CONCEPTUAL PHYSICS

TEXTBOOK CONCEPTUAL PHYSICS BY PAUL HEWITT.

CHAPTER REVIEWS ARE GIVEN AS HOMEWORK AT THE END OF EACH CHAPTER AND QUIZZES EVERY OTHER FRIDAY WITH AP STYLE QUESTIONS ON WORK SO FAR.

LAB EXPERIMENTS ARE CONDUCTED ON THE FRIDAYS THAT THERE ARE NO QUIZZES

week	Subject Covered	Chapter
		in
		textbook
1	Physics why?	
	Definition	
	Order, why did we ever think that there was order to be found?	
	Measurement – the birth of numbers	
	The Scientific Method	
2.2	Our Need to Verify; Standardized Units	
2-3	Linear Motion	2
	• Motion is relative	
	• Speed	
	• Velocity	
	• Kinematics Concepts	
	• What is one-dimensional motion?	
	• Measuring distances	
	• Speed	
	• Average speed	
	• Speeds are relative	
	Instantaneous Speed	
	• Constant Speed	
	• Practice quiz on speed	
	• Velocity	
	• Practice quiz on velocity	
	• Acceleration	
	• What's the difference between velocity and acceleration?	
	• Practice quiz on acceleration	
	Constant acceleration	
	• An algebraic approach	
	• Applications	
	• Free Fall - What is it?	
	 Velocity and Acceleration of an object dropped from rest 	
	 Distance fallen for an object dropped from rest 	
	• What about a non-zero initial speed?	

	• What if there is an initial upward velocity?	
	• Calculating Velocity, Acceleration, and Distance moved	
	• Solving Free Fall problems	
4	Vectors & Scalars	3
	• Difference between vectors and scalars	
	Addition of Vectors	
	Vector Components	
	• Projectiles	
	• Concept Summary (PowerPoint) (download)	
	Object projected horizontally	
	• Separating the horizontal and vertical motions	
	• Calculating the position of the projectile	
	• Calculating the velocity of the projectile	
	• Quiz over projectiles launched horizontally	
	• Object projected at an angle to the horizontal	
	• Calculating the position of the projectile	
	component method	
	distance fallen method	
	• How does range depend on angle of launch?	
	Maximum range	
	• Quiz on projectiles launched at an angle	
	• Why do projectiles act like that?	
	• Frames of reference and projectiles	
	• Solving Projectile Problems Using a Spreadsheet	
	• A "Basic" Projectile Spreadsheet	
	• An "Enhanced" Projectile Spreadsheet	
	• Example 1 - Horizontally-launched projectile	
	• Example 2 - Projectile launched at an angle	
5	Newton's First Law	4
	A historical perspective	
	Aristotle's views on motion	
	Copernicus' conundrum	
	Galileo's views on motion	
	Newton's First Law	
	• How Many Ways Can You State Newton's 1st Law?	
	• Riding in a Car - Applying of Newton's First Law	
	• Thinking about forces	
	• What's a force - really?	
	• The Net Force	
	Balanced and Unbalanced forces	
	Practice quiz on net force	
	 Accelerating Reference Frames and Fictitious Forces 	
	• Equilibrium	
	Equilibrium practice quiz	

	Practice quiz on Newton's First Law			
6	Newton's Second Law	5		
	The First and Second Laws			
	The effect of force			
	The effect of mass			
	Some simple numerical problems			
	Practice quizzes on Newton's Second Law			
	Concepts			
	Numerical			
	Mass & Weight			
	What is Mass?			
	Masses of Things - a table of typical masses in the Universe			
	What is Weight			
	Practice quiz on Weight & Mass			
	Friction			
7	Pressure			
/	Newton's Inira Law	0		
	• Forces are interactions			
	• Identifying Action and Reaction Forces			
	Practice quiz on action/reaction forces			
	• Why Don't Action and Reaction Forces Cancel?			
	• Internal Forces			
	• What's an Object and What Isn't?			
	• Why Does a Bullet Accelerate More Than a Rifle?			
	Concept Summary			
	• Applications			
	Horse and Wagon Problem			
	• The Horse and Wagon Explained:			
	 with No Friction on the Wagon 			
	With Friction on the Wagon			
	• In table form			
	• Why do the Horse and Wagon Need to be Separate			
	Objects?			
	Quiz on Newton's Third Law			
	Labs and Activities			
	• Newton's Third Law in an Explosion - a good introductory			
	activity			
	Balloon Rocket Activity			
	• How Does a Spring Scale Work? (Hooke's Law)			
	• Tension in a String			
	• Tug-of-War			
	Newton's Laws Review Activity			
8	Momentum	7		
	• Impulse			
	• Momentum			

	• The "real" Newton's Second Law	
	• Deriving $F = ma$	
	• The Impulse-Momentum Equation	
	• Deriving the Impulse-Momentum Equation	
	• Using the Impulse-Momentum Equation	
	• Getting the Largest Possible Velocity	
	Getting the Smallest Possible Force	
	• Bouncing	
	• Practice quiz on Impulse & Momentum	
	Conservation of Momentum	
	• An Alternate Derivation of the Law of Conservation of	
	Momentum	
	• Conservation of Momentum in a Single-Object System	
	• Example: A Rock Floating Through Space	
	• Example: A Projectile	
	• Conservation of Momentum in two-object systems	
	Collisions	
	• Bouncing (Elastic Collisions)	
	• Sticking (Inelastic Collisions)	
	Impulses Involved in Collisions	
	• Quiz - Analysis of a Car-Truck Collision (Conceptual)	
	"Explosions"	
	Conceptual Example: Firing a Gun	
	• Conceptual Example: How Does a Rocket Work?	
	• Numerical Example: The Exploding Meatball	
	Conservation of Momentum in multi-object systems	
	Practice quiz on Conservation of Momentum	
9-10	Energy	8
	The Work/Energy Equation	
	Deriving the Work/Energy Equation	
	• An Alternate Derivation of the Work/Energy Equation	
	Kinetic Energy	
	 Calculating the Kinetic Energy of an object 	
	• Kinetic Energy is not the same as Momentum	
	• Work	
	• Work done by a constant force	
	• Work done by a force in the direction of motion	
	• Work done by a force in the direction opposite the motion	
	• Work done by a force perpendicular to the motion	
	• Work done when no motion occurs	
	• Work is not Force!	
	 Some numerical examples of calculating work 	
	A More Mathematical Look at Work	
	Vectors and Work	

	• Work done by a varying force	
	• Work done by the average force	
	• Work as area	
	• Work done to stretch a spring	
	• A more-mathematical view	
	• Work - the general case	
	• The Work-Energy Equation Revisited (AP)	
	• Power	
	• Applying the Work/Energy Equation to Stopping a Car	
	• A more-algebraic approach to the problem	
	• Quiz on Kinetic Energy, Work, & Power	
	• Potential Energy	
	Storing Work/Energy	
	• Lifting a Book - Work Done Against Gravity	
	Pushing a Book - Work Done Against Friction	
	Conservative and Non-conservative forces	
	Properties of Conservative Forces	
	Calculating Potential Energy - In General	
	Gravitational Potential Energy	
	• Elastic (Spring) Potential Energy	
	Conservation of Mechanical Energy	
	• Free Fall and Conservation of Energy	
	Conservation of Energy and the Simple Pendulum	
	Conservation of Energy on a Spring	
	Simple Machines	
	Mechanical Advantage	
	• Efficiency of a Machine	
	Inclined Plane	
	• Simple Pulley	
	Multiple Pulleys	
	• Lever	
	• Class 1	
	• Class 2	
	• Class 3	
	Conservation of Energy in General	
	• Work - What is it really?	
	Conservation of Energy in Living Organisms	
	Perpetual Motion Machines	
	Quiz on Conservation of Energy	
11-12	Circular Motion	9
	Kinematics of Circular Motion	
	• Rotation vs. Revolution	
	• Linear (tangential) speed vs. rotational (angular) Speed	
1	Centripetal Acceleration	

	Dynamics of Circular Motion	
	Centripetal Force	
	• Work done by the centripetal force	
	Centripetal vs. Centrifugal Force	
	Rotating Reference Frames	
	• Simulating Gravity in Space	
	• Centripetal Force and the Rotation of the Earth	
	• If the Earth is rotating, why don't we get dizzy?	
	• How do we know that the Earth is actually rotating?	
	• How can people on the Earth have a huge linear velocity	
	and tiny rotational velocity at the same time?	
	• What supplies the centripetal force to keep you rotating	
	with the Earth?	
	• Concept Summary (PowerPoint presentation)	
	Applications	
	• Turning a Car	
	• An unbanked turn	
	• A banked turn - no friction	
	• A banked turn - with friction	
	Practice Quizzes	
	Quiz on Circular Motion Concepts	
	• Quiz on Circular Motion Numerical Problems	
13	Center of Gravity	10
	• Center of gravity/Center of mass	
	• Center of gravity and motion of an object	
	• Finding the center of gravity	
	• Center of gravity and stability	
	• Types of stability	
	Quiz on Center of Gravity	
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	Rotational Mechanics	11
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	• Falling, Sliding, and Rolling - a comparison of 3 interesting	
	situations	
	Quiz on Rotational Mechanics	
15	Universal Gravitation	12
	• The Falling Apple	
	The Falling Moon	
	The Falling Earth	
	 Newton's Law of Universal Gravitation 	
	• Gravity and Distance: the inverse square law	
	Universal Gravitation	
16	Satellite Motion	14
	• Earth Satellites	
	Circular Orbits	
	Elliptical orbits	
	• Energy conservation and satellite motion	
	• Escape speed	
17	Temperature, Heat and Expansion	21
	• Temperature - related to average KE of molecules	
	• Fahrenheit scale	
	• Celsius scale	
	• Kelvin scale	
	• Internal Energy - total KE and PE of molecules	
	• Heat - transfer of internal energy due to a temperature difference	
	• compare to Work - transfer of energy due to a force	
	• If there is thermal contact, heat "flows" from high	
	temperature to low temperature until thermal equilibrium is reached.	
	• 1 calorie = heat to raise temperature of 1 gram of water by	
	1° Celsius = 4.2 Joules	
	• 1 Calorie = 1000 cal (diet calorie)	
	Specific Heat Capacity	
	 amount of energy need to raise the temperature of 1 gram of a substance by 1°C 	
	• high specific heat capacity	
	• lots of energy required to raise the temperature	
	• lots of energy available at high temperature	
	• Water's specific heat capacity is high (1 cal/gram ^o C)	
	low specific heat capacity	
	• large rise in temperature for a little added energy	
	• not much heat energy available even at high temperatures	
	Solving heat transfer problems	
	• Example	

	•	Expansion	
	•	most substances expand when heated	
	•	solids least, gasses most	
	•	water's behavior is unusual	
	•	maximum density at 4°C	
	•	pond freezing	
18	Heat 7	Fransfer	22
	•	Conduction	
	•	Convection	
	•	Radiation	
	•	Absorption of Radiant Energy	
	•	Emission of Radiant Energy	
	•	Newton's Law of Cooling	
	•	Global Warming	
21	•	Vibrations and Waves	25
		Vibration of a pendulum	
	•	Wave description	
	•	Wave Motion	
	•	Wave Speed	
	•	Transverse waves	
	•	Longitudinal waves	
	•	Interference	
	•	Standing Waves	
	•	The Doppler Effect	
	•	Bow Waves	
	•	Shock Waves	
22	Sound	l	26
	•	The origin of sound	
	•	Sound in air	
	•	Media that transmit sound	
	•	Speed of sound	
	•	Loudness	
	•	Forced vibration	
	•	Natural frequency	
	•	Resonance	
	•	Interference	
23	Light		27
	•	Early concepts of light	
	•	Speed of light	
	•	Electromagnetic waves	
	•	Light and transparent materials	
	•	Opaque material	
	•	Shadows	
24	Color		28

	• The color spectrum	
	Color by reflection	
	Color by transmission	
	• Sunlight mixing colored light	
	Complementary colors	
	Mixing colored pigments	
	• Why the sky is blue	
	• Why sunsets are red	
	• Why water is greenish blue	
25	Reflection and Refraction	29
	Reflection	
	Law of Reflection	
	Mirrors	
	Diffuse Reflection	
	Reflection of Sound	
	Refraction	
	Refraction of Sound	
	Refraction of Light	
	Atmospheric Refraction	
	• Dispersion in a Prism	
	• The Rainbow	
	Total internal Reflection	
26	Lenses	30
	Converging and diverging lenses	
	• Image formation by a lens	
	 Constructing images through ray diagrams 	
	- Image formation another and	
	• Image formation summarized	
	Image formation summarizedSome common optical instruments	
	 Image formation summarized Some common optical instruments The eye 	
	 Image formation summarized Some common optical instruments The eye Some defects of vision 	
	 Image formation summarized Some common optical instruments The eye Some defects of vision Some defects of lenses 	
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	Neutral atoms	
	• Ions	
	• Charging by:	
	• friction	
	• contact	
	• electric charge is conserved	
	Electrical Forces	
	Coulomb's Law	
	• inverse square law	
	• same form as Newton's Law of Universal Gravitation	
	• $k = 9.0 \text{ x } 10^9 \text{ N } \text{m}^2/\text{C}^2$	
	• much stronger than gravitational forces (~1039)	
	• Induction	
	• How charged objects attract neutral objects	
	electric dipoles	
	• charging by induction	
	• lightning	
	Practice Quizzes	
	• Atomic Structure and the Electric Force Quiz	
	Coulomb's Law and the Electric Force Quiz	
	• Labs & Demos:	
	• Lab Activity: Electrostatics 1 - Charging by Friction &	
	Contact	
	 Lab Activity: Electrostatics 2 - The Electroscope 	
	Lab Activity: Electrostatics 3 - Induction & Polarization	
29	Electric Fields & Potential	33
	• The Electric Field	
	 Historical development of the field concept 	
	Lines of force	
	 Drawing & Interpreting Electric Fields 	
	Electric Shielding	
	• Electric field calculations ($E = F/q$)	
	• The Electric Field Game - an interactive applet to help you	
	visualize the electric field produced by a group of charges	
	Practice quiz on electric fields	
	• Electric Potential Energy	
	• Electric Potential	
	Potential difference	
	• Voltage	
	Compare/Contrast Electric Potential Energy & Electric Potential	
	• Volt/meter as a measure of electric field strength	
	Storing Electric Energy	
	The Capacitor	

	• The Van de Graaf Generator	
	• Practice quiz on electric potential & voltage	
30	Electric Current	34
	Potential Difference	
	• Electric current	
	Measuring current	
	• Maintaining a potential difference - voltage sources	
	Ohm's Law	
	• Resistance	
	 Using Ohm's Law to solve simple numeric problems 	
	• the Ohm's Law Triangle	
	Practice Quiz on Ohm's Law	
	• Electric shock	
	• Effects	
	• How to avoid electric shocks	
	• What to do in case someone is shocked	
	• Why do some electric plugs have 2 prongs and some have	
	3?	
	Direct & Alternating Current	
	• AC/DC conversions	
	• diodes	
	• Electron motion in a circuit	
	• Where do the electrons come from in a circuit?	
	• What carries the energy in an electric circuit?	
	• Electric Power	
	• Calculating power, voltage, current, and resistance	
	Practice quiz on electric power	
	• How much does it cost to run a light bulb?	
0.1	Practice quiz on cost of electric energy	
31	Electric Circuits	35
	• Series Circuits	
	• Single pathway	
	• Disadvantages	
	• When one device fails, all fail	
	• Voltage (and energy) must be shared by all devices in the	
	circuit	
	• Equivalent (total) resistance is the sum of the individual	
	 Total voltage equals the sum of individual voltages 	
	 Fotal voltage equals the sum of mulvidual voltages Current – Voltage/Total resistance (Ohm's Law) 	
	Ohm's Law applies to each separate device	
	 Onin's Law applies to each separate device Ouiz on series circuits 	
	Quiz on series circuits Parallel Circuits	
	 Voltage is the same across each device 	

•	Ohm's Law applies separately to each branch
•	Total current is the sum of the branch currents
•	Equivalent (total) resistance decreases as the number of
	branches increases
•	Equivalent (total) resistance of 2 equal resistances is half
	the individual resistance
•	Equivalent (total) resistance of 2 parallel branches is less
	than the smallest resistance
•	Overloading
•	Home circuits connected in parallel
•	Total current increases as each device is added
•	Total energy supplied increases as each device is added
•	short circuits
•	fuses & circuit breakers
•	Quiz on parallel circuits
•	Comparing Series and Parallel Circuits
•	Compound Circuits
•	Equivalent resistance
•	Applying Ohm's Law
•	total current
•	separate components
•	Analyzing Simple Circuits - a Summary