Flavour 5

Physics 207 – Exam II

Fall 2024 (all UP sections) **March 24, 2025**

Do **not** open the exam until told to do so.

Before you begin, make sure you filled out the bubbles on the grading sheet indicating this exam flavour (this is **flavour 5**) *and* your UIN! Without this information, your exam will not be able to be processed and may result in a zero.

Mark what answers you put on the bubble sheet on this copy of the exam and keep it for your records so that you can refer back to this later in the semester and know what you did; it will be your only record of Exam II.

There are several flavours of this exam. Do not read anything into the sequence of the questions nor the answers; they are randomized. The "*Qid*" label is the ordering of questions the answer key (and your professor, should you want to ask about a particular problem) will have.

⇒ When filling out the grading sheet, **use the problem number of your flavour**, *not* the "*Qid*" ⇐

Rules of the exam:

1) You have **120** minutes to complete the exam.

2) You will answer using the **Grading Sheet** provided. **Make sure you have one before the exam starts**. Be sure to fill out the bubbles of the Grading sheet **completely** with a dark (e.g. #2) pencil or dark (black, blue) pen so as not to lose marks. If necessary (e.g. you cannot adequately erase a mistake), the proctor has extra Grading Sheets.

3) Formulae are similarly provided to you for the exam. **Make sure you have one before the exam starts**. You may *not* use your own or any other formula sheet.

4) Cell phone use during the exam is **strictly prohibited**. Please turn off all ringers as calls during an exam can be quite distracting. If we see you using a cell phone we will assume you are cheating.

5) Check to see that there are **12 numbered pages** (6 double-sided sheets) in your exam.

6) You are **not** required to show any work, and you will only submit the Grading Sheet at the end of the exam. You may use the blank spaces on the exam to work out problems. If you run out of room, your proctor should have extra scratch paper you may use.

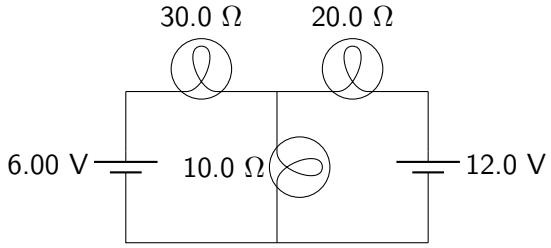
7) Calculators that cannot wirelessly connect to the internet are allowed during the exam.

8) There is only one correct answer of the options given, but incorrect answers may yield some reduced amount of points as partial credit.

   - **Multiple answers are not allowed**. If two or more bubbles are filled for a given question, you will receive a zero for that question – even if one is correct.
   - There is **no penalty** for incorrect answers. So there is no harm in guessing if you can't solve the problem and/or run out of time.

9) Have your **TAMU ID ready when submitting your Grading Sheet** to the proctor. You should keep the exam, any blank sheets you used to work out problems, and/or the formula sheet following submitting your grading sheet. Alternatively, your proctor can recycle any material you don't want to keep.

1. [*Qid 7*] (8 points) The figure below shows 3 incandescent light bulbs that behave like resistors with the labeled values. What is the power dissipated in the brightest light bulb?



   (A) 2.92 W

   (B) 16.2 W

   (C) 7.20 W

   (D) 32.4 W

   (E) 1.90 W

   (F) 1.20 W

   (G) 10.8 W

   (H) 0.0893 W

2. [*Qid 14*] (8 points) A spherical capacitor is created using two concentric spherical shells of radius 2.00 and 5.00 m respectively. What is the capacitance of this capacitor if there is only air between the shells?

   (A) 234 pF

   (B) 148 pF

   (C) 538 pF

   (D) 371 pF

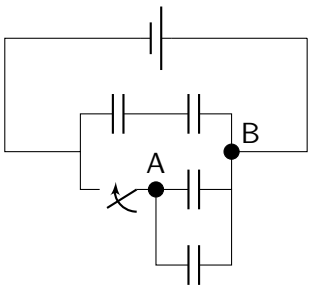
   (E) 833 pF

   (F) 748 pF

   (G) 465 pF

   (H) 927 pF

3. [*Qid 10*] (8 points) Four identical 1.0 μF capacitors are connected to a battery of potential $V = 10$ V as seen below. How much does the charge delivered by the battery change when the switch closes?



(A) Charge decreases by 8.0 μC

(B) Charge increases by 16 μC

(C) Charge increases by 12 μC

(D) Charge increases by 20 μC

(E) Charge increases by 8.0 μC

(F) Charge decreases by 16 μC

(G) Charge decreases by 20 μC

(H) Charge decreases by 12 μC

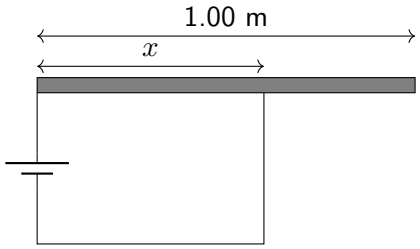
4. [*Qid 11*] (4 points) In the previous circuit what happens to $|V_{AB}|$, the absolute value of the potential difference between A and B when the switch closes?

(A) $|V_{AB}|$ increases

(B) $|V_{AB}|$ decreases

(C) $|V_{AB}|$ does not change

5. [*Qid 3*] (6 points) A variable resistor is created using a 2.00 m long bar that has a rectangular cross-section that is 2.00 mm by 1.00 mm. The material in the bar has a resistivity of 1.20×10^{-6} Ωm. For a particular application, a 3.00-V battery will be attached to the bar which will provide the only resistance in the circuit. If there is supposed to be 2.00 A of current in the circuit, what distance x from the left end of the bar should the circuit be connected? Use the figure below for reference.



(A) 0.166 m

(B) 0.610 m

(C) 1.11 m

(D) 1.25 m

(E) 1.60 m

(F) 1.84 m

(G) 0.900 m

(H) The bar is not long enough for this to happen under these conditions.

6. [*Qid 13*] (8 points) A battery with $\mathcal{E} = 12$ V is connected with $R_1 = 6.0\ \Omega$, $R_2 = 3.0\ \Omega$, and $C = 4.0\ \mu$F as shown below. The switch is closed until the capacitor reaches 50% of maximum charge then the switch is immediately opened. How long does it take for the capacitor to fall below 1.0% of maximum charge from the time the switch was opened?

   (A) 249 μs

   (B) 55.3 μs

   (C) 74.2 μs

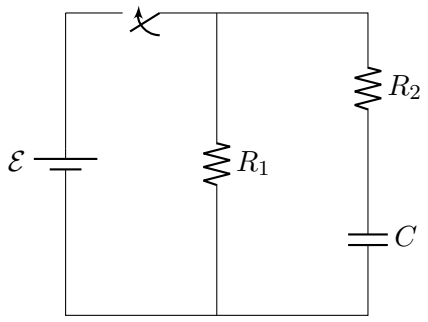
   (D) 11.1 μs

   (E) 46.9 μs

   (F) 141 μs

   (G) 88.3 μs

   (H) 166 μs



7. [*Qid 5*] (8 points) In the circuit below you are given two of the currents and know that they are moving in the direction shown. What is the potential difference $V_A - V_B$?

(A) -16.7 V

(B) -20.9 V

(C) +4.93 V

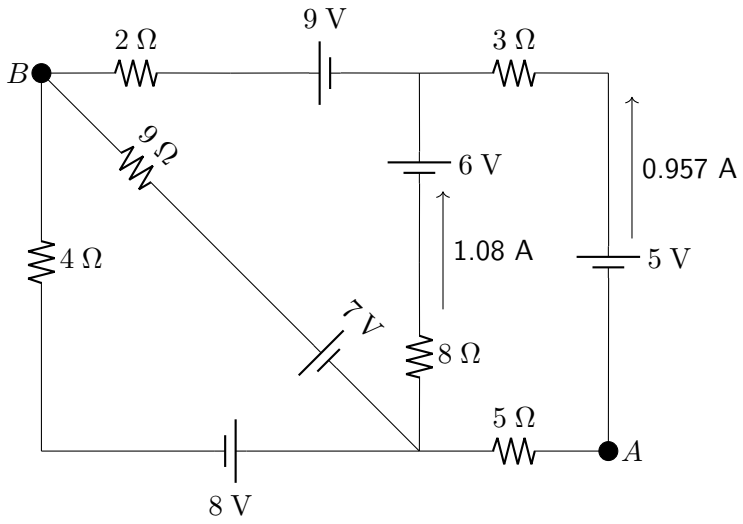
(D) -4.93 V

(E) +16.7 V

(F) -7.05 V

(G) +7.05 V

(H) +20.9 V



8. [*Qid 1*] (6 points) An air-filled, parallel-plate capacitor is connected to a battery and allowed to fully charge. While still connected to the battery, the plate separation is changed so that the charge increases by 25%. By what percentage did the distance between the plates change?

   (A) The distance decreased by 20%

   (B) The distance increased by 56%

   (C) The distance decreased by 25%

   (D) The distance increased by 36%

   (E) The distance decreased by 56%

   (F) The distance increased by 25%

   (G) The distance decreased by 36%

   (H) The distance increased by 20%

9. [*Qid 4*] (8 points) How much charge is stored on the capacitor in the circuit below a very long time after the switch is closed?

(A) 0.743 mC

(B) 3.37 mC

(C) 6.74 mC

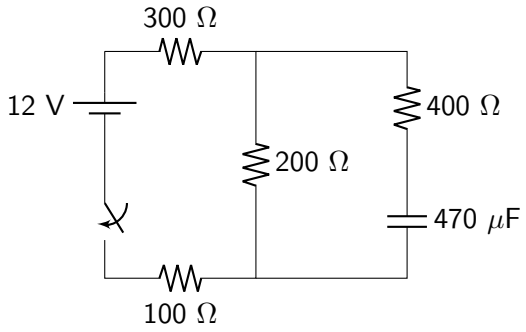
(D) 5.64 mC

(E) 1.41 mC

(F) 2.82 mC

(G) 1.88 mC

(H) 8.59 mC



10. [*Qid 6*] (6 points) In the circuit below, you know that $C_1 > C_2$. What do you know about the charges stored on the capacitors (Q_1 and Q_2 respectively) and the potential at A relative to the potential at B?

(A) $Q_1 < Q_2$ and $V_A = V_B$

(B) $Q_1 > Q_2$ and $V_A < V_B$

(C) $Q_1 < Q_2$ and $V_A > V_B$

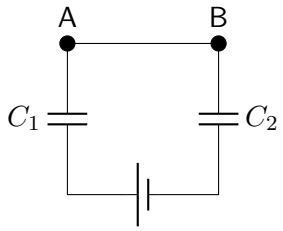
(D) $Q_1 > Q_2$ and $V_A > V_B$

(E) $Q_1 = Q_2$ and $V_A > V_B$

(F) $Q_1 > Q_2$ and $V_A = V_B$

(G) $Q_1 < Q_2$ and $V_A < V_B$

(H) $Q_1 = Q_2$ and $V_A = V_B$



11. [*Qid 15*] (4 points) A parallel plate capacitor is connected in series to a battery. The capacitor is fully charged and then while staying connected to the battery, the plate separation is doubled. What happens to the energy stored in the capacitor?

(A) The energy stays constant

(B) The energy decreases by a factor of 2

(C) The energy increases by a factor of 2

(D) The energy decreases by a factor of 4

(E) The energy increases by a factor of 4

12. [*Qid 16*] (4 points) What happens to the magnitude of the electric field between the plates of the capacitor when the plate separation was doubled in the previous problem?

    (A) The electric field increases by a factor of 4

    (B) The electric field decreases by a factor of 2

    (C) The electric field stays constant

    (D) The electric field decreases by a factor of 4

    (E) The electric field increases by a factor of 2

13. [*Qid 9*] (8 points) An air-filled capacitor is connected in series to a battery of potential V. The initial charge on the capacitor is Q_0 after being connected to the battery for a long time. If the charge on the capacitor is supposed to increase to $4Q_0$ while staying connected to the battery, what percentage of the volume should be filled with a dielectric of $\kappa = 8.00$? Assume the dielectric filled the whole plate area but only part of the separation distance as shown below.

    (A) 28.2%

    (B) 44.1%

    (C) 76.2%

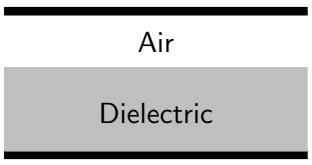
    (D) 50.0%

    (E) 91.4%

    (F) 33.3%

    (G) 85.7%

    (H) 10.8%



14. [*Qid 8*] (4 points) Assuming the battery has been connected to the circuit for a long time, which resistors DO NOT contribute to calculating the power dissipated across the battery's internal resistance?

(A) R_5 and R_6

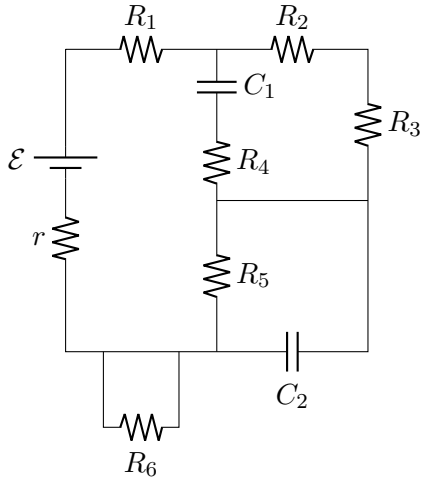
(B) R_4 and R_6

(C) R_2 and R_3

(D) R_4 and R_5

(E) R_4, R_6 and r

(F) Only r contributes



15. [*Qid 2*] (4 points) In a simple RC-circuit like the one shown below, it takes a time T for the capacitor to be fully charged according to the "5 time constant" rule *if* the capacitor was uncharged when the switch was closed. What if instead, the capacitor already had half of the full charge when the switch was closed? Which of the following describes how much time t it would take to reach full charge?

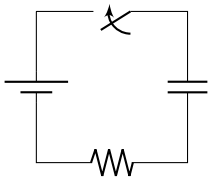
(A) $t = T$

(B) $0.5T < t < T$

(C) $t = 0.5T$

(D) $0 < t < 0.5T$

(E) It is impossible to tell without values.



16. [*Qid 12*] (6 points) What is the effective resistance of the circuit below? Treat each resistor as identical with resistance R.

(A) $\frac{2R}{3}$

(B) $2R$

(C) $3R$

(D) R

(E) $\frac{R}{3}$

(F) $\frac{R}{2}$

(G) $\frac{3R}{2}$