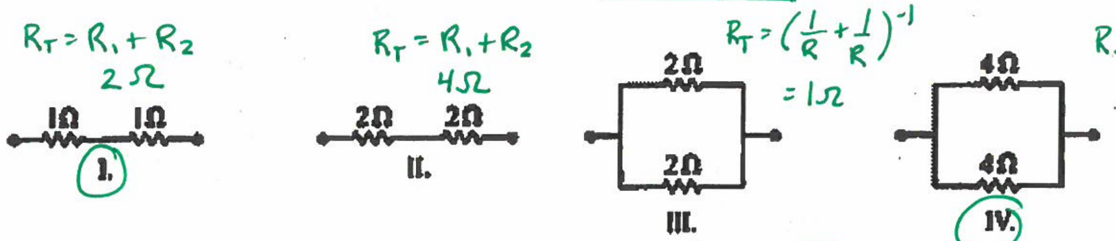
Key

cs

Date ______________________

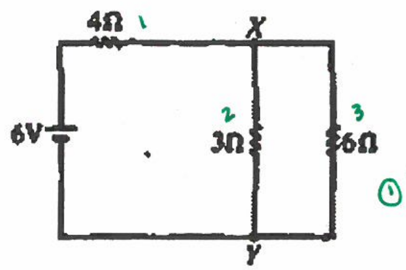
Electric Circuits

1) Which two arrangements of resistors shown below have the same resistance between the terminals?



A) II and III B) III and IV C) I and II D) I and IV E) II and IV

2)



① $R_{23} = (\frac{1}{R} + \frac{1}{R})^{-1} = (\frac{1}{3Ω} + \frac{1}{6Ω})^{-1} = 2Ω$

In the circuit shown above, what is the value of the potential difference between points X and Y if the 6-volt battery has no internal resistance?

A) 4 V
B) 1 V
C) 3 V
D) 6 V
E) 2 V

② $R_T = R_1 + R_{23} = 4Ω + 2Ω = 6Ω$

③ $I_T = \frac{V_T}{R_T} = \frac{6V}{6Ω} = 1A$ ④ $V_{23} = I_{23} R_{23} = (1A)(2Ω)$

3) One joule of work is needed to move one coulomb of charge from one point to another with no change in velocity. Which of the following is true between the two points?

A) The electric field strength is one joule per electron. $E = Fq$
B) The potential difference is one volt. $V = \frac{W}{q}$
C) The current is one ampere. $I = q/t$
D) The resistance is one ohm. $R = V/I$
E) The electric field strength is one newton per coulomb.

4) 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

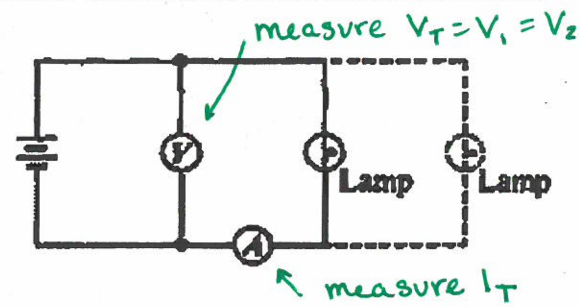
A) 25%
B) 75%
C) 7%
D) 53%
E) 13%

$P_{out} = \frac{mgd}{t} = mgv = (9)(10)(.5) = 45W$

$P_{in} = IV = (.5)(120V) = 60W$

$eff = \frac{P_{out}}{P_{in}} \times 100 = \frac{45}{60} \times 100$

5) A lamp, a voltmeter V, an ammeter A, and a battery with zero internal resistance are connected as shown below.



Connecting another lamp in parallel with the first as shown by the dashed lines would

A) decrease the ammeter reading
B) increase the ammeter reading
C) produce no change in either meter reading
D) decrease the voltmeter reading
E) increase the voltmeter reading

↓R_T ↑I_T ; no change

6) 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?

A) 2*R*
B) 4*R*
C) *R*/2
D) *R*
E) *R*/4

$R = \frac{\rho L}{A} = \frac{\rho L}{\pi r^2}$; $\frac{(1)(\frac{1}{2})}{(1)(\frac{1}{2})^2} = \frac{1/2}{1/4} = \frac{4}{2}$

7) 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) 4.8 cents
B) 8.0 cents
C) 16 cents
D) 2.4 cents
E) 9.6 cents

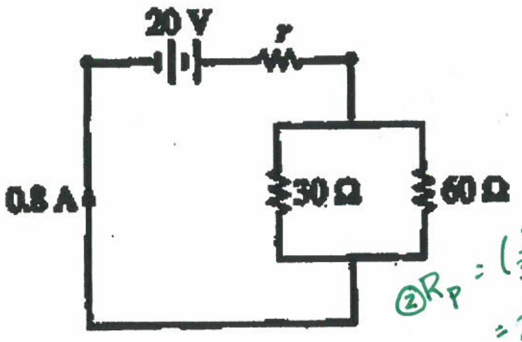
$W = Pt$

① $P = IV = (4A)(120V) = 480W = .48kW$

② $W = Pt = (.48)(2) = .96\ kW \cdot hr$

③ Cost = W($) = .96 (10 cents)

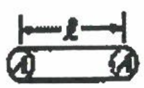
8) A 30-ohm resistor and a 60-ohm resistor are connected as shown below to a battery of emf 20 volts and internal resistance *r*.

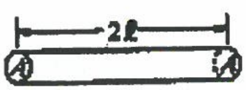


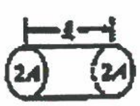
The current in the circuit is 0.8 ampere. What is the value of *r*?

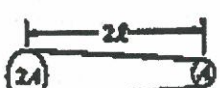
A) 0.22 Ω
B) 5 Ω
C) 16 Ω
D) 70 Ω
E) 4.5 Ω

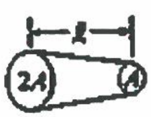
9) The five resistors shown below have the lengths and cross-sectional areas indicated and are made of material with the same resistivity. Which has the greatest resistance?

A) 

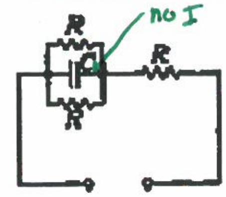
B) 

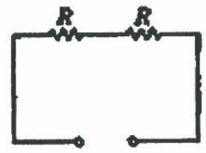
C) 

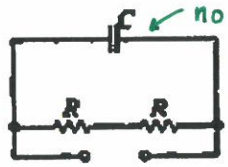
D) 

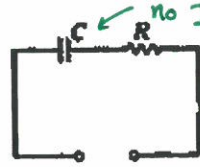
E) 

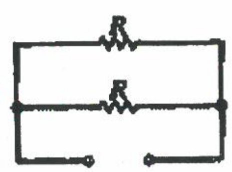
10) The diagrams below represent five incomplete circuits composed of resistor R, all of equal resistance, and capacitors C, all of equal capacitance. A battery that can be used to complete any of the circuits is available. Into which circuit should the battery be connected to obtain the greatest steady power dissipation?

A) 

B) 

C) 

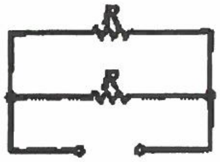
D) 

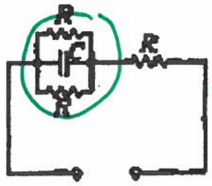
E) 

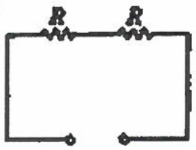
11) An immersion heater of resistance R converts electrical energy into thermal energy that is transferred to the liquid in which the heater is immersed. If the current in the heater is I, the thermal energy transferred to the liquid in time t is

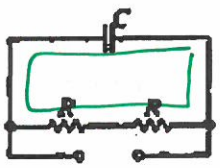
A) I^2Rt
B) IRt^2
C) IRt
D) IR^2t
E) IR/t

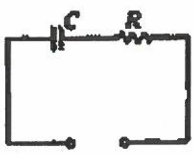
12) The diagrams below represent five incomplete circuits composed of resistor R, all of equal resistance, and capacitors C, all of equal capacitance. A battery that can be used to complete any of the circuits is available. Which circuit will retain stored energy if the battery is connected to it and then disconnected?

A)


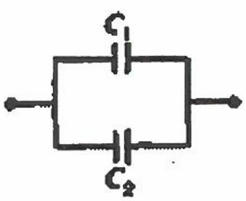
B)


C)


D)


E)


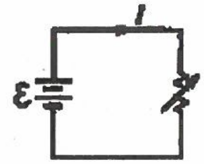
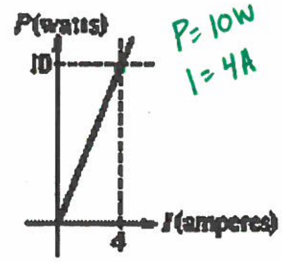
13) Two capacitors are connected in parallel as shown below.



What is the ratio of charge stored on C_1 to the charge stored on C_2, when $C_1 = 1.5C_2$?

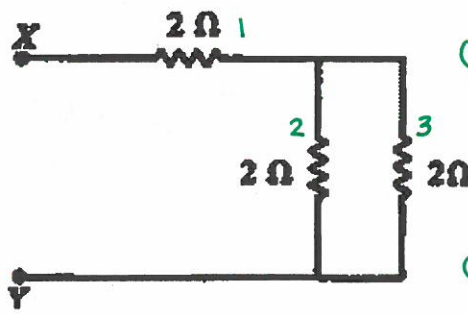
A) 1
B) 2/3
C) 9/4
D) 4/9
E) 3/2

14) The circuit shown below is made up of a variable resistor and a battery with negligible internal resistance.

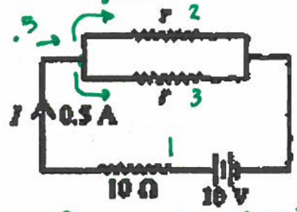
A graph of the power *P* dissipated in the resistor as a function of the current *I* supplied by the battery is also given above. What is the emf of the battery?

A) 2.5 V
B) 40 V
C) 0.025 V
D) 0.67 V
E) 6.25 V

15)


The total equivalent resistance between points X and Y in the circuit shown above is

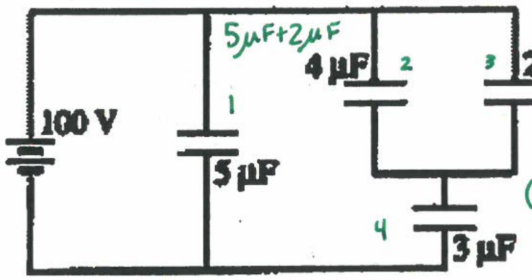
A) 5 Ω
B) 7 Ω
C) 4 Ω
D) 3 Ω
E) 6 Ω

16)


In the circuit shown above, the value of r for which the current I is 0.5 ampere is

A) 10 Ω
B) 5 Ω
C) 1 Ω
D) 0 Ω
E) 20 Ω

Questions 17 and 18 refer to the following:



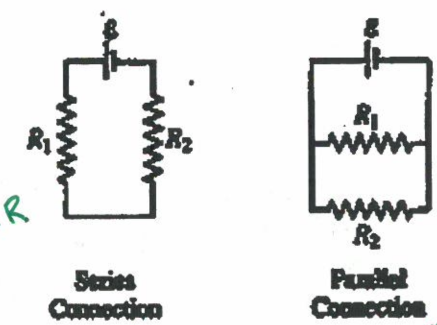
17) The equivalent capacitance for this network is most nearly

A) 10/7 μF
B) 14 μF
C) 3/2 μF
D) 7 μF
E) 7/3 μF

18) The charge stored in the 5-microfarad capacitor is most nearly

A) 1,800 μC
B) 710 μC
C) 1,100 μC
D) 500 μC
E) 360 μC

19) In the diagrams below, resistors R_1 and R_2 are shown in two different connections to the same source of emf ε that has no internal resistance.



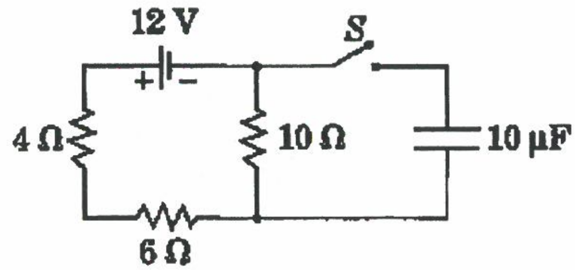
How does the power dissipated by the resistors in these two cases compare?

A) It is greater for the series connection.
B) It is the same for both connections.
C) It is greater for the parallel connection.
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.

20) The product 2 amperes x 2 volts x 2 seconds is equal to

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

Questions 21 and 22 refer to the following:



The circuit shown above includes a battery which has zero internal resistance.

21) What is the current in the 4 Ω resistor while the switch S is open?

A) 1.2 A
B) 0 A
C) 0.6 A
D) 3.0 A
E) 2.0 A

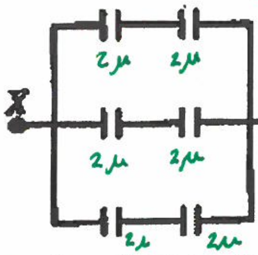
22) When the switch S is closed and the 10 μF capacitor is fully charged, what is the voltage across the capacitor?

A) 60 V
B) 0 V
C) 120 V
D) 12 V
E) 6 V

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

Questions 24 and 25 refer to the following:



The diagram above shows a system of six 2-microfarad capacitors.

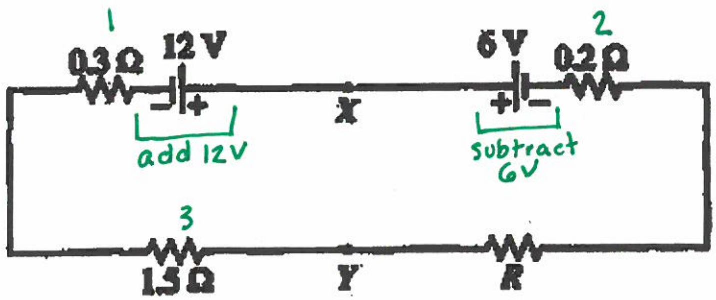
24) The equivalent capacitance of the system of capacitors is

A) 12 μF
B) 4/3 μF
C) 6 μF
D) 3 μF
E) 2/3 μF

25) What potential difference must be applied between points *X* and *Y* so that the charge on each plate of each capacitor will have magnitude 6 microcoulombs?

A) 18 V
B) 3 V
C) 6 V
D) 9 V
E) 1.5 V

Questions 26 through 28 refer to the following:



In the circuit above, the emf's and the resistances have the values shown. The current *I* in the circuit is 2 amperes.

26) The resistance *R* is

A) 2 Ω
B) 3 Ω
C) 4 Ω
D) 1 Ω
E) 6 Ω

27) The potential difference between points *X* and *Y* is

A) 12.2 V
B) 8.4 V
C) 10.8 V
D) 1.2 V
E) 6.0 V

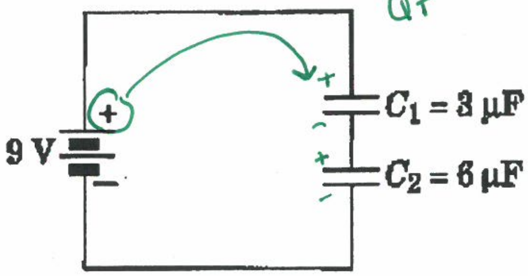
28) How much energy is dissipated by the 1.5-ohm resistor in 60 seconds?

A) 1440 J
B) 720 J
C) 6 J
D) 360 J
E) 180 J

29) The power dissipated in a wire carrying a constant electric current *I* may be written as a function of *I*, the length ℓ of the wire, the diameter *d* of the wire, and the resistivity ρ of the material in the wire. In this expression, the power dissipated is directly proportional to which of the following?

A) *d* and ρ only
B) ℓ, *d*, and ρ
C) *d* only
D) ℓ and ρ only
E) ℓ only

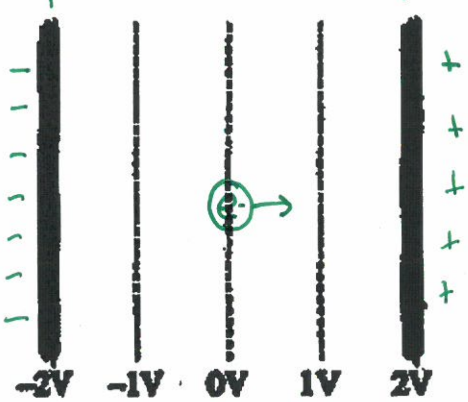
30) Two capacitors initially uncharged are connected in series to a battery, as shown below.



What is the charge on the top plate of C_1?

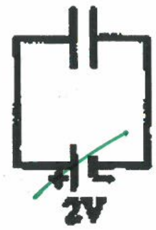
A) 81 μC
B) 0 μC
C) +18 μC
D) -18 μC
E) +81 μC

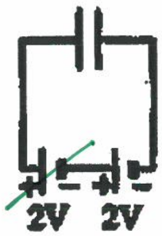
Questions 31 and 32 refer to the following:

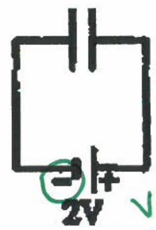


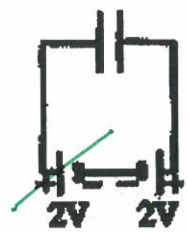
A battery or batteries connected to two parallel plates produce the equipotential lines between the plates shown above.

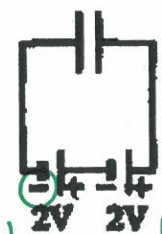
31) Which of the following configurations is most likely to produce these equipotential lines?

A)


B)


C)


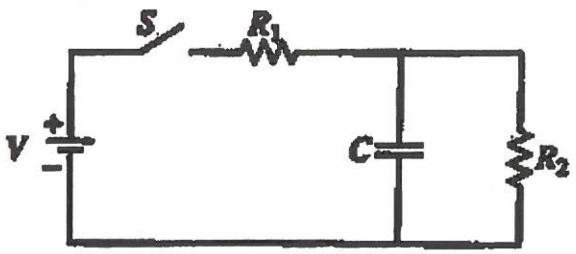
D)


E)


32) The force on an electron located on the 0-volt potential line is

A) 1 N, directed to the right
B) 0 N
C) directed to the right, but its magnitude cannot be determined without knowing the distance between the lines
D) directed to the left, but its magnitude cannot be determined without knowing the distance between the lines
E) 1 N, directed to the left

Questions 33 and 34 refer to the following:



In the circuit shown above, the battery supplies a constant voltage V when the switch S is closed. The value of the capacitance is C, and the value of the resistances are R_1 and R_2.

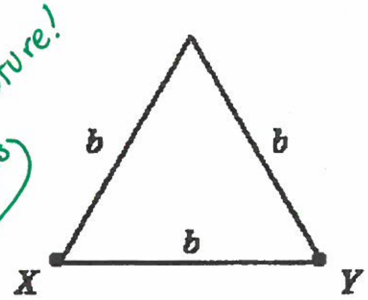
33) Immediately after the switch is closed, the current supplied by the battery is

A) $V(R_1 + R_2)/R_1R_2$
B) V/R_1
C) zero
D) V/R_2
E) $V/(R_1 + R_2)$

34) A long time after the switch has been closed, the current supplied by the battery is

A) $V/(R_1 + R_2)$
B) $V(R_1 + R_2)/R_1R_2$
C) zero
D) V/R_2
E) V/R_1

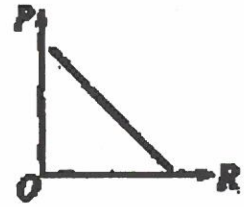
35) Wire of resistivity ρ and cross-sectional area A is formed into an equilateral triangle of side b, as shown below.

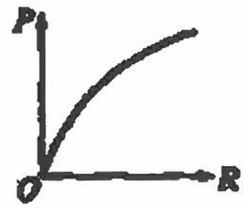


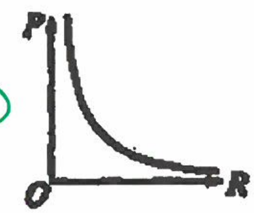
The resistance between two vertices of the triangle, X and Y, is

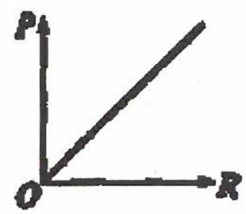
A) $\frac{3}{2} A/(\rho b)$
B) $3 \rho b/A$
C) $\frac{3}{2} \rho b/A$
D) $\frac{2}{3} \rho b/A$
E) $3 A/(\rho b)$

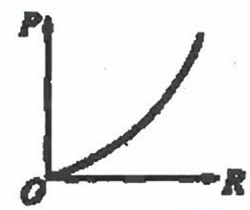
36) A variable resistor is connected across a constant voltage source. Which of the following graphs represents the power P dissipated by the resistor as a function of its resistance R?

A) 

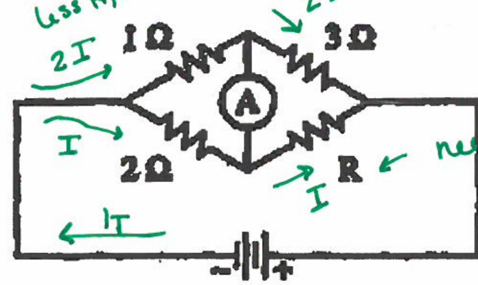
B) 

C) 

D) 

E) 

37)



If the ammeter in the circuit above reads zero, what is the resistance R?

A) 2 Ω
B) 1.5 Ω
C) 5 Ω
D) 4 Ω
E) 6 Ω

1) D

2) E

3) B

4) B

5) B

6) A

7) E

8) B

9) B

10) E

11) A

12) E

13) E

14) A

15) D

16) E

17) D

18) D

19) C

20) C

21) C

22) E

23) B

24) D

25) C

26) D

27) B

28) D

29) D

30) C

31) E

32) C

33) B

34) A

35) D

36) C

37) E