

# Practice Final Exam

Your Name:

## Instructions

This is a practice final exam. You can use it to review concepts and fill in your note sheets!

1. Two point charges, each with a charge of  $+1.5 \text{ mC}$ , are separated by a distance of  $0.20 \text{ m}$ . What is the electric force between the particles? Do they attract or repel? ( $506,250 \text{ N}$ , Repel)
2. Two point charges, each with a charge of  $+1.3 \text{ mC}$ , are separated by a distance of  $0.15 \text{ m}$ . What is the electric potential energy of the two-particle system? ( $101,400 \text{ J}$ )
3. A chunk of material stores a charge of  $2.70 \text{ C}$  when a voltage of  $9 \text{ V}$  is connected to it. What is its capacitance? ( $0.30 \text{ F}$ )
4. Two capacitors, each with a capacitance of  $10 \text{ mF}$  are connected in parallel with a battery of voltage  $20 \text{ V}$ . What is the charge stored in one of the capacitors when it is fully charged? ( $0.4 \text{ C}$ )
5. Four resistors, each with a resistance of  $20 \Omega$ , are connected in series along with a battery of voltage  $10 \text{ V}$ . What is the current drawn from the battery? ( $0.125 \text{ A}$ )
6. A simple RC circuit consists of a  $100 \text{ ohm}$  resistor, a  $20 \text{ mF}$  capacitor, and a  $10 \text{ V}$  battery connected in series. What is the time constant of the circuit? ( $2 \text{ seconds}$ )
7. A uniform electric field points in the  $+z$  direction. A negatively charged particle enters the field with an initial velocity in the  $+x$  direction. What is the direction of the electric force on the particle? ( $-z$  direction)
8. A positively charged particle is fired into a magnetic field with an initial velocity in the  $+x$  direction. If the magnetic field is pointing in the  $-y$  direction, in which direction is the initial force on the particle? ( $-z$  direction)
9. A velocity selector consists of a crossed electric field ( $1000 \text{ N/C}$ ) and magnetic field ( $0.5 \text{ T}$ ). What speed should I fire a positively charged particle through the velocity selector if I want it to pass through, undeflected? ( $2000 \text{ m/s}$ )
10. A particle of mass  $0.25 \text{ kg}$  and charge  $0.10 \text{ C}$  undergoes uniform circular motion with a speed of  $100 \text{ m/s}$  and an orbital radius of  $100 \text{ m}$ . What is the strength of the magnetic field? ( $2.5 \text{ T}$ )
11. A charging DC LR circuit consists of a battery ( $10 \text{ V}$ ), a resistor ( $100 \Omega$ ), and an inductor ( $0.5 \text{ H}$ ) in series. What is the time constant of the circuit? ( $0.005 \text{ seconds}$ )
12. The magnetic flux passing through a loop of wire with 10 turns increases at a rate of  $40 \text{ Webers per second}$ . What is the induced EMF in the loop at time  $t = 2 \text{ seconds}$  (including the correct sign)? ( $-400 \text{ V}$ )
13. A sinusoidal signal has a peak voltage of  $10 \text{ V}$ . What is the RMS voltage of the signal? ( $7.07 \text{ V}$ )
14. An AC RLC circuit is made up of a  $1 \text{ ohm}$  resistor, a  $1.5 \text{ mF}$  capacitor, and a  $1.8 \text{ mH}$  inductor. What is the phase angle of the circuit if I drive it at a frequency of  $100 \text{ Hz}$ ? ( $3.9 \text{ degrees}$ )

15. Modern microwave ovens operate at the frequency 2,450 MHz. What is the wavelength of these waves? (0.112 m)
16. Light, initially polarized along the z-axis, encounters a polarizing filter oriented at 25 degrees with respect to the z-axis. What percentage of light passes through the filter? (82%)
17. A supernova is an exploding star that is billions of times brighter than an ordinary star. Supernova SN1987a occurred  $1.6 \times 10^{21}$  m from Earth. How long did it take light to travel from the supernova to Earth? ( $5.3 \times 10^{12}$  seconds)
18. A ray of light with a wavelength of 650 nm passes from air ( $n = 1.00$ ) to water ( $n = 1.33$ ). Calculate the angle of reflection if the angle of incidence of the ray of light is 21 degrees. (21 degrees)
19. A ray of light with a wavelength of 650 nm passes from air ( $n = 1.00$ ) to water ( $n = 1.33$ ). Calculate the angle of refraction if the angle of incidence of the ray of light is 45 degrees. (32 degrees)
20. What is the critical angle as light travels from plate glass ( $n = 1.52$ ) to benzene ( $n = 1.501$ )? (80.9 degrees)
21. An object with a height of 5 cm is located 20 cm in front of a converging mirror with a focal length of  $|f| = 10$  cm. Where is the image located? ( $s' = 20$  cm)
22. An object with a height of 10 cm is located 30 cm in front of a diverging lens with a focal length of  $|f| = 5$  cm. What is the final height of the image? ( $h = 1.43$  cm)
23. The index of refraction of fused silica is around 1.51. What is the wavelength of red light (700 nm in vacuum) as it passes through the material? (463.6 nm)
24. A double slit interference apparatus has a slit separation of 0.2 mm. At what angle would we see the 20<sup>th</sup> order maximum if we shine light with a wavelength of 600 nm on it? (3.43 degrees)
25. A thin film of soapy water ( $n = 1.33$ ) is sandwiched between layers of air in a soap bubble. At what minimum thickness of the film would I see red light with a wavelength of 700 nm? (132 nm)
26. What is the “gradient” of a scalar field? What information does it give us?
27. What is the “curl” of a vector field? What information does it give us?
28. What does wave-particle duality mean in the context of light?
29. Sketch a diagram showing some electric field lines and equipotential lines around the plates of a parallel plate capacitor. Be sure to label the field lines and the equipotential lines.
30. Why might we use a dielectric material within a parallel plate capacitor?
31. In the context of the Ampere-Maxwell equation, how is displacement current different from “regular” current?
32. Would a transformer work in a DC current circuit? Why or why not?
33. A uniform electric field of 100 N/C points in the +x direction in some region of space. Suppose I move a charged particle from the point (0,0) to the point (5,5). Would this particle experience a conservative or non-conservative force as it moves? Why?