Drill:

- Exam is multiple choice 90 minutes.
- You will need a calculator, #2 pencil, scratch paper.
- You can also use 1 side of a 3x5 index card for notes/equations.
- But you will be supplied with fundamental constants, etc

1. Two 15-Ω and three 25-Ω light bulbs and a 24 V battery are connected in a series circuit. What is the current that passes through each bulb?
   A) 0.23 A
   B) 0.51 A
   C) 0.96 A
   D) 1.6 A
   E) The current will be 1.6 A in the 15-Ω bulbs and 0.96 A in the 25-Ω bulbs.

2. Determine the length of a copper wire that has a resistance of 0.172 Ω and a cross-sectional area of 1 × 10⁻⁴ m². The resistivity of copper is 1.72 × 10⁻⁸ Ω • m.
   A) 0.1 m
   B) 10 m
   C) 100 m
   D) 1000 m
   E) 10 000 m
Use the following to answer questions 3-5:

The sketch shows cross sections of equipotential surfaces between two charged conductors shown in solid black. Points on the equipotential surfaces near the conductors are labeled A, B, C, ..., H.

3. What is the magnitude of the potential difference between points A and H?
   A) 100 V
   B) 200 V
   C) 400 V
   D) 600 V
   E) 700 V

4. How much work is required to move a +6 µC point charge from B to F to D to A?
   A) +1.2 × 10^{-3} J
   B) −1.2 × 10^{-3} J
   C) +3.6 × 10^{-3} J
   D) −3.6 × 10^{-3} J
   E) zero joules

5. What is the direction of the electric field at point E?
   A) toward G
   B) toward B
   C) toward H
   D) toward C
   E) toward F
6. A computer monitor uses 2.0 A of current when it is plugged into a 120 V outlet. The
monitor is never turned off. What is the yearly cost of operating the monitor if the cost
of electricity is $0.12/kWh?
A) $14  
B) $21  
C) $98  
D) $170  
E) $250

Use the following to answer questions 7-8:

Three resistors are connected as shown in the figure. The potential difference between
points A and B is 26 V.

7. How much current flows through the 2-Ω resistor?
A) 2.0 A  
B) 4.0 A  
C) 6.0 A  
D) 8.7 A  
E) 10.0 A

8. What is the equivalent resistance between the points A and B?
A) 3.8 Ω  
B) 4.3 Ω  
C) 5.1 Ω  
D) 6.8 Ω  
E) 9.0 Ω
Use the following to answer question 9:

Four point charges are individually brought from infinity and placed at the corners of a square as shown in the figure. Each charge has the identical value $+Q$. The length of the diagonal of the square is $2a$.

9. The first two charges are brought from infinity and placed at adjacent corners. What is the electric potential energy of these two charges?

A) $\frac{kQ^2}{a\sqrt{2}}$

B) $\frac{2kQ}{a}$

C) $\frac{kQ}{a\sqrt{2}}$

D) $\frac{kQ^2}{2a}$

E) $\frac{kQ^2}{4a}$

10. Three parallel plate capacitors, each having a capacitance of 1.0 $\mu$F are connected in parallel. The potential difference across the combination is 100 V. What is the charge on any one of the capacitors.

A) 30 $\mu$C

B) 100 $\mu$C

C) 300 $\mu$C

D) 1000 $\mu$C

E) 3000 $\mu$C
A solid, conducting sphere of radius $a$ carries an excess charge of $+6 \ \mu C$. This sphere is located at the center of a hollow, conducting sphere with an inner radius of $b$ and an outer radius of $c$ as shown. The hollow sphere also carries a total excess charge of $+6 \ \mu C$.

11. Determine the excess charge on the \textit{inner surface} of the outer sphere (a distance $b$ from the center of the system).
   A) zero coulombs
   B) $-6 \ \mu C$
   C) $+6 \ \mu C$
   D) $+12 \ \mu C$
   E) $-12 \ \mu C$

12. Determine the excess charge on the \textit{outer surface} of the outer sphere (a distance $c$ from the center of the system).
   A) zero coulombs
   B) $-6 \ \mu C$
   C) $+6 \ \mu C$
   D) $+12 \ \mu C$
   E) $-12 \ \mu C$
13. Which one of the following figures shows a qualitatively accurate sketch of the electric field lines in and around this system?

(a) ![Diagram A]
(b) ![Diagram B]
(c) ![Diagram C]
(d) ![Diagram D]
(e) ![Diagram E]

14. A capacitor has a very large capacitance of 10 \( \text{F} \). The capacitor is charged by placing a potential difference of 2 \( \text{V} \) between its plates. How much energy is stored in the capacitor?

A) 2000 J  
B) 500 J  
C) 100 J  
D) 40 J  
E) 20 J

15. A 10-A current is maintained in a simple circuit with a total resistance of 200 \( \Omega \). What net charge passes through any point in the circuit during a 1-minute interval?

A) 200 C  
B) 400 C  
C) 500 C  
D) 600 C  
E) 1200 C
16. At what separation will two charges, each of magnitude 6 \( \mu \text{C} \), exert a force of 1.4 N on each other?
A) \( 5.1 \times 10^{-6} \) m
B) 0.23 m
C) 0.48 m
D) 2.0 m
E) 40 m

17. A parallel plate capacitor is fully charged at a potential \( V \). A dielectric with constant \( \kappa = 4 \) is inserted between the plates of the capacitor while the potential difference between the plates remains constant. Which one of the following statements is false concerning this situation?
A) The energy density remains unchanged.
B) The capacitance increases by a factor of four.
C) The stored energy increases by a factor of four.
D) The charge on the capacitor increases by a factor of four.
E) The electric field between the plates increases by a factor of four.

Use the following to answer questions 18-19:

Two charges of opposite sign and equal magnitude \( Q = 2.0 \) C are held 2.0 m apart as shown in the figure.

![Diagram of charges](image)

18. Determine the electric potential at the point \( P \).
A) \( 1.1 \times 10^9 \) V
B) \( 2.2 \times 10^9 \) V
C) \( 4.5 \times 10^9 \) V
D) \( 9.0 \times 10^9 \) V
E) zero volts
19. Determine the magnitude of the electric field at the point \( P \).
A) \( 2.2 \times 10^9 \) V/m
B) \( 5.6 \times 10^8 \) V/m
C) \( 4.4 \times 10^8 \) V/m
D) \( 2.8 \times 10^8 \) V/m
E) zero V/m

20. A 4-A current is maintained in a simple circuit with a total resistance of 2 \( \Omega \). How much energy is dissipated in 3 seconds?
A) 3 J
B) 6 J
C) 12 J
D) 24 J
E) 96 J
Answer Key

1. A
2. D
3. D
4. A
5. A
6. E
7. B
8. B
9. A
10. B
11. B
12. D
13. E
14. E
15. D
16. C
17. E
18. E
19. B
20. E