Linnemann,

James T

Keep this exam **CLOSED** until advised by the instructor.

Fill out the bubble sheet: last name, first initial, student number, section number. Leave the code area empty.

120 minute long closed book exam.

Four 8.5 by 11 handwritten help sheets are allowed.

When done, hand in your **bubble sheet** and your **exam**. Keep your help sheets.

Thank you and good luck!

Possibly useful constants:

- $k_e = 8.99 \times 10^9$ Nm^2/C^2

- $\epsilon_0 = 8.85 \times 10^{-12}$ As/(Vm)

- $\mu_0 = 4\pi \times 10^{-7}$ Vs/(Am)

- $c = 3.00 \times 10^8$ m/s

- $e = 1.60 \times 10^{-19}$ C

- $m_e = 9.11 \times 10^{-31}$ kg

- $h = 6.63 \times 10^{-34}$ Js

- $h = 4.14 \times 10^{-15}$ eVs

- hc = 1240 eVnm

- Wien's constant = 2.898×10^{-3} Km

- 1 eV = 1.60×10^{-19} J

$\boxed{6\ pt}$ The figure shows two point charges. Calculate the magnitude of the electric field at point P. Use the following data: Q_1= - 1.90 μC, Q_2= - 1.50 μC, d_1= 1.40 m, d_2= 1.80 m.
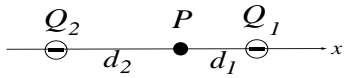
(in N/C)

1.A⚪ 4.55×10^3 **B**⚪ 6.06×10^3 **C**⚪ 8.05×10^3
    D⚪ 1.07×10^4 **E**⚪ 1.42×10^4 **F**⚪ 1.89×10^4
    G⚪ 2.52×10^4 **H**⚪ 3.35×10^4

$\boxed{6\ pt}$ Calculate the size of the force on a charge $Q = +1.50$ μC placed at P due to the two charges from the previous problem.
(in N)

2.A⚪ 3.64×10^{-3} **B**⚪ 4.26×10^{-3} **C**⚪ 4.99×10^{-3}
    D⚪ 5.84×10^{-3} **E**⚪ 6.83×10^{-3} **F**⚪ 7.99×10^{-3}
    G⚪ 9.35×10^{-3} **H**⚪ 1.09×10^{-2}

$\boxed{4\ pt}$ A parallel-plate air capacitor of area A = 22.1 cm^2 and plate separation of d = 3.90 mm is charged by a battery to a voltage of 52.0 V. What is the charge on the capacitor?
*(in nC)*

3.A⚪ 1.80×10^{-1} **B**⚪ 2.61×10^{-1} **C**⚪ 3.78×10^{-1}
    D⚪ 5.48×10^{-1} **E**⚪ 7.95×10^{-1} **F**⚪ 1.15
    G⚪ 1.67 **H**⚪ 2.42

$\boxed{6\ pt}$ If a dielectric material with $\kappa = 4.60$ is inserted so that it fills the volume between the plates (with the capacitor still connected to the battery), how much additional charge will flow from the battery onto the positive plate?
(in nC)

4.A⚪ 3.08×10^{-1} **B**⚪ 3.85×10^{-1} **C**⚪ 4.81×10^{-1}
    D⚪ 6.01×10^{-1} **E**⚪ 7.51×10^{-1} **F**⚪ 9.39×10^{-1}
    G⚪ 1.17 **H**⚪ 1.47

$\boxed{6\ pt}$ The figure below shows two points in an electric field. Point **1** is at $(X_1,Y_1) = (3,4)$, and point **2** is at $(X_2,Y_2) = (12,9)$. (The coordinates are given in meters.) The electric field is constant with a magnitude of 77.3 V/m, and is directed parallel to the +X-axis. The potential at point **1** is 1200.0 V.
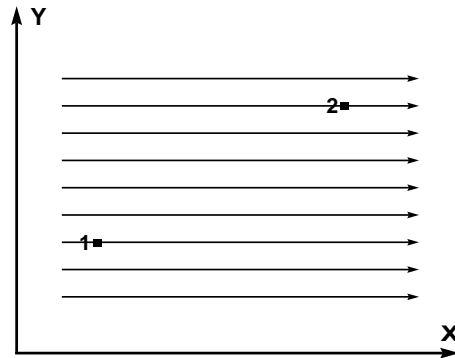
Calculate the potential at point **2**.
(in V)

5.A⚪ 1.21×10^2 **B**⚪ 1.61×10^2 **C**⚪ 2.14×10^2
    D⚪ 2.85×10^2 **E**⚪ 3.79×10^2 **F**⚪ 5.04×10^2
    G⚪ 6.71×10^2 **H**⚪ 8.92×10^2

$\boxed{6\ pt}$ Calculate the work required to move a negative charge of Q=-585.0 μC from point **1** to point **2**.
(in J)

6.A⚪ 3.06×10^{-1} **B**⚪ 4.07×10^{-1} **C**⚪ 5.41×10^{-1}
    D⚪ 7.20×10^{-1} **E**⚪ 9.57×10^{-1} **F**⚪ 1.27
    G⚪ 1.69 **H**⚪ 2.25

$\boxed{6\ pt}$ Consider the circuit shown in the figure. Calculate the potential difference across R_4. Use the following data: $R_1 = 540\ \Omega$, $R_2 = 760\ \Omega$, $R_3 = 640\ \Omega$, $R_4 = 230\ \Omega$, $\varepsilon = 4.5$ V.
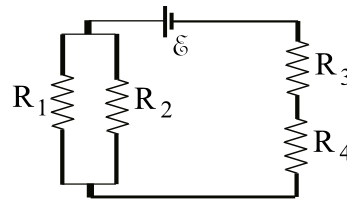
(in V)

**7.A**⚪ 9.39×10^{-2} **B**⚪ 1.36×10^{-1} **C**⚪ 1.97×10^{-1}
    D⚪ 2.86×10^{-1} **E**⚪ 4.15×10^{-1} **F**⚪ 6.02×10^{-1}
    G⚪ 8.73×10^{-1} **H**⚪ 1.27

$\boxed{6\ pt}$ Calculate the power dissipated by R_3.
(in W)

8.A⚪ 4.38×10^{-3} **B**⚪ 6.36×10^{-3} **C**⚪ 9.22×10^{-3}
    D⚪ 1.34×10^{-2} **E**⚪ 1.94×10^{-2} **F**⚪ 2.81×10^{-2}
    G⚪ 4.08×10^{-2} **H**⚪ 5.91×10^{-2}

4 pt The picture shows a battery connected to two cylindrical wires in parallel. Both wires are made out of the same material and are of the same length, but the diameter of wire **A** is twice the diameter of wire **B**.
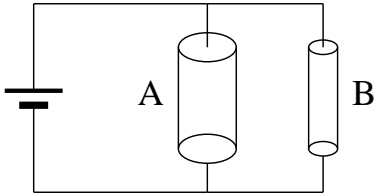
Choose the correct answer.

9. **A**◯ The resistance of wire B is equal to the resistance of wire A.
B◯ The resistance of wire B is four times as large as the resistance of wire A.
C◯ The resistance of wire B is half as large as the resistance of wire A.
D◯ The resistance of wire B is twice as large as the resistance of wire A.
E◯ The resistance of wire B is one quarter as large as the resistance of wire A.

4 pt Choose the correct answer.

10. **A**◯ The voltage drop across wire B is half as large as the voltage drop across wire A.
B◯ The voltage drop across wire B is equal to the voltage drop across wire A.
C◯ The voltage drop across wire B is four times as large as the voltage drop across wire A.
D◯ The voltage drop across wire B is twice as large as the voltage drop across wire A.
E◯ The voltage drop across wire B is one quarter as large as the voltage drop across wire A.

4 pt Choose the correct answer.

11. **A**◯ The power dissipated in wire B is 1/16 as large as the power dissipated in wire A.
B◯ The power dissipated in wire B is one quarter as large as the power dissipated in wire A.
C◯ The power dissipated in wire B is equal to the power dissipated in wire A.
D◯ The power dissipated in wire B is 4 times as large as the power dissipated in wire A.
E◯ The power dissipated in wire B is 16 times as large as the power dissipated in wire A.

4 pt A point charge Q moving in a uniform magnetic field of 1.95 T experiences a force of 1.21×10^{-12} N. The velocity of the charge is perpendicular to the magnetic field. If the magnetic field points South and the force points out of the page, then choose the single correct answer. (In this problem we use the points of the compass for directions on the paper with North pointing to the top of the page, and 'into' and 'out of' to indicate directions with respect to the page.)

12. **A**◯ Q is negative, moving West.
B◯ Q is negative, moving South.
C◯ Q is negative, moving North.
D◯ Q is positive, moving North.
E◯ Q is positive, moving East.
F◯ Q is positive, moving West.

4 pt The speed of the point charge is 3.87×10^6 m/s. Calculate the magnitude of the charge.
(in C*)*

13.**A**◯ 3.36×10^{-20} **B**◯ 4.19×10^{-20}
C◯ 5.24×10^{-20} **D**◯ 6.55×10^{-20}
E◯ 8.19×10^{-20} **F**◯ 1.02×10^{-19}
G◯ 1.28×10^{-19} **H**◯ 1.60×10^{-19}

8 pt A square loop of wire with a small resistance is moved with constant speed from a field free region into a region of uniform B field (B is constant in time) and then back into a field free region to the left. The self inductance of the loop is negligible.
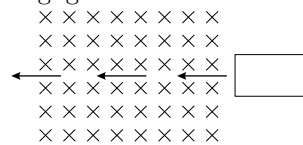
▷ When entering the field the coil experiences a magnetic force to the left.
14. **A**◯ True **B**◯ False

▷ When leaving the field the coil experiences a magnetic force to the left.
**15**. **A**◯ True **B**◯ False

▷ Upon entering the field, a clockwise current flows in the loop.
16. **A**◯ True **B**◯ False

▷ While the loop is entirely in the field, the emf in the loop is zero.
17. **A**◯ True **B**◯ False

$\boxed{10\ pt}$ After having been in the open position for a very long time, the switch S in the following circuit is closed (t=0). The current through the battery immediately after the switch is closed is $i_0(t=0)$ and its final value (after a very long time) is i_{inf} (t $\rightarrow$ infinity.) Calculate i_{inf}/i_0, the ratio of the two currents. Use the following data: EMF = 6.0 V, R_1 = 53.0 Ω, R_2 = 41.0 Ω, L = 35.0 mH.
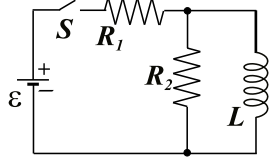
18.A◯ 5.82×10^{-1} **B**◯ 8.44×10^{-1} **C**◯ 1.22
  D◯ 1.77 **E**◯ 2.57 **F**◯ 3.73
  G◯ 5.41 **H**◯ 7.84

$\boxed{4\ pt}$ Consider the RLC circuit shown in the figure driven by a sinusoidal emf. Use the following data: ε_{RMS} = 180 V, R = 760 Ω, L = 33.0 mH, C = 0.180 mF.
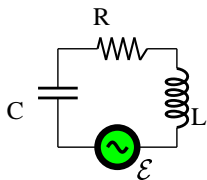
Calculate the RMS current through the capacitor at the resonance frequency.
(in A)

19.A◯ 1.89×10^{-1} **B**◯ 2.37×10^{-1} **C**◯ 2.96×10^{-1}
  D◯ 3.70×10^{-1} **E**◯ 4.63×10^{-1} **F**◯ 5.78×10^{-1}
  G◯ 7.23×10^{-1} **H**◯ 9.03×10^{-1}

$\boxed{2\ pt}$ What is the resonant frequency of this circuit?
(in Hz)

20.A◯ 2.98×10^1 **B**◯ 3.48×10^1 **C**◯ 4.08×10^1
  D◯ 4.77×10^1 **E**◯ 5.58×10^1 **F**◯ 6.53×10^1
  G◯ 7.64×10^1 **H**◯ 8.94×10^1

$\boxed{6\ pt}$ Calculate the RMS voltage across the inductor at the resonance frequency.
(in V)

21.A◯ 2.57 **B**◯ 3.21 **C**◯ 4.01
  D◯ 5.01 **E**◯ 6.26 **F**◯ 7.83
  G◯ 9.79 **H**◯ 1.22×10^1

$\boxed{8\ pt}$ An object is placed between a converging lens and the focal point of the lens. Which of the following is true?

22. A◯ The image is bigger than the object, virtual and inverted.
  B◯ The image is bigger than the object, real and upright.
  C◯ The image is bigger than the object, real and inverted.
  D◯ The image is smaller than the object, virtual and inverted.
  E◯ The image is bigger than the object, virtual and upright.
  F◯ The image is smaller than the object, real and upright.
  G◯ The image is smaller than the object, virtual and upright.
  H◯ The image is smaller than the object, real and inverted.

$\boxed{8\ pt}$ A green light is submerged 1.90 m beneath the surface of a liquid with an index of refraction 1.31. What is the radius of the circle from which light escapes from the liquid into the air above the surface?
(in m)

23.A◯ 1.99 **B**◯ 2.25 **C**◯ 2.54 **D**◯ 2.87
  E◯ 3.24 **F**◯ 3.66 **G**◯ 4.14 **H**◯ 4.67

$\boxed{8\ pt}$ A glass plate (n = 1.65) is covered with a thin, uniform layer of oil (n = 1.20). A light beam of variable wavelength from air is incident normally on the oil surface. Observation of the reflected beam shows destructive interference at 461 nm. From this information, calculate the minimum thickness of the oil film.
(in nm)

24.A◯ 9.60×10^1 **B**◯ 1.09×10^2 **C**◯ 1.23×10^2
  D◯ 1.39×10^2 **E**◯ 1.57×10^2 **F**◯ 1.77×10^2
  G◯ 2.00×10^2 **H**◯ 2.26×10^2

$\boxed{8\ pt}$ Unpolarized light passes through two polaroid sheets. The axis of the first is vertical and that of the second is at 27.0 degrees to the vertical. What fraction of the initial light is transmitted?

25.A◯ 3.97×10^{-1} **B**◯ 5.76×10^{-1} **C**◯ 8.35×10^{-1}
  D◯ 1.21 **E**◯ 1.75 **F**◯ 2.54
  G◯ 3.69 **H**◯ 5.35

$\boxed{8\ pt}$ A tired physics professor can easily read the fine print of the financial page when the newspaper is held at arm's length, 65.0 cm from the eye. What should be the focal length of an eyeglass lens that will allow him to read at the more comfortable distance of 23.0 cm?
(in cm*)*

26.A◯ 1.19×10^1 **B**◯ 1.39×10^1 **C**◯ 1.62×10^1
   D◯ 1.90×10^1 **E**◯ 2.22×10^1 **F**◯ 2.60×10^1
   G◯ 3.04×10^1 **H**◯ 3.56×10^1

$\boxed{8\ pt}$ Imagine Mike lives on the earth at rest. Judy traveling past the earth with a speed of 0.60 **c**. If a rocket moving in the same direction passes Judy, Mike sees the rocket speed to be 0.83 **c**. What is the speed of the rocket seen by Judy in terms of the speed of the light?

27.A◯ 0.22   **B**◯ 0.25   **C**◯ 0.28   **D**◯ 0.32
   E◯ 0.36   **F**◯ 0.41   **G**◯ 0.46   **H**◯ 0.52

$\boxed{6\ pt}$ When light of wavelength 311 nm falls on a potassium surface, electrons are emitted that have a maximum kinetic energy of 1.75 eV. Find the work function for potassium.
(in eV*)*

28.A◯ 2.24   **B**◯ 2.80   **C**◯ 3.50
   D◯ 4.38   **E**◯ 5.47   **F**◯ 6.84
   G◯ 8.54   **H**◯ 1.07×10^1

$\boxed{6\ pt}$ What is the longest wavelength of light that will produce photoelectrons from potassium?
(in nm*)*

29.A◯ 3.39×10^2 **B**◯ 3.84×10^2 **C**◯ 4.33×10^2
   D◯ 4.90×10^2 **E**◯ 5.53×10^2 **F**◯ 6.25×10^2
   G◯ 7.07×10^2 **H**◯ 7.99×10^2

$\boxed{8\ pt}$ Photons of wavelength 65.0 pm are Compton-scattered from a free electron which picks up a kinetic energy of 0.71 keV from the collision. What is the wavelength of the scattered photon?
(in pm*)*

30.A◯ 3.24×10^1 **B**◯ 3.66×10^1 **C**◯ 4.14×10^1
   D◯ 4.68×10^1 **E**◯ 5.29×10^1 **F**◯ 5.97×10^1
   G◯ 6.75×10^1 **H**◯ 7.63×10^1

$\boxed{8\ pt}$ Electrons are accelerated through a voltage of 21.0 kV in a television's picture tube. Calculate the de Broglie wavelength of the electrons?
(in m*)*

31.A◯ 4.07×10^{-12} **B**◯ 4.59×10^{-12}
   C◯ 5.19×10^{-12} **D**◯ 5.87×10^{-12}
   E◯ 6.63×10^{-12} **F**◯ 7.49×10^{-12}
   G◯ 8.46×10^{-12} **H**◯ 9.56×10^{-12}

$\boxed{8\ pt}$ An atom is ionized so that it has only one electron. When the electron drops from the n = 4 shell to the n = 1 shell, an X-ray of wavelength 220.53 pm is emitted. What is the atomic number?

32.A◯ 11   **B**◯ 13   **C**◯ 17   **D**◯ 21
   E◯ 26   **F**◯ 33   **G**◯ 41   **H**◯ 51

$\boxed{2\ pt}$ Consider the nucleus ^{98}Zr. How many protons does this nucleus contain?

33. **A**◯ 58
   B◯ 20
   C◯ 40
   D◯ 138
   E◯ 49
   F◯ 196
   G◯ 80
   H◯ 98

$\boxed{2\ pt}$

How many neutrons does this nucleus contain?

34. **A**◯ 138
   B◯ 196
   C◯ 58
   D◯ 49
   E◯ 80
   F◯ 40
   G◯ 98
   H◯ 20

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2 pt

How many nucleons does this nucleus contain?

35. **A**◯ 20
 B◯ 138
 C◯ 98
 D◯ 40
 E◯ 49
 F◯ 196
 G◯ 58
 H◯ 80

2 pt

How many electrons orbit this nucleus in an un-ionized atom?

36. **A**◯ 80
 B◯ 98
 C◯ 40
 D◯ 196
 E◯ 58
 F◯ 49
 G◯ 138
 H◯ 20

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6 pt A radioactive isotope has an activity of 8.62 mCi. After 3.35 hours the activity is 6.55 mCi. What is the half-life of the isotope?
(in h)

37.A◯ 1.32 **B**◯ 1.91 **C**◯ 2.78
 D◯ 4.02 **E**◯ 5.84 **F**◯ 8.46
 G◯ 1.23×10^1 **H**◯ 1.78×10^1

6 pt

What is the activity after an additional 3.35 hours in mCi units?

38.A◯ 2.12 **B**◯ 2.39 **C**◯ 2.70 **D**◯ 3.05
 E◯ 3.45 **F**◯ 3.90 **G**◯ 4.41 **H**◯ 4.98