Electricity

Topic Review Q

Q1

A negative charge of -2.0×10^{-4} C and a positive charge of 8.0×10^{-4} C are separated by 0.30 m. What is the force between the two charges?

Q2

A negative charge of -6.0×10^{-6} C exerts an attractive force of 65 N on a second charge that is 0.050 m away. What is the magnitude of the second charge?

Q3

Electric Forces Two charged spheres are held a distance, r, apart. One sphere has a charge of $+3\mu C$, and the other sphere has a charge of $+9\mu C$. Compare the force of the $+3\mu C$ sphere on the $+9\mu C$ sphere with the force of the $+9\mu C$ sphere on the $+3\mu C$ sphere.

Q4

A positive and a negative charge, each of magnitude 2.5×10^{-5} C, are separated by a distance of 15 cm. Find the force on each of the particles.

Q5

A force of 2.4×10^2 N exists between a positive charge of 8.0×10^{-5} C and a positive charge of 3.0×10^{-5} C. What distance separates the charges?

Q6

Electrons and protons have equal but opposite charges. The magnitude of this charge is known as the:

$$\textit{Elementary Charge} = 1.60 \times 10^{-19}\ C$$

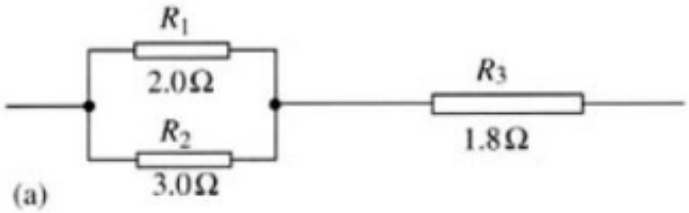
A hydrogen atom contains one proton and on electron. If the electrostatic force of attraction is 8.2×10^{-8} N, how far apart are they?

Q7

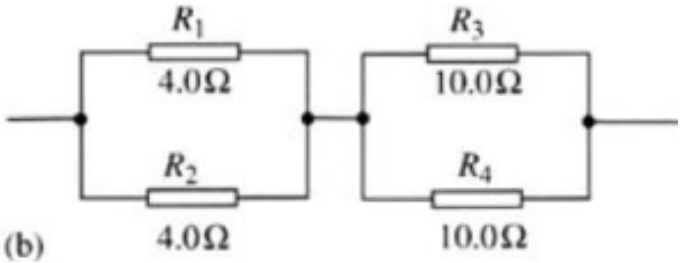
The force between a proton and an electron is 3.5×10^{-10} N. What is the distance between these two particles?

Q8

Find the total resistance in each of the circuits



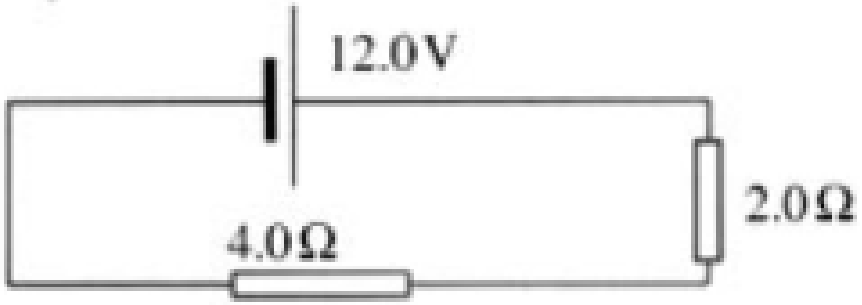
(a)



(b)

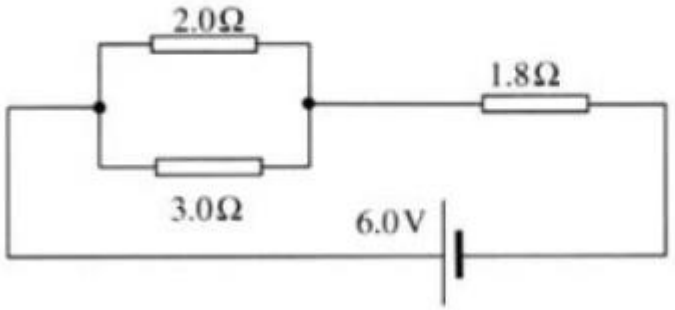
Q9

What is the total current in the circuit in



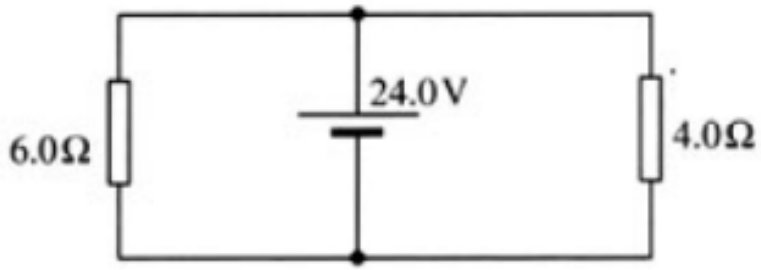
Q10

Find the current in each of the resistors in the

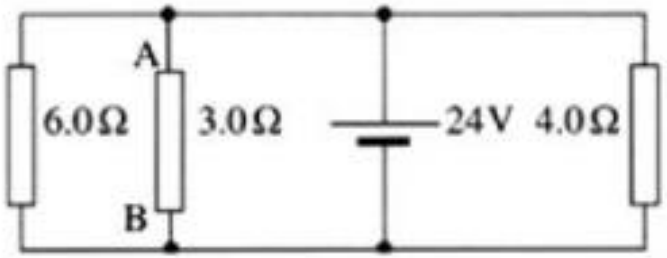


Q11

Find the current in each resistor in the circuit in



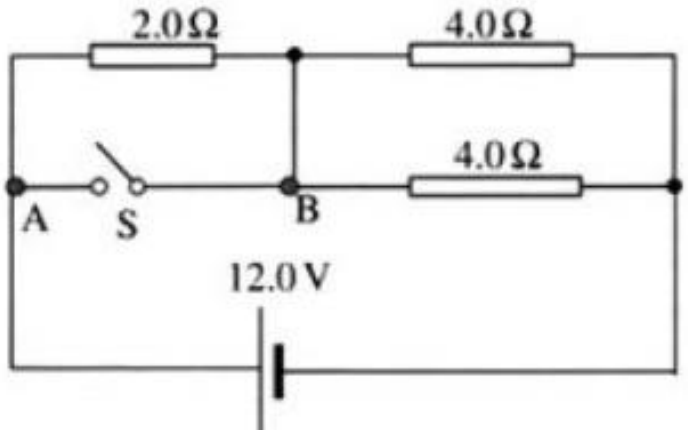
Q12



What is the potential difference between A and B? What is the current leaving the battery?

Q13

What is the current in the 2.0 Ω resistor when the switch is open and when the switch is closed? What is the potential difference across the two marked points, A and B, when the switch is open and when the switch is closed?



Q14

An electric kettle rated as 2000 W at 220 V is used to warm 2.0 L of water from 15 °C to 90 °C.

(a) How much current flows in the kettle?

(b) What is the resistance of the kettle?

(c) How long does it take to warm the water? (Specific heat capacity of water = 4200 $J\ kg^{-1}\ K^{-1}$.)

(d) How much does this cost if the power company charges $0.10 per kW h?

Q15

Three appliances are connected (in parallel) to the same outlet, which provides a voltage of 220 V. A fuse connected to the outlet will blow if the current drawn from the outlet exceeds 10 A. If the three appliances are rated as 60 W, 500 W and 1200 W at 220 V, will the fuse blow?

Q16

An electric kettle rated as 1200 W at 220 V and a toaster rated at 1000 W at 220 V are both connected in parallel to a source of 220 V. If the fuse connected to the source blows when the current exceeds 9.0 A, can both appliances be used at the same time?

Q17

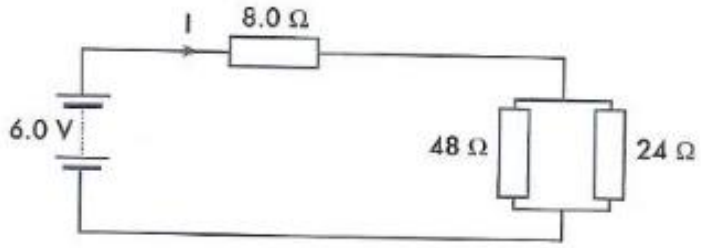
For the circuit drawn below calculate the

(a) total resistance of the circuit,

(b) I,

(c) potential difference across the 24 Ω resistor, and

(d) power dissipated through 8.0 Ω resistor.



Q18

A television set owned by Michael is rated at 180 W and is designed to operate on a 240 V supply. If standard values for fuses are 2.00 A, 5.00 A and 10.0 A,

(a) suggest a value for a fuse to be placed in the circuit to which Michael's television is connected, and

(b) if a 10.0 A fuse was inadvertently used instead of the recommended fuse, predict what may happen if fault in the television caused a much larger current to flow in the television set.

Q19

The 12.0 V battery in a car supplies a current of 3.50×10^2 A to provide the starter motor with maximum power.

(a) Calculate the maximum power of the starter motor.

(b) Determine the maximum resistance of the starter motor, the battery and the connective wires.

(c) Compare the thickness of the wire connecting the battery to the starter motor with the thickness of the wire used in most other circuits in the car. Give a reason for your answer.

Q20

A 110-volt toaster oven draws a current of 6 amps on its highest setting as it converts electrical energy into thermal energy. What is the toaster's maximum power rating?

Q21

An electric iron operating at 120 volts draws 10 amperes of current. How much heat energy is delivered by the iron in 30 seconds?

Q22

A potential drop of 50 volts is measured across a 250-ohm resistor. What is the power developed in the resistor?

Q23

A driving lamp fitted to a car is specified as a 100 W, 12.0 V lamp. Calculate

(a) the current flowing through the lamp, and

(b) the resistance of the lamp.

Q24

An electric motor found in a child's toy requires two 1.50 V dry cell batteries to be connected in series. If the motor draws a maximum current of 300 mA calculate

(a) the resistance of the motor, and

(b) the maximum power consumption of the toy.

Q25

A Christmas tree is decorated by a string of 16 light globes which are connected in series to a mains outlet of 240 V. If the total power consumption is 24.0 W, calculate the

(a) potential difference across each light globe, and

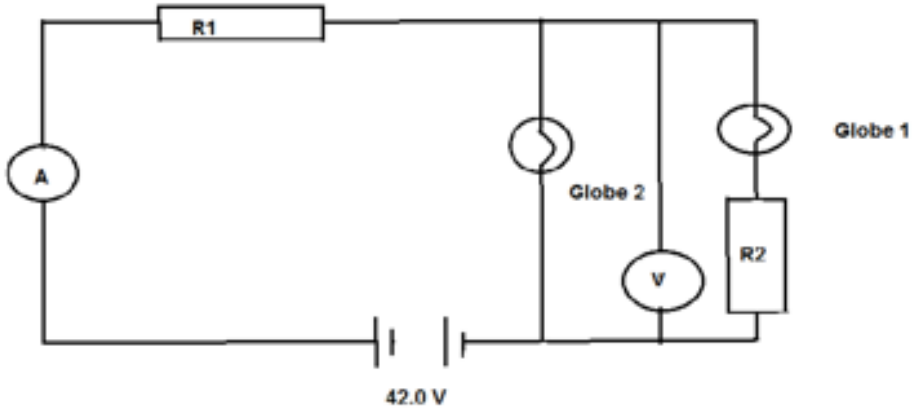
(b) resistance of each light globe.

Q26

When a resistor is connected to a battery, 6.02×10^{23} electrons pass through the resistor in a time of 70.0 s. Calculate the current in the resistor. (2 marks)

Also, put a labelled arrow on the diagram to indicate the direction of conventional current in this circuit. (1 mark)

Q27



Globe 1 is rated at 12.0 V and 3.00 W

Globe 2 is rated at 36.0 V and 12.0 W

Assume that this circuit allows both globes work at the exact values at which they are rated.

Q27 continued

a) Determine:

(i) Current in Globe 1

(ii) Current in Globe 2

(iii) Resistance of R2

(iv) Resistance of R1

(iv) The total resistance of the circuit

Q27 continued

b) What is the reading on the:

(i) ammeter

(ii) voltmeter

Q28

The heating elements in a toaster are designed to get red hot in order to toast bread placed in the toaster. A typical toaster draws a current of 7.5 A when operating on household voltage (240 V).

(a) Calculate the resistance of the heating elements and the power produced by the toaster when in normal operation. (2 marks)

(b) Describe how and explain why the current through the heating element changes when the toaster is switched on. (2 marks)

Q29

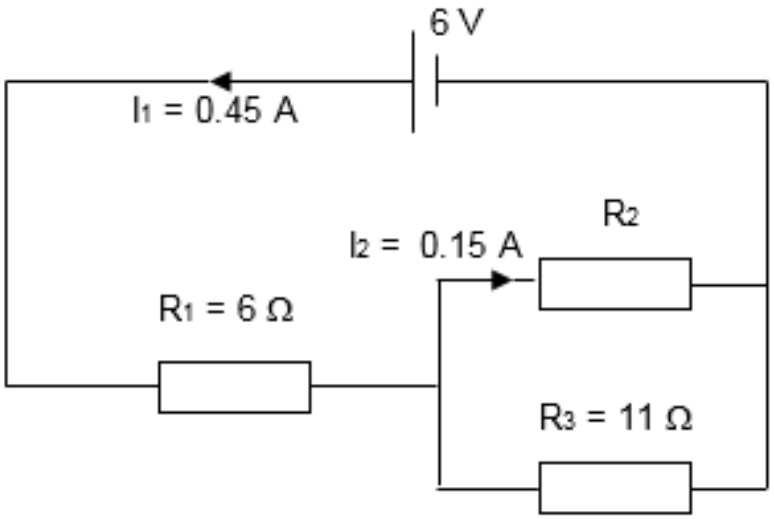
For the circuit shown at right state the value of each of the quantities listed below (no working out needs to be shown, just the answers)

(a) voltage drop across R_1

(b) current through R_3

(c) size of resistor R_2

(d) total resistance of the circuit



Q30

An electric kettle contains 450 mL of water at an initial temperature of 18°C. The kettle operates on mains voltage (240 V) and draws a current of 6.25 A when switched on. The kettle is 90% efficient at converting electrical energy into thermal energy in the water.

(a) Calculate the amount of heat that the kettle supplies to the water every second after it is switched on. (2 marks)

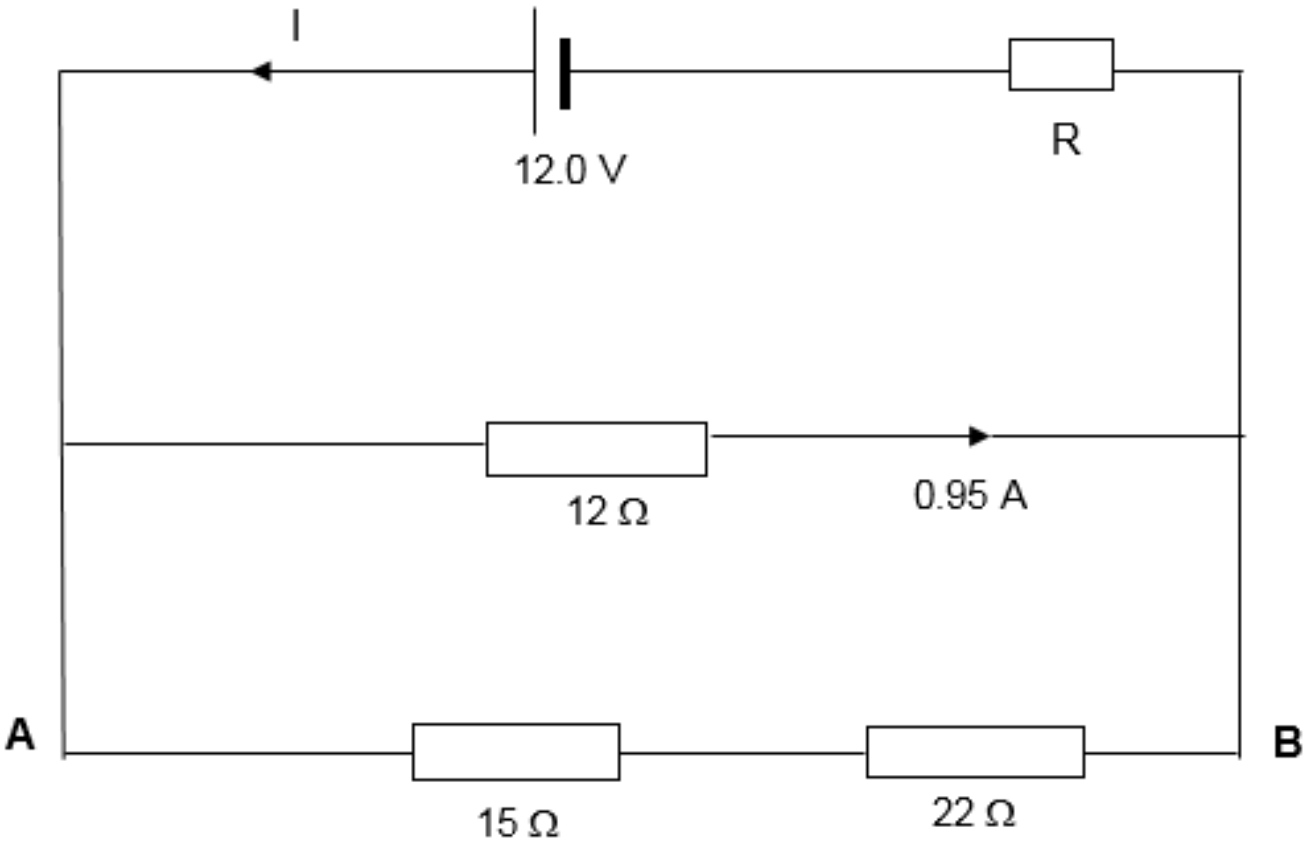
(b) How much heat is needed by the water to reach boiling point (100°C)?

Q30 continued

(c) How long will it take for the water to reach boiling point?

Q31

A 12.0 V battery is connected to a circuit with four resistors as shown in the diagram below. A current of 0.95 A flows through the 12 Ω resistor.



Q31 continued

(a) Calculate the potential difference (voltage) between points A and B.

(b) Find the current flowing through the 15 Ω resistor.

Q31 continued

(c) Determine the rate at which heat is being produced in the 22 Ω resistor.

(d) What is the current I from the battery?

Q31 continued

(e) Find the value of the resistance R in series with the battery.

Q32

- (a) What is the current involved when a truck battery sets in motion 720 C of charge in 4.00 s while starting an engine?

- (b) How long does it take 1.00 C of charge to flow through a handheld calculator if a 0.300-mA current is flowing?

Q33

- What is the resistance of an automobile headlight through which 2.50 A flows when 12.0 V is applied to it?

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Q34

- A car headlight filament is made of tungsten and has a cold resistance of 0.350 Ω . If the filament is a cylinder 4.00 cm long (it may be coiled to save space), what is its diameter?

Material	Resistivity ρ ($\Omega \cdot m$)
Conductors	
Silver	1.59×10^{-8}
Copper	1.72×10^{-8}
Gold	2.44×10^{-8}
Aluminum	2.65×10^{-8}
Tungsten	5.6×10^{-8}

Q35

- If the cost of electricity in your area is 12 cents per kWh, what is the total cost (capital plus operation) of using a 60-W incandescent bulb for 1000 hours (the lifetime of that bulb) if the bulb cost 25 cents? (b) If we replace this bulb with a compact fluorescent light that provides the same light output, but at one-quarter the wattage, and which costs $1.50 but lasts 10 times longer (10,000 hours), what will that total cost be?
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Q36

A light bulb draws a current of 0.60 A. If the bulb is left on for 8.0 min, how many electrons (elementary charges) pass through the bulb?

Q37

Calculate the resistance of a 15 m length of copper wire, at 20°C, that has a diameter of 0.050 cm.

Involved in the problem		Known	Implied	Unknown
R	A	$d = 0.050$ cm	$\rho = 1.7 \times 10^{-8}\ \Omega \cdot$ m	R
L	ρ	$L = 15$ m		A
d (diameter)				

Q38

What is the resistance of a load if a battery with a 9.0 V potential difference causes a current of 0.45 A to pass through the load?

Q39

Four loads (3.0 Ω, 5.0 Ω, 7.0 Ω, and 9.0 Ω) are connected in series to a 12 V battery. Find

(a) the equivalent resistance of the circuit

(b) the total current in the circuit

(c) the potential difference across the 7.0 Ω load

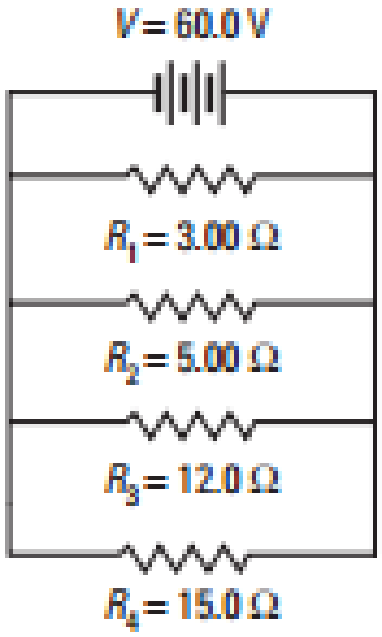
Q40

A 60 V battery is connected to four loads of 3.0 Ω, 5.0 Ω, 12.0 Ω and 15.0 Ω in parallel.

(a) Find the equivalent resistance of the four combined loads.

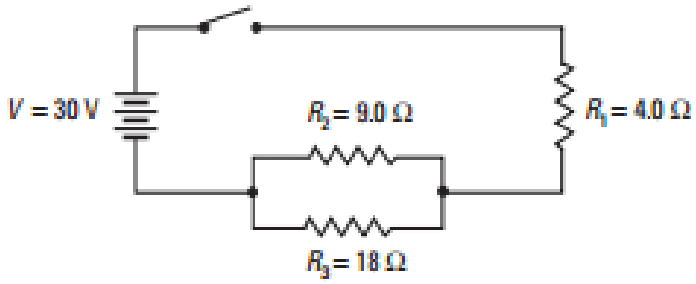
(b) Find the total current leaving the battery.

(c) Find the current through the 12.0 Ω load.



Q41

Find the equivalent resistance of the entire circuit shown in the diagram, as well as the current through, and the potential difference across, each load.

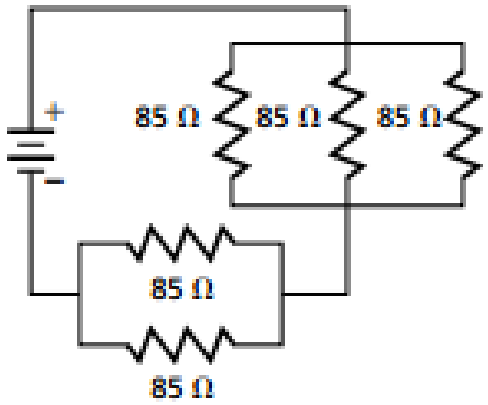


Q42

What is the power rating of a segment of Nichrome™ wire that draws a current of 2.5 A when connected to a 12 V battery?

Q43

Determine the total resistance of three, 85-Ω resistors connected in parallel and then series-connected to two 85-Ω resistors connected in parallel, as shown in



Q44

How many electrons flow through a light bulb each second if the current through the light bulb is 0.75 A?

Q45

A metal rod is 2 m long and 8 mm in diameter. Compute its resistance if the resistivity of the metal is $1.76 \times 10^{-8}\ \Omega \cdot \mathrm{m}$.

Q46

An electric motor takes 5.0 A from a 110 V line. Determine the power input and the energy, in J and $kW \cdot h$, supplied to the motor in 2.0 h.

Q47

A line having a total resistance of 0.20 Ω delivers 10.00 kW at 250 V to a small factory. What is the efficiency of the transmission?

Q48

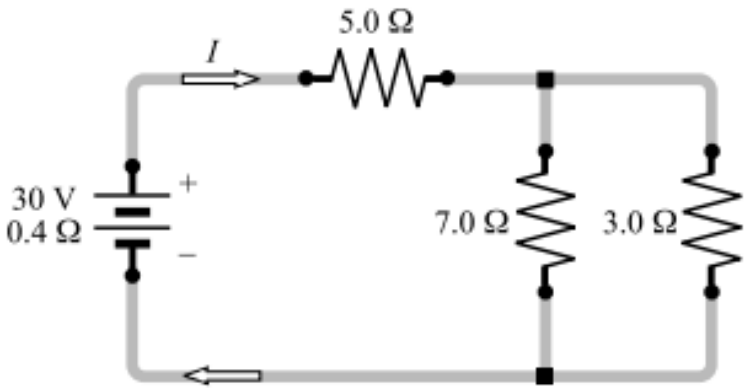
A 120-V house circuit has the following light bulbs turned on: 40.0 W, 60.0 W, and 75.0 W. Find the equivalent resistance of these lights.

Q49

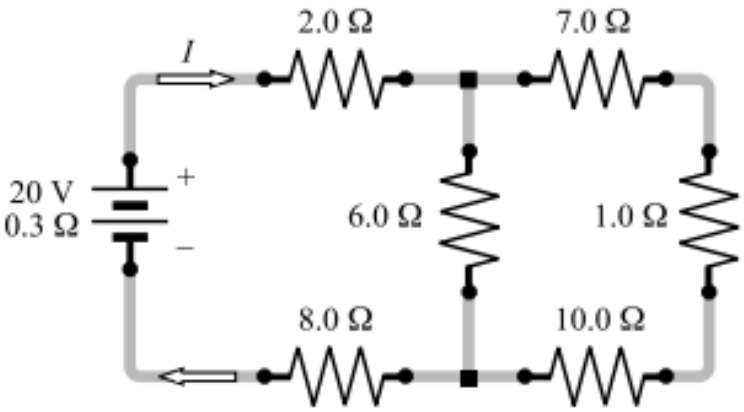
What resistance must be placed in parallel with 12 Ω to obtain a combined resistance of 4 Ω?

Q50

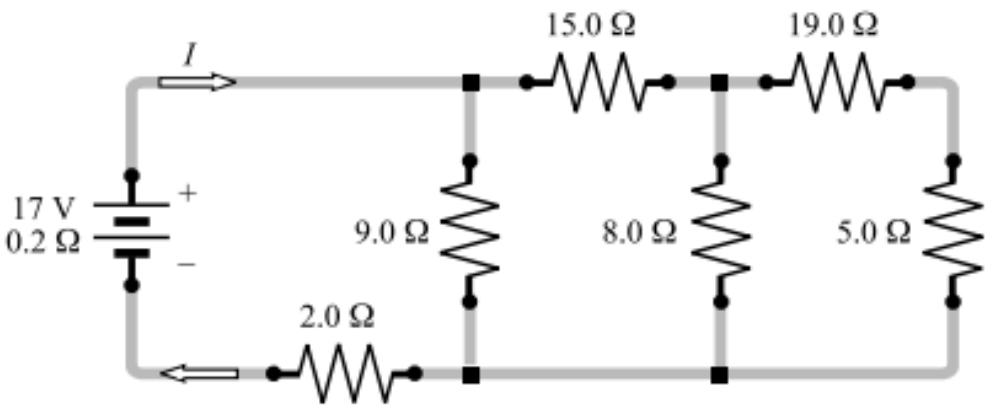
For each circuit shown determine the current I through the battery.



(a)



(b)



(c)