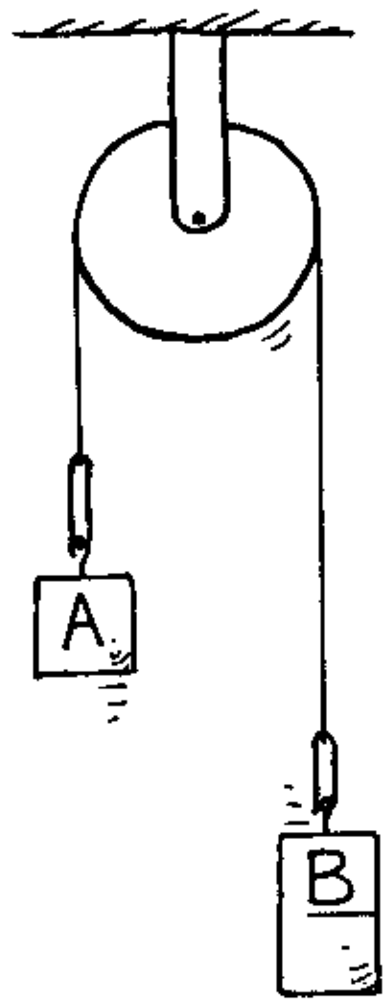
CONCEPTUAL **Physics**

Two identical rubber bands connect masses A and B to a string over a frictionless pulley of negligible mass. The amount of stretch is greater in the band that connects

a) A

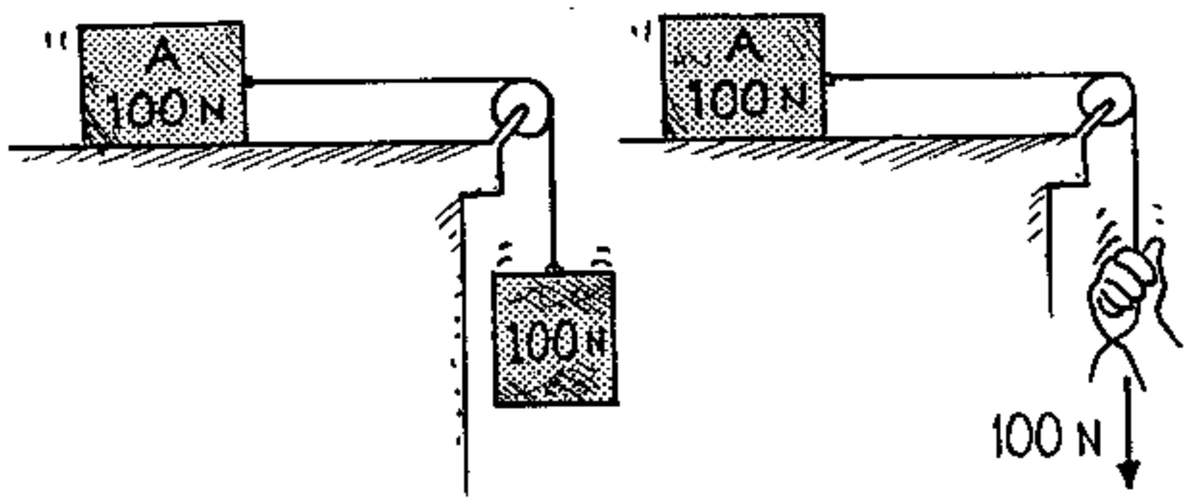
b) B

c) Both the same



Hewitt Drew it!

CONCEPTUAL **Physics**



IN BOTH CASES AN APPLIED FORCE OF 100 N ACCELERATES THE 100-N BLOCK.

IN WHICH CASE IS THE ACCELERATION GREATER?

Hewitt Drew it!

CHAP. 4-6

Mass and Weight

Answer each of the following questions. If needed, use a value of 10 m/s^2 for the gravitational acceleration on earth and 3 m/s^2 on the moon.

1. What is the SI unit for mass?

2. What is the SI unit for weight?

3. What is the mass of a 3 kg object on the earth?

4. What is the mass of a 3 kg object on the moon?

5. What is the weight of a 3 kg object on the earth?

6. What is the weight of a 3 kg object on the moon?

7. An object weighs 60 N when on the earth. What is the mass of this object?

8. What is the weight of this object on the moon?

9. Another object weighs 60 N when on the moon. What is the mass of this object?

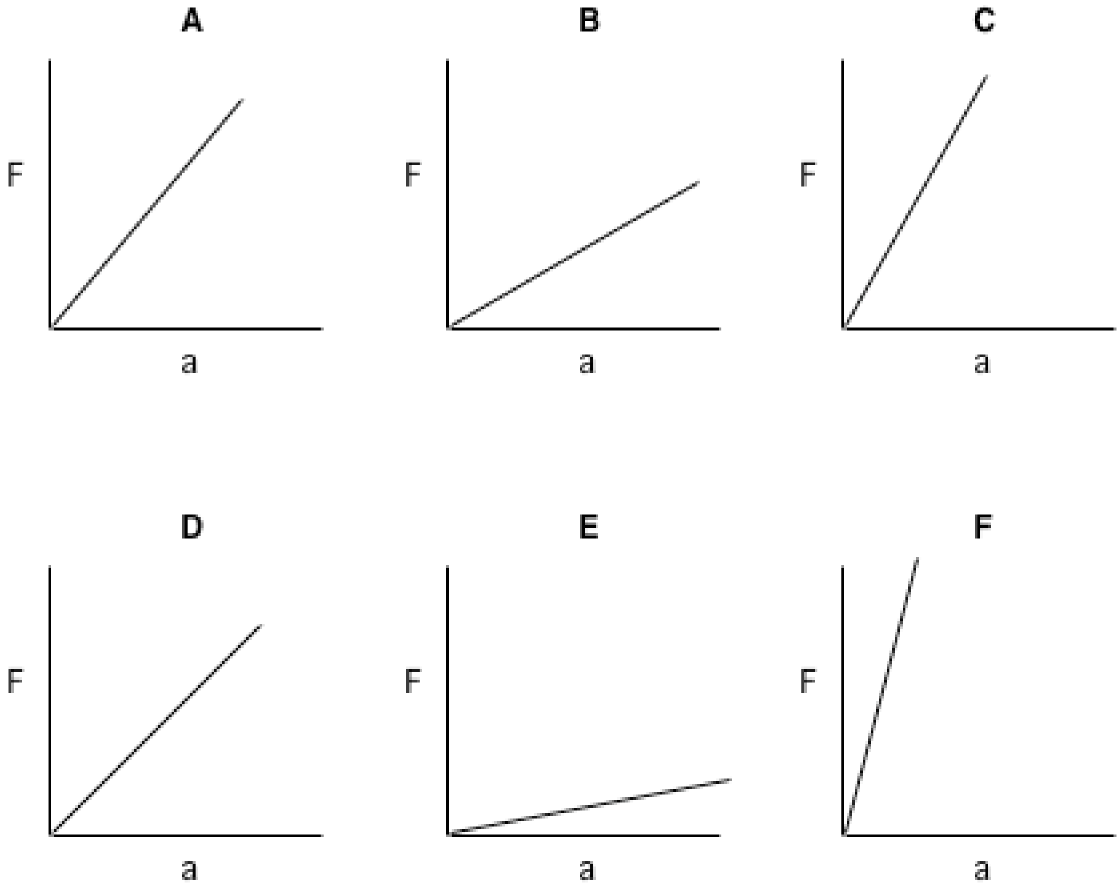
10. Research and reward. The gravitational force on a satellite when a distance **r** from the center of the earth is 4000N. Determine the gravitational force when a distance of 2**r** from the center of the earth. Hint: Look up gravitational force in your text.

Supported by NSF grant # 9352046

Exercise 1.

Force Acceleration Graphs—Mass [24]

The following graphs plot force vs acceleration for several objects. Rank each situation according to mass. That is, order the situations from the largest to the smallest mass that the force is acting upon. All graphs have the same scale for each respectivie axis.



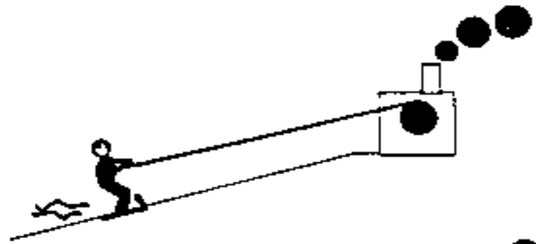
Largest 1________ 2________ 3________ 4________ 5________ 6_______ Smallest

Or, all the masses are the same. _________

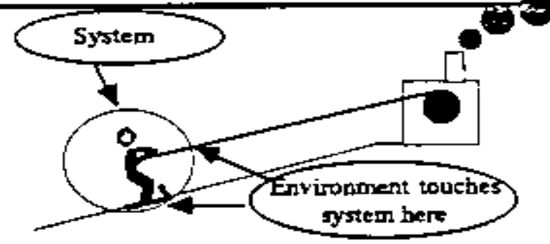
Please carefully explain your reasoning.

Constructing Free-Body Diagrams

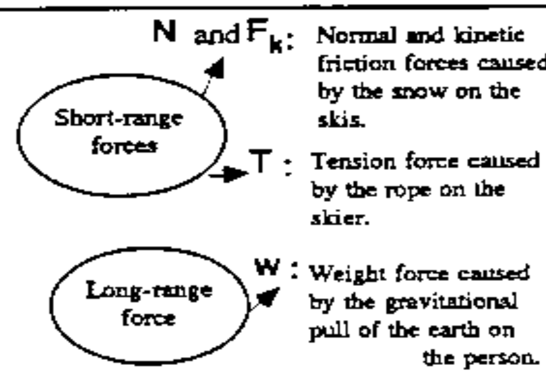
EXAMPLE 1.6 Draw a free-body diagram for the skier and skis shown in the sketch at theright. Ignore air resistance. Cover the right side of the page below the sketch and try each step on a separate sheet of paper before looking at the answer at the side



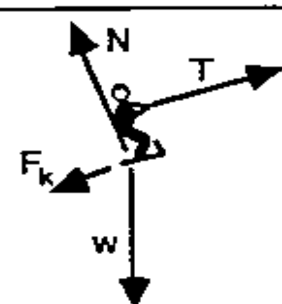
STEP 1: Use a line to encircle and identify the system in the sketch that accompanies the problem statement.



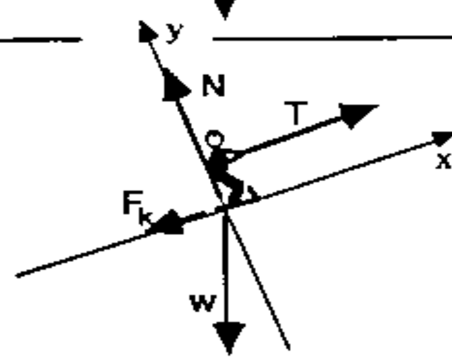
STEP 2: Look along the system boundary for objects in the environment that touch objects in the system. Choose symbols for the forces caused by these touching objects. Also, represent in symbol form any long-range forces acting on the system. Describe in words the environmental object causing each force and the part of the system on which the force acts.



STEP 3: Draw a separate sketch of the object(s) in the system. Then, draw arrows representing all forces acting on the system. Label the arrows with the same symbols as used in Step 2. If possible, try to make the lengths of the arrows representative of the relative magnitudes of the forces.

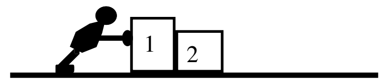


STEP 4: Add coordinate axes to the free-body diagram. Make one axis parallel to the direction of motion and the other axis perpendicular. The head of the coordinate axis arrow points in the positive direction. Do not use two-headed coordinate axis arrows!

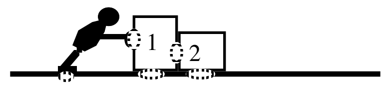


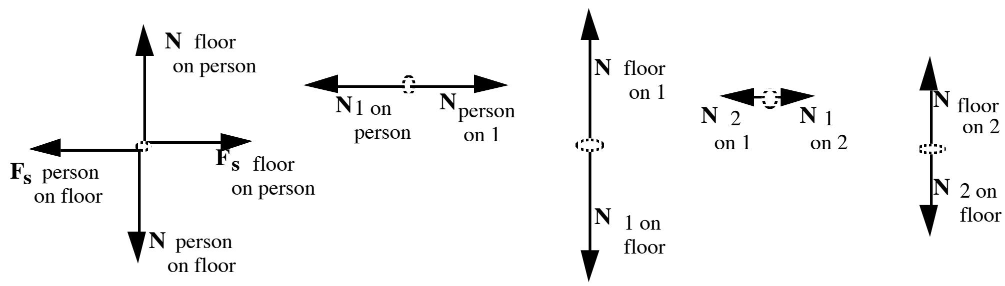
Interactions, Free-body Diagrams, and Newton's third law—1

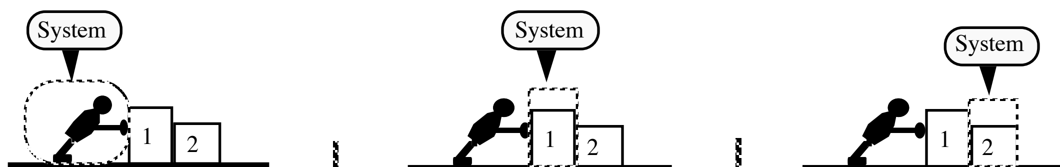
You are to construct a free-body diagram and a force diagram for the person and for each block shown at the right. The blocks have frictionless gliders.

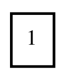
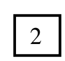


* Points or surfaces of contact between touching objects ( ) are “interaction points or surfaces.” At each point, one object exerts a force on the other and the other exerts an equal magnitude, oppositely directed force on the first. Use this menu of forces to construct the free-body and force diagrams below. Also include any long-range forces needed.







	Include all contact (short range) and long-range forces acting on the person.	Include all contact (short range) and long-range forces acting on block 1.	Include all contact (short range) and long-range forces acting on block 2.
Free-body diagrams		 1	 2
Force diagrams	•	•	•

* The idea of using interaction bubbles in helping to construct free-body diagrams and to understand Newton's second and third laws was provided by Jill Larkin.

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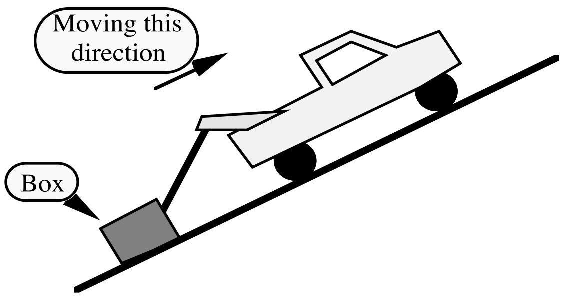
Supported by NSF grant # 9352046 Last revision date: August 19, 2013

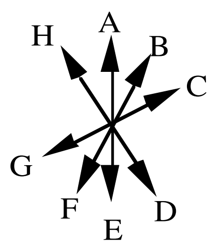
Directions of Forces—2

For each situation below, indicate the arrow that points closest to the direction of the force that some object exerts on the box.

A rope attached to a truck pulls a box along hill with friction.



Possible directions of the forces.



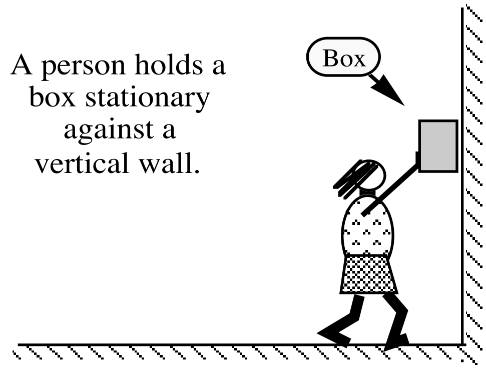
(a) Direction of the tension force of the rope on the block is closest to ____.

(b) Direction of the normal force of the surface on the block is closest to ____.

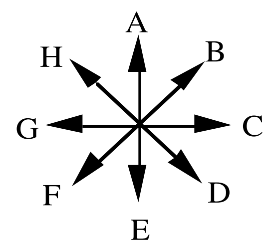
(c) Direction of the kinetic friction force of the surface on the block is closest to ____.

(d) Direction of the force of the earth's mass on the block (the weight force) is closest to ____.

A person holds a box stationary against a vertical wall.



Possible directions of the forces.



Direction of the normal force of the wall on the block is closest to ____.

Direction of the static friction force of the wall on the block is closest to ____.

Could it point in another direction? Explain.

____

____

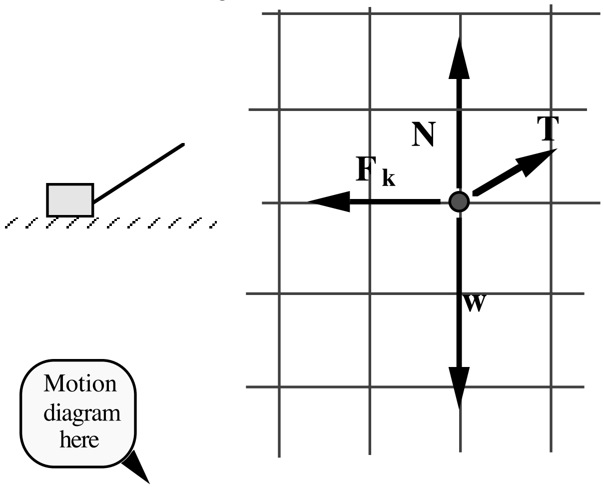
Direction of the normal force of the person's hands on the block is closest to ____.

Direction of the static friction force of the person's hands on the block is closest to ____.

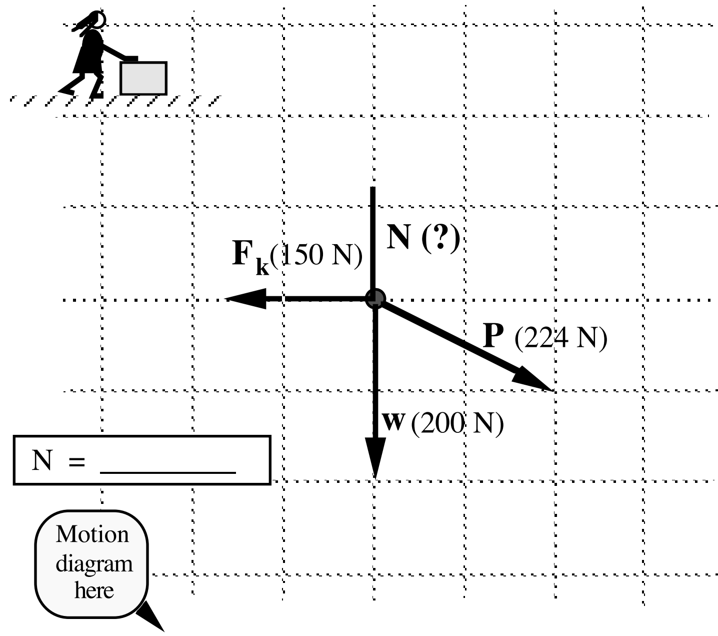
Direction of the force of the earth's mass on the block (the weight force) is closest to ____.

Qualitative Reasoning about Newtonian Processes—8

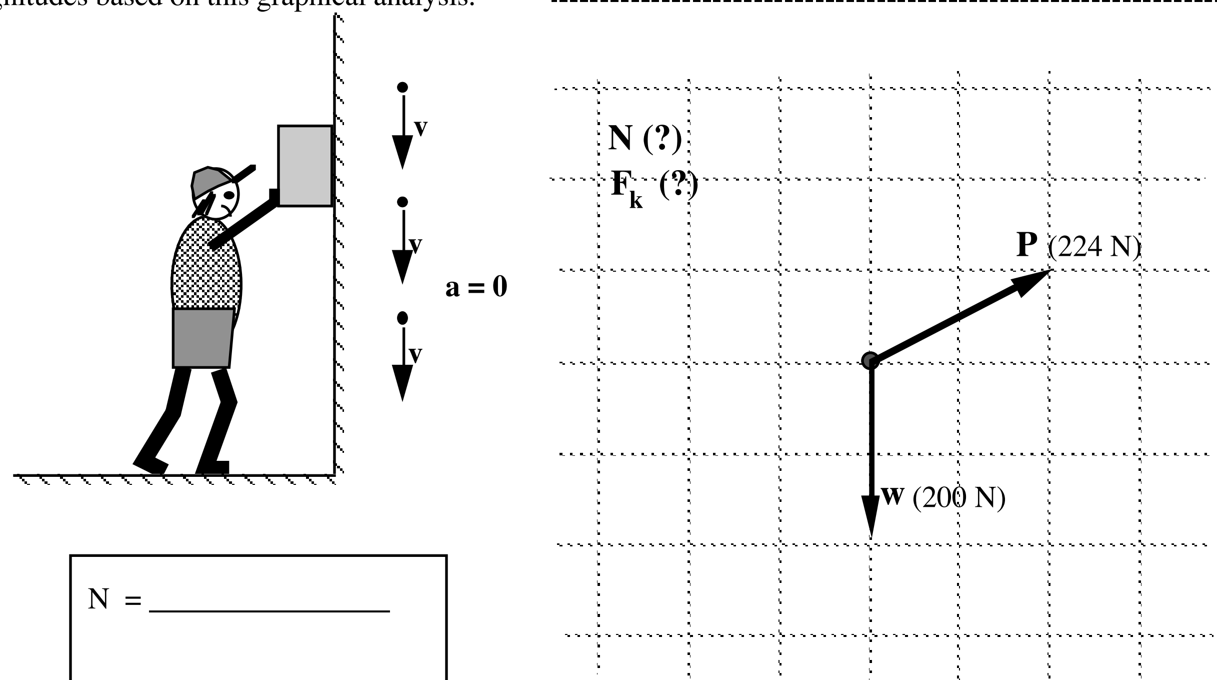
1. Construct a motion diagram for the block whose force diagram is shown below.



2. Draw the normal force to the appropriate length, determine its magnitude graphically, and then construct a motion diagram for the crate initially moving right.



3. A motion diagram for the crate is shown beside it. Place arrows with the correct lengths on the force diagram to represent the normal and kinetic friction forces and indicate their magnitudes based on this graphical analysis.

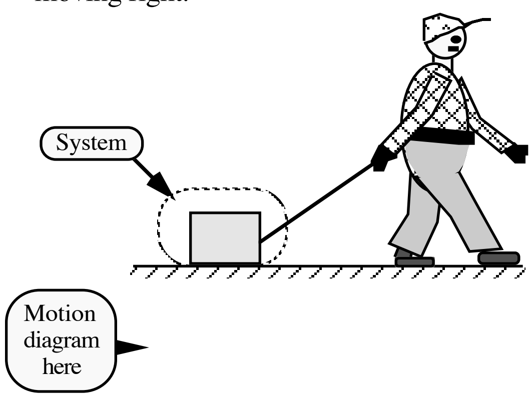


N = ________________

F_k= ________________

Qualitative Reasoning about Newtonian Processes—9

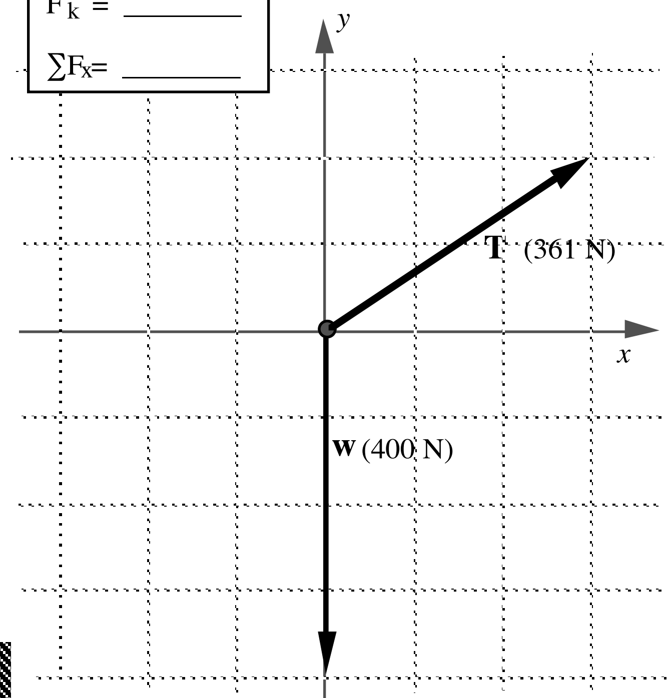
1. (a) Draw the normal force to the appropriate length and determine its magnitude graphically.
(b) The coefficient of friction between the block and surface is 0.70—the kinetic friction force is 0.70 times the normal force. Draw the kinetic friction force and determine its magnitude.
(c) Determine the net force acting on the block in the x direction.
(d) Construct a motion diagram for the crate, initially moving right.



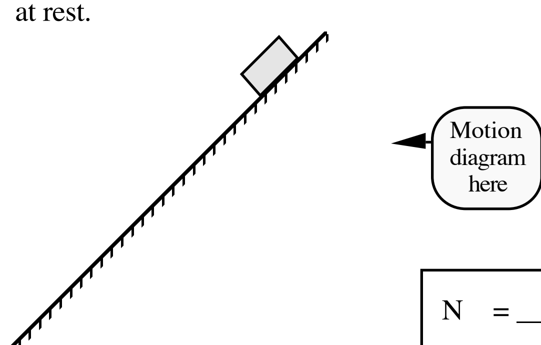
N = ________

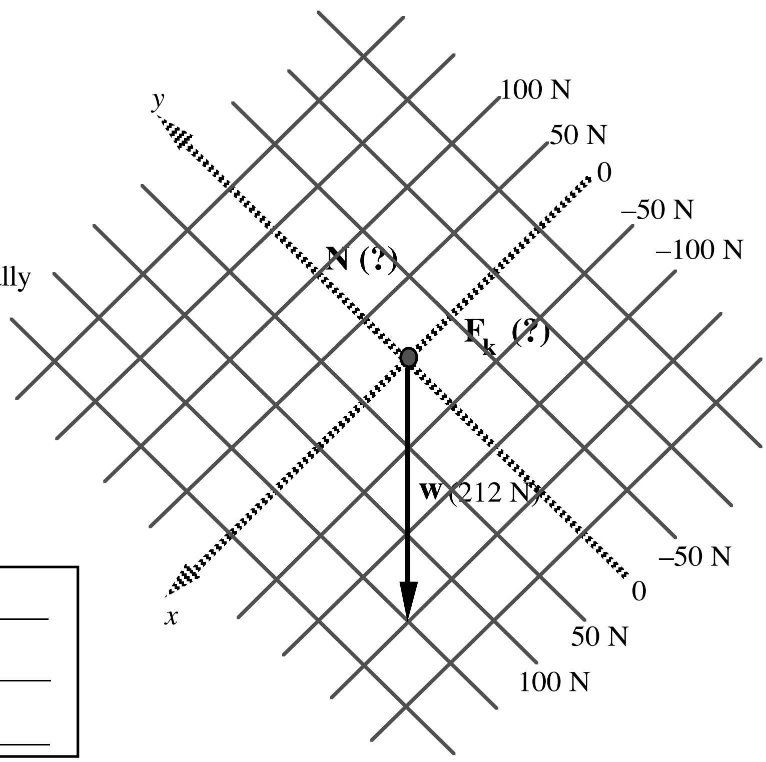
F_k = ________

$\sum F_x$= ________



2. The crate below slides down a 45° incline.
(a) Draw on the graph an arrow representing the normal force of the plane on the block and indicate the magnitude of the normal force. Note that the crate's acceleration in the y direction is zero. Do all work graphically.
(b) Draw the kinetic friction force assuming a 0.67 coefficient of kinetic friction—the ratio of the friction force and the normal force.
(c) By graphical analysis, estimate the magnitude and sign of the net force in the x direction.
(d) Construct a motion diagram for the cart, initially at rest.





N = ________

F_k = ________

$\sum F_x$= ________

Reality Physics
Supported by NSF grant # 9352046
From Paul D'Alessandris's SPIRAL
Central Alabama Community College
Last revision date: August 19, 2013

Physics 213 Discussion # 6 5.7 Wednesday 9-2-2009
Newton's Third Law, Tension, Weight

Today's Agenda:

1. Reading Quiz # 6: Do online quizzes 7a & 7b, Newton's 3rd Law
2. do more from workbook and Chapter 5

4. **STOP AT 10:20**
5. Do ch 5b clickers.

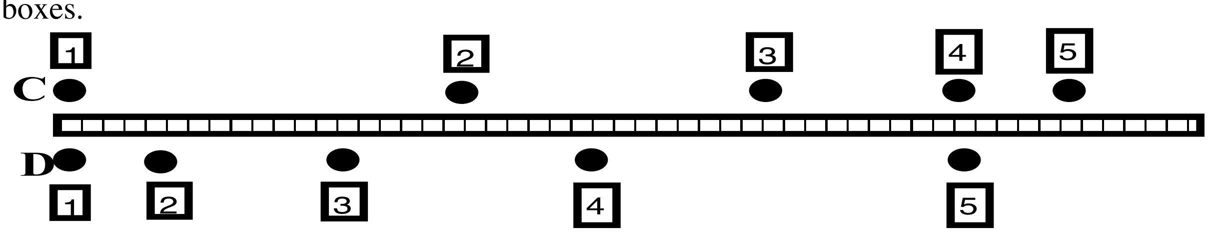
Adjourn.

We have Test 1 Next Wednesday!

Physics 213 Test 1 Pract 7 Points Each Sept. 10, 2008

(1 point Absolutely FREE!)

1. Below is the motion diagrams for two different objects C and D. Clock readings are indicated in the boxes.



a. Which is travelling fastest to begin with? ____________________

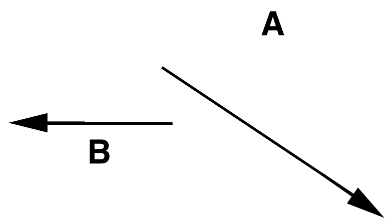
b. Which travels the greatest distance ?____________________

c. At which clock readings(instants) do they occupy the same location at the same time?_________________

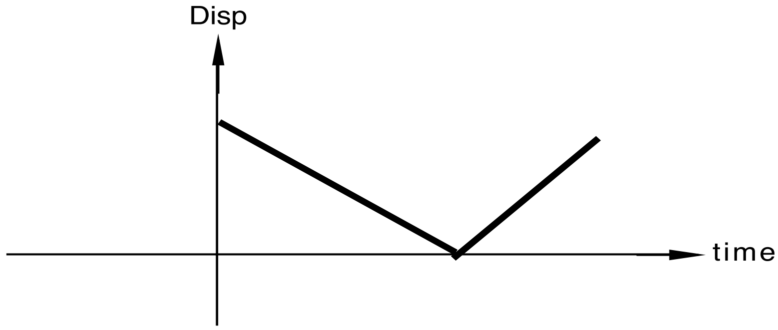
d. Is there any time interval over which they have the same average velocity? ____________________

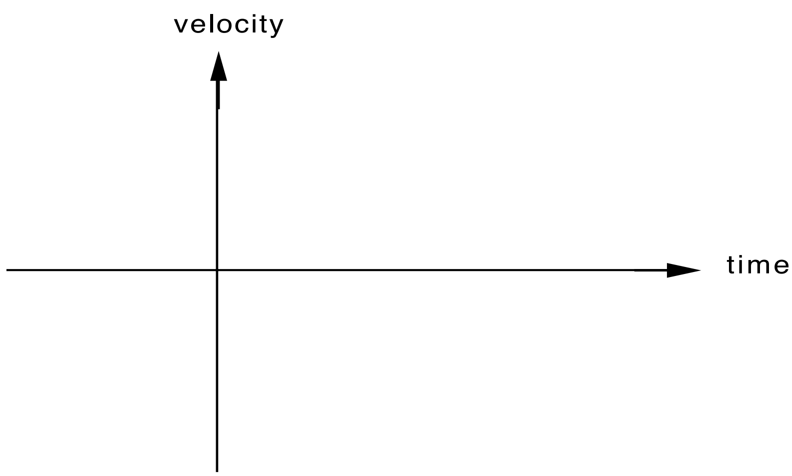
2. What is the speed of an object shot straight up 3 seconds after it reaches its maximum height? **You must explain your answer!**

3. Draw A + B and A -B for the pair of vectors.
Remember, the vectors on this page are real vectors, meaning you can redraw them elsewhere, but you cannot change their direction or magnitude. Make certain you make it absolutely clear to me what you mean by A + B and A - B .



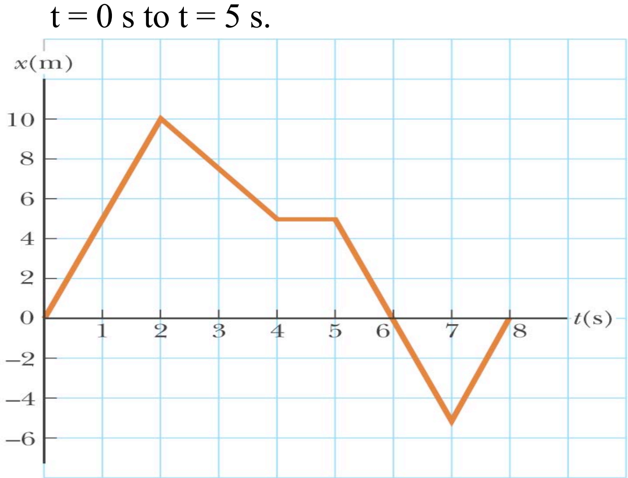
4. Draw the velocity vs time graph for the given displacement vs time graph.





5. Describe the motion in words. for problem 4.

6. Use the position vs time graph below to calculate the average velocity of the object from $t = 0$ s to $t = 5$ s.



7. Find the magnitude and direction (relative to the positive x axis) of the vector **A** = -3 **i** + 4 **j.**

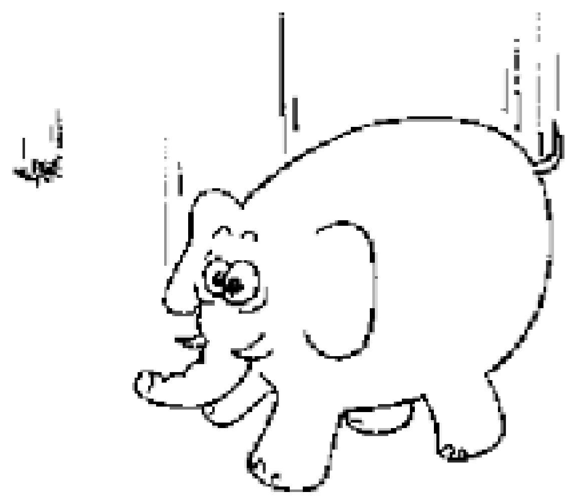
8. A jet plane lands with a speed of 100 m/s and can accelerate at maximum rate of - 5 m/s^2 as it comes to rest. From the instant it touches the runway what is the minimum time interval needed to bring it to rest and what length of runway does it take?

9. Martha is riding in a hot air balloon, rising at a constant 5 m/s. George watches nervously from the ground. At 30 m according to her altimeter, she releases a bouquet of flowers for George to catch.

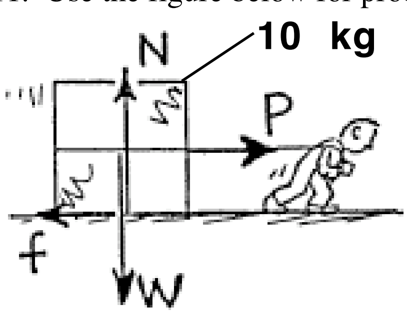
How long does it take the bouquet to reach the ground?
(Use 10 m/s^2 for the acceleration due to gravity.)

10. An elephant and a feather are falling in the earth's atmosphere near the surface of the earth, **having reached terminal velocity**. Circle all the correct statements.

The force of gravity acting on them is the same.
The force of gravity acting on the elephant is biggest.
The force of gravity acting on the feather is biggest.
The force of air resistance acting on the feather is greatest.
The force of air resistance acting on the elephant is greatest.
They both have the same acceleration.
The elephant will fall faster than the feather.
They both have the same terminal velocity.
The net force acting on the feather is the biggest.
The net force acting on the elephant is the biggest.
They have the same net force acting on them.



11. Use the figure below for problems a thru d.



a. If the pulling force P is 150 N and the crate doesn't move, what is the magnitude of friction force f?

b. If the pulling force P is 200 N and the crate doesn't move, what is the magnitude of friction force f?

c. If the force of sliding friction is 250 N, what force P is necessary to keep the crate sliding at constant velocity?

d. If the force of sliding friciton is 250 N and the force P is 300 N, what is the acceleration of the block?

12. A girl stands on a bathroom scale inside an elevator. When the elevator is at rest, the scale reads 750 N (170 lb). State whether the scales reading increases, decreases, or remains the same when:

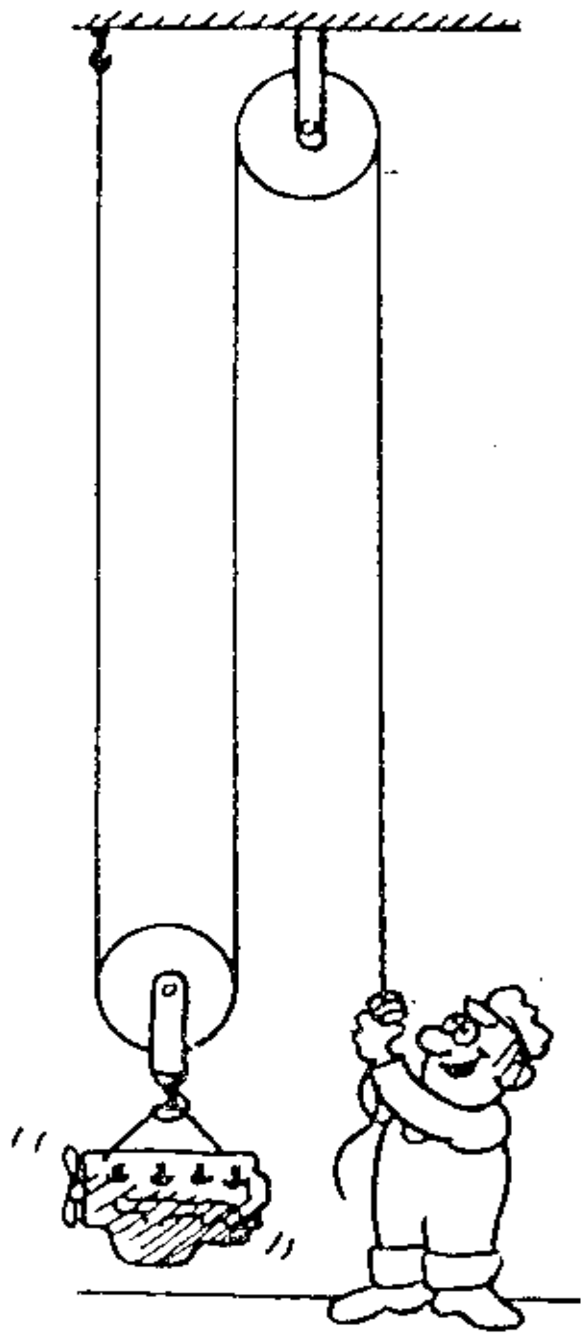
a. The elevator is moving upward at an increasing speed.

b. The elevator is moving upward at a decreasing speed.

c. The elevator is moving upward at constant speed.

d. The elevator is moving downward at decreasing speed.

e. The elevator is moving downward at constant speed.



14. The mechanic is raising this 300-pound engine at a constant rate using the frictionless pulley system shown. With how much force is he pulling on the rope? (circle the correct answer.)

1 . 600 lbs

2. 450 lbs.

3. 300 lbs.

4. 200 lbs.

5. 150 lbs.

6. 100 lbs.

7. 50 lbs.

8 . impossible to determine

Physics 213 Discussion # 8 5.8 Monday 9-14-2009
Friction

Today's Agenda:

1. Reading Quiz # 6 -ch 5.8 frct read.ppt
2. Chapter 5 do problems36, 41,44, 46

3. **STOP AT 10:20**
4. Do ch5c_5.8 friction.ppt clickers.

Adjourn.

Physics 213 Discussion # 9 6.1 - 6.3Wednesday 9-16-2009
Force & Circular Motion

Today's Agenda:

1. Reading Quiz # 7-ch 6 read.ppt:
2. Do problems from chapter 6- 6,8,18,23,51

4. **STOP AT 10:20**
5. Do ch 6 clickers.

Adjourn.

Physics 213 Discussion # 10 7.1 - 7.5Monday 9-21-2009
Work

Today's Agenda:

1. Reading Quiz # 8-ch7 read.ppt
2. Chapter 7 do problems 10,12,14,25,28,32,39

3. **STOP AT 10:20**
4. Do ch7 clickers.

Adjourn.

Physics 213 Discussion # 11 7.6-7.9Wednesday 9-23-2009
Kinetic Energy & Power

Today's Agenda:

1. Reading Quiz # 8-ch 7 read.ppt:
2. Do problems from chapter 6- 6,8,18,23,51

3. **STOP AT 10:20**
4. Do ch 7 clickers.

Adjourn.

Physics 213 Discussion # 12 Chap 8 Monday 9-28-2009 Potential Energy

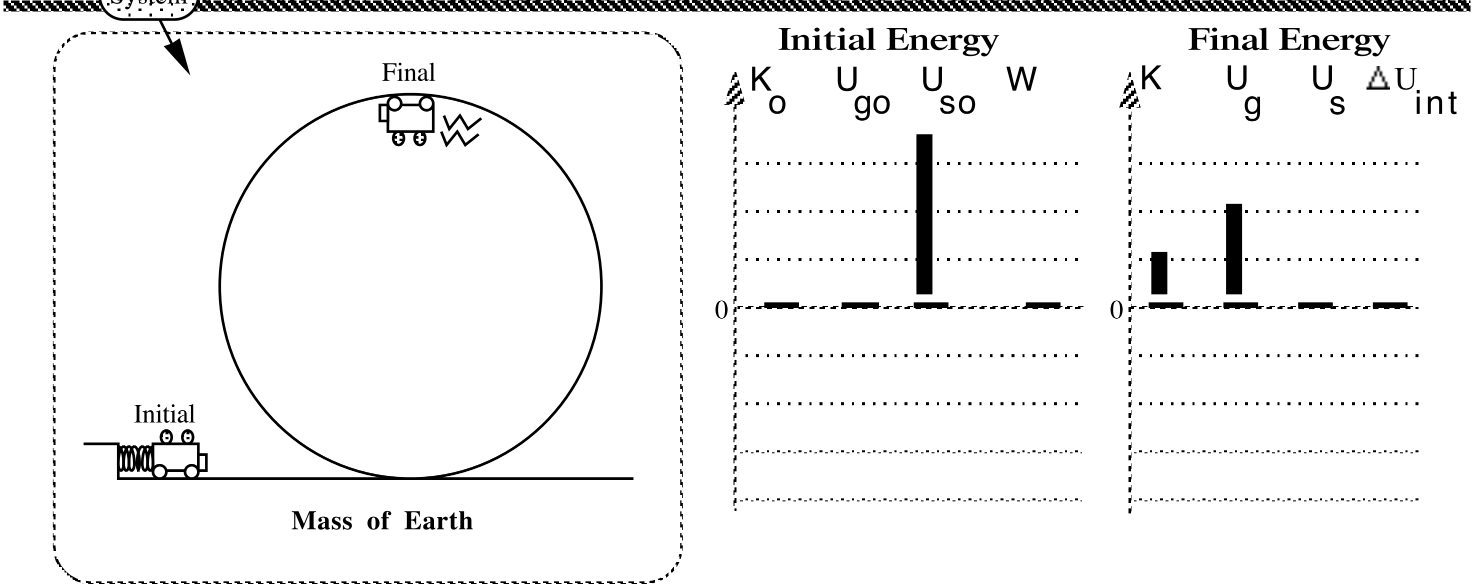
Today's Agenda:

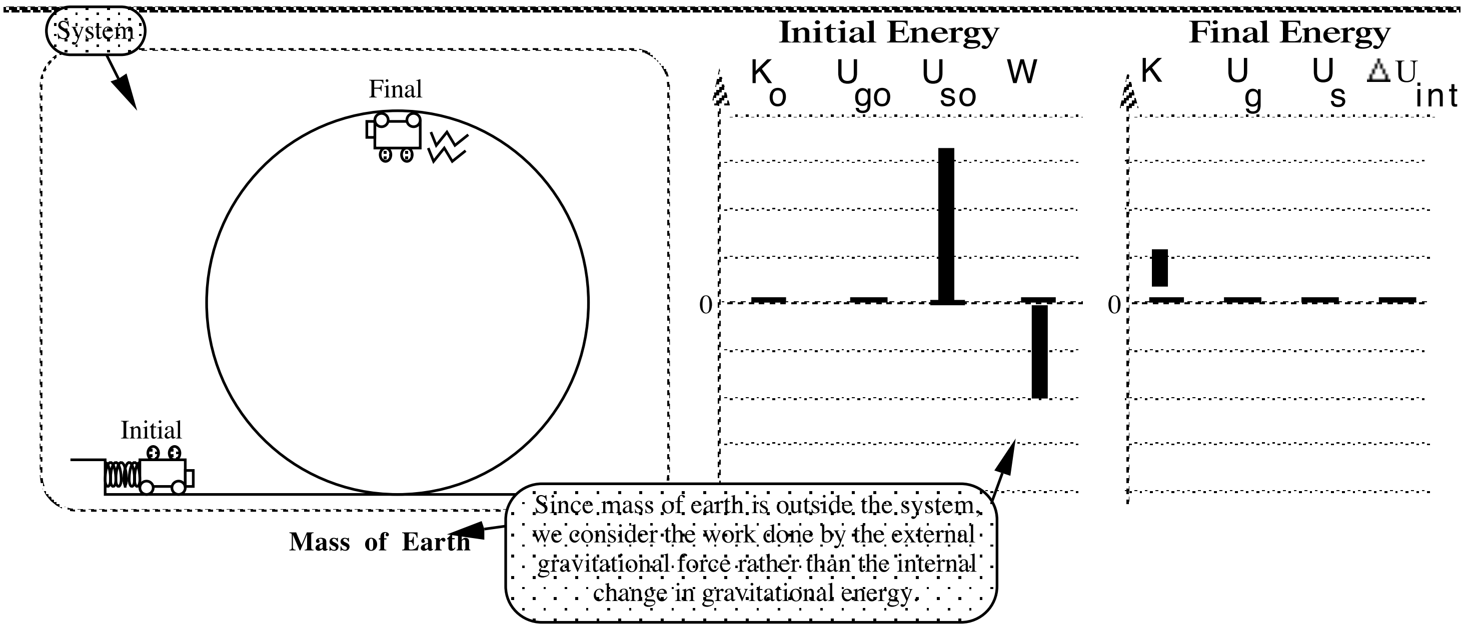
1. Reading Quiz #9-ch8 read.ppt
2. Demo Energy Bar Charts
3. Chapter 8 do problems2,9,14,21,22,24,26,36,42,46
4. **STOP AT 10:20**
5. Do ch8 po ential Energy clickers.

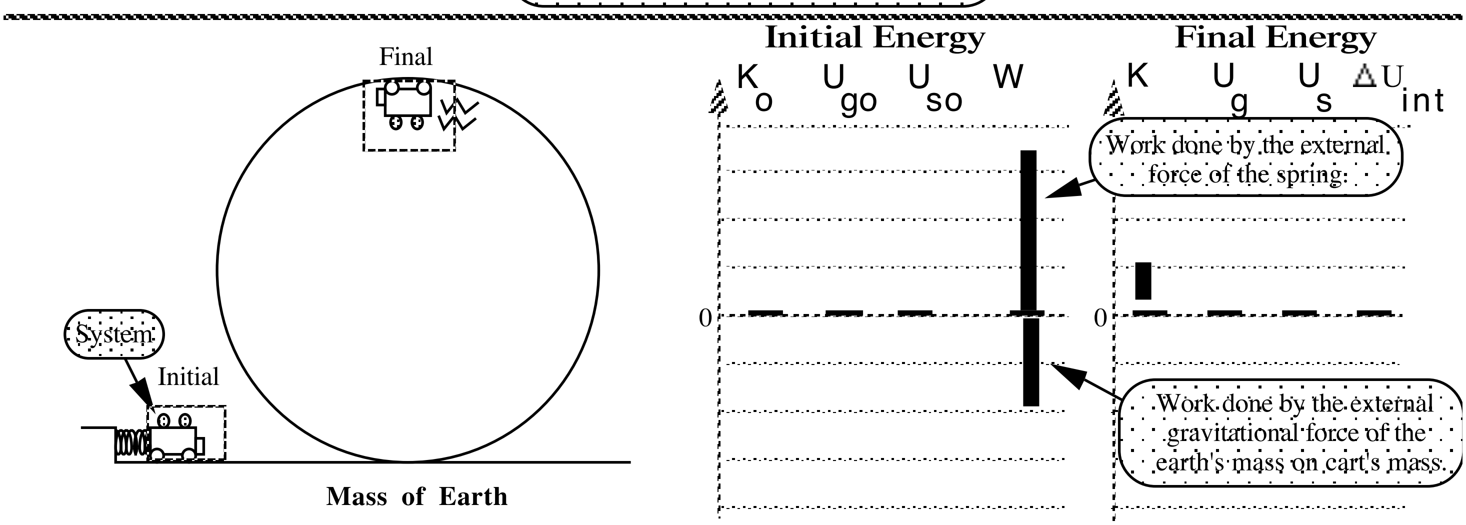
Adjourn.

Work-Energy Bar Graphs and System Choice—1

The work-energy bar graphs below illustrate the way in which we account for work and energy for the same process but using different systems. Initially the spring is compressed and the cart is at rest ready to be launched. In the final situation, the cart is moving at the top of the frictionless loo

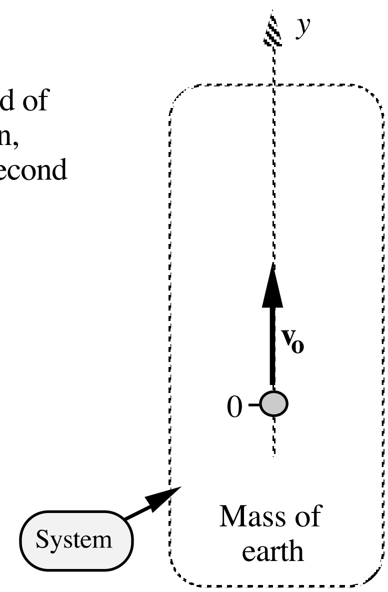






Conservation of Energy

A 2.0-kg ball is projected vertically from the origin with an initial speed of 30 m/s. Complete the table below indicating the ball's velocity, position, kinetic energy, gravitational potential energy, and total energy at one-second time intervals. Ignore air resistance and assume that $g = 10\ m/s^2$.
[Hint: Use Newtonian concepts to determine the velocities and the positions. You should be able to determine the velocities in about 20 s if you understand the meaning of acceleration. The displacement during each one-second time interval can be determined easily using the average velocity during that time interval.]

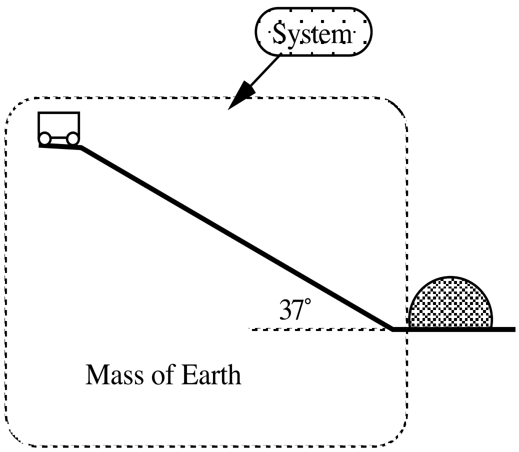


Note that this is a very special problem involving only two types of energy for a system for which no work is done by external forces. The activity is intended to show how energy ideas apply to a very simple system.

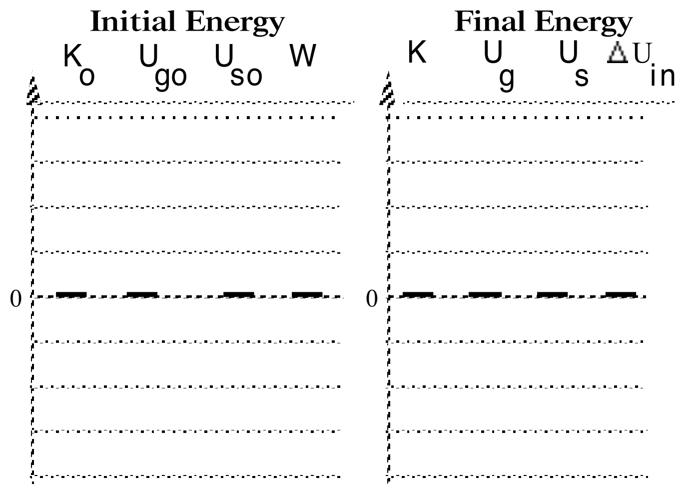
time (s)	velocity (m/s)	position (m)	K (J)	U_g(J)	total energy (J)
0	+ 30	0			
1					
2					
3					
4					

Stopped by a Hay Stack

A 100-kg cart, initially at rest, rolls down a 50-m long frictionless hill. At the bottom, the cart stops after plowing 2.0 m into a hay stack. Determine the average force of the hay stack on the cart while stopping it. Assume that $g = 10\ m/s^2$.



(a) Construct a qualitative work-energy bar chart for the process at the left.



(b) Use the work-energy bar chart to help construct the work-energy equation for this process.

(c) Rearrange the above to determine the unknown force of the hay stack on the cart while stopping it.

(d) Evaluation

- Does the answer have the correct units?
- Does the answer seem reasonable?
- How would the answer differ if the incline was somewhat less than 37°? Does this make sense?

Physics 213Discussion # 13 9.1 - 9.4Wednesday 9-30-2009
Linear Momentum

Today's Agenda:

1. Reading Quiz 10-ch9 read
2. Any questions ?
3. Chapter 9 do problems 2,8,16,20,26,

4. **STOP AT 10:20**
5. Do ch 9 Lin mom clickers.

Adjourn.

Physics 213Discussion # 14 9.5-9.7 Monday 10-5-2009
Center of Mass & Rockets

Today's Agenda:

1. Reading Quiz 11-Write down the formulas for center of mass for a 2 D system of particles.
2. Do the torque definition demo & a couple of home-made discrete problems.
3. Chapter 9 do problems 43,**44**, 45,50,52
4. **STOP AT 10:20**
5. maybe test review?

Adjourn.

Wkb Ch 7 Lecture Notes on Momentum & Impulse

Definition: **Momentum** (designated **P** for some sicko reason) = m**v**

Definition: **Impulse** (denoted by **I** !) = chg in **P** = m**v** - m$\mathbf{v_o}$ = Δ **P**

notice $\Delta\mathbf{P}/\Delta T = m\Delta\mathbf{v}/\Delta t = m\,\Delta\mathbf{v}/\Delta t = m\,\mathbf{a} = \mathbf{F}_{avg}$

$\mathbf{I} = \Delta\mathbf{P} = \mathbf{F}_{\mathbf{avg}}\,\Delta T$ but if **F** <u>varies</u> $\mathbf{I} = \Delta\mathbf{P} = \int \mathbf{F}\,dt$ or $\mathbf{F}_{\mathbf{inst}} = d\mathbf{P}/dt$ (original def. of **F**)

LAW OF CONSERVATION OF MOMENTUM - COMES FROM NEWTONS 3RD

$\mathbf{F}_{12}\,\Delta t = -\mathbf{F}_{21}\,\Delta t$

$\Delta\,\mathbf{P_1} = -\Delta\mathbf{P_2}$

$m_1\,\mathbf{v_1} - m_1\,\mathbf{v_{10}} = -(m_2\,\mathbf{v_2} - m_2\,\mathbf{v_{20}}) = m_1\,\mathbf{v_1} + m_2\,\mathbf{v_2} = m_1\,\mathbf{v_{10}} + m_2\,\mathbf{v_{20}}$

$\mathbf{P} = \sum \mathbf{P_i} = \mathbf{P_o} = \sum \mathbf{P_{io}}$

<u>Collisions 2 Kinds</u>

Def. Perfectly in elastic collisions - hit and stick. $P_f = P_o$

$(m_1 + m_2)\,v_f = m_1\,v_{10} + m_2\,v_{20}$ etc.

Def. Perfectly elastic collisions - hit and bounce off so that Kinetic Energy is conserved.

so $v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1o} + \frac{2m_2}{m_1 + m_2} v_{2o}$ $v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1o} + \frac{m_2 - m_1}{m_1 + m_2} v_{2o}$

Discuss what happens when $m_1 = m_2$?

get out the moon & Earth, the horse and the roller thing.

Center of Mass - The point of balance - How to find it:

Center of mass of an object, or set of objects is the balance point for this object(s). To discuss this we really must introduce a related topic; **Torque**. Torque can be thought of as the tendency to make something rotate and officially, $\boldsymbol{\tau} \equiv \mathbf{r} \times \mathbf{F}$, where r is the distance from the pivot point (called the moment arm), and F is the force and x represents the cross product (Later).

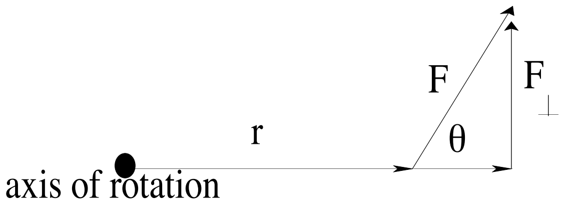
Perspective:

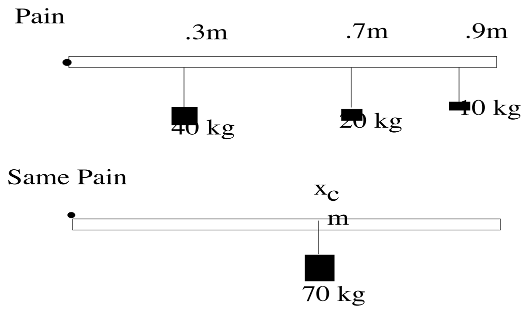
Velocity v is the rate of change of distance w.r.t. time. Force F is a measure of an objects tendency to change velocity. Angular velocity about some axis of rotation is the rate of change of angle w.r.t. time.
Torque about some axis of rotation is a measure of an objects tendency to change angular velocity.

Definition: The magnitude of Torque $\tau = r\,F_\perp$, where r(called the moment arm), is the distance from the axis of rotation, to the point of application of force, and $F_\perp$ is the component of force perpendicular to the moment arm. $F_\perp = F\sin\theta$, where θ is the angle between the direction of r and the direction of F.

Now suppose we have a meter stick with masses attached like so. Pain is caused by torque $\tau_{@0}$
The center of mass of this system of objects is the balance point of the stick, but it is also the point at which all the mass could be located to get equivalent torque.

i.e. $\sum m_i g x_i = m_T g x_{cm}$, or $x_{cm} = (\sum m_i x_i)/m_T$





Now suppose we had a set of point masses located in a two dimensional plane. The x_{cm} and y_{cm} could be found independently of one another in exactly the above fashion, so, $y_{cm} = (\sum m_i y_i)/m_T$

Do example here with the set of mass points 2 kg at (-5,-2), 5 kg at (-2,2), 4 kg at (2,3), and 3 kg at (5,1).

Furthermore, if we wanted to obtain the center of mass of a two dimensional object, we could approximate its center of mass by dividing it up into rectangles, using the center of each rectangle as the center of mass of that rectangle, then obtain x_{cm} and y_{cm} as above. Then, in typical analytical fashion, we could take the limit as the number of rectangles goes to ∞, and bingo, we have another integral!

So, for planar objects, $x_{cm} = \dfrac{\int x\,dm}{\int dm}$ and $y_{cm} = \dfrac{\int y\,dm}{\int dm}$

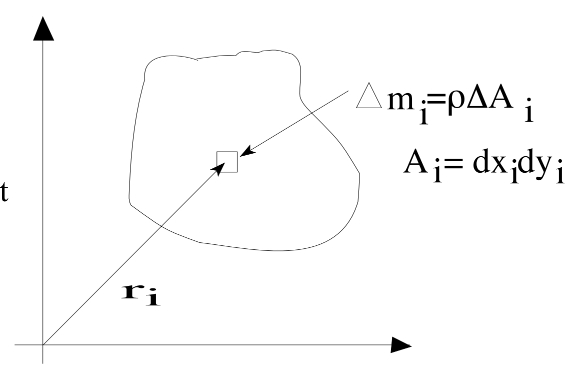
Now for a two dimensional object density ρ = mass/area = m/A= dm/dA

If we assume uniform density, then the density cancels out and we can just talk about the center of a plane region (called the Centroid of that region), in which case, the dm's above become dA's.

dA = dx dy, $\mathbf{r}_i = x_i\mathbf{i} + y_i\mathbf{j}$ so $\mathbf{r}_{cm} = (x_{cm}, y_{cm})$, where

$$x_{cm} = \frac{\int_A x_c\,\rho\,dx\,dy}{\int_A \rho\,dx\,dy} \quad \text{and } y_{cm} = \frac{\int_A y_c\,dx\,dy}{\int_A dx\,dy}$$

and x_c and y_c are expressions of the center of mass of the arbritrary mass point dm.



Phy 213 Conservation of Momentum Exercises

Here's how you get paid. 1 pt each.

1. Draw Before Pict
2. Draw After Pict
3. Draw reference Frame
4. You will be given speeds you must show arrow and value of **velocity** of each object in both before and after picts.
5. Write expression representing the total initial momentum underneath the before side of picture
6. Write expression representing the total final momentum underneath the After side of the picture
7. Solve for the required quantity.

1. A 30 kg object is moving east at 20 m/s. It hits and sticks to a 40 kg object that is stationary. What is the speed and direction of the two stuck togther? Assume no friction is involved.

2. A 30 kg object is moving east at 20 m/s. It hits and sticks to a 40 kg object that is moving 10 m/s west. What is the speed and direction of the two stuck togther? Assume no friction is involved.

3. A 40 kg dog is riding a 20 kg skateboard east at 30 m/s. The 20 kg cat riding its back suddenly leaps west at a speed of 30 m/s relative to the earth. What is the final speed of the dog on the skateboard?

4. A 8 kg wagon rolls east on frictionless wheels at 20 m/s. Suddenly a 40 kg dog drops out of a tree and lands on the wagon. What is the final speed of the dog and wagon?

5. A 60 kg roller skater moving 40 m/s east slams into a huge glob of yellow jello. When she emerges from the other side of the blob 3 seconds later, she is only moving 20 m/s. What was the magnitude and direction of the average force she felt while inside the yellow yuck?

6. A 30 kg object is moving east at 20 m/s. It hits and sticks to a 40 kg object that is also moving east at 8 m/s. What is the speed and direction of the two stuck togther? Assume no friction is involved.

7. A 30 kg object is moving east at 20 m/s. It hits and sticks to a 40 kg object that is moving west. What was the initial speed of the 40 kg object if the final speed of the two stuck togther is 20 m/s west? Assume no friction is involved.

8. A 40 kg dog is riding a 20 kg skateboard east at 30 m/s. The 20 kg cat riding its back suddenly leaps east at a speed of 30 m/s relative to the earth. What is the final speed of the dog on the skateboard?

9. A 8 kg wagon rolls east on frictionless wheels at 20 m/s. Inside the wagon is a 20 kg monkey and a 40 kg watermelon. Suddenly the monkey simply drops the watermelon overboard. What is the final speed of the monkey and wagon?

10. A 60 kg roller skater moving 40 m/s east slams into a huge glob of yellow jello. The impulse delivered to the skater by the blob is 1200 N s. What is her speed upon exiting the blob?

Wkb 6c
Doing Energy Problems

Like Real Estate: The RBD is Location, Location, how you get ther is of no interest.

The System: in which energy is added, subtracted, or altered, is equally important.

Kinds of Energy

$\mathbf{K = (1/2)\ mv^2}$ = kinetic energy = energy of motion

$\mathbf{PE_g = U_g = mgy = -\int F(x)\ dx}$ = gravitational potential energy = energy due to position

$\mathbf{PE_s = U_s = (1/2)\ k_s\ \Delta s^2}$ = spring potential energy = energy due to compression or extension of a spring.

W = Work done on the system (positive work) or by the system on (negative work) that enables us to arrive at the final location.

$\mathbf{\Delta U_{int} = F_k\ \Delta x}$ = change in internal energy of the system , heated up (positive ΔUint) or cooled down (negative ΔU_{int})

ΔU_{int} will be expressed as a **negative** bar in the W column under the initial side if the **surface is not** part of the system.

ΔU_{int} will be expressed as a **positive** bar in the ΔU_{int} column under the final side if the **surface is** part of the system.

Phy 213 Conservation of energy Exercises

Here's how you get paid. 1 pt each.

1. Draw Pict
2. Indicate system with a dotted circle
3. Draw bar chart
4. Underneath the Before side, write the formula for that side.
5. Underneath the After side, write the formula for that side.

6. Place an equal sign (=) between the two sides and solve the equation

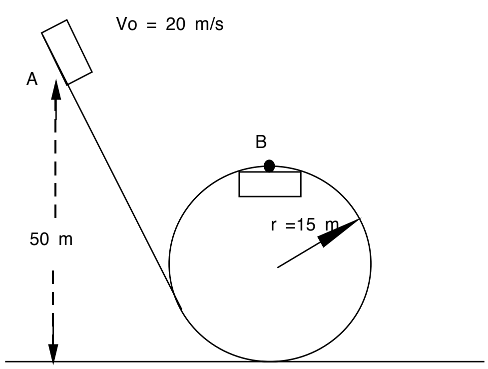
1. An object is thrown upward at a speed of 50 m/s. What will be it's maximum height?

2. An object is thrown upward at a speed of 50 m/s. What will be it's speed when it's height is 8 m? Does it matter whether this position is on the trip up or the trip down?

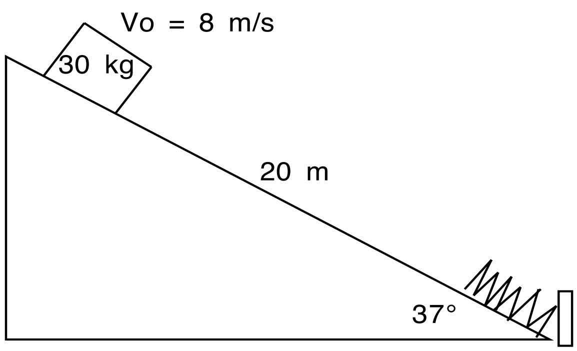
3. A block slides down a friction free incline that is 20 m long and has an incline of 37° below the horizontal. How fast will it be traveling when it reaches the bottom? Assume no friction losses.

4. A 80 kg wagon rolls east on frictionless wheels at 20 m/s. Suddenly a 40 kg dog leaps in front of the wagon to stop it, saving a toddler in the street. The dog is given a certificate of achievement by the city for "all that work he did." How much work did he do?

5. What is the velocity of the block sliding down the loop - the - loop ramp at B if the track is friction free?

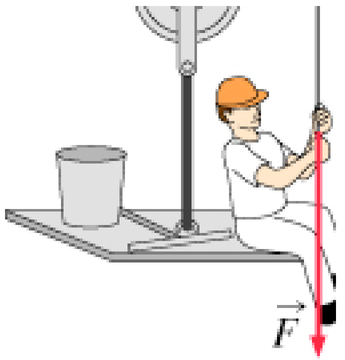


6. A block slides down a plane and compresses a spring when coming to rest. If the coefficient of kinetic friction between the block and the plane is $\mu_k = .3$ and the spring is compressed 2 m, what is the spring stiffness constant of the spring?

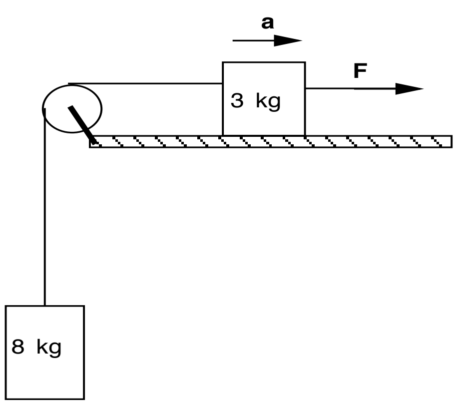


Physics 213 Test 2 Practice 10 points eachWednesday 10-22-2008

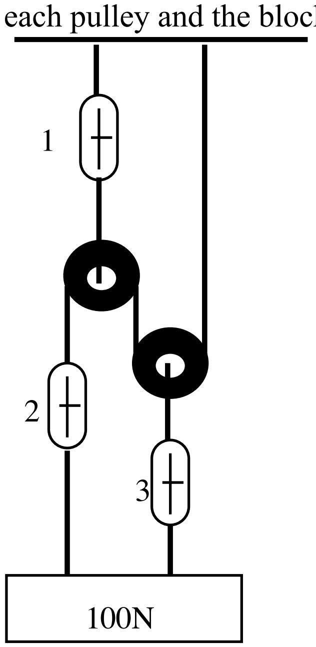
1. In the figure below, assume the platform has mass m_p, the man has mass m_h , and the man must apply a force F to the rope in order to move with constant speed up the wall.
Make a two column chart. In the left column, list all the forces acting on the **platform.** In the right column list all the forces that are reactions to these forces.



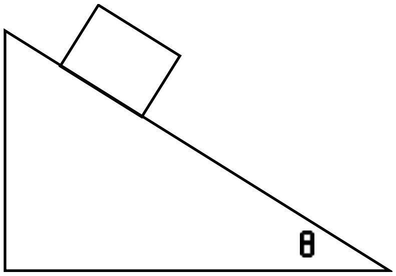
2. The surfaces are friction free. The 3 kg block acclerates 5 m/s^2 to the right. Find the magnitude of F.



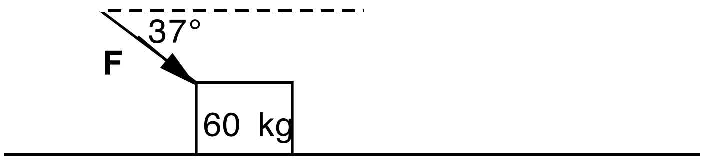
3. Determine the reading of each of the scales in the figure below. (hint: draw a FBD and sum the forces for each pulley and the block.)



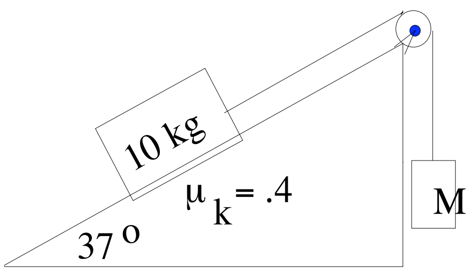
4. A block slides down the slope at a **constant** speed. The coefficient of kinetic friction between the slope and the block is $\mu_k = 0.3$. Find the angle θ.

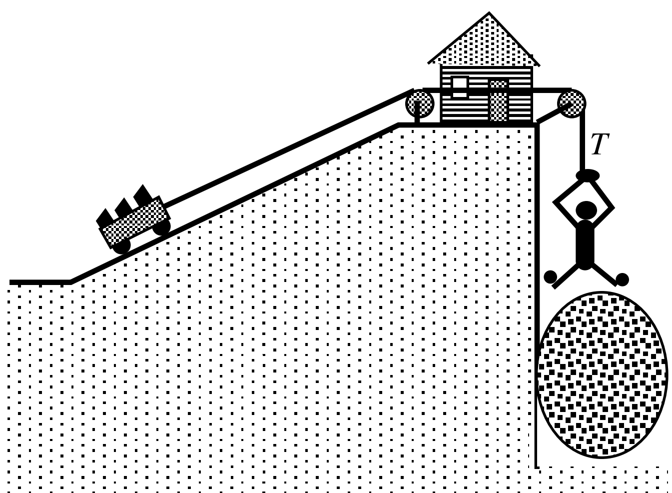


5. An object is pushed along a horizontal surface at constant speed by the force indicated. The coefficient of kinetic friction between surfaces is 0.4 . What is the magnitude of the force F ?



6. a. Determine the mass M so that the 10 kg block will slide up the plane with constant velocity.
b. Explain why the same mass will not work if the block is to slide down the plane.





7. A 400 N kid rides a Ferris Wheel at the circus. She is sitting on a scales, to see how her weight (according to the scales) varies as she goes around. The Ferris Wheel has a radius of 40 m and she is moving with a constant speed . If the strap holding her in the seat must exert a force of 100 N down to hold her in the seat at the top of the ride,

a) How fast is she moving? (You **must** draw a FBD to receive any credit.)

b) What does the scales read at the bottom of the of the Ferris Wheel? (You **must** draw a FBD to receive any credit.)

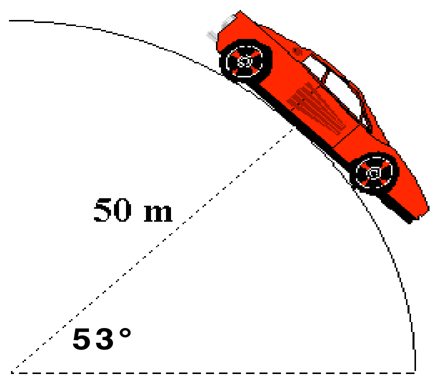
8. The cart full of goodies moves toward the cabin **slowly** increasing speed since the miner is just barely heavy enough to make this idea work. As the miner enters the antigravity cloud below, tension T in the rope suddenly drops in half.

a. What happens to the carts velocity at this point? (You **must** draw a FBD to receive any credit.)

b. **5 pts bonus!** Assuming a worst case senario, what could be the miner's ultimate fate? You **must explain** your answer.

9

A 1000 kg car goes over a hill and is located as indicated on the figure below.



a. Find the normal force of the hill on the car at this point if it is at rest.

b. Find the normal force if the car is moving at 20 m/s.

11. A girl pushes with a force of 800 N on a 100 kg refrigerator (that glides on friction free rollers) for a distance of 30 m . If the refrigerator is originally at rest, how fast is it going when she releases it?

12. A girl pushes with a force of 800 N on a 100 kg refrigerator (that glides on friction free rollers) for a time of 30 seconds . If the refrigerator is originally at rest, how fast is it going when she releases it?

13. In a land not very far away, a popular sport is to do the yellow jello slam on a skate board. A 60 kg skate boarder is zooming along at 28 m/s when she slams into the giant blob of jello. She exits the other side 4 seconds later drenched in yucky jello travelling only 12 m/s.

a. How much work is done on the drenched damsel by the yellow blob?

b. What is the average force the blob imposes on the skate boarder?

14. Given that **F** = 3i - 4 j and Δ**r** = -2**i** + **j** , find the work done by the force **F** over the displacement Δ**r.**

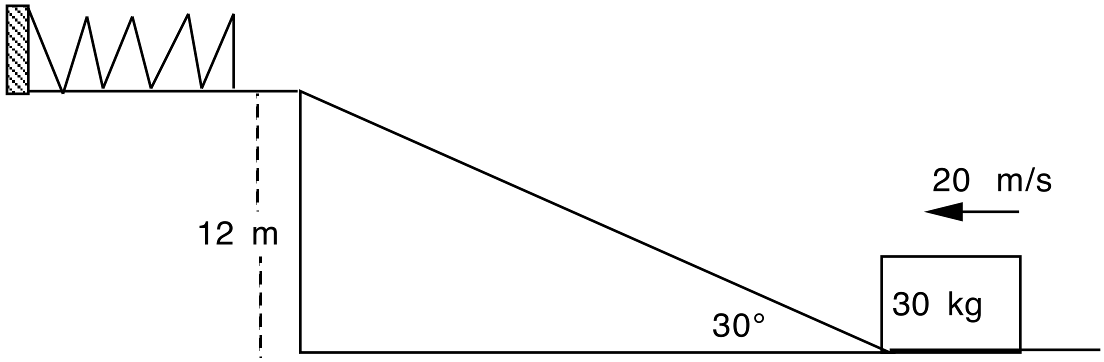
15. A 40 kg dog is riding a 20 kg skateboard east at 30 m/s. The 20 kg cat riding its back suddenly leaps west at a speed of 30 m/s relative to the earth. What is the final speed of the dog on the skateboard?

16. How far must you stretch a spring with stiffness constant k = 1000 N/m to store 200 J of energy ?

17. An object is thrown upward at a speed of 50 m/s. What will be it's speed when it's height is 8 m? Does it matter whether this position is on the trip up or the trip down?

18. A block starts from rest and slides down a friction free incline that is 20 m long and has an incline of 37° below the horizontal. How fast will it be traveling when it reaches the bottom? Assume no friction losses.

19. A block sliding with a velocity of 20 m/s slides up a plane and collides with a spring whose spring stiffness constant is 500 N/m. The coefficient of kinetic friction between the block and the incline is 0.20. If the incline is as indicated in the diagram below, how far does the spring get depressed?



20. Definitions: Aft thrust engines propel a craft **forward**, forward thrust engines propel a craft **backwards**. A 10^4 kg space ship is moving forward at 60 m/s. A 5 x 10^4 W forward thrust engine is employed for 30 seconds used to slow down the space ship.

a. What is the final velocity of the space ship?
b. What was the total impulse delivered to the space craft ?
c. What is the average force produced by the engine ?

Physics 213 Discussion # 16 10.1-10.3 Monday 10-12-2009
Rotational Motion

Today's Agenda:

1. Reading Quiz 11: Write down the three kinematic equations of rotational motion with constant angular motion.
2. Do ch 10 problems 1,2,8,12,18
3. **STOP AT 10:20**
4. do ch10a clickers

Adjourn.

Physics 213 Discussion # 17 10.4-10.6Wednesday 10-14-2009
Rotational KE, Moment of Inertia, Torque

Today's Agenda:

1. Reading Quiz 11-ch10-.ppt

2. Chapter10 do problems 20,22,30,32,36,38

3. **STOP AT 10:20**
4. Do ch10b clickers

Adjourn.

Physics 213 Discussion # 18 10.7-10.9 Monday 10-19-2009
Work & Power

Today's Agenda:

1. Reading Quiz 12: Write down the formula for power for rotating objects.
2. Do ch 10 problems 36,38,46,72,77
3. no clickers today

Adjourn.

Physics 213 Discussion # 19 11.1 - 11.4Wednesday 10-21-2009
Angular Momentum

Today's Agenda:

1. Reading Quiz 12 ch11 read

2. Chapter11 do problems 4,6,12,24,30,36

3. **STOP AT 10:20**
4. Do ch11 clickers

Adjourn.

Physics 213Discussion # 20 12.1 & 12.2 Monday 10-26-2009
Statics I

Today's Agenda:

1. Reading Quiz 13: State the three conditions for equilibrium.
2. Do ch 12 problems 2,12,16,39,45684
3. no clickers today

Adjourn.

Physics 213 Discussion # 21 12.3 - 12.4Wednesday 10-28-2009
Statics & ElasticProperties

Today's Agenda:

1. Reading Quiz 14: Write down formulas for :
   a. Young's Modulus
   b. Shear Modulus
   c. Bulk Modulus

2. Chapter12 do problems28,30,32,34,36

3. **No clickers today.**

Adjourn.

Physics 213 Discussion # 22 14.1 - 14.4 Monday 11-2-2009
Pressure & Archimedes Principle

Today's Agenda:

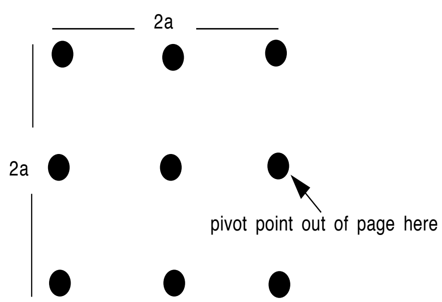
1. Reading Quiz 13-ch14 read
2. Do ch 14 problems 6,7,8,16,18,20,22,25,34
3. Stop at 10:20
4. Do ch14 Pressure clickers.

Adjourn.

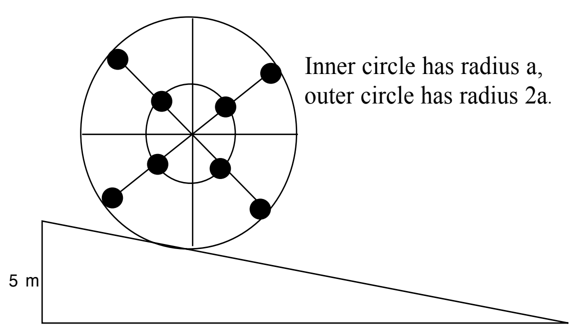
Physics 213Test 310 pts each   Nov 4, 2009

1. A wheel starts from rest and rotates with constant angular acceleration to reach an angular speed of 12 rad/s in 3 seconds. Find :
a. the angular acceleration of the wheel
b. The angle through which it rotates in this time.

2. Determine the rotational mass of the system of masses in the figure if the system is pivoted about an axis perpendicular to the plane containing the masses and thru one of the corner masses.

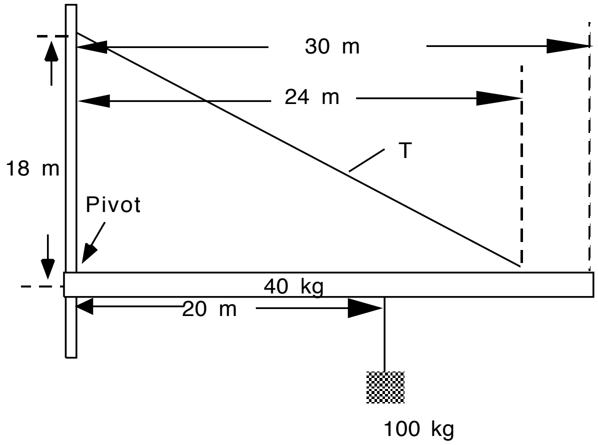


3. We have here a massless hoop system, with 8 masses, m, attached as shown. It begins at rest from the top of the incline that is 5 m high, how fast is it going when it reaches the bottom?



4. Fido the fat (200 kg) is sitting on a stationary merry-go-round. When Fido begins galloping clockwise around the merry-go-round a distance of 2 m from the center at a speed of 4 m/s, the merry-go-round rotates in the opposite direction 2 rad/s, what must be it's moment of inertia?

5. Find the tension T in the rope. (FBD is essential for credit.)

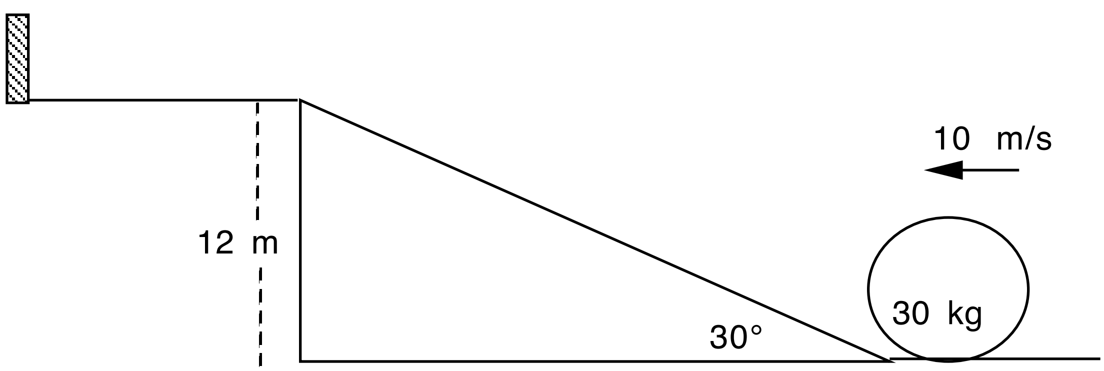


6. How much work is required to increase the speed of a 40 kg object from 30 m/s to 50 m/s if: the object is a solid disk of radius 2 m rollling on a horizontal plane.

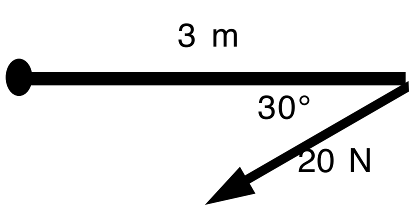
7. A solid sphere of mass 30 kg and radius 3 m rolls along the ground at 10 m/s as it approaches an incline. (moment of inertia of a solid sphere is .4 m $r^{2)}$.

a. If it doesn't reach the top of the incline, how far up the incline does it go ?

b. If so, with what speed does it strike the block?



8. A 3 m rod pivots about one end. A force of 20 newtons is applied to the other end at at the angle indicated in the figure below. What is the torque produced by this force?



9. The small piston of a hydraulic lift has a cross-sectional area of 3 cm^2, and the large piston has a cross-sectional area of 200 cm^2. What force must be applied to the small piston forthe lift to raise a load of 15 000 N ?

10. A ping pong ball has a diameter of 3.8 cm, and an average density of 0.084 g/cm^2. What force is required to hold it completely submerged under water?

Physics 213 Discussion # 24 14.5 - 14.7 Monday 11-9-2009
Bernoulli's Principle

Today's Agenda:

1. No reading quiz today.
2. Do ch 14 problems 38,44
3. Stop at 10:20
4. no clickers today

Adjourn.

Physics 213 Discussion # 24 14.5 - 14.7 Monday 11-9-2009
Bernoulli's Principle

Today's Agenda:

1. No reading quiz today.
2. Do ch 14 problems 38,44
3. Stop at 10:20
4. no clickers today

Adjourn.

Physics 213 Discussion # 26 Wednesday 11-18-2009
Simple Harmonic Motion

Today's Agenda:

1. Reading Quiz 1

2. Chapter15 do problems 2,10,21,24,29,30

3. Stop at 10:20

4. do ch 15 clickers

Adjourn.

Physics 213 Discussion # 27 Ch 19 Monday 11-30-2009
Temperature

Today's Agenda:

1. Reading Quiz 15-ch19 read
2. Do ch 19 problems 2,6,10,16,24,28,37,48
3. Stop at 10:20
4. Ch 19 Temperature clickers

Adjourn.

Physics 213 Discussion # 28 Chap 20Wednesday 12-2-2009
Heat & the First Law of Thermodynamics

Today's Agenda:

1. Reading Quiz 16-ch20 read.ppt
2. Do ch 20 problems 11,17,18,24,30,32,34,36
3. Stop at 10:20
4. Ch20 s&j clickers

Adjourn.

Physics 213Discussion # 29 Ch 22 Monday 12-7-2009
Heat Engines

Today's Agenda:

1. Reading Quiz 17-ch22 read.ppt
2. Do ch 22 problems 2,4,8,12,24,36
3. Stop at 10:20
4. Ch22 clickers

Adjourn.