Biomedical Admissions Test (BMAT)

Section 2: Physics

Questions by Topic

P1: Electricity

P1: Electricity - Question by Topic

Mark scheme and explanations at the end

1 A cell with an internal resistance of 0.6Ω and an E.M.F of 42V is connected to a fan with a resistance of 1.5Ω.

What is the current flowing through the fan when it is connected to a power supply?

A 0.05A
B 28A
C 20A
D 70A
E None of the above

2 Two non-identical resistors are connected in a series circuit.
Which one of the following statements are true?

1 The current through both of the resistors is the same.
2 The voltage across both of the resistors is the same.
3 The voltage across the two resistors can be calculated using Ohm's law.

A 1 and 2 only
B 1 and 3 only
C 1 only
D 2 only
E 3 only
F All of the above

3 A transformer has 100 turns in the primary coil and 4 turns in the secondary coil and has a voltage of 2V across the secondary coil.

What was the voltage across the primary coil?

A 50V
B 5V
C 500V
D 10V

4 Which of the following best defines an electrical conductor?

A Conductors are usually made from metals and conduct electrical charge in multiple directions.
B Conductors are usually made from non-metals and conduct electrical charge in multiple directions.
C Conductors are usually made from metals and conduct electrical charge in one direction only.
D Conductors are usually made from non-metals and conduct electrical charge in one direction only.

5 A circuit contains four identical resistors connected in series with a 20V battery. The power output of the circuit is 80 W. Two further identical resistors are added into the circuit in series.

What is the overall resistance of the circuit?

A 0.125Ω
B 1.25Ω
C 5Ω
D 7.5Ω

6 Which one of the following statements are correct with respect to parallel circuits?

1 The current flowing through a branch of the circuit is dependent on the branch's resistance.
2 The total current flowing into the branches is equal to the total current flowing out of the branches.
3 An ammeter will show the same reading at any point in the circuit.

A 1 only
B 2 only
C 1 and 2 only
D 1 and 3 only
E 3 only
F 2 and 3 only
G All of the above

7 Which of the following is not equivalent to a volt (V)?

A AΩ
B WA^{-1}
C JC^{-1}
D NmC

8 A 100% efficient transformer has 1200 turns in its primary coil with an input of 40V. The secondary coil has 600 turns and the total power generated is 0.18kW.

What is the output current in amperes (A)?

A 0.09
B 3600
C 9
D 0.0025
E 2.25

9 Which of the following statements are true with regards to resistance in an electrical circuit?

1 Resistance is directly proportional to the length of the conductor
2 Resistance is inversely proportional to the length of the conductor.
3 Resistance is directly proportional to the cross sectional area of the conductor.
4 Resistance is indirectly proportional to the cross sectional area of the conductor.

A 1 and 3 only
B 2 and 3 only
C 1 and 4 only
D 2 and 4 only

10 A parallel circuit is made up of a cell and 2 branches with a resistor of 4Ω in one branch and a resistor of 8Ω in the other branch. The total current of the circuit is 16A.

What is the overall voltage of the circuit?

A 192
B 6
C 10
D 48
E 3

11 A series circuit is composed of a battery, one fan with a resistance of 10Ω and another fan with a resistance of 14Ω. The overall current of the circuit is 10A.

What is the overall voltage of the circuit?

A 240
B 2.40
C 1.71
D 280
E 17

12 Circuit 2 has two 12.5V cells connected in series to a speaker with a fixed resistance of 10Ω.

What is the current flowing through circuit 2?

A 2.5
B 25
C You cannot calculate it with this information.
D 250
E 0.12

Questions 13 and 14 refer to the following information

Circuit 1 has a filament bulb which is initially connected to a 25V cell. After ten minutes the 25V cell in Circuit 1 is replaced by a 12.5V cell. The overall current of Circuit 1 before the cell is replaced is 5A.

13 What happens to the current in Circuit 1 after the cell is replaced and why?

A It increases because the voltage decreased therefore there is less resistance.
B It increases because the voltage decreased therefore there is more resistance.
C It decreases because the voltage decreased therefore there is more resistance.
D It decreases because the voltage decreased therefore there is less resistance.
E It stays the same because the overall current is constant in a series circuit.

14 What is the resistance in Circuit 1 before and after the cell is replaced?

A It is 5Ω before and cannot be calculated after.
B It is 5Ω before and 2.5Ω after.
C It cannot be calculated before and is 2.5Ω after.
D It cannot be calculated before or after the cell is replaced as the resistance varies in both.
E It is 2.5Ω before and 5Ω after.

Solutions

1 **C is the answer**

First, you need to remember to consider the total resistance of the series circuit:
$1.5\Omega + 0.6\Omega = 2.1\Omega$

Then, you can use this to calculate the current flowing in the circuit. This will be the same as the current flowing through the fan.
$I = V/R$
$42 \div 2.1 = 20A$

A is incorrect as the equation V=IR was incorrectly rearranged.
B is incorrect as **internal resistance** was not considered.
D is incorrect as the equation V=IR was incorrectly rearranged.
E is incorrect.

2 **B is the answer**

Components in a series circuit have the same current flowing through them. Knowing this, you could calculate the potential difference across them using V=IR.

Statement 1 is correct as the current through two resistors in series is the same.

Statement 2 is incorrect the voltage across the resistors will be shared in a ratio dependent on the resistance of the resistors.

Statement 3 is correct as you can use the equation $potential\ difference = current \times resistance$to calculate the potential difference across the two resistors in series.

3 **A is the answer**

Transformers work by stepping up or down voltage through the ratio of primary and secondary turns on the core:

$$\frac{Number\ of\ turns\ on\ the\ secondary\ coil}{Number\ of\ turns\ on\ the\ primary\ coil} = \frac{Potential\ difference\ across\ \ the\ secondary\ coil}{Potential\ difference\ across\ the\ primary\ coil}$$

$$\frac{4}{100} = \frac{2}{potential\ difference\ across\ the\ primary\ coil}$$

$$Primary\ potential\ difference\ = 2 \div 0.4 = 50v$$

4 **A is the answer**

Metals conduct electricity easily; there with little resistance to the flow of electrons. Charge can also flow in multiple directions in a metal. However there is some internal resistance to electrical charge.

Statement A is correct as Conductors are usually made from metals and conduct electrical charge in multiple directions.

Statement B is incorrect as conductors are not usually made from non-metals

Statement C is incorrect as conductors can conduct charge in multiple directions

Statement D is incorrect as conductors are not usually made from non-metals and do not conduct electrical charge in one direction only.

5 **D is the answer**

This question can be answered by rearranging the following equations:

$Power = potential\ difference \times current$

$Potential\ difference = current \times resistance$

$Current = 80W \div 20V = 4A$

$Resistance = 20V \div 4A = 5\Omega$

If the total resistance of the 4 resistors in series is 5Ω so each resistor has a resistance of 1.25Ω

Therefore if $6 \times 1.25\Omega$resistors are put in series the total resistance will be 7.5Ω

6 **C is the answer**

In a parallel circuit, current is split among the branches in a ratio to the resistance of each branch. The total current split amongst the branches is equal to the total current when the branches meet again.

Statement 1 is correct as the current flowing through a branch of the circuit is dependent on the branch's resistance.

Statement 2 is correct as the total current into the branches must equal the total current when the branches join back together.

Statement 3 is incorrect as there will be different currents shown on the ammeter in each branch depending on the resistance of each branch.

7 **D is the answer**

Statement A is correct as $voltage = current \times resistance$ so $1V = 1A \times 1\Omega$
Statement B is correct as $voltage = power \div current$ so $1V = 1W \div 1A$
Statement C is correct as $voltage = energy \div charge$ so $1V = 1J \div 1C$

8 **C is the answer**

Transformers work by stepping up or down the voltage based on the number of turns on the primary and secondary coils. In this question you have the number of turns on the primary coil and the input voltage as well as the number of turns on the secondary coil.

Using the equation:

$$\frac{Number\ of\ turns\ on\ the\ secondary\ coil}{Number\ of\ turns\ on\ the\ primary\ coil} =$$

$$\frac{Potential\ difference\ across\ the\ secondary\ coil}{Potential\ difference\ across\ the\ primary\ coil}$$

$$\frac{600}{1200} = \frac{Potential\ difference\ across\ the\ secondary\ coil}{40}$$

So the output potential difference (voltage) is 20V. Using the equation:

Power(W) = Voltage(V) x Current(A)

180= 20 x Current

Rearranging that produces an output current of 9A. Remember to convert the 0.18kW to W.

A is incorrect because the conversion of kW to W was not done.

B The equation Power(W) = Voltage(V) x Current (I) was incorrectly rearranged.

D is incorrect because the numbers of turns on the primary and secondary coils are the wrong way around and the conversion of kW to W was not done.

E is incorrect because the numbers of turns on the primary and secondary coils are the wrong way around.

9 **C is the answer**

Resistance is directly proportional to the length of the conductor and inversely proportional to the cross sectional area. All conductors have resistance.

10 **B is the answer**

Resistance in a parallel circuit is calculated by the equation:

Resistors in parallel:

$1/R = 1/R_1 + 1/R_2$

$1/R = 1/4 + 1/8 = 2/8 + 1/8 = 3/8$

therefore $R = 8/3$

Resistance= Voltage / Current

$V = IR = 16 * 8/3 = 42.667$

Therefore the answer is 6V. Remember that in parallel circuits voltage is the same throughout.

A is incorrect because instead of the equation $1/R_T=1/R_1+1/R_2+1/R_3$ the resistances were just added up.

C is incorrect because ¼ was incorrectly converted to 4/8 instead of 2/8.

D is incorrect because whilst calculating resistance, 48 was not divided by 8.

E is incorrect because the current was taken as 8A instead of 16A.

11 **A is the answer**

In a series circuit you add up the individual resistance of the components to get the overall resistance using the equation:

$$R_T=R_1+R_2+R_3$$

$$24= 10 + 14$$

Then using the equation:

Voltage = Current x Resistance

$$240= 24 \times 10$$

B is incorrect because Voltage = Current x Resistance was rearranged incorrectly and the total resistance was divided by the current.

C is incorrect because the equation for calculating total resistance in parallel circuits was used instead of the equation for calculating resistance in series circuits.

D is incorrect because the wrong figures were used for voltage and current.

E is most likely chosen as a guess.

12 **A is the answer**

In a series circuit you calculate the total voltage of the circuit using the equation:

$$V_T=V_1+V_2+ V$$

25= 12.5 + 12.5

Then you rearrange the equation:

Voltage= Resistance x Current

25= 10 x Current

2.5= Current

B is incorrect because it incorrectly rearranged the equation Voltage= Resistance x Current
C is incorrect. It would be correct if non-ohmic resistors were used in the circuit as the current would vary.
D is incorrect because it incorrectly rearranged the equation Voltage= Resistance x Current
E is incorrect because the total voltage of the circuit was not calculated. 12.5V was entered into the equation Voltage= Resistance x Current instead of 25V.

13 **D is the answer**

A filament bulb is a non-ohmic conductor- this means its resistance is not fixed and varies depending on the current and voltage flowing through it. In this question there is a decrease in potential difference, therefore the amplitude of the current decreases. This is because fewer electrons are flowing through the filament so there are fewer collisions between electrons and less resistance.

A is incorrect because it states that the amplitude of the current would increase.
B is incorrect because it states that the amplitude of the current would increase and that there is more resistance.
C is incorrect because although it correctly identifies that the amplitude of the current decreases, it incorrectly states that there is more resistance
E is incorrect because the current would not stay the same as the voltage has changed and therefore the voltage would change.

14 **A is the answer**

A filament bulb is a non-ohmic resistor- this means that the resistance varies across it depending on the current and the voltage. Before the cell is replaced the resistance of the circuit can be calculated because the voltage and current are both constant and known. Using the equation:

Voltage= Resistance x Current

25= Resistance x 5

Resistance = 5

However, after changing the cell, the resistance of the circuit cannot be calculated. This is because the new current running through the circuit is not given. As the voltage varies, the current varies. As there would be fewer electrons running through the filament, there would be fewer collisions and less resistance. We cannot calculate the resistance because there are two unknown variables in the equation

Voltage= Resistance x Current

B is incorrect because it assumes that the current before and after the cell is replaced is the same.

C is incorrect because it assumes that 5A is the current of circuit 1 after the cell has been replaced not before it has been replaced.

D is incorrect because it assumes that the resistance of non-ohmic conductors cannot be calculated as the resistance constantly varies. This is incorrect. If the current and voltage are known in a series circuit with a non-ohmic resistor then the resistance can be calculated.

E is incorrect because it assumes that 5A is the current of circuit 1 before and after the cell has been replaced. It then swaps around the figures of the resistance calculated before and after the cell is replaced.