Phys 2B Summer 2022

Final Exam Practice

Question 1:

An inductor, capacitor, and resistor are connected in series. The inductor has inductance 81 nH. The capacitor has capacitance 12 nF. If the circuit is critically damped, what is the resistance of the resistor?

(a) $0.77\,\Omega$

(b) $2.6\,\Omega$

(c) $3.7\,\Omega$

(d) $5.2\,\Omega$

(e) $14\,\Omega$

Question 2:

If the capacitor in the critically damped circuit of the previous problem starts out maximally charged, when does it reach 12% of its initial charge for the first time?

(a) 14 ns

(b) 23 ns

(c) 39 ns

(d) 57 ns

(e) 66 ns

Question 3:

An inductor, capacitor, and resistor are connected in series. The inductor has inductance 45 nH. The capacitor has capacitance 6.2 nF. The resistor has resistance 1.7 Ω. What is the damped angular frequency?

(a) 33 Mrad/s

(b) 39 Mrad/s

(c) 49 Mrad/s

(d) 57 Mrad/s

(e) 60 Mrad/s

Question 4:

For the RLC circuit in the previous problem, if the charge on the capacitor is 2.2 μC at time $t = 0$ and the current at that time is 0, what is the charge on the capacitor at time $t = 9.0$ ns?

(a) $-1.9\,\mu$C

(b) $-0.87\,\mu$C

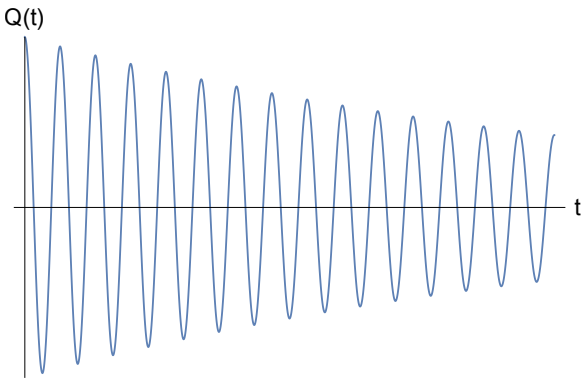
(c) $+0.25\,\mu$C

(d) $+0.90\,\mu$C

(e) $+1.6\,\mu$C

Question 5:

The charge on the capacitor of a certain RLC circuit is plotted below as a function of time.



Is this circuit undamped, underdamped, critically damped, overdamped, or is there not enough information to determine?

(a) Undamped

(b) Underdamped

(c) Critically damped

(d) Overdamped

(e) Not enough information

Question 6:

A certain parallel plate capacitor has circular plates with radii 2.5 cm and plate separation 4.0 mm. At a moment while the capacitor is charging, the magnetic field wrapping around the capacitor right at the edge of the plates, produced by the strengthening electric field, has strength $22\,\mu$T. What is the rate of change of the electric field between the plates, $\frac{\mathrm{d}E}{\mathrm{d}t}$?

(a) $1.3 \times 10^{9}\,(\mathrm{N/C})/\mathrm{s}$

(b) $5.6 \times 10^{10}\,(\mathrm{N/C})/\mathrm{s}$

(c) $3.0 \times 10^{11}\,(\mathrm{N/C})/\mathrm{s}$

(d) $8.8 \times 10^{12}\,(\mathrm{N/C})/\mathrm{s}$

(e) $1.6 \times 10^{14}\,(\mathrm{N/C})/\mathrm{s}$

Question 7:

Which of the following is the speed of light in vacuum, c?

(a) $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$

(b) $\frac{1}{\mu_0 \epsilon_0}$

(c) $\sqrt{\mu_0 \epsilon_0}$

(d) $\mu_0 \epsilon_0$

(e) $\frac{\mu_0}{\epsilon_0}$

Question 8:

The magnitude of the electric field in a certain light wave is 90 N/C. What is the magnitude of the magnetic field in this light wave?

(a) $9 \times 10^{-14}\,\mu\text{T}$

(b) $0.30\,\mu\text{T}$

(c) $550\,\mu\text{T}$

(d) $90\,\text{T}$

(e) $160\,\text{kT}$

Question 9:

The human eye's peak sensitivity is to light of wavelength roughly 555 nm. What is the energy of a photon of this wavelength?

(a) $4.0 \times 10^{-20}\,\text{J}$

(b) $9.2 \times 10^{-20}\,\text{J}$

(c) $3.6 \times 10^{-19}\,\text{J}$

(d) $9.4 \times 10^{-19}\,\text{J}$

(e) $7.8 \times 10^{-18}\,\text{J}$

Question 10:

A star $9.5 \times 10^{17}\,\mathrm{m}$ from Earth (about 100 light years) is known to have a radius of about $7.0 \times 10^{8}\,\mathrm{m}$. At Earth, the electric field of the star's emitted light wave has average magnitude $1.2 \times 10^{-3}\,\mathrm{N/C}$. What is the average strength of the radiative electric field at the star's surface?

(a) $1.6 \times 10^{6}\,\mathrm{N/m}$

(b) $2.0 \times 10^{7}\,\mathrm{N/m}$

(c) $7.9 \times 10^{11}\,\mathrm{N/m}$

(d) $2.2 \times 10^{15}\,\mathrm{N/m}$

(e) $2.8 \times 10^{16}\,\mathrm{N/m}$

Question 11:

A charge $q_1 = 1.0\,\mathrm{C}$ is at $x = 0$ and a second charge $q_2 = -3.0\,\mathrm{C}$ is at $x = 2.0\,\mathrm{m}$. At which value of x is the net electric field 0?

(a) -2.7 m

(b) -0.73 m

(c) 0.33 m

(d) 0.73 m

(e) 2.7 m

Question 12:

Protons are not true point charges; they have a radius of about $R_p = 1\,\text{femtometer} = 1 \times 10^{-15}\,\text{m}$. So, an electron can go inside a proton, and when it does, the field it feels from the proton has only a fraction of the magnitude that it would have if the proton were a point charge located at its own center. Let's model a proton as a uniformly distributed sphere of positive charge. What is the ratio of the magnitude of the electric field that an electron 0.5 fm from the center of a proton feels, to the field it would feel if the proton were truly a point charge?

(a) $1/8$

(b) $1/4$

(c) $1/\sqrt{8}$

(d) $1/2$

(e) $1/\sqrt{2}$

Question 13:

The electric field inside a spherically symmetric charge distribution is constant as a function of the radial coordinate, r. If the charge-per-volume is given by $\rho(r) = br^a$ where b is a nonzero constant, what must be the exponent a?

(a) -1

(b) 0

(c) $\frac{1}{2}$

(d) 1

(e) 2

Question 14:

The potential in a certain region is given by $V(x) = (1.40\,\mathrm{V/m^2})x^2$. What is the electric field inside this region at $x = 15.0\,\mathrm{m}$?

(a) $(-42.0\,\mathrm{V/m})\hat{x}$

(b) $(-21.0\,\mathrm{V/m})\hat{x}$

(c) $(+21.0\,\mathrm{V/m})\hat{x}$

(d) $(+42.0\,\mathrm{V/m})\hat{x}$

(e) $(+315\,\mathrm{V/m})\hat{x}$

Question 15:

A 12 nF capacitor is fully charged by a 9.0 V battery. It is then disconnected from the battery, and connected to a 9.0 nF capacitor, which is initially uncharged. What will be the final charge on the 12 nF capacitor, once it is done transferring charge to the 9.0 nF capacitor?

(a) 33 nC

(b) 62 nC

(c) 71 nC

(d) 88 nC

(e) 108 nC

Question 16:

Aluminum's resistivity is not exceptional, but it is often chosen for electrical grid wiring because it is relatively light and inexpensive by the standards of conducting metals, making very thick wires feasible. The resistivity of aluminum is about $2.65 \times 10^{-8}\,\Omega$-m. The resistivity of copper is about $1.72 \times 10^{-8}\,\Omega$-m. Thus, copper's resistivity is smaller, but since copper is heavier and more expensive than aluminum, it is not a strictly superior wiring material. What is the cross-sectional area of an aluminum wire that has the same resistance as a $1.0\,\text{cm}^2$ copper wire of the same length?

(a) $0.421\ \text{cm}^2$

(b) $0.649\ \text{cm}^2$

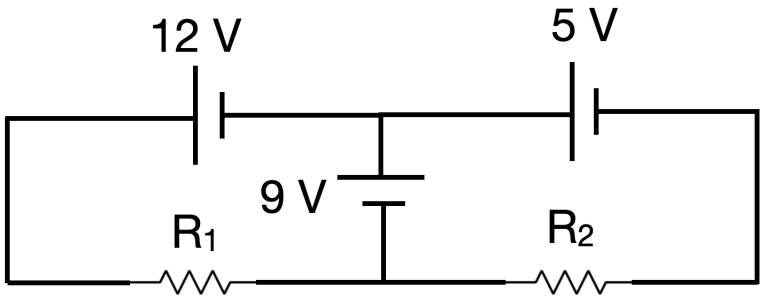
(c) $1.19\ \text{cm}^2$

(d) $1.54\ \text{cm}^2$

(e) $2.37\ \text{cm}^2$

Question 17:

The diagram below shows a circuit with three emfs and two resistors.



If $R_1 = 6\,\Omega$ and $R_2 = 4\,\Omega$, what is the current flowing on the central branch, which has the 9 Volt emf?

(a) 1.0 A

(b) 2.5 A

(c) 3.5 A

(d) 4.5 A

(e) 5.0 A

Question 18:

A 2.0 m wire carries a current $\vec{I} = (+2.0\,\text{A})\hat{y}$. It is subject to an external magnetic field given by $\vec{B} = (2.5\,\text{T})\hat{x} + (-1.2\,\text{T})\hat{y}$. What is the approximate magnitude of the magnetic force on the wire?

(a) 2.4 N

(b) 4.8 N

(c) 5.0 N

(d) 10 N

(e) 11 N

Question 19:

A certain ion is known based on its chemistry to have a charge of +2e. In order to measure its mass, it is sent into a magnetic field of strength 0.20 T at a velocity of 44,000 m/s, perpendicular to the field. If the ion moves in a circle of radius 0.14 m, what is its mass?

(a) $1.8 \times 10^{-30}\,\text{kg}$

(b) $1.7 \times 10^{-27}\,\text{kg}$

(c) $3.4 \times 10^{-27}\,\text{kg}$

(d) $1.0 \times 10^{-25}\,\text{kg}$

(e) $2.0 \times 10^{-25}\,\text{kg}$

Question 20:

An LC circuit has a current of 97 A at the same time that the capacitor has a charge of 18 mC. If the capacitance is 45 μC and the circuit stores 4.0 J of total energy, what is the inductance?

(a) 2.6 μH

(b) 85 μH

(c) 770 μH

(d) 850 μH

(e) 4.1 mH