FINAL EXAM PREP

PHY-1409/1430 – Physics 2

Final exam weekly resource for PHY 1409/1430!

This week is the last week of class, and typically in this week (and the surrounding weeks of class) you are reviewing for the final exam. Please use the review below (as well as other resources from the semester) as a general overview of some of the key concepts taught in the course! Please take a look at all 16 weekly resources listed on our website to help you review for the final exam!

If you have any questions about these study guides, the final schedule of group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours. M-Th 9am-8pm on class days 254-710-4135. **The last day of tutoring in the drop-in center will be the last day of class.** To learn about additional resources available during Finals Week, please visit CASE in the West Wing basement of Sid Rich! Good luck on your final exam!

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Electric Potential (Week 3)

Electric potential is the electric potential energy per unit charge. But in a simpler sense, electric potential is the ability of the charge to move in an electric field. The difference in the potential at on position versus another is called the potential difference. This distinction is highly important.

$$PE_b - PE_a = -qEd = q(V_b - V_a) = qV_{ba}$$

Also remember that all the equations of electric field and electric potential describe the behavior of a POSITIVE charge. If the charge is negative, the behavior is opposite that predicted by these equations. For example, when a negative charge moves with the electric field, its potential increases whereas when it is a positive charge, the electric potential decreases as the charge moves with the electric field.

For point charges, we derive a different formula. What is important with the formulas for point charges for electrostatic force, electric field and electric potential are very similar, so make sure you know them well.

$$V = k\frac{Q}{r} \qquad F = k\frac{Q_1 Q_2}{r^2} \qquad \vec{\mathbf{F}} = q\vec{\mathbf{E}} \qquad E = k\frac{Q}{r^2}$$

Capacitance (Week 3)

Each capacitor has a capacitance, which is the ability of a capacitor to hold charge. The capacitance of a capacitor can only be affected by the physical characteristics of the capacitor, and the potential difference or current do not affect it. Keep this in mind. It is a very common concept question.

$$C = K\epsilon_0\frac{A}{d} \qquad Q = CV \qquad PE = \tfrac{1}{2}QV = \tfrac{1}{2}CV^2 = \tfrac{1}{2}\frac{Q^2}{C}$$

Electric Circuits(Week 4):

When charges are moving in a conductor, to continue the flow, they require an electric field to keep them in motion. The flow of the charges in the conductor is controlled by electric potential. This electric potential is controlled by a battery. In circuits, batteries are the source potential difference that drives charges in the circuit. The flow of charges in the wire is referred to as electric current. Charges leave the battery with the highest potential and move through the circuit losing their potential asthey pass through wires and devices. Once the charges get to the negative end of the battery, they are at their lowest potential. The battery takes those charges and brings them back to the high potential so that they can continue the process.

$$I = \frac{\Delta Q}{\Delta t}$$

$$V = IR$$

Resistance is the property that causes a drop in voltage because its impedes the flow of current. The larger the resistance, the bigger the voltage drop in the circuit path. Like capacitance, resistance is also a physical property. The resistance of a wire is directly proportional to the length of the wire and inversely proportional to the cross-section area of the wire. The proportionality constant for the relation is resistivity.

$$R = \rho \frac{\ell}{A}$$

When there is no current flowing in the surface, the measured potential difference of the battery terminals is its emf. The emf from a battery is denoted by ξ. The battery itself also has resistance, which is referred to as internal resistance.

$$V_{ab} = \mathcal{E} - Ir$$

DC Circuits (Week 4)

The goal while working with complex circuits is to break it down to the simplest form and then working through the math.

When resistors are in a series, they are placed on the same path. When the resistors are in series, the equivalent resistance is calculated simply by adding the resistors in the circuit.

$$R_{eq} = R_1 + R_2 + R_3 \ldots$$

When resistors are in parallel, they are placed on different paths which are formed by junctions. To find the equivalent resistance for resistors in parallel, you calculate it by adding up the reciprocal of each resistors individually.

$$R_{eq} = (1/R_1 + 1/R_2 + 1/R_3 \ldots)^{-1}$$

For resistors in series, the current across the all the resistors is the same. For resistors in parallel, the voltage across the junctions is the same (between A and B in the second diagram, which also means it is the same across R1, R2 and R3). These characteristics are highly important to always keep in mind. It makes answering concept questions much easier.

Capacitors can also be placed in parallel and in series but the rules for breaking them down to the equivalent capacitors is the opposite of what you see in resistors.

In series,

$$C_{eq} = [(1/C_1) + (1/C_2) + (1/C_3) \ldots]^{-1}$$

In parallel,

$$C_{eq} = C_1 + C_2 + C_3 \ldots$$

Kirchhoff's Rules (Week 4)

1) At any junction point, the sum of all currents entering the junction equals the sum of all currents leaving the junction.

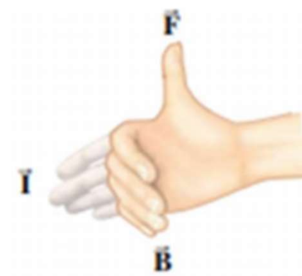
2) The sum of the changes in potential around any closed loop of a circuit must be zero.

Magnetic Field (Week 5)

Magnets have a field that exists between their poles, which are north and south. Much like the properties we see in charges, like poles repel one another and unlike poles attract. The magnetic field always goes from the north pole to the south pole. The magnetic field produced wraps around the wire. The magnetic field direction can be visualized using the right-hand rule. Use your thumb to point in the direction of the current flow. The direction in which your fingers wrap around is the direction of the magnetic field.

When the current carrying wire is present in a magnetic field, it experiences a force due to the magnetic field. You can use a different form of the right hand rule.

$$F = I\,l\,B\sin\theta$$



Right-hand rule

Moving charges are much like current, the moving charges in an magnetic field experience a force due to the field, which is perpendicular to the magnetic field and the direction of motion. The four fingers must point in the direction of motion of the charge. The palm of the hand should point in the direction of the magnetic field and the thumb will point in the direction of the force. The direction of the force described is for a positive charge only

$$F = q\,v\,B\sin\theta$$

The magnetic field produced in by the current in the wire can be calculated using the following formula.

$$B = \frac{\mu_0}{2\pi}\frac{I}{r} \qquad F_2 = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}\ell_2$$

The force exerted by the wires on one another can be calculated using the following formula. The direction of the flow of the current determines whether the wires attract each other or repel each other. When the current travels in the same direction, the wires attract one another. When the current flows in opposite directions, the wires repel one another.

Induced EMF(Week 6)

A changing magnetic field produces an electric current, which is called the induce current. Hence, changing magnetic fields induce an EMF. This phenomenon is called electromagnetic induction. the induced current moves in a direction such that the magnetic field it produces, opposes the change in the magnetic field.

All Images are from Physics: Principles with Applications (7th Edition) by Douglas C. Giancoli

Magnetic flux is the magnitude of the magnetic field that is passing through a given area. The magnetic field considered must be perpendicular to the direction of the face of the surface.

$$\Phi_B = B_\perp A = BA\cos\theta.$$

The flux is proportional to the number of magnetic field lines passing through area enclosed. The induced emf is equal to the rate of change of the flux over time.

$$\mathscr{E} = -N\frac{\Delta\Phi_B}{\Delta t}$$

Transformers (Week 7)

A transformer is used to increase or decrease an AC voltage. Since the voltage used is alternating, there is a change in flux through the second coil, which induces an AC voltage of the same frequency as the primary coil. These devices are meant to increase or decrease the voltage. This is determined by the number of coils in the secondary coil.

$$V_S = N_S\frac{\Delta\Phi_B}{\Delta t} \qquad V_P = N_P\frac{\Delta\Phi_B}{\Delta t} \qquad \frac{V_S}{V_P} = \frac{N_S}{N_P}. \qquad \frac{I_S}{I_P} = \frac{N_P}{N_S}$$

If the number of coils in the primary coil is greater than the secondary coil, it is step down transformer. If the number of coils in the secondary coil is greater than the primary coil, it is a step-up transformer.

Inductance (Week 7)

Induction of current is proportional to the rate of change in the current because that rate of change is proportional to the flux. The factor of proportionality for the emf induced is called mutual inductance (M).

$$\mathscr{E}_2 = -M\frac{\Delta I_1}{\Delta t} \qquad \mathscr{E}_1 = -M\frac{\Delta I_2}{\Delta t}$$

The value of mutual inductance is dependent upon physical properties only. This also occurs in single coils, where there is an induced emf due to AC electricity in the coil itself. The change in current causes a changing magnetic flux in the coil itself, which leads to self-inductance(L). This value is also determined by the physical properties of the coil.

$$\mathscr{E} = -L\frac{\Delta I}{\Delta t}$$

Electromagnetic Waves (Week 8)

EM waves carry energy. EM waves do not require a medium for propagation unlike other waves like sound. EM waves are a product of the electric and magnetic field, so the electric and magnetic field carry the energy for EM waves. we can use them to find the energy that EM waves are transporting. The u below is for the energy density.

$$u = \epsilon_0 E^2 \qquad u = \frac{B^2}{\mu_0} \qquad u = \sqrt{\frac{\epsilon_0}{\mu_0}} EB$$

<u>Ray Model of Light (Week 9 and Week 10)</u>

The ray that hit the surface is called the incident ray. The ray that reflects off is the reflected ray. The point at which the light rays hits the surface, we project and imaginary perpendicular line to the surface. This is called the normal to the surface. The angle that the incident ray makes with the normal (angle of incidence) is ALWAYS equal to angle the reflected ray makes with the normal (angle of Important Notes Very Important Conventions reflection). This is the law of reflection.

There two kinds of spherical mirrors:

1) Convex Mirror: this is a diverging mirror. The light rays that hit the surface diverge as shown in the image.

2) Concave Mirror: this a converging mirror. The light rays that hit the surface converge toward a focal point.

Please refer to the resource for week 11 to review the strategy for drawing ray diagrams with spherical mirrors.

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

Using the equation above, we can predict the position of the image formed. But it is important to use the correct sign convention for spherical mirrors for it to work.

The sign conventions are as follows:

1) The image height is positive if the image is upright and inverted if it is negative.

2) The image distance, object distance and focal length are positive it they are in front of the mirror and negative if they are behind the mirror

Refraction is the change of direction of the light rays when it passes through a material. For the direction of refraction, the influence comes from the index of refraction of a material (n).

$$n = \frac{c}{v}$$

When the n of the first medium is smaller than the second medium, the refracted ray bends towards the normal. When the n of the first medium is bigger than that of the second medium, the refracted ray bends away from the normal.

$$n1 \sin \theta 1 = n2 \sin \theta 2$$

The converging lenses are called convex lenses. The diverging lenses are called concave lenses. For lenses, there are two focus points on both side of the lens, the same distance from the lens.

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

There are different sign conventions for lenses:

1. The focal length is positive for convex lenses and negative for concave lenses.

2. The object distance is positive if the source of light and the object are on the same side otherwise it is negative

3. The image distance is positive if the image is on the opposite side of the lens as the source of light and negative otherwise.

4. The height of the image is positive if it is upright and negative if inverted.

<u>Wave Nature of Light (Week 11)</u>

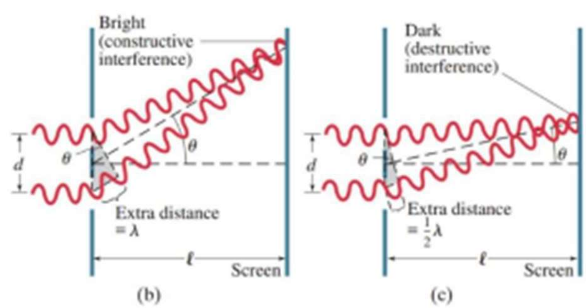
When a light wave hits an obstacle, the part of the wave behind the obstacle bends. This bending of the wave is what is called diffraction. The one component of light as a wave that remains constants is the frequency of the wave. Hence, when light passes into a new medium and refracts, it changes the wavelength of light.

$$\lambda_n = \frac{\lambda}{n}$$

When light passed through the two slits, it produced a pattern of lines decreasing in intensity on the screen. This pattern is called the interference pattern. If the light waves are in phase, waves add up together, which we called a constructive interference. If the light waves are out of phase, waves eliminate one another, which is called destructive interference. When light passes through the slits, the waves diffract in both slits and the two resulting waves produce constructive interferences where the light bands are present and no bands where the destructive interference occurs.

$$d \sin\theta = m\lambda, \qquad m = 0, 1, 2, \cdots. \qquad \begin{bmatrix}\text{constructive} \\ \text{interference} \\ \text{(bright)}\end{bmatrix}$$

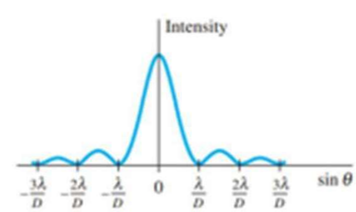
$$d \sin\theta = \left(m + \tfrac{1}{2}\right)\lambda, \qquad m = 0, 1, 2, \cdots. \qquad \begin{bmatrix}\text{destructive} \\ \text{interference} \\ \text{(dark)}\end{bmatrix}$$



The m refers to the order of the band. The first order is m = 1.
The center bands, which has the highest constructive interference is called the central fringe, at m =0.

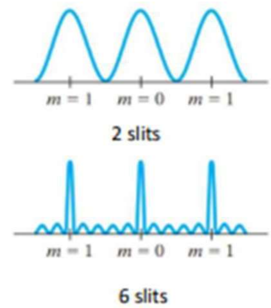
The patterns emerge again with single slits. The center band is always the one with the highest intensity.

$$D \sin\theta = m\lambda, \qquad m = \pm 1, \pm 2, \pm 3, \cdots,$$



In diffraction gratings, we have multiple, equally spaced slits. Following the same behavior, they produce maximas at predictable angles. What is special is that they have the same intensity. Another property it has is that as you increase the number of slits, the peaks of the maxima's get narrower.

$$\sin\theta = \frac{m\lambda}{d}, \qquad m = 0, 1, 2, \cdots \qquad \begin{bmatrix}\text{diffraction grating} \\ \text{principal maxima}\end{bmatrix}$$



Relativity, quantum mechanics and nuclear physics have been summarized in the week 12,13 and 15. These topics are much less likely to be stressed in a comprehensive final due to their complexity.

Thanks for using these resources this semester! Best wishes on your final exam!