

These exams are taken from the spring 2003 offering of the course, written by Julio Gea-Banacloche. In spring 2007, all the students were future teachers, and they all chose the lesson plan option.

Physics in Perspective First Exam (BS version), February 11, 2003

Question 1:

- (a) Compare and contrast (in as few words as possible) the atomic models of gases proposed by Descartes, Bernouilli, and Dalton.
- (b) Which, if any, of the above models is closest to our current understanding of gases?

Question 2:

Give some reasons for and against the existence of caloric, as they may have been proposed around the year 1800.

Problem 3:

Gay-Lussac observed that 1 volume of nitrogen gas combined with 1 volume of oxygen gas to give two volumes of nitric oxide gas. Show how this result follows naturally from Avogadro's hypothesis about gases, and from the assumptions that the formula for nitric oxide is NO and oxygen and nitrogen are both diatomic gases. Is there any way that this experimental result could happen if nitrogen and oxygen were both monatomic? (Assuming that Avogadro's model of gases is correct.)

Problem 4: (BS students)

A mercury barometer is inside a sealed glass container that holds a certain amount of gas, initially at atmospheric pressure (1 atm) and room temperature (about 300 K). If the gas in the container is heated to 400 K, by how many centimeters does the mercury in the tube rise?

Physics in Perspective First Exam (BA version), February 11, 2003

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Problem 4: (BA students)

A balloon is filled with gas at room temperature (about $27^{\circ}\text{C} = 300\text{ K}$) and atmospheric pressure. Suppose that the temperature is lowered to -10°C , by sticking it in a freezer; assume that the pressure does not change. What is the percentage change in its volume?

Review questions-Second exam

What was the fundamental theoretical concept that Clausius introduced in the kinetic theory of gases?

What counterintuitive prediction did Maxwell make in his first paper on the kinetic theory?

Which one of Maxwell's theoretical results on the collisions of gas molecules can be regarded as "proof" of Avogadro's hypothesis regarding the number of molecules in equal volumes of different gases? Why?

Who was the first to estimate the size of an atom (or molecule)? Briefly summarize the method by which he reached his result.

What was the main argument used by some scientists at the turn of the 20th century to deny the reality of atoms?

State the principle of equipartition of energy.

Briefly explain what the problem of the specific heat of gases was, and how quantum mechanics provided a resolution to it.

Who appears to have been the first scientist to draw diagrams showing light rays? What was the main thing wrong with his diagrams?

For centuries there was a debate between the extramission and intromission theories of vision. Give a couple of arguments that each side may have used either to support their position, or to criticize the opposite side.

Name the two scientists who most contributed to the understanding of how the eye allows one to see images of objects.

Give two reasons why Newton seemed to favor a corpuscular model of light.

To explain the observed refraction of light at an air-water interface, would light have to travel faster in air or in water? Answer under the two alternative assumptions, (a) light is a stream of particles (b) light is a wave.

Give two experimental reasons in support of the wave nature of light, which became

known to scientists in the early years of the 19th century.

Why was it so difficult to devise a mechanical model for the luminiferous ether?

With whom did the idea of electromagnetic waves originate? Who showed that they were mathematically possible?

Why did Maxwell consider it very likely that light was an electromagnetic wave?

Physics in Perspective Second exam B.S. Version

1. Explain briefly what the mean free path of a molecule in a gas is. Who was the scientist who first introduced this concept?
2. Who was the first scientist to correctly estimate the size of an atom (or molecule)? Explain how one could use (a) the knowledge of the size of a molecule to estimate its mass (using also other empirical data) and (b) the knowledge of the mass to estimate Avogadro's number.
3. Give two reasons why Newton seemed to favor a corpuscular model of light.
4. Give two reasons why it was very difficult for the 19th century scientists to devise a mechanical model for the luminiferous ether.

Physics in Perspective Review for third (final) exam

How and by whom was the speed of light first measured in an earth-bound laboratory?

List a couple of features of the photoelectric effect that do not seem to be compatible with the wave theory of light.

Be prepared to work out some photoelectric effect numerical problem.

Essay-type question: discuss the nature of the knowledge that we have gained, through physics, about the physical world. Distinguish between the various elements that make up this body of knowledge. Could one speak of "varying degrees of certainty" among these?

Discuss the following statement: "in science we deal, perforce, with connections between human observations: the rest of science is a theoretical imagery whose connection to reality must remain forever uncertain." Do you agree or disagree? (Give reasons.) What philosophical point of view appears to underlie this observation?

Give some examples of "cultural bias" in the history of physics (for instance, examples where some physicists favored one theory over another, or refused to accept some theory, because it conflicted with their philosophical preconceptions).

List the book's main criteria that a "good physics theory" must satisfy, and be prepared to discuss how they apply to any of the theories we have covered in class this semester.

List three or four main features of "pathological science." Illustrate them with some examples.

Discuss the similarities and differences between "pathological science" and pseudoscience.

Would you classify astrology as a science or a pseudoscience? (be prepared to argue your case)

Explain Popper's principle regarding the importance of "falsifiability" for a scientific theory. Be ready to discuss its applicability to any of the theories we have covered in class this semester.

Explain Planck's principle of how changes in scientific thinking take place, and be ready to discuss its applicability to any of the theories we have covered in class this semester.

Essay question: should Stapp's article (a paper that studies, mathematically, how one could modify Schrodinger's equation to allow for a sort of "causal anomaly" of a type that may have been investigated by psychic researchers) have been published in The Physical Review, or not? Argue your case.

**Physics in
Perspective
Third (final)
exam
BS Version**

1. The work function of sodium is 2.75 eV. What is the energy of electrons emitted in the photoelectric effect, if any, when light of wavelength 748 nm bombards sodium?
2. List the book's main criteria that a "good physics theory" must satisfy, and discuss how they apply (or not) to the wave theory of light, as it was developed throughout the nineteenth century.
3. List three telltale signs of "pathological science" and illustrate them with an example, among those covered in class.
4. Your book states that "scientists sometimes prefer an inadequate theory to none at all." Give an example, taken from the material covered in class this semester, where it was historically the case that many (perhaps a majority of) scientists did hold on to a theory for a long time after it was shown to be inadequate. Discuss (a) how one could tell that the theory was, in some respects at least, inadequate, and (b) whether there really was "no alternative theory at all," or whether there was, rather, some kind of alternative, but for some reason (why?) it was perceived as inferior to the "accepted" theory.

**Physics in
Perspective
Third (final)
exam
BA version**

1. The largest wavelength of light that will induce a photoelectric effect in potassium is 564 nm. Calculate the work function for potassium in electron volts.
2. List the book's main criteria that a "good physics theory" must satisfy, and discuss how they

apply (or not) to the wave theory of light, as it was developed throughout the nineteenth century.

3. List three telltale signs of "pathological science" and illustrate them with an example, among those covered in class.

4. Your book states that "scientists sometimes prefer an inadequate theory to none at all." Give an example, taken from the material covered in class this semester, where it was historically the case that many (perhaps a majority of) scientists did hold on to a theory for a long time after it was shown to be inadequate. Discuss (a) how one could tell that the theory was, in some respects at least, inadequate, and (b) whether there really was "no alternative theory at all," or whether there was, rather, some kind of alternative, but for some reason (why?) it was perceived as inferior to the "accepted" theory.