AS-2007 Q4

A 20 Ω resistor is connected to an AC power supply with a voltage output that varies from 4V to –2V at equal time intervals as shown on the graph below. What is the average heating power dissipated in the resistor?

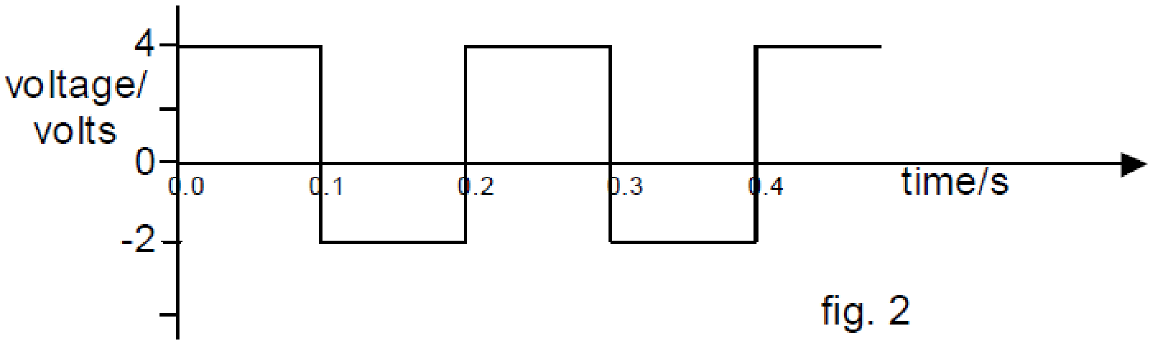


fig. 2

A. 0.2W B. 0.5W C. 0.8W D. 1.0W

AS-2007 Q5

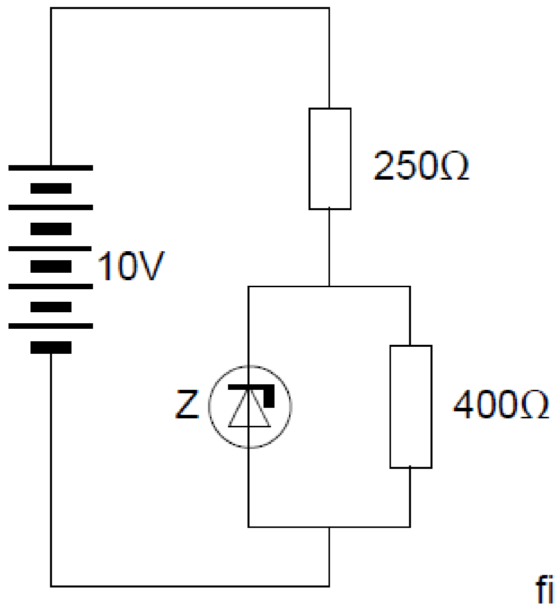


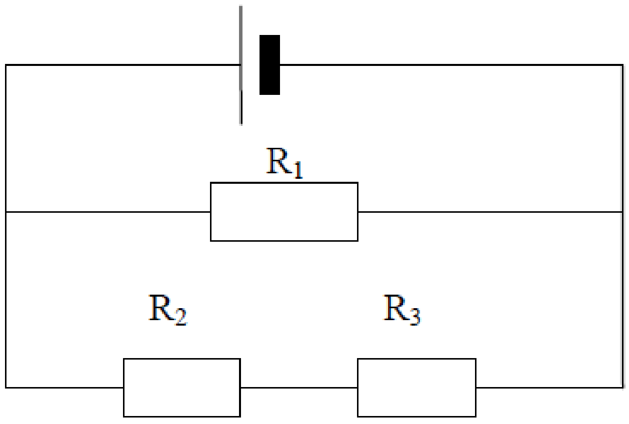
fig. 3

A 10 V battery, with negligible internal resistance, is connected to two resistors of resistance 250 Ω and 400 Ω and to the component Z as shown. Z is a device which has the property of maintaining a potential difference of 5 V across the 400 Ω resistor. The current through Z is

A. 2.9 mA B. 7.5 mA C. 12.5 mA D. 15.4 mA

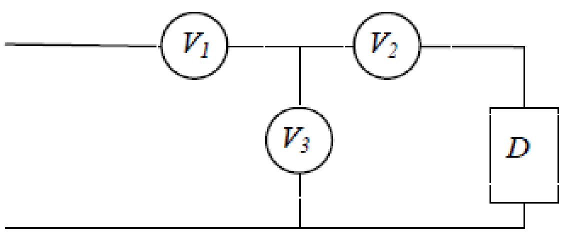
AS-2009 Q5 & Q6

5. In the circuit, the resistors have identical resistances. If the power converted in R_1 is P, what is the power converted in R_2?



A. $P/4$ B. $P/2$ C. P D. $2P$

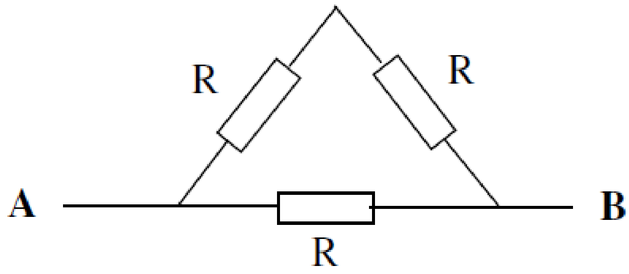
6. Three identical voltmeters each have a fixed resistance R which allows a small current to flow through them when they measure a potential difference in a circuit. The voltmeters, V_1, V_2, V_3 are connected in the circuit shown below. The voltage-current characteristics of the device D are unknown. If V_2 reads 2V and V_3 reads 3V, what is the reading on V_1?



A. 1V B. 2.5V C. 3V D. 5V

AS-2011 Q5

5. If the potential difference between **A** and **B** on the diagram below is V, then what is the current between **A** and **B**? All three resistors are identical.



A. $\frac{V}{3R}$

B. $\frac{2V}{3R}$

C. $\frac{3V}{2R}$

D. $\frac{3VR}{2}$

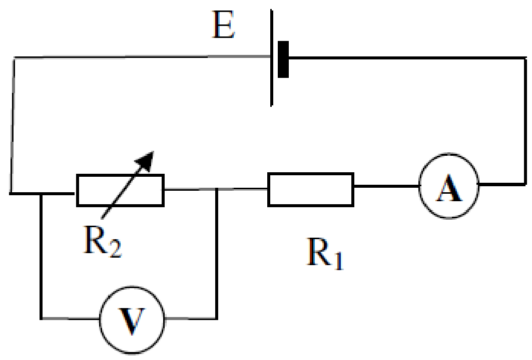
AS-2011 Q10

10. A cell which produces a potential E (called an emf) is shown in the diagram below and is connected to two resistors in series, a fixed resistor R_1 and a variable resistor R_2. The current I in the circuit is measured by the ammeter **A** and the potential difference V across resistor R_2 is measured with the voltmeter **V**.

The relation between the potential E and the current I is given by

$$E = IR_1 + IR_2$$

Which of these graphs would produce a straight line fit?



A. V against I B. V against $1/I$ C. $1/V$ against $1/I$ D. I against $1/V$

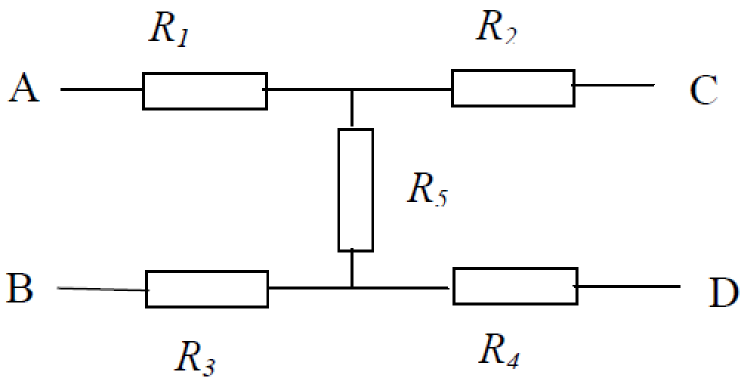
AS-2012 Q5

5. An estimate of the energy stored in a 1½ V torch battery is

A. 10^4 J B. 3×10^5 J C. 10^7 J D. 3×10^8 J

AS-2010 Q12

A combination of resistors shown below represents a pair of transmission lines with a fault in the insulation between them. The wires have a uniform resistance, but do not have the same resistance as each other. The following procedure is used to find the value of the resistance R_5.



A potential difference of 1.5 V is connected in turn across various points in the arrangement.

With 1.5 V applied across terminals AC a current of 37.5 mA flows

With 1.5 V applied across terminals BD a current of 25 mA flows

With 1.5 V applied across terminals AB a current of 30 mA flows

With 1.5 V applied across terminals CD a current of 15 mA flows

a) Write down four equations relating the potential difference, the resistor values and the currents.

____

____

____

____ [4]

b) Determine the value of resistor R_5.

____

____

____ [2]

c) If the ends C and D are connected together, what would be the resistance measured between A and B?

____

____

____ [3]

d) If the length AC (and also BD) is 60 metres of resistive wire, how far from A (or C) does the fault occur?

____

____ [2]

/11

AS-2011 Q13

The resistance of a wire is proportional to its length and inversely proportional to its cross sectional area. The resistance of a wire of length ℓ and cross sectional area A is given by $R = \frac{\rho \ell}{A}$ where ρ is a constant which depends upon the material of the wire. Some metals are ductile, which means that they can be drawn into long thin wires. In doing so, the volume V remains constant whilst the length increases and the cross sectional area of the wire decreases.

A wire of length 32 m has a resistance of 2.7 Ω. We wish to calculate the resistance of a wire formed from the same volume of metal, but which has a length of 120 m instead.

a) Write down the relation between V, A and ℓ. Obtain an expression to show how R depends upon the length ℓ of the wire and its volume V.

____

____ [2]

b) Rewrite the equation with the constants ρ and V on one side and the variables we are changing, R and ℓ, on the other.

____

____ [1]

c) Calculate the resistance of the longer wire.

____

____

____ [3]

/6

AS-2012 Q12

A student decides to calibrate a thermistor in order to measure variations in the temperature of the room. He connects a small bead sized thermistor across the terminals of a 5 V power supply and in series with a 1 A ammeter. The resistance of the thermistor is 120 Ω at room temperature.

a) Instead of showing small variations in room temperature, the thermistor is likely to go up in smoke. Explain why.

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____

____

In the light of his experience, he decides to redesign his simple circuit as is shown in figure 3 below. He has a few values of resistor R to choose from; 5 kΩ, 500 Ω, 50 Ω.

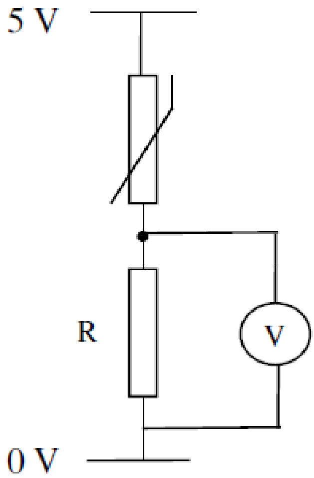

Figure 3.

b) State which value of *R* would give the biggest variation of V with temperature. Explain your choice.

____

____ [2]

c) State which value of *R* would be most likely to cause the same problem as in (a). Again, explain your choice.

____

____ [1]

/7

AS-2007 Q11

The transformer, shown in fig. 7, outputs power at 415 V, along a copper cable 50 m in length, to an electrical machine. The total resistance of the copper conductor (100 m there and back) is 0.0493 Ω at an operating temperature of 60°C. The machine takes a current of 200 A.

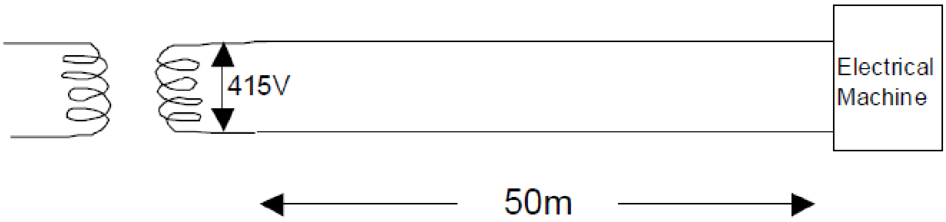

fig. 7

a) What is the total power that the transformer is supplying to the machine and cable?

____

____

____ [2]

b) What is (i) the power loss in the cable, and (ii) what percentage is this of the total power supplied?

____

____

____

____

____ [3]

c) Often the conductor size is chosen not on the basis of the steady current required, but on the short circuit current that might occur. If in our wiring, a short circuit occurred at the machine end of the cable, a current of 6000 A could be expected. Explain why this current is significantly less than that calculated from the 415 V supply and the 0.0493 Ω resistance of the cable.

____

____

____ [2]

d) If the circuit breaker produces a delay of 0.4 s before it breaks the circuit, calculate the heat energy generated in this short time interval. Assume that the resistance of the wire does not change significantly as it heats up.

____

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____________________ [2]

e) The heat energy required to raise the temperature of 1kg of copper by 1^{o}C is called the specific heat capacity of copper. It has the value is 385 J kg^{-1} ^{o}C^{-1}. We can use a simple formula,

heat energy supplied = mass **x** specific heat capacity **x** temperature rise

in order to determine the temperature rise of the copper cable, assuming no heat loss to the surroundings.
Calculate

(i) The mass of copper in the 100 m of cable, given that its
cross sectional area = 50 mm^2
density of copper = 8960 kg/m^3

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____________________ [2]

(ii) Calculate the final temperature of the cable after 0.4s, if its initial temperature is 60^{o}C.

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____________________ [2]

/13

AS-2007 Q12

A single uniform underground cable linking A to B, 50 km long, has a fault in it at distance *d* km from end A. This is caused by a break in the insulation at X so that there is a flow of current through a fixed resistance *R* into the ground. The ground can be taken to be a very low resistance conductor. Potential differences are all measured with respect to the ground, which is taken to be at 0 V.

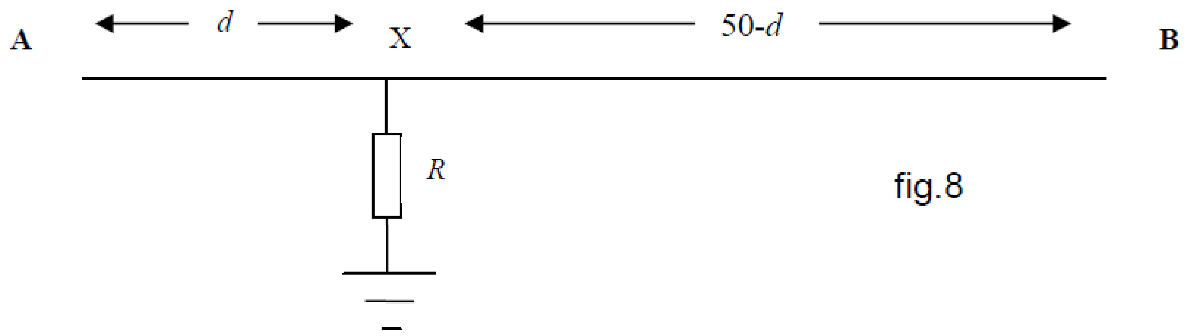

fig.8

In order to locate the fault, the following procedure is used. A potential difference of 200V is applied to end A of the cable. End B is insulated from the ground, and it is measured to be at a potential of 40V.

a) What is the potential at X? Explain your reasoning.

____

____

____ [2]

b) What is

(i) the potential difference between A and X?

____

____ [1]

(ii) the potential gradient along the cable from A to X (i.e. the volts/km)?

____

____

____ [1]

AS-2007 Q12 (continued)

c) The potential applied to end A is now removed and A is insulated from the ground instead. The potential at end B is raised to 300 V, at which point the potential at A is measured to be 40 V.

(i) What is the potential at X now?

____ [1]

(ii) Having measured 40 V at end B initially, why is it that 40 V has also been required at end A for the second measurement?

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____ [2]

d) What is the potential gradient along the cable from B to X?

____

____ [1]

e) The potential gradient from A to X is equal to the potential gradient from B to X.

(i) Explain why this is true

____

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____ [2]

(ii) From the two potential gradients that you obtained earlier, deduce the value of d.

____

____

____

____

____ [1]

/11

AS-2008 Q10

a) The power dissipated as heat in a resistor in a circuit is given by $P = VI$. Show that this may also be expressed as $P = I^2R$ and $P = \frac{V^2}{R}$.

____

____ [1]

b) A student goes out to purchase an electric heater for his flat. The salesman says that, to get more heat, he should purchase a heater with a high resistance because $P = I^2R$, but the student thinks that a low resistance would be best, because $P = \frac{V^2}{R}$. Explain who is correct.

____

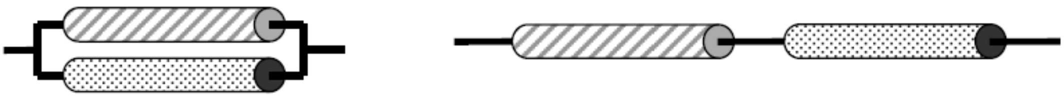
____

____

____ [2]

c) Copper is a better conductor than iron. Equal lengths of copper and iron wire, of the same diameter, are connected first in parallel, and then in series. A potential difference is applied across the ends of each arrangement in turn, and the p.d. is gradually increased from a small value until, in each case, one of the wires begins to glow. Explain this, and state which wire will glow first in each case.

Case 1 Case 2



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____ [4]

AS-2008 Q10 (continued)

d) A surge suppressor is a device for preventing sudden excessive flows of current in a circuit. It is made of a material whose conducting properties are such that the current flowing through it is directly proportional to the fourth power of the potential difference across it. If the suppressor dissipates energy at a rate of 6 W when the applied potential difference is 230 V, what is the power dissipated when the potential rises to 1200 V?

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____

____

____ [3]

/10