Physics 6B Practice Final

1. Two speakers placed 4m apart produce sound waves with frequency 425Hz. A listener is standing 3m in front of the left speaker. Describe the sound that he hears. Assume the speed of sound is 340 m/s.

   a) he hears a loud sound (constructive interference)
   b) he hears a quiet sound (destructive interference)
   c) neither constructive or destructive interference
   d) he runs away screaming like a child.

2. Charge $q_1 = -5.4 \mu C$ is placed at the origin, and charge $q_2 = -2.2 \mu C$ is on the x-axis at x=1m. Where should a charge $q_3$ be placed between $q_1$ and $q_2$ so that the net force acting on it is zero?
   a) $x=0.20$ m
   b) $x=0.42$ m
   c) $x=0.61$ m
   d) $x=1.2$ m

3. An object with a charge of $-3.6 \mu C$ and a mass of 12g experiences an upward electric force, due to a uniform electric field, equal in magnitude to its weight. Find the direction and magnitude of the electric field.
   a) 33,000 N/C upward
   b) 33,000 N/C downward
   c) 33,000 N/C to the right
   d) 66,000 N/C downward

4. Two conducting spheres have net charges $q_1=+8 \mu C$ and $q_2=-2 \mu C$. The spheres touch and some charge is transferred. How many electrons are transferred, and to which sphere?
   a) $3.1x10^{13}$ electrons are transferred to sphere 1
   b) $3.1x10^{13}$ electrons are transferred to sphere 2
   c) $5x10^6$ electrons are transferred to sphere 1
   d) $5x10^6$ electrons are transferred to sphere 2

5. During a lightning strike, electrons are transferred from the bottom of a thundercloud to the ground. During this process, the electrons:
   a) gain potential energy as they move toward a higher potential
   b) lose potential energy as they move toward a lower potential
   c) gain potential energy as they move toward a lower potential
   d) lose potential energy as they move toward a higher potential

6. During a lightning strike, electrons are transferred from the bottom of a thundercloud to the ground. This occurs due to dielectric breakdown of the air, when the electric field is greater than $3x10^6 \text{ V/m}$. The distance from the ground to the cloud is 1000m. Find the magnitude of the potential difference between the cloud and the ground.
   a) 3000 V
   b) $3x10^6$ V
   c) $9x10^6$ V
   d) $3x10^9$ V

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7. An electric dipole consists of two equal charges, \( +q \) and \( -q \), a distance \( d \) apart. Find the total electric potential at a point that is a distance of \( d/2 \) to the right of the positive charge, as shown.

a) \( kq/d \)
b) \( 2kq/d \)
c) \( (4/3)kq/d \)
d) \( (1/2)kq/d \)

8. How much charge is on each plate of the capacitors in the circuit shown? The battery has voltage 12V, and the capacitances are: \( C_1=3\mu F \), \( C_2=2\mu F \), \( C_3=4\mu F \).

a) \( Q_1=24 \mu C; \ Q_2=8 \mu C; \ Q_3=16 \mu C \)
b) \( Q_1=24 \mu C; \ Q_2=16 \mu C; \ Q_3=8 \mu C \)
c) \( Q_1=12 \mu C; \ Q_2=4 \mu C; \ Q_3=8 \mu C \)
d) \( Q_1=12 \mu C; \ Q_2=8 \mu C; \ Q_3=16 \mu C \)

9. A parallel-plate capacitor is initially charged by a battery with voltage \( V \). The battery is disconnected, and a dielectric with constant \( k \) is inserted between the plates. What happens to the energy stored in the capacitor?

a) The stored energy increases by a factor of \( k^2 \)
b) The stored energy increases by a factor of \( k \)
c) The stored energy decreases by a factor of \( k \)
d) The stored energy decreased by a factor of \( 2k \)

10. How much power is dissipated in each of the resistors in the circuit shown? The battery has voltage 12V, and the resistances are: \( R_1=4\Omega \), \( R_2=3\Omega \), \( R_3=6\Omega \).

a) \( P_1=16 \text{ W}; \ P_2=5.3 \text{ W}; \ P_3=2.7 \text{ W} \)
b) \( P_1=16 \text{ W}; \ P_2=3 \text{ W}; \ P_3=3 \text{ W} \)
c) \( P_1=16 \text{ W}; \ P_2=1.5 \text{ W}; \ P_3=4.5 \text{ W} \)
d) \( P_1=4 \text{ W}; \ P_2=6 \text{ W}; \ P_3=2 \text{ W} \)
11. In the circuit below all the bulbs have the same resistance. When the switch is closed, what happens to bulb A?

a) Bulb A gets brighter
b) Bulb A gets dimmer
c) Bulb A remains the same
d) Bulb A gets burned out by physics

12. Resistor 1 is a solid cylinder with length L and diameter D. Resistor 2 is made of the same material, but it has length 2L and diameter 2D. Compared to the resistance of resistor 1, resistance 2 is:
a) twice as large
b) half as large
c) the same
d) four times as large

13. A coil has 1000 turns of wire and a cross-sectional area of 0.5m². A uniform magnetic field of magnitude 2 Teslas is directed along the axis of the coil. Find the voltage induced in the coil as the strength of the magnetic field decreases steadily to zero in a time of 4 seconds.
a) 250 V  
   b) 1000 V  
   c) 125 V  
   d) 500 V

14. Two singly ionized isotopes of uranium (one electron has been removed) are projected at v=1.5x10⁵ m/s into a region with a uniform magnetic field of strength 0.75T directed into the page, as shown. The particles land at distances d₁=68.2cm and d₂=69.2cm from the entry point. Find the difference between the masses of the particles.

a) 4x10⁻²⁵ kg  
   b) 1x10⁻²⁵ kg  
   c) 4x10⁻²⁷ kg  
   d) 1x10⁻²⁷ kg

15. Consider the three electric charges shown below. Charge B is equidistant from charges A and C. List the charges in order of the magnitude of the force they experience, from smallest to largest.

a) A, B, C  
   b) A, C, B  
   c) C, A, B  
   d) C, B, A

16. A beam of electrons is passing through a region with a uniform magnetic field directed downward. If the electrons are initially moving East, which direction are they deflected when they enter the field?

a) the electrons are deflected downward  
   b) the electrons are deflected South  
   c) the electrons are deflected North  
   d) the electrons are not deflected

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17. A circuit is arranged with a sliding wire that can move vertically, as shown. There is a uniform magnetic field directed out of the page. The sliding wire is released from rest in the position shown. As the wire falls:

   a) induced current is clockwise and
   the bulb gets brighter until it reaches a steady intensity.
   b) induced current is clockwise and
   the bulb glows with a constant brightness.
   c) induced current is counter-clockwise and
   the bulb gets brighter until it reaches a steady intensity.
   d) induced current is counter-clockwise and
   the bulb glows with a constant brightness.

18. A metal ring is falling toward a wire with a steady current flowing to the right. What direction is the induced current in the ring?

   a) clockwise
   b) counter-clockwise
   c) there is no current induced in the loop
   d) the ring bursts into flame and disappears in a puff of smoke

19. A metal ring is falling along a wire with steady current flowing upward. What direction is the induced current in the ring, as viewed from above?

   a) clockwise
   b) counter-clockwise
   c) there is no current induced in the loop
   d) the ring bursts into flame and disappears in a puff of smoke

20. In Europe, the standard voltage available from a wall socket is 240V rms. What is the maximum voltage in this case?

   a) 240V
   b) 120V
   c) 170V
   d) 340V