

Exam 2 Review

Physics 211
Syracuse University, Physics 211 Spring 2015
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February 26, 2015

- Exam 2 next Tuesday
- Homework 5 due Friday
- No recitation next Wednesday (TA's will be grading)
- Recitation next Friday: going over exams
- Exam regrades still in progress (I've been teaching nonstop, sorry!)

- 4 questions (+ possible extra credit)
- No detailed graphs
- More symbolic problems (no numbers) than before
- Please arrive a bit early if at all possible
- **Please know your recitation section number to get your exam back on time**
- Bring a calculator and your pencil

- Practice exam posted
 - Solutions posted Friday after recitations
- Review session **today: 3:30-6:00, Physics Building B126**
- Review session **tomorrow: 10AM-4PM, Heroy Geology Building room 013**
- I'm available to answer questions by email, Facebook chat, etc. all weekend
 - Lots of people have been Facebook-messaging me cellphone pictures of work with questions; please do this!
- There is a huge amount of help available to you: use it!

Midterm evaluations

- There are midterm course evaluations at Syracuse – you should have gotten emails about this
- Go to <http://aaf-ratings.syr.edu/> and enter a passcode you were sent by mail
- I take your feedback extremely seriously
- At the end of class if you like I can give you time to complete this if you'd like

- Newton's second law: $\sum \vec{F} = m\vec{a}$
 - Forces (left hand side) cause accelerations (right hand side)
 - Acceleration is not a force; it *results* from forces
- Newton's third law: Forces come in pairs. If A pushes on B, B pushes back on A
- Forces are things you can feel:
 - Normal forces: one thing pushes on another
 - Gravity
 - Tension: a rope pulls on something
 - Friction: opposes things sliding
 - Acceleration is not a force: forces *cause* acceleration
 - “Centripetal force” is not a separate force: it describes one of the above

A few things about these forces: gravity

- On Earth: always acts downward with $F_g = mg$
- The acceleration of an object is *only* g if there are no other forces

$$-mg = ma_y : \text{only if } \sum F_y = -mg!$$

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- This is only true on Earth. Elsewhere: all objects attract each other

$$F_g = \frac{Gm_1m_2}{r^2}$$

- m_1 and m_2 are the masses of the two objects; r is the distance between their centers.
- $G = 6.67 \times 10^{-11} \text{N} \cdot \text{m}^2/\text{kg}^2$
- This distance is measured between their centers (for planets)
- On Earth: $F_g = m_1g = \frac{GM_em_1}{r_e^2}$, so $g = \frac{GM_e}{r_e^2}$

A few things about these forces: tension

- Just the force exerted by a rope
- Always goes in the direction of the rope, and is the same throughout
- Can only pull; can never push
- Force is the same on both ends (Newton's 3rd law)

A few things about these forces: normal forces

- Stops two things from moving through each other
- Always directed normal (perpendicular) to a surface
- Magnitude is as large as it needs to be to stop objects from “crossing” ($a_{\perp} = 0$)
- Newton’s third law: if A pushes on B, B pushes back on A (the book problem)
- Can only push; can never pull (the water-in-bucket problem)

A few things about these forces: friction

Friction depends on a property of the surfaces called the **coefficient of friction** μ

- Roughly: “how sticky things are”.
- Force of kinetic friction = $\mu_k F_N$
- Max force of static friction = $\mu_s F_N$
- Friction points in whatever direction opposes the tendency to slide
- Static friction *can* make objects move (cars, people walking)

Rotational motion

- “Uniform circular motion”: object steadily moving in a circle
- Angular velocity: how fast does the thing turn? (RPM’s, degrees per second, **radians per second**)
- Constant speed does *not* mean constant velocity or zero acceleration!

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- “How many force problems and how many circular motion problems will we have?”
- They’re the same: circular motion just tells you that $a = \omega^2 r$. You do these problems in *exactly the same way*.

Problem solving strategies (the important thing!)

- 1. Force diagrams (“Accounting”)
 - Draw all forces and only forces (things you can feel)
 - Choose a pair of axes (tilted axes are sometimes helpful, like for things on ramps)
 - Break forces into components along these axes, if needed

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• 2. Newton’s laws (“Physics”)

- Write down $\sum F = ma$ for **each object** in **each direction**. You can read this off your diagram. For instance:

$$T_1 \cos \theta - T_2 = ma_x$$

$$T_1 \sin \theta - mg = ma_y$$

- Forces (real things) go on the left side; acceleration goes on the right
- Put in things you know about the acceleration
- Different objects : different acceleration variables (are they related?)
 - Sometimes $a = 0$
 - Circular motion: $a_r = \omega^2 r = \frac{v^2}{r}$ toward the center

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• 3. Algebra (“Math”)

- Put in the stuff you have, solve for the stuff you need
- Need at least as many equations as unknowns
- “Systems of equations”: solve by substitution

Sample problems: elevator

A 100 kg person stands in an elevator. What is the normal force if the elevator is accelerating upward at 3 m/s^2 ?

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- Sum of forces goes on the left, acceleration goes on the right
- We know the acceleration; we don't know one of the forces \rightarrow solve for it!

Sample problems: Mass on a string

A 2 kg mass hangs on a string 1m long, which is being spun in a vertical circle once per second. What is the tension force at the bottom of the arc?

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- This is the same idea as the last problem; we just know the acceleration in an indirect way

Sample problems: Mass on a string

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- Remember, the acceleration goes toward the center of the circle: think about your signs!

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A block sits on a ramp inclined at an angle of 40 degrees. The coefficient of kinetic friction is 0.3. What is its acceleration?

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- Tilted coordinate axes
- Break gravity into components (remember how this goes!!)

Sample problems: Atwood's machine

Two masses of 1 kg and 1.1 kg hang from either side of a massless pulley. What is their acceleration?

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- Separate force diagram for each object
- How do the accelerations relate?

Sample problems: Train problem

A toy locomotive of mass 4 kg tows two toy train cars of mass 2 kg each, accelerating at 2 m/s^2 . Find the two tension forces and the force of static friction on the locomotive's wheels.

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- Static friction = traction force
- Separate force diagram for each object
- Only have forces that directly connect – don't “guess the answer”, ask the question

Sample problems: your request!

Mid-semester evaluations