1. A copper wire 1 km in length and 1 cm in diameter dissipates 4900 W of power. How much current (in A) is flowing through the wire? The resistivity of copper ($\rho_{Cu}$) is $1.72 \times 10^{-8}$ m.

   (1) 150   (2) 20   (3) 3000   (4) 80   (5) 5

2. Compute the equivalent resistance (in $\Omega$) between points A and C for the resistor network shown in Figure 1.

   (1) 5.7   (2) 12.0   (3) 10.0   (4) 16.0   (5) 2.3

3. If a 12 V battery is connected to the resistor network in Figure 1 (between points A and E), find the current (in A) in the 3- resistor.

   (1) 1.0   (2) 0.5   (3) 1.6   (4) 0.2   (5) 4.0
4. Each of the light bulbs in Figure 2 has equal resistance. List the light bulbs from brightest to dimmest. Group light bulbs with the same brightness in parentheses.

(1) (C,E), (A,B), (D,F)
(2) (D,F), (A,B), (C,E)
(3) (A,B), E, (C,D), F
(4) (C,D,E), (A,B), F
(5) (A,B), (C,E), (D,F)

5. You are given N resistors to make a resistor network. Which statements below are FALSE?
   I. If the network is put into a circuit with a battery, the largest current will be generated if the resistors are all connected in series.
   II. Connecting the resistors in series will give the largest equivalent resistance.
   III. Connecting the resistors in parallel will give the smallest equivalent resistance.
   IV. If the network is put into a circuit with a battery, the largest current will be generated if the resistors are all connected in parallel.
   V. If the network is put into a circuit with a battery, the largest current will be generated if the resistors are connected in a combination of series and parallel.

(1) I, V  (2) II, III  (3) IV  (4) V  (5) I,II,V

6. What is the potential difference (in V) between points D and E in the circuit shown in Figure 3?

(1) 2.67 V, E is at a higher potential
(2) 2.67 V, D is at a higher potential
(3) 1.81 V, E is at a higher potential
(4) 1.81 V, D is at a higher potential
(5) 0 V, D and E are at equal potentials

7. For the circuit shown in Figure 3, how much current (in A) is going through the 4 - resistor?

(1) 0.038  (2) 0.123  (3) 0.382  (4) 0.342  (5) 0.089

8. At time $t = 0$ s, the switch is closed on the circuit shown in Figure 4. How much time (in s) will elapse before the current in the resistor has decreased to $1/e$ of its initial value at $t = 0$?

(1) 0.003  (2) 0.010  (3) 0.006  (4) 0.012  (5) 0.008

9. A battery has an internal resistance of $0.25\text{ }\Omega$. A number of identical resistors ($R = 10\text{ }\Omega$) are connected in parallel across the battery terminals. The terminal voltage is found to be $2/3$ of the EMF of the battery. How many resistors are connected?

(1) 20  (2) 40  (3) 5  (4) 8  (5) 6
10. Which statement below must be TRUE?

(1) Two resistors connected in parallel have the same voltage drop across them.
(2) Two resistors connected in parallel have the same current through them.
(3) Two capacitors connected in parallel have the same charge on them.
(4) Two resistors connected in parallel have identical power dissipation.
(5) Two capacitors connected in series have the same stored energy.

11. The current flowing in a wire is 22 mA. How many electrons pass by a given point on the wire in 1 minute?

(1) $8.3 \times 10^{18}$  (2) $1.4 \times 10^{17}$  (3) $5.6 \times 10^{19}$  (4) $5.6 \times 10^{17}$  (5) $3.2 \times 10^{20}$

12. A 20 cm long wire is suspended in uniform magnetic field of 2 T directed downward as shown in Figure 5. A 3 A current runs through the wire in the direction indicated. The wire has a mass of 0.2 kg. Find the tension (in N) in each rope.

(1) 1.15  (2) 0.58  (3) 3.43  (4) 28.1  (5) 12.3

13. Consider a region of spatially uniform magnetic field shown in Figure 6. The magnetic field is directed out of the page. Two particles with identical masses are moving in circular orbits in the direction shown with instantaneous velocities $v_1$ and $v_2$. Which statement must be true?

(1) $q_1, q_2 < 0$, $|v_1/q_1| > |v_2/q_2|$  
(2) $q_1, q_2 > 0$, $|v_1/q_1| > |v_2/q_2|$  
(3) $q_1, q_2 < 0$, $|v_1/q_1| > |q_2|$  
(4) $q_1, q_2 > 0$, $|v_1/q_1| < |q_2|$  
(5) $q_1 > 0$, $q_2 < 0$, $|v_1/q_1| > |v_2/q_2|

14. A $+3 \mu C$ charge travelling in the +x direction with a velocity $4 \times 10^5$ m/s enters a region where a B field of 0.2 T is pointed in the +z direction (see Figure 7). The particle continues to travel undeflected in the +x direction. How can this be?

(1) There is an electric field $E = 8 \times 10^4$ V/m pointed in the -y direction.  
(2) There is an electric field $E = 2 \times 10^3$ V/m pointed in the +y direction.  
(3) There is an electric field $E = 5 \times 10^3$ V/m pointed in the -y direction.  
(4) There is an electric field $E = 5 \times 10^3$ V/m pointed in the -z direction.  
(5) Trick question; it’s impossible.

15. The same length of wire is used to make a circular coil and a square coil. Each coil contains a single turn. Compute the ratio of the maximum torque exerted on the square coil to that exerted on the circular coil if both have the same current and experience the same magnetic field. ($C = 2\pi r$ for the circumference of a circle.)

(1) 0.79  (2) 12.6  (3) 39.5  (4) 102.3  (5) 423.2

16. A $+3.0 \mu C$, $3.0 \times 10^{-6}$kg charged particle is trapped in a 6.28 T magnetic field (see Figure 8). How long (in s) does it take the particle to complete one orbit? ($C = 2\pi r$ for the circumference of a circle.)

(1) 1.0  (2) 3.5  (3) 45  (4) 0.0003  (5) 0.003
17. A rectangular loop is placed in a uniform magnetic field with the plane of the loop parallel to the direction of the field (See Figure 9). If a current is made to flow through the loop in the sense shown by the arrows, the field exerts on the loop:

(1) a net torque.  (2) a net force.  (3) both a net force and a net torque.  (4) neither a net force nor a net torque.  (5) none of the above.

18. Two charged particles enter a mass spectrometer ($B = 1.2 \, \text{T}$). They have identical charges $1.2 \times 10^{-17} \, \text{C}$, but different masses ($m_1 = 6.5 \times 10^{-26} \, \text{kg}$, $m_2 = 3.9 \times 10^{-26} \, \text{kg}$). Both are accelerated by a potential difference of 5 kV. How far are they separated (in m) when they reach the detector?

(1) 0.003  (2) 0.03  (3) 0.103  (4) 0.045  (5) 0.001

19. A negatively charged particle traveling with velocity $v$ enters the magnetic field regions shown in Figure 9. Describe the direction of the magnetic fields in each of the four regions.

I: $B$ is out of page
II: $B$ is into page
III: $B$ is parallel to $v$

(1) region 1- III, region 2 - I, region 3 - I, region 4 - II
(2) region 1- III, region 2 - II, region 3 - II, region 4 - I
(3) region 1- I, region 2 - II, region 3 - II, region 4 - I
(4) region 1- II, region 2 - I, region 3 - I, region 4 - II
(5) region 1- III, region 2 - I, region 3 - I, region 4 - III

20. Please check again that you have correctly bubbled in your NAME, SOCIAL SECURITY NUMBER, and EXAM CODE. Which of the following statements is correct?

(1) I have correctly bubbled in this information. (If you haven’t, this question will be marked wrong!!)
(2) I have not correctly bubbled in this information.
(3) I don’t want to bubble in this information.
(4) I have an unlisted social security number.
(5) I use an alias and would prefer not to reveal my true self.