12. . The total capacitance of several capacitors in parallel is the sum of the individual capacitances for which of the following reasons?

(A) The charge on each capacitor depends on its capacitance, but the potential difference across each is the same.

(B) The charge is the same on each capacitor, but the potential difference across each capacitor depends on its capacitance.

(C) Equivalent capacitance is always greater than the largest capacitance.

(D) Capacitors in a circuit always combine like resistors in series.

(E) The parallel combination increases the effective separation of the plates.

A wire of length L and radius r has a resistance R. What is the resistance of a second wire made from the same material that has a length $L/2$ and a radius $r/2$?

13. .

(A) $4R$
(B) $2R$
(C) R
(D) $R/2$
(E) $R/4$

14. . The operating efficiency of a 0.5 A, 120 V electric motor that lifts a 9 kg mass against gravity at an average velocity of 0.5 m/s is most nearly

(A) 7%
(B) 13%
(C) 25%
(D) 53%
(E) 75%

Questions 15-16 refer to the following diagram that shows part of a closed electrical circuit.
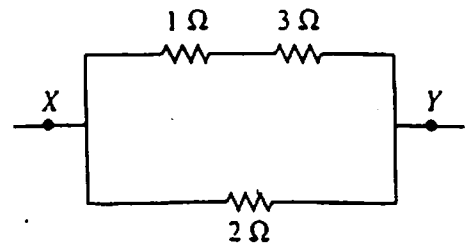
15. The electrical resistance of the part of the circuit shown between point X and point Y is

(A) $1\frac{1}{3}\ \Omega$

(B) $2\ \Omega$

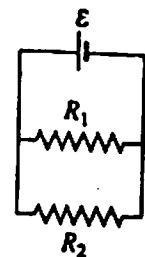(C) $2\frac{3}{4}\ \Omega$

(D) $4\ \Omega$

(E) $6\ \Omega$

16. When there is a steady current in the circuit, the amount of charge passing a point per unit of time is

(A) the same everywhere in the circuit
(B) greater at point X than at point Y
(C) greater in the $1\ \Omega$ resistor than in the $2\ \Omega$ resistor
(D) greater in the $1\ \Omega$ resistor than in the $3\ \Omega$ resistor
(E) greater in the $2\ \Omega$ resistor than in the $3\ \Omega$ resistor

17. .
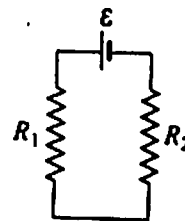
Series Connection

Parallel Connection

In the diagrams above, resistors R_1 and R_2 are shown in two different connections to the same source of emf ε that has no internal resistance. How does the power dissipated by the resistors in these two cases compare?

(A) It is greater for the series connection.
(B) It is greater for the parallel connection.
(C) It is the same for both connections.
(D) It is different for each connection, but one must know the values of R_1 and R_2 to know which is greater.
(E) It is different for each connection, but one must know the value of ε to know which is greater.

Questions 18 & 19

18.

$R_2 = 2000\ \Omega$

$R_1 = 2500\ \Omega$

I_2

I_3

$R_3 = 6000\ \Omega$

I_1

$\mathcal{E} = 12\ V$
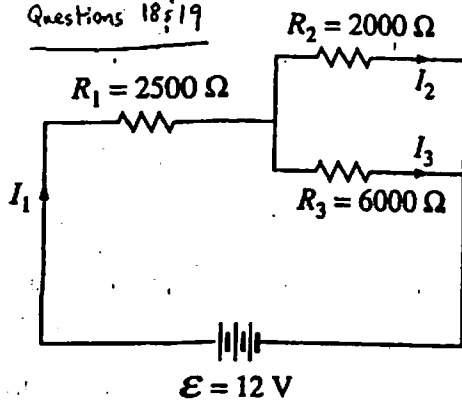
. What is the current I_1 ?

(A) 0.8 mA
(B) 1.0 mA
(C) 2.0 mA
(D) 3.0 mA
(E) 6.0 mA

How do the currents I_1, I_2, and I_3 compare?

19. (A) $I_1 > I_2 > I_3$
(B) $I_1 > I_3 > I_2$
(C) $I_2 > I_1 > I_3$
(D) $I_3 > I_1 > I_2$
(E) $I_3 > I_2 > I_1$

Questions 20-22 relate to the following circuit diagram, which shows a battery with an internal resistance of 4.0 ohms connected to a 16-ohm and a 20-ohm resistor in series. The current in the 20-ohm resistor is 0.3 amperes.

$16\ \Omega$

X

$\mathcal{E}$

$I = 0.3\ A$

$4\ \Omega$
Internal
Resistance

$20\ \Omega$

Y

20. What is the emf of the battery?

(A) 1.2 V
(B) 6.0 V
(C) 10.8 V
(D) 12.0 V
(E) 13.2 V

21. What is the potential difference across the terminals X and Y of the battery?

(A) 1.2 V
(B) 6.0 V
(C) 10.8 V
(D) 12.0 V
(E) 13.2 V

22. What power is dissipated by the 4-ohm internal resistance of the battery?

(A) 0.36 W
(B) 1.2 W
(C) 3.2 W
(D) 3.6 W
(E) 4.8 W
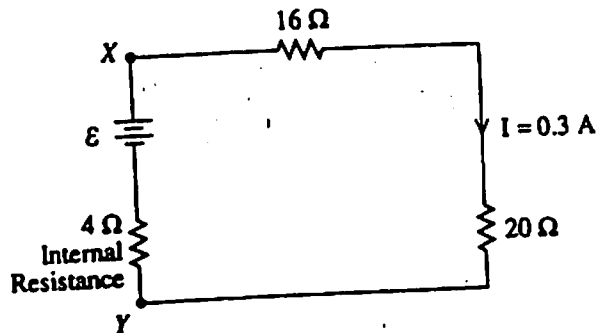
23. The product

2 amperes × 2 volts × 2 seconds

is equal to

(A) 8 coulombs
(B) 8 newtons
(C) 8 joules
(D) 8 calories
(E) 8 newton-amperes

24. A certain coffeepot draws 4.0 A of current when it is operated on 120 V household lines. If electrical energy costs 10 cents per kilowatt-hour. how much does it cost to operate the coffeepot for 2 hours?

(A) 2.4 cents
(B) 4.8 cents
(C) 8.0 cents
(D) 9.6 cents
(E) 16 cents

25. . Which of the following will cause the electrical resistance of certain materials known as superconductors to suddenly decrease to essentially zero?

(A) Increasing the voltage applied to the material beyond a certain threshold voltage
(B) Increasing the pressure applied to the material beyond a certain threshold pressure
(C) Cooling the material below a certain threshold temperature
(D) Stretching the material to a wire of sufficiently small diameter
(E) Placing the material in a sufficiently large magnetic field