First and Last Name____________________________________

ASPC Quiz 3

Point values for each item are shown in parentheses. Show all your work on the computations. Verbal questions may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar. For full credit, your paper must be neat and complete. Useful conversion factors are listed at the bottom of the other side.

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1. This quiz will last 30.00 minutes. How many years of your life will pass during this quiz? (15)

2. The density of mercury is 13,600 kg/m^3. Convert this value into g/cm^3. (15)

3. How many milliliters of milk are in a gallon jug of milk? (Assume a jug holds 1.00 gal.) (15)

4. The measured drift velocity of the South American continent is 1.45 cm/yr. Convert this value to mm/day. (15)

5. Susan is talking to her friend Jane over coffee. Jane has a Ph.D. in astrophysics. Susan says, “Jane, I am telling you the truth: Jesus Christ is the only way to God.” Jane replies, “To me, truth is things like the universe starting with the Big Bang. I *know* that is true. This stuff about Jesus, I don’t know if that is true or not.”

   Using ideas from the text and class discussion, briefly describe how the word truth is being used in this conversation. If you were Susan, what would you say next? (10)

6. Distinguish between accuracy and precision. (20)

7. What is science? (10)

Useful information

1,609 m = 1 mi 0.3048 m = 1 ft (exact) 3.785 L = 1 gal

First and Last Name___________________________________

ASPC Quiz 7

Point values for each item are shown in parentheses. Show all your work on the computations. Verbal questions may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar. For full credit, your paper must be neat and complete. Useful conversion factors are listed at the bottom of the other side.

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1. A tennis player serves the ball at 65.7 m/s. The ball lands 77.5 feet away, just inside the baseline on the other end of the court. Assuming the ball travels in a straight line at a constant speed, how long is the ball in the air? (15)

2. A fighter jet is traveling at a velocity of 513.0 m/s. (FYI, this is Mach 1.5.) The pilot slows the plane at a rate of –12.25 m/s^2 during an interval of 27 seconds. What is the final velocity of the plane? (15)

3. A proton with a mass of 1.673×10^{-24} g is accelerated from rest to 1.10 % of the speed of light in a time interval of 45.000×10^4 ms. Calculate the force required to make this happen. (15)

4. The engines of a freight train can deliver 233.9 kN to accelerate the train. If the resulting acceleration is 0.3148 m/s^2, what is the mass of the train? Also, what is the weight of the train? (15)

5. Tell us about Tycho Brahe. (20)

6. State Newton's laws of motion. (10)

7. Distinguish between mass, matter, and inertia. (10)

Useful Information

1,609 m = 1 mi   0.3048 m = 1 ft (exact)

First and Last Name__________________________________

ASPC Quiz 15

Point values for each item are shown in parentheses. Show all your work on the computations. Verbal questions may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar. For full credit, your paper must be neat and complete. Useful conversion factors are listed at the bottom of the other side.

---

1. The wavelength of green light from a laser is 532 nm. Determine the frequency and period of green light. (15)

2. A worker uses a motorized hoist to lift a heavy piece of machinery. The machinery being lifted weighs 3,755 lb and the hoist raises it 4.25 ft above the floor. Determine the work done by the hoist. (15)

3. A proton with mass $m_p = 1.673 \times 10^{-24}$ g is accelerated from rest to 4.05% of the speed of light in 3,560 ms.

   a. What is the acceleration of the proton? (10)

   b. What is the force required to do this? (10)

   c. What is the kinetic energy of the proton after it is at the indicated speed? (10)

4. Static electricity can be created three different ways. Briefly describe each of them and explain how two of them were clearly involved in the electroscope demonstration. (10)

5. Use what we learned in class to explain why we can tell the difference between a clarinet and an oboe, even if they are playing the same note. This question can be answered in a sentence or two. (10)

6. A tamale vendor used to come to my place of employment selling hot tamales that he had packed into a Styrofoam ice chest. (They were most tasty – I always bought a dozen!) If this man were to leave his ice chest full of hot tamales sitting in a room, the tamales would eventually cool down and reach thermal equilibrium with the room. Briefly explain which heat transfer mechanisms would be involved and not involved in this process. The ice chest was packed solid with piping hot tamales. (10)

7. What is static electricity? (5)

8. Tell us about Volta. (5)

Useful Information

1,609 m = 1 mi   4.45 N = 1 lb   0.3048 m = 1 ft (exact)

First and Last Name___________________________________

ASPC Quiz 27

Point values for each item are shown in parentheses. Show all your work on the computations. Verbal questions may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar. For full credit, your paper must be neat and complete. Useful conversion factors and a periodic table are shown at the bottom of the other side.

---

1. Write the electron configuration for the following elements: (15)

   a. silicon

   b. phosphorus

   c. nickel

2. Write the formulas for the compounds that form between the given substances: (15)

   a. sodium and carbonate

   b. ammonium and nitrite

   c. calcium and bicarbonate

   d. potassium and hydroxide

   e. lithium and chlorate

3. A car weighing 3,125 lb is accelerated by three students pushing it from the rear. If each student pushes with a force of 55 lb, determine the acceleration of the car. (15)

4. A student uses a graduated cylinder and mass balance to determine the volume and mass of a small stone using the displacement method. Her data are shown below. Determine the density of the stone. State your answer in kg/m^3. (15)
   V_1 = 35.3 mL
   V_2 = 39.1 mL
   m = 8.05 g

0.3048 m = 1 ft 4.45 N = 1 lb 1609 m = 1 mi

5. Consider a chemical reaction between one of the alkaline-earth metals and one of the halogens. In a single sentence, state what kind of bond forms and the numerical ratio of atoms of each of these elements that are present in the resulting compound. (10)

6. Use electron dot diagrams to show the covalent bonds in the following molecules. Show all valence electrons. Also write the name of each substance. (10)

   a. O_2

   b. CH_4

   c. CO_2

   d. NH_3

7. State the five propositions in Dalton's atomic model. Also indicate which ones are still regarded as correct and which are partially correct and why. (10)

8. Distinguish between ionic and covalent bonds. (10)

liquid at room temperature

radioactive

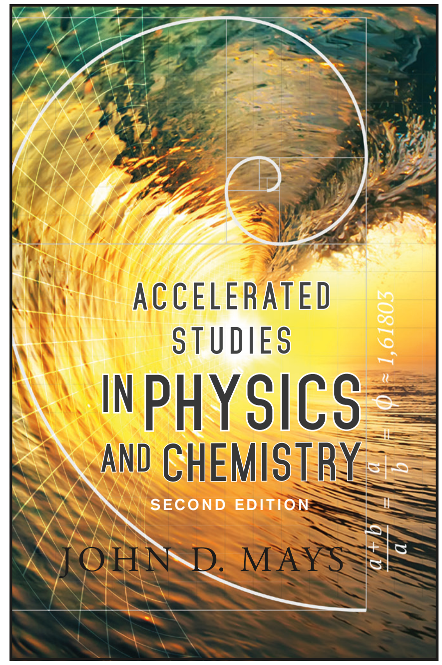
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.0079																	2 He Helium 4.0026
2	3 Li Lithium 6.941	4 Be Beryllium 9.0122											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.1797
3	11 Na Sodium 22.9898	12 Mg Magnesium 24.3050											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.9738	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
4	19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
5	37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.224	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9072	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.82	50 Sn Tin 118.710	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.29
6	55 Cs Cesium 132.905	56 Ba Barium 137.327	71 Lu Lutetium 174.967	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium 208.9824	85 At Astatine 209.9871	86 Rn Radon 222.0176
7	87 Fr Francium 223.0197	88 Ra Radium 226.0254	103 Lr Lawrencium 262.11	104 Rf Rutherfordium 261.11	105 Db Dubnium 262.114	106 Sg Seaborgium 263.118	107 Bh Bohrium 262.12	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (281)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)

57 La Lanthanum 138.9055	58 Ce Cerium 140.115	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9253	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9303	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.0289	93 Np Neptunium 237.0482	94 Pu Plutonium 244.0642	95 Am Americium 243.0614	96 Cm Curium 247.0703	97 Bk Berkelium 247.0703	98 Cf Californium 251.0796	99 Es Einsteinium 252.083	100 Fm Fermium 257.0951	101 Md Mendelevium 258.10	102 No Nobelium 259.1009

0.3048 m = 1 ft   4.45 N = 1 lb   1609 m = 1 mi

Accelerated Studies in Physics and Chemistry

Keys and Sample Answers
2nd edition



Thank you for using *Accelerated Studies in Physics and Chemistry*.
This document contains sample answers to all verbal questions in the text, on quizzes, and on exams. Also included are the solutions to the computations on the quizzes and tests. Solutions to computational exercises in the text are available separately in the solutions manual, available on our website. (Answers to all exercises are found in the book.)

The sample answers in this document are provided to aid in situations in which the adult teacher responsible for conducting the course does not possess a background in this subject, or in which a student is studying independently. The written answers provided here are only samples and should not be considered the only correct responses to the questions.

In environments where there are multiple students in a class or group, it is recommended that students form their own answers to chapter exercises in complete sentences as a homework assignment. These should be graded for completion only, not accuracy. Then in the group setting, students bring their preliminary answers to class where they collaborate with each other and the teacher to improve their answers. The final product is a useful study tool developed by the group. In such a setting, there is little need for the written answers in the present document, but it is provided for the many home study situations in which there is no collaborative group.

Additional information about how this course should be conducted is provided in the textbook introduction and in documents on the Resource CD. A full presentation of strategies and techniques for mastery-learning can be found *Teaching Science so that Students Learn Science*, available from our website.

Thank you!

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Contents

Note: Solutions to computational exercises in the text are available separately in the solutions manual, available on our website. (Answers to all exercises are found in the book.)

Note: There is an errata page on our website

http://www.novarescienceandmath.com/more/errata/

Chapter 1 Exercises

Study Questions

1. Distinguish between theories and hypotheses.

A theory is a mental model or explanatory system that attempts to explain the scientific data in a sphere of knowledge. Theories enable us to make new predictions about the natural world. A hypothesis is a prediction based on a theory about what will happen in an experiment. A hypothesis is tested by conducting an experiment that either confirms or disconfirms the theory upon which it is based.

2. Explain why a single experiment can never prove or disprove a theory.

First, theories are models and thus are never proved or disproved at all. Instead they get stronger or weaker based on their ability to explain experimental data.

Because an effective experiment is difficult to perform, the experiment must be replicated by several different experimental teams for any experimental outcome to be regarded as fact. There are many reasons a hypothesis might not be confirmed by a particular experiment, including flaws in the experiment, an incorrect understanding of the theory upon which the hypothesis is based (and thus a faulty hypothesis), or inaccurate or imprecise measurements during the experiment.

3. Explain how an experiment can still provide valuable data, even if the hypothesis under test is not confirmed.

If an experiment cannot confirm the hypothesis under test, the scientist must first double-check the experiment for flaws and re-examine his or her understanding of the theory to ensure that the hypothesis is a correct statement of what the theory says will happen. But an experiment that is replicated again and again by several different experimental teams with the same results and still cannot confirm the hypothesis under test provides very valuable data, namely a new fact. This new fact is not consistent with the prevailing theory.

The theory may be able to be altered to account for the new fact. But if the theory simply cannot account for the new fact, then the theory has a weakness. If enough of these weaknesses accumulate, then over a long period of time (often decades, or even centuries) the theory might eventually be replaced with a better theory.

4. Explain the difference between truth and facts and describe the sources of each.

Truth is the way things really are and cannot change. Truth may be known by direct observation, by valid reasoning from true premises or by divine revelation. Revelation may be either Special Revelation (the book of God's Word, the Bible) or General Revelation (the book of God's Works, nature). Truth is true for all time and all people. Scientific facts, on the other hand, are propositions that are supported by a great deal of evidence. They are discovered by observation, experiment, and by making inferences from what we observe or the results of our experiments. Facts are considered to be correct so far as we know. However, facts can change when new information becomes known.

5. State the two primary characteristics of a theory.

A successful scientific theory must account for most or all the known facts, tying them together in a single explanation. Secondly, a successful theory must lead to the formation of new hypotheses that can be tested.

6. Does a theory need to account for all known facts? Why or why not?

No. A useful scientific theory must account for most of the related facts, but no theory ever explains everything perfectly. There are always phenomena that theories do not adequately explain. Still, scientists continue their work in a field hoping eventually to have a theory that explains as many of the facts as possible.

7. It is common to hear people say, "I don't accept that; it's just a theory." What is the error in a comment like this?

In science, theories are all we have. All scientific knowledge is theoretical, or theory-based. There is no scientific statement that can be made apart from the theoretical framework that explains the statement. Theories take a long time to develop and support with experimental facts, and they should not be dismissed simply because they are theories. Theories are the glory of science.

Comment: This discussion about the nature of science and the distinction between the terms truth, fact, and theory, is essential in training our students well and equipping them to live "purposefully and intelligently in the service of God and man," as one school's mission statement puts it. The misuse of the term "theory," by both Christians and non-Christians alike, is one of the primary elements fueling cultural controversies over science in our country. Christian schools have a very important responsibility in this regard: to instruct students on what theories are, how they develop, and the central role they play in all scientific research. For additional resources on responsibly addressing this issue see our book *Teaching Science so that Students Learn Science*.

8. Distinguish between facts and theories.

A theory is a mental model that explains most or all of the facts in a certain sphere of knowledge. A theory becomes stronger by producing successful predictions that are confirmed by experiment. A theory will be gradually weakened if new facts resulting from experiments turn out to be inconsistent with the theory. Facts are propositions supported by a lot of experimental evidence that are correct so far as we know.

9. Distinguish between explanatory variables, response variables, and lurking variables.

The explanatory variable is the variable that is deliberately manipulated by the researchers. As it is manipulated, the researchers monitor the effect this variation has on the response variable. Usually only one explanatory variable is manipulated at a time so that researchers can definitively tell what its effect is on the response variable. A lurking variable is a variable that is affecting the response variable without the researchers being aware of it. Researchers have to study their experimental projects very carefully to minimize the possibility of lurking variables affecting their results.

10. Why do good experiments that seek to test some kind of new treatment or therapy include a control group?

When experimenting on people to try new therapies or medications, researchers divide the patients involved in the study into two groups: the control group and the experimental group. The control group receives no treatment or some kind of standard treatment. The experimental group receives the new treatment being tested. The results of the experimental group are assessed by comparing them to the control group.

11. Explain specifically how the procedure students follow in the Pendulum Experiment satisfies every step of the "scientific method."

The eight steps of the Scientific Method are below, along with explanations of how the procedure in the

Pendulum Lab follows these steps.

1. State the problem. In our class discussion, we suggested possibilities for explanatory variables that could affect the period of a pendulum. We identified the weight, the length of the string, and the starting angle from which the pendulum is released as the three possible explanatory variables.
2. Research the problem. In teams, we discussed the three possible explanatory variables and considered our own experience and knowledge to determine which affect the period of a pendulum.
3. Form a hypothesis. We formed a team hypothesis and documented it in our lab journals.
4. Conduct an experiment. The team tested these three explanatory variables by manipulating one variable while keeping the other two variables constant.
5. Collect data. During the experiment, we recorded all experimental results in our lab journals. We had four tables of data in all, which included the results from 24 separate trials.
6. Analyze the data. After the experiment, we reviewed the data as a team and discussed which potential explanatory variables affected the period of the pendulum and which did not.
7. Form a conclusion. In our team discussion, we reached a conclusion and afterwards documented it in our lab reports.
8. Repeat the work. During the experiment, we repeated each of the different combinations of variables three times to ensure good, consistent data. We also followed this step by comparing our data with those of other groups.

12. This chapter argues that scientific facts should not be regarded as true. Someone might question this and ask, If they aren't true, then what are they good for? Develop a response to this question.

Scientific facts, though not truth claims, are also important knowledge and are correct so far as we know. They are essential to understanding the natural world around us. Scientific facts allow us to develop theories and make discoveries that enable us to better appreciate, use and steward our planet.

13. Explain what a model is, and why theories are often described as models.

A model is a representation of something else. The model is used to explain how the thing that it represents works. The more accurate the model, the more useful it is. A theory is a model, because it is a representation of how part of the world works.

14. Consider an experiment that does not deliver the result the experimenters expect. In other words, the result is negative because the hypothesis is not confirmed. There are many reasons why this might happen. Consider each of the following elements of the Cycle of Scientific Enterprise. For each one, describe how it might be the driving factor that results in the experiment's failure to confirm the hypothesis.

a. the experiment

a. The experiment may have been flawed. For example, the equipment might not have been working properly, the calculations may have been incorrect, or the measurement instruments may not have been accurate or precise enough to provide meaningful data.

b. the hypothesis

b. The hypothesis may have been based on an incorrect understanding of the theory. Maybe the experimenters did not understand the theory well enough, and maybe the hypothesis was not a correct statement of what the theory says will happen.

c. the theory

c. Finally, there could be a problem with the theory itself. Perhaps the theory can be altered to account for the new fact that the experiment demonstrated, or maybe the theory simply cannot account for the new fact and it has a weakness.

15. Identify the explanatory and response variables in the Pendulum Experiment, and identify two realistic possibilities for ways the results may be influenced by lurking variables.

The explanatory variables in the Pendulum Lab were the weight, the length of the string, and the starting angle from which the pendulum is released. The response variable is the period of the pendulum. The results may have been affected by lurking variables such as air friction, moving air in the room, or vibrations/movements at the location where the top of the pendulum was attached.

Chapter 2 Exercises

Ptolemaic Model and Copernican Revolution Study Questions

1. Make a list of all the regions in the Ptolemaic Model in their correct order. (There are 10 of them, and the first nine are called spheres.) For each of the last three regions write a brief description of the meaning of the name.

Sphere 1 – Moon
Sphere 2 – Mercury
Sphere 3 – Venus
Sphere 4 – Sun
Sphere 5 – Mars
Sphere 6 – Jupiter
Sphere 7 – Saturn
Sphere 8 – The Firmament. This region consists of the stars arranged in their constellations according to the zodiac.
Sphere 9 – *The Primum Mobile*. This Latin name means "first mover." This sphere rotates around the earth every 24 hours and drags all the other spheres with it, making them all move.
Beyond – The Empyrean. This is the region beyond the spheres. The Empyrean is the abode of God, or the gods.

2. Describe why some theologians in the 16th century were strongly opposed to Copernicus' heliocentric theory.

Many theologians at the time did not understand that Scripture must be interpreted. Thus, they assumed that statements such as "He set the earth on its foundations so that it should never be moved" (Ps 104) and "The sun rises and the sun goes down, and hastens to the place where it rises" (Eccl 1) were literal descriptions of nature. In Copernicus' model, the earth orbits the sun, not vice versa, and this seemed to these theologians to be in direct contradiction to what Scripture taught.

3. State six features of the Ptolemaic model other than the spheres.

1. All seven of the heavenly bodies are perfectly spherical.
2. All heavenly bodies move in circular orbital regions, called spheres.
3. All the spheres are centered on the earth, so this system is a geocentric system.
4. Corruption and change only exist on earth. All other places in the universe are perfect and

unchanging.
5. All the spheres containing the heavenly bodies and all the stars rotate completely around the earth every 24 hours.
6. Epicycles are used to explain retrograde motion.

4. Describe Copernicus' model of the heavens.

Copernicus proposed a detailed heliocentric model, with the earth rotating on an axis, all the planets moving in circular orbits around the sun, and the moon orbiting the earth. Copernicus' model used circular orbits, and like the Ptolemaic model, used epicycles to make the model work. Still, Copernicus' model was much closer to today's understanding than the Ptolemaic model was.

5. What are some of the "proofs" people used to argue that there is no way that the earth rotates on an axis?

If you are simply observing from earth, it appears that everything is orbiting around the earth while the earth sits still. The sun and moon appear to rise each day, track across the sky, and set.

It also doesn't feel at all like the earth is rotating. Eratosthenes had already accurately estimated the circumference of the earth, so most scientists felt that if something that big were spinning in a circle once a day the people on its surface would be moving very fast. People on earth would have to hang on for dear life to keep from falling off. People used these arguments up until the time of Galileo to prove that there was no way the earth was orbiting the sun and spinning around once a day.

6. For what reason did Copernicus decide to keep his theory private?

Copernicus knew how committed the church theologians were to the Ptolemaic system and did not want to offend them with his ideas. He also did not want to be "hooted off the stage," as he wrote in *On the Revolutions of the Heavenly Spheres*. So he published his work privately to his close friends in 1514, and it became public at his death in 1543 when one of Copernicus' admirers got it published.

7. Write a description of the two key observations Tycho made (including dates) that challenged the Ptolemaic system.

First, in 1563 he observed a conjunction between Jupiter and Saturn. A conjunction is when two planets are in a straight line with the earth, so that from earth they appear to be in the same place in the sky. Tycho closely predicted the date for this conjunction using Copernicus' new heliocentric model. Second, in 1572 he observed what he called a "nova" (what we would now call a supernova) and proved that it was a new star. This discovery was strong evidence that the stars were not perfect and unchanging as Aristotle had thought and as Church doctrine declared.

8. Briefly describe the cosmological model put forward by Tycho.

In Tycho's model, the sun and moon orbit the earth. All the other planets orbit the sun, which orbits the earth. Tycho was able to avoid controversy since in his model the sun and moon orbit the earth and the earth is stationary, which lines up with a literal reading of the Bible.

9. State Kepler's three laws of planetary motion.

1. Each of the planetary orbits is an ellipse, with the sun at one focus.
2. A line drawn from the sun to any planet sweeps across the same area in space in any given period of time.
3. The orbits of any two planets are related according to the equation

22. Explain why the aluminum case of an Apple MacBook or iPad always feels cool when you touch it.

Aluminum has a high thermal conductivity. Any time you touch aluminum that is at room temperature it will feel cold because heat will flow continuously out of your hand into the aluminum.

Chapter 7 Exercises

Study Questions

1. What is a wave?

A wave is a disturbance in space and time that carries energy from one place to another.

2. Write paragraphs explaining reflection, refraction, dispersion, diffraction, resonance, and interference.

Reflection: Waves reflect off surfaces. As they do, they obey the law of reflection: the angle of incidence equals the angle of reflection.

Refraction: As a wave passes from one medium to another, its propagation velocity and direction of propagation both change. The bending of the wave as it changes direction is refraction.

Dispersion: The amount of refraction depends slightly on the wavelength. Thus, when a beam of white light composed of many individual wavelengths (colors) of light refracts, the different colors refract different amounts and the colors separate.

Diffraction: As waves encounter obstructions or corners, they diffract, which means they bend around the corner or obstruction and begin spreading out.

Resonance: When a wave interacts with its reflection in a medium (room, string, etc), standing waves are formed. If the dimensions of the medium correspond to an integral multiple of half the wavelength, the medium itself tends to oscillate that the same frequency as the wave. Under these conditions, instead of absorbing the wave the medium amplifies it, producing a wave with a much larger amplitude.

Interference: When two separate waves arrive at the same place at the same time, they add together. If the waves are in phase when this happens, constructive interference occurs—the waves add together and combine to produce a wave with a larger amplitude. If the waves are out of phase, destructive interference occurs—the waves combine and cancel each other out.

3. Explain why one guitar sounds different from another, according to the discussion in Chapter 7.

All instruments produce tones by resonances. But in addition to resonating at the fundamental frequency of the tone, they also resonate at multiples of that frequency. These different resonant frequencies are called harmonics. All guitars have similar harmonic structure (i.e., the relative strengths of the different harmonics produced by the instrument), which is why they sound similar. But there are slight differences in harmonic structure between guitars because of the different ways they are made, and this is why they sound different.

4. Distinguish between mechanical and electromagnetic waves.

Mechanical waves require a medium in which to propagate; electromagnetic waves do not require a medium and can propagate through the empty vacuum of space.

5. Look at your answers for problems 5 and 6 above and try to explain the fact that when a car drives under a bridge FM radio signals come through fine while AM radio signals do not.

We calculated the wavelengths broadcasted by the AM station KAHL to be 229 m. Very few waves this long reflecting around every which way will have just the right orientation to fit under a bridge and pass through, so the signal under the bridge is so weak that the car radio loses it. This is true for all frequencies in the AM range. The wavelengths in the FM range are much smaller, in this case 3.35 m, so they fit under bridges much more easily, meaning that FM radios don't blank out when we drive under one.

6. What does it mean to say that waves are in phase?

When waves are in phase, their peaks and troughs occur in the same place at the same time.

7. Distinguish between transverse, longitudinal, and circular waves.

In a transverse wave, the oscillating motion that causes the wave is perpendicular to the direction of wave propagation, as is the case with light waves. With longitudinal waves, the oscillating motion that causes the wave is in the same direction as the wave propagation, as is the case of sound waves produced by a loudspeaker. Circular waves are typical of waves on water. An object floating on water as waves pass by moves in a circular fashion as the waves pass by beneath it.

8. Explain why you cannot hear radio stations in the air right now (or any other time).

Our ears respond to sound waves, which are variations in air pressure. Radio waves are electromagnetic waves (like light), not sound waves.

9. Think of as many ways to distinguish sound waves from light waves as you can.

Sound waves are longitudinal, light waves are transverse.

Sound waves are mechanical, light waves are not.

The frequencies of sound waves are very low compared to the frequencies of light waves: in the range of a few hundred or thousand Hz for sound, but around 10^{14} Hz for visible light.

10. Using words and not equations, distinguish between the period and frequency of a wave.

The period is the length of time required for a wave to complete one complete cycle. The frequency is the number of complete cycles the waves completes per second.

11. Explain why laser light is referred to as being coherent.

For light to be coherent means that all the waves in a light beam are in phase with each other. The waves of light from a normal light bulb are not in phase with each other; the phase of each photon is random. But in laser light, all the photons are in phase with each other, so laser light is coherent.

Chapter 8 Exercises

Historical Questions

1. Describe the origin of the voltaic pile.

Count Alessandro Volta first began working on what he called the voltaic pile when he heard about Luigi Galvani's experiment making frog legs contract with iron and copper prongs. After nine years of thought and experimentation, Volta invented the voltaic pile in 1800, the predecessor to the modern battery.

2. Describe the design and operation of the voltaic pile.

In Volta's original design, the voltaic pile consisted of a stack of cells encased in a tall glass jar or wooden frame. Each cell consisted of a layer of copper (positive charge), an electrolyte layer (cloth or cardboard soaked in saltwater), and a layer of zinc (negative charge). Because the electrolyte layer allowed the conduction of electricity, current could flow from one end to the other of the voltaic pile.

3. Why was the invention of the voltaic pile so important?

For the first time, scientists had a reliable source of electricity they could use in the lab. This was crucial for the further study of electricity.

4. What scientific model do Maxwell's equations represent?

Maxwell's four simple, beautiful equations constitute a complete description of all known electric and magnetic phenomena in the universe (at least all that can be said apart from the quantum theory that emerged in the 20th century).

5. Why are Maxwell's equations recognized as such a great achievement in theoretical physics?

These equations demonstrated that light was an electromagnetic wave. From the study of these equations first came the idea that we could create radio waves and transmit information with them, which is without doubt one of the most influential ideas in the history of human technology. Because of these equations and Maxwell's contributions to the pioneering work on the Kinetic Theory of Gases, Maxwell's theoretical work is ranked at the same level as that of Newton and Einstein.

Static Electricity Study Questions

1. Explain what static electricity is and how it forms.

Static electricity is an accumulation of charge that is stationary. Static accumulations can be caused by rubbing (friction), by conduction as charges move in conductors, and induction, which is when charges are forced to squeeze together due to a nearby charged object pushing them away.

2. Describe two examples of friction causing a build-up of static electricity.

An easy way to accumulate static electricity is by combing your hair with a rubber comb. The friction between the comb and the hair can cause static electricity to build up. Another way that friction is caused by a build-up of static electricity is by walking across a nylon carpet in the winter. Your feet are actually scraping loose some of the electrons from the atoms in the carpet. These electrons accumulate on you and spread out all over your body.

3. Explain what electrical conduction is, and describe how it is involved in the operation of an electroscope.

Electrical conduction is the flow of electric charge. The effect is demonstrated in the electroscope when the charged object touches the metal sphere. When this happens the electric charge conducts down the metal rod in the electroscope and into the metal foil leaves, forcing them to push away from each other. Conduction occurs again if someone touches the metal sphere atop the electroscope with his hand, allowing the extra charge to drain off the electroscope by flowing onto him.

4. Explain what induction is, and describe how it is involved in the operation of an electroscope.

Induction is a process that forces electric charges to accumulate. This effect is demonstrated in the electroscope when the charged object is brought near the metal sphere, but not allowed to touch it. The leaves move apart because of the charge induced in them, or forced down into them, by the nearby presence of the charged object.

5. What is a static discharge?

A static discharge is an arc or spark that occurs when a large accumulation of static electricity is suddenly released. The biggest of these arcs we can see in nature is a lightning bolt, which is a huge discharge of the static electricity that builds up in clouds and discharges to the ground.

6. Why do we say that an accumulation of static electricity by induction is a temporary effect?

Induction occurs without any charges transferring from one object to another, such as the cup and the metal sphere of the electroscope. This means the accumulation of static electricity is temporary, because as soon as the object is pulled away the charges in the metal parts of electroscope all relax and spread back out again.

Electric Current Study Questions

1. Explain what electric current is.

Electric current is flowing or moving charge, either positive or negative.

2. Explain what the "electron sea" in a metal is.

In metals, there is a very, very large number of free electrons, also called conduction electrons. There are so many free conduction electrons in a metal that scientists refer to this ocean of electrons as the "electron sea."

3. Why is it that the electric current in everyday electrical circuits consists of moving electrons and not moving protons?

In ordinary circumstances the protons in a solid substance are locked in the atomic nuclei of atoms that are held in place. So although a current of protons can be created in a laboratory under special circumstances, that is not usually what happens.

4. Why do metals conduct electricity so well?

In most substances, the electrons of an atom are held around the atomic nucleus by the force of electrical attraction between the nucleus and the negative electrons. However in metals, many of the electrons are free to move about easily within the crystal lattice when an electric force is present. There are so many of these free electrons, called conduction electrons, that scientists refer to this ocean as the "electron sea."

Relationships Between Variables in Electric Circuits

For this exercise you will again refer to the basic DC circuit shown in Figure 8.25, with one change. Instead of a fixed-voltage battery, assume the voltage source is adjustable. For this circuit make two graphs. First, make a graph of *I* vs. *V* for the circuit assuming a resistance value of 3.3 kilohms. In your table of values for this graph, use voltages ranging from 0 to 15 V. Compute a table of values with at least five points and show your table of values with your graph.

Next, make a graph of the power (P_R) consumed by the resistor as a function of the current *I* in the

resistor, or P_R vs. I. The power equation, $P = VI$, can be expressed in terms of only the current and the resistance. If you insert Ohm's law into the power equation in place of V, you have an expression for power in terms of only the current and the resistance: $P = I^2R$. Use this expression to create your data set. In your table of values for this graph, use currents ranging from 0 to 5 mA. Compute a table of values with at least five points and show your table of values with your graph.

Calculations for first exercise:

$$R = 3.3\text{ k}\Omega$$

$$V = 0\text{ V}, 3.0\text{ V}, 6.0\text{ V}, 9.0\text{ V}, 12.0\text{ V}, 15.0\text{ V}$$

$$I = ?$$

$$V = IR$$

$$I = \frac{V}{R}$$

$$I = \frac{0\text{ V}}{3.3\text{ k}\Omega} = 0\text{ mA}$$

$$I = \frac{3.0\text{ V}}{3.3\text{ k}\Omega} = 0.91\text{ mA}$$

$$I = \frac{6.0\text{ V}}{3.3\text{ k}\Omega} = 1.8\text{ mA}$$

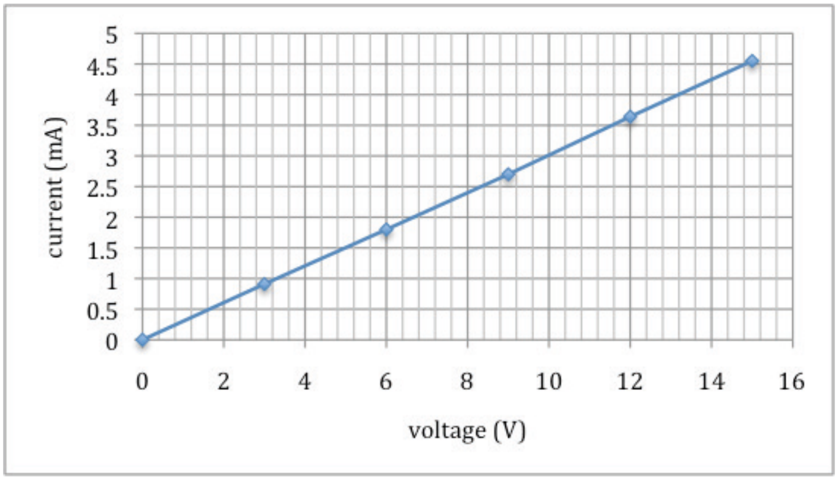
$$I = \frac{9.0\text{ V}}{3.3\text{ k}\Omega} = 2.7\text{ mA}$$

$$I = \frac{12.0\text{ V}}{3.3\text{ k}\Omega} = 3.64\text{ mA}$$

$$I = \frac{15.0\text{ V}}{3.3\text{ k}\Omega} = 4.55\text{ mA}$$

Voltage (V)	Current (mA)
0	0
3.0	0.91
6.0	1.8
9.0	2.7
12.0	3.64
15.0	4.55

Table 8.1. Current at select voltages, with resistant of 3.3 kΩ.



Graph 8.1. *I* vs. *V*.

Calculations for second exercise:

$R = 3.3\ \text{k}\Omega$

$I = 0.0\ \text{mA}, 1.0\ \text{mA}, 2.0\ \text{mA}, 3.0\ \text{mA}, 4.0\ \text{mA}, 5.0\ \text{mA}$

$P_R = ?$

$P = I^2R$

$P = (0.0^2)\cdot 3.3\ \text{k}\Omega = 0\ \text{mW}$

$P = (1.0^2)\cdot 3.3\ \text{k}\Omega = 3.3\ \text{mW}$

$P = (2.0^2)\cdot 3.3\ \text{k}\Omega = 13\ \text{mW}$

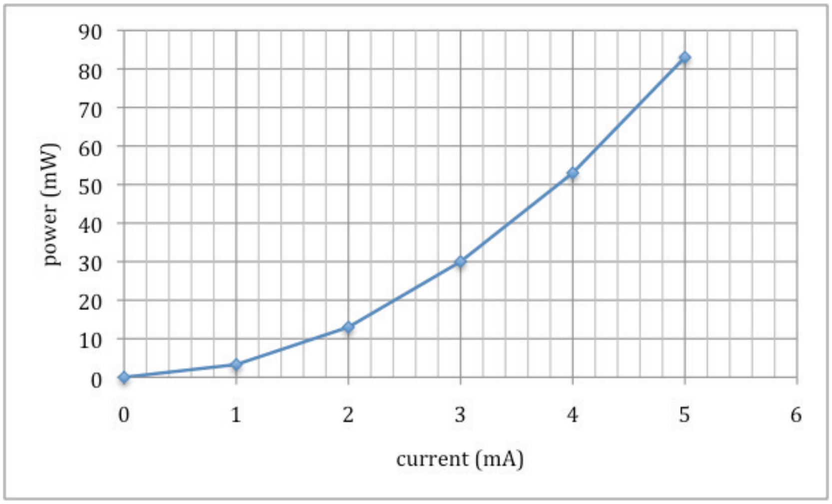
$P = (3.0^2)\cdot 3.3\ \text{k}\Omega = 30\ \text{mW}$

$P = (4.0^2)\cdot 3.3\ \text{k}\Omega = 53\ \text{mW}$

$P = (5.0^2)\cdot 3.3\ \text{k}\Omega = 83\ \text{mW}$

Current (mA)	Power (mW)
0	0
1.0	3.3
2.0	13
3.0	30
4.0	53
5.0	83

Table 8.2. Power at select currents, with resistant of 3.3 kΩ.



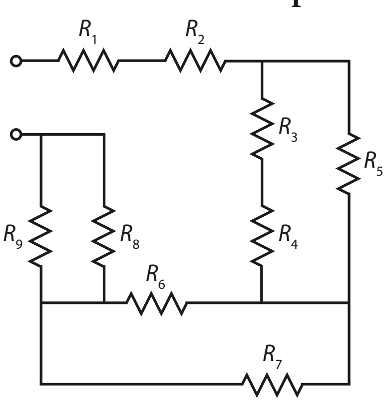
Graph 8.2. P_R vs. I.

Equivalent Resistance Exercises

Identify the following networks as either series or parallel and calculate R_{EQ}.

1. series
2. series
3. parallel
4. parallel
5. parallel

6. For the network shown, identify a) every pair of resistors connected in series and b) every pair of resistors connected in parallel.



R_1 and R_2 are in series.
R_3 and R_4 are in series.
R_6 and R_7 are in parallel.
R_8 and R_9 are in parallel.

Course Lesson Schedule   ASPC   Fall Semester

Lesson Number	Topic	Text Key	Assignment	Notes
1	Welcome; study strategy		Read Study Strategy in Student Preface	Discuss roles of Objectives Lists, Conversion Factors (App. A), Scientists List (App. D). Announce students to get lab journals and correct calculators.
2	Modeling knowledge	1.1	Read 1.1	
3	Cycle of Scientific Enterprise	1.2	Read 1.2	
4	Cycle of Scientific Enterprise	1.2	Chapter 1 Exercises 1-8, 12-14	
5	Cycle of Scientific Enterprise; Scientific Method	1.2	Read 1.2	
6	Quiz 1		Read Pendulum Experiment, p. 381	
7	Scientific Method and Controlling variables in experiments	1.3	Chapter 1 Exercises 9-11, 15	
8	Pendulum Experiment	p. 381	Read Student Lab Report Handbook (SLRH) Preface to Students and Chapters 1-6 Lab Report	Report due in approx two weeks
9	Metric system	2.1.1-2.1.2	Read 2.1	Discuss lab report expectations (See *Teaching Science*…)
10	Quiz 2	2.1.3		Accuracy and precision after quiz
11	Accuracy and precision; significant digits	2.1.3-2.1.5	Unit Conversion Exercises	Unit conversion examples from App E
12	Scientific notation; unit conversions (See App E)	2.1.6	Unit Conversion Exercises	Handout Weekly Review Guide 1
13	Motion: velocity and acceleration	2.1.7 2.2.1-2.2.2	Read 2.2 Motion Study Questions Set 1	Review problem solving method with the examples.
14	Quiz 3		Motion Study Questions Set 1	Class work on Motion Study Questions Set 1
15	Graphical analysis of motion	2.2.3	Motion Study Questions Set 2	
16	Graphical analysis of motion	2.2.3	Motion Study Questions Set 2	Class work on Motion Study Questions Set 2 Handout WRG 2
17	Copernican Revolution	2.3	Read 2.3	
18	Quiz 4	2.3		Continue Copernican Rev after quiz
19	Copernican Revolution	2.3	Ptolemaic Model etc Study Questions	
20	Matter, inertia, mass; Newton's laws of motion	3.1-3.2.1	Read 3.1-3.2	Handout WRG 3
21	Computations with Newton's Second Law	3.2.1-3.2.4	Newton's Second Law Practice Problems	Review Motion Study Quest Set 2
22	Quiz 5			Class work on NSL Practice Problems
23	Computations with Newton's Second Law	3.2.1	Newton's Second Law Practice Problems	Class work on NSL Practice Problems
24	Applications and examples of Newton's Laws	3.2.2, 3.2.5	Newton's Laws of Motion Study Questions	Class work on NLM Study Questions Handout WRG 4
25	Quiz 6		Newton's Laws of Motion Study Questions	Class work on NLM Study Questions
26	Discuss NLM Study Questions; Prep for SOM Experiment		Read SOM Experiment, p. 384	Handout WRG 5
27	Soul of Motion Experiment	p. 384	Read SLRH Chapters 6-8; Lab Report	Report due in approx two weeks.
28	Quiz 7			After quiz: Demo graphing in Microsoft Excel
29	Variation, variables, types of variation, normalizing equations	4.1-4.2	Read Ch 4 Variation and Proportion Study Packet	Students begin work on study packets
30	Variation, variables, types of variation, normalizing equations	4.1-4.2	Variation and Proportion Study Packet	Students work on study packets Handout WRG 6
31	Drill Day			Spend the period drilling computations using all equations learned to date.
32	Quiz 8		Variation and Proportion Study Packet	Students work on study packets
33	Charles' law demo, Activity 8	4.1-4.2	Variation and Proportion Study Packet	
34	Variation and Proportion	4.1-4.2	Variation and Proportion Study Packet	Students work on study completing packets; Packets due in approx. 1 week Handout WRG 7
35	Energy	5.1-5.2.2	Read Ch 5 Energy Study Questions	
36	Quiz 9	5.2.3		Begin 5.2.3 after quiz
37	The Energy Trail, Friction	5.2.3-5.2.5		
38	Calculations with Energy Work Classroom Examples, p 127-128	5.3.1	Energy Calculations Set 1	Class work on Energy Calculations Set 1 Handout WRG 8
39	Work	5.3.2	Energy Calculations Sets 2 and 3	Class work on Energy Calculations Sets 2 and 3
40	Quiz 10		Energy Calculations Sets 2 and 3	Class work on Energy Calculations Sets 2 and 3
41	Calculations with Conservation of Energy	5.3.3-5.3.4	Energy Calculations Set 4	Class work on Energy Calculations Set 4

42	Energy in the Pendulum	5.3.5	Energy Calculations Set 4; Read the Hot Wheels Experiment, p. 389	Class work on Energy Calculations Set 4 Handout WRG 9
43	Hot Wheels Experiment	p. 389	Lab Report	Report due in approx two weeks
44	Quiz 11			Class work on Energy Calculations Set 4
45	Drill Day 2			Spend the period drilling computations using all equations learned to date.
46	Temperature scales and unit conversions	6.1.1-6.1.2	Read Ch 6 Temperature Unit Conversions	Handout WRG 10
47	Energy in substances; heat transfer processes	6.2-6.3	Heat Transfer and Kinetic Theory Study Questions	
48	Quiz 12	6.4		6.4 after quiz
49	Thermal properties: heat capacity	6.5.1	Specific Heat Capacity and Thermal Conductivity Questions	Class work on Specific Heat Capacity and Thermal Conductivity Questions
50	Thermal conductivity	6.5.2-6.5.3	Specific Heat Capacity and Thermal Conductivity Questions	Class work on Specific Heat Capacity and Thermal Conductivity Questions Handout WRG 11
51	Discuss study questions	6.2-6.5		
52	Quiz 13			After quiz, begin 7.1 Modeling waves
53	Modeling waves	7.1-.1-7.1.3	Read 7.1-7.2 Wave computations	Classwork on wave computations
54	Wave interactions	7.2.1-7.2.4		Demos of reflection, refraction, dispersion

Course Lesson Schedule   ASPC   Spring Semester

Lesson Number	Topic	Text Key	Assignment	Notes
1	Wave interactions	7.2.5-7.2.6	Read 7.2	Demos of resonance, diffraction, interference
2	Sound and light	7.3-7.4	Read 7.3-7.4 Study Questions	Sound demos
3	History of electricity	8.1.1-8.1.2	Read 8.1	Handout WRG 12
4	Voltaic Pile Day	8.1.2		Students work in teams to make their own voltaic piles. Highest voltage wins.
5	Quiz 14			Complete history after quiz
6	Static Electricity	8.2	Read 8.2	Demos and playtime with electroscope, Wimhurst generator, Van de Graaff generator
7	Electric current, water analogy; Basic DC circuits and schematics	8.3-8.4.2	Read 8.3-8.4	Handout WRG 13
8	Quiz 15			After quiz, complete 8.4.1-8.4.2
9	Units of measure, Ohm's law	8.4.3-8.4.8		
10	Calculations with Ohm's Law and power	8.4.9-8.4.10	Introductory Circuit Calculations Relationships Between Variables in Electric Circuits	Handout WRG 14
11	Series and parallel networks; Calculating REQ	8.5.1-8.5.4	Read 8.5 Equivalent Resistance Exercises Equivalent Resistance Calculations	
12	Quiz 16			After quiz, begin 8.6.1
13	Kirchhoff's Laws Multi-resistor circuit calcs.	8.6.1	Read 8.6	
14	Solving Multi-Resistor DC Circuits	8.6.2	Multi-Resistor Circuit Calcs 1-5	Multi-Resistor Circuit Calcs 1-5 Handout WRG 15
15	Quiz 17			Multi-Resistor Circuit Calcs 1-5
16	Solving Multi-Resistor DC Circuits	8.6.2		Multi-Resistor Circuit Calcs 1-5
17	Solving Multi-Resistor DC Circuits	8.6.2		Multi-Resistor Circuit Calcs 1-5 Handout WRG 15
18	Solving Multi-Resistor DC Circuits	8.6.2		Multi-Resistor Circuit Calcs 1-5
19	Quiz 18		Read DC Circuits Experiment, p. 391	
20	DC Circuits Experiment Initial setup	8.6.2	Read DC Circuits Experiment, p. 391	This experiment requires 1.5-2 days
21	DC Circuits Experiment Data collection		Lab Report	Report due in approx two weeks Handout WRG 16
22	Types of fields	9.1	Read 9.1-9.2 Fields Study Questions	Magnetic field demos
23	Quiz 19			After quiz, begin 9.2
24	Ampere's Law, Faraday's Law Solenoids, motors, generators	9.2-9.3.2	Read 9.3 Magnetism Study Questions	Model generator demo
25	Transformers	9.3.3	Magnetism Study Questions	Handout WRG 17
26	Quiz 20			
27	Review answers to study questions			
28	Types of Substances	10.1-10.2	Read 10.1-10.2 Activity in Figure 10.14 Substances Study Questions	Handout WRG 18
29	Review substances family tree. Regions/names in periodic table; solutions	10.2		
30	Quiz 21	10.3	Solubility Calculations	After quiz: Solubility
31	Phases and phase transitions Calorimetry demo	10.4	Read 10.4 Phases of Matter Study Questions	Demonstrate difference in final temperature when ice or metal of equal mass are placed in hot water
32	Physical and chemical properties and changes	10.5	Read 10.5 Physical and Chemical Properties and Changes Study Questions	Handout WRG 19
33	Discuss study questions		Read Solubility Experiment, p. 398	
34	Solubility Experiment			This experiment takes two full days No quiz because we are just returning from class trips and Spring Break
35	Solubility Experiment		Lab Report	
36	Video: *The Privileged Planet*			Handout WRG 20
37	History of atomic models	11.1	Read 11.1 Volume, Mass, and Weight Exercises	
38	Quiz 22			After quiz, continue history

39	History of atomic models	11.1	Atomic Model Study Questions	
40	Density	11.2	Read 11.2 Density Exercises	Handout WRG 21
41	The Bohr Model; Atomic spectra	12.1	Read 12.1	
42	Quiz 23	12.1	Spectroscopy Practice Questions Part 1	After quiz: spectrum tubes demos
43	The Quantum Model/Orbitals/Electron Configuration Notation	12.2	Read 12.2 Spectroscopy Practice Questions Part 2	
44	Quiz 24	12.2	Electron Configuration Exercises	After quiz: continue 12.2
45	Atomic masses and isotopes	12.3	Read 12.3 Atomic Data Exercises	
46	Review and discuss all Ch 12 exercises			Handout WRG 22
47	Bonds and valence electrons	13.1	Read 13.1	
48	Quiz 25		Read Density Experiment, p. 402	After quiz: continue 13.1
49	Density Experiment	11.2	Lab Report	
50	Metallic bonding; Ionic bonds	13.2-13.3	Read 13.2-13.3 Number of Atoms exercises Writing Binary Formulas exercises	
51	Covalent Bonds	13.4	Read 13.4	
52	Quiz 26	13.5	Read 13.5	After quiz: 13.5
53	Polyatomic ions	13.6	Read 13.6 Exercises: Types of chemical bonds; Writing Formulas with Polyatomic Ions; Atomic Bonding Study Questions	
54	Four Types of Chem Reactions	14.1-14.2	Read 14.1-14.2	Reaction demonstrations
55	Other Reaction types	14.3	Read 14.3 Types of Reactions Study Questions	
56	Quiz 27			After quiz: demonstrations
57	Balancing chemical equations	14.4	Read 14.4 Balancing Chemical Equations	
58	Energy in chemical reactions	14.5	Read 14.5	Handout WRG 23
59	Reaction rates and collision theory	14.6	Read 14.6 Energy and Rates in Reactions Study Questions	
60	Quiz 28			After quiz: discuss study questions
61	Exploding coffee creamer and sodium demos			
62	Film: Richard Feynman: Take the world from another point of view			
63	Review and drill			
64	Quiz 29 (Optional)			
65	Film: Hidden by Time: High speed videos and images			

ASPC
Weekly Review Guide No. 4

Your assignments this week include the following review tasks:

1. Review last week's quiz and figure out what you lost points for. If you are not clear on how to improve your responses, visit with your instructor about it during the week. Do this before the next quiz.

2. This week you need to begin a regular practice of reviewing the specific types of problems we are studying. Using your Motion Problems Set 1 and last week's quiz as resources, pick out three problems involving velocity and distance, and three more involving acceleration, and work these six problems again as practice. Pay attention to sig digs and to units.

3. Go through your flash cards for the metric prefixes and the speed of light once.

4. Go through your scientist flash cards twice.

5. Go through your flash cards on technical terms once. (Did you make sure to add new terms such as acceleration to this card set?)

6. You should be keeping a set of flashcards containing all equations, including the units for unfamiliar quantities (such as newtons for force). So far there are four equations in the set. Rehearse them thoroughly.

7. Rehearse Kepler's laws and the regions in the Ptolemaic model once.

8. Practice stating the steps in the scientific method.

9. Read over all Objectives Lists completed so far and make sure you can do all the things on it that we have covered so far. Raise a question in class if you are ever in doubt about anything.

New review problems. If you have been keeping up you should be able to work these four problems perfectly on the first try. If you don't get the right answer on the first try, then find two more similar problems and work them for additional practice. Be sure to come to tutorials to get help any time you need it.

1. A cyclist pedaling at 16.88 mph pedals past a pair of infrared photogates positioned to measure the cyclist's speed. The gates are positioned 12.75 cm apart. How much time does it take the bike to move from the first photogate to the second?

2. An astronaut in the Space Shuttle is orbiting the earth at an altitude of 344.4 km. He sends a radio transmission to a receiving antenna directly below him on the earth. What is the time delay between the time he sends his signal and when the receiving antenna on the earth picks it up? State your answer in microseconds. (All radio waves travel at the speed of light.)

3. The Space Shuttle's main engines generate a net thrust of 6.8 MN for liftoff. The entire vehicle with full payload weighs 18.23 million newtons. Determine the acceleration of the vehicle at liftoff.

4. Use your previous answer for this problem. To reach Low Earth Orbit the Shuttle's main engines have to take the Shuttle to a velocity of 17,500 mph. If we make the simplifying assumption that the acceleration is constant, how long does this take? State your answer in minutes.

Answers

1. 0.01690 s
2. 1,150 μs
3. 3.7 m/s^2
4. 35 min. (In reality, it takes under 6 minutes because the acceleration increases constantly as the fuel is consumed because the mass of the vehicle is decreasing drastically.)

ASPC
Weekly Review Guide No. 16

Your assignments this week include the following review tasks:

1. Review last week's quiz and figure out what you lost points for. If you are not clear on how to improve your responses, visit with your instructor about it during the week. Do this before the next quiz.

2. Read over the Cycle of Scientific Enterprise section in Chapter 1. Review definitions for truth, fact, science, and all the terms in the cycle.

3. Drill all the equations. Make sure you know them all flawlessly.

4. Name and state the two laws attributed to Herr Kirchhoff.

5. Go through your seven scientist cards once. Recite out loud to yourself everything you know about each of the scientists in the card set.

6. Go through your technical term cards once. Make sure you added the equations for electricity.

7. Review the types of variables and the scientific method.

8. Recite out loud: the six wave interactions, the three ways heat can transfer, the three ways static electricity can form, the three laws of motion, and the three laws of planetary motion.

9. Recite the energy transformations and types of energy in various versions of the "energy trail."

10. Read over the new Objectives List and make sure you can do all the things on it that we have covered so far. Raise a question in class if you are ever in doubt about anything.

New review problems. If you have been keeping up, you should be able to work these four problems perfectly on the first try. If you don't get the right answer on the first try, then find two more similar problems and work them for additional practice. Be sure to come to tutorials to get help any time you need it.

1. The period of a certain laser's beam is 1.773×10^{-9} μs. Determine the wavelength of the laser beam and state your answer in nanometers.

2. A Lotus Elise has a mass of 874 kg. This car can accelerate from 0 to 60.0 mph in 4.7 s. What force does the engine have to produce to do this?

3. A certain falling object is 25.00 m above the ground and falling with a velocity of 12.666 m/s. How high is the object when its velocity reaches 13.5 m/s? The mass of the object is 7,755 g.

4. Fill in the chart.

˚F	˚C	K
15.6		
	15.6	

Answers

1. 532 nm
2. 5.0×10^3 N
3. 23.9 m
4.

˚F	˚C	K
15.6	–9.1	264.1
60.1	15.6	288.8

ASPC
Weekly Review Guide No. 21

Your assignments this week include the following review tasks:

1. Review last week's quiz and figure out what you lost points for. If you are not clear on how to improve your responses, visit with your instructor about it during the week. Do this before the next quiz.

2. Review the chemical symbols and names of areas in the periodic table.

3. Review the substance family tree and chemical/physical changes.

4. Practice again your descriptions of how motors, generators, and transformers work.

5. Review your knowledge of Volta and Maxwell. Also review Democritus, Einstein, and Newton.

6. Rehearse describing the experiments and key discoveries of Lavoisier, Thomson, Millikan, and Rutherford.

7. Review the volume conversion factors.

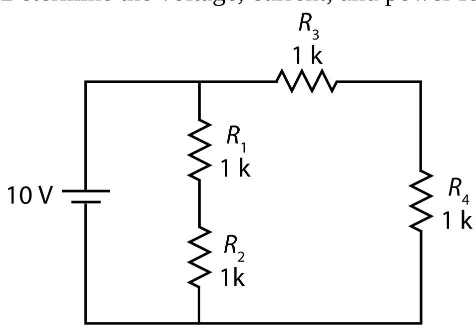
8. Review Kepler's laws of planetary motion and the three processes of heat transfer.

9. Review the six wave interactions.

10. Read over the new Objectives List and make sure you can do all the things on it that we have covered so far. Raise a question in class if you are ever in doubt about anything.

New review problems. If you have been keeping up, you should be able to work these four problems perfectly on the first try. If you don't get the right answer on the first try, then find two more similar problems and work them for additional practice. Be sure to come to tutorials to get help any time you need it.

1. Determine the voltage, current, and power for resistors R_3 and R_4.



2. A Hot Wheels car, mass m = 42.53 g, arrives at the base of a hill moving with a velocity of 15.19 ft/s. As it goes up the hill, how fast is it going when it is 815 mm above the level where it started?

3. Determine the frequency and period of a 633 nm laser light beam.

4. This sheet of paper is 8.5 in × 11 in × 0.0038 in and has a mass of 4.61 g. Determine its density and state your answer in g/cm^3.

Answers

1. I = 5.0000 mA; $V_3 = V_4$ = 5.0000 V; $P_3 = P_4$ = 25.0000 mW
2. v_f = 2.34 m/s
3. $f = 4.74 \times 10^{14}$ Hz; $\tau = 2.11 \times 10^{-15}$ s
4. ρ = 0.79 g/cm^3