COE. DC

Challenging **MCQ** questions by The Physics Cafe

Compiled and selected by The Physics Cafe

1 A battery of internal resistance *r* and e.m.f. *E* can supply a current of 6.0 A to a resistor R as shown in **Fig 29.1.**

The *I V* characteristics of the resistors R and R_1 respectively is shown in **Fig 29.2.**

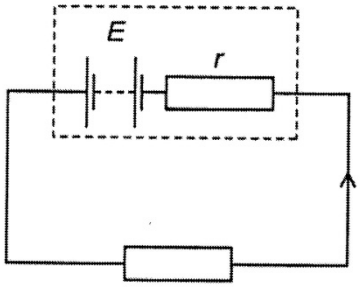

Fig 29.1.

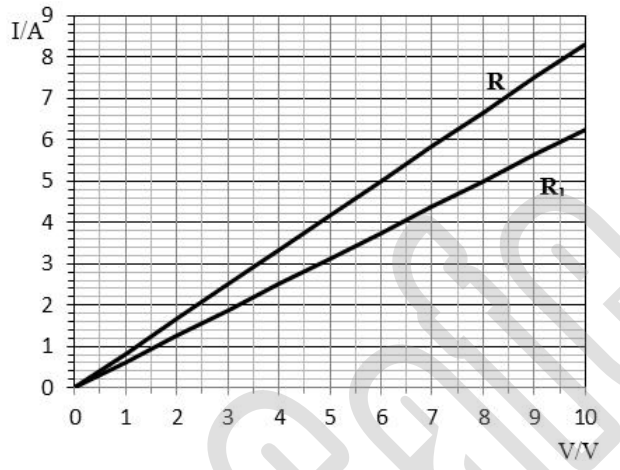

Fig 29.2

When the resistor R is replaced by R_1, the current becomes 5.0 A

What are the values of the e.m.f. *E* and the internal resistance *r*?

	***E* / V**	***r* / Ω**
A	7.6	0.073
B	12	2.0
C	12	0.80
D	15	8.0

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2 Four identical resistors are connected as shown in **Fig 30**.

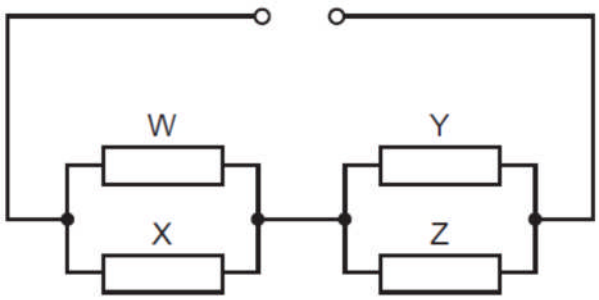


Fig 30

How will the powers to the resistors change when the resistor W is removed?

A The powers to X,Y and Z will all increase.

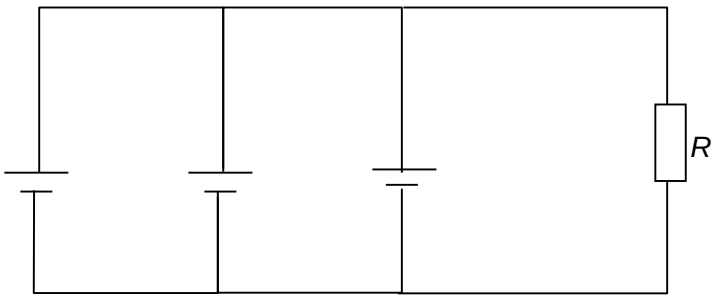
B The powers X will decrease and the powers to Y and Z will increase.

C The powers to X will increase and the powers to Y and Z will decrease.

D The powers to X will increase and the powers Y and Z will remain unaltered.

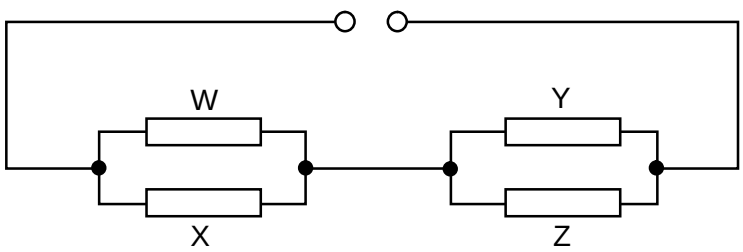
3 Three identical electrical sources each with internal resistance *r* are used to operate a lamp of resistance *R* as shown in figure below.

What fraction of the total power is lost due to the internal resistance of the sources?



A $\frac{3R+r}{3R}$ **B** $\frac{3R-r}{3R}$ **C** $\frac{r}{3R+r}$ **D** $\frac{3R}{3R+r}$

4 Four resistors of equal values are connected as shown.



How will the current through the resistors change when resistor W is removed?

A The current through X will increase and the currents through Y and Z will decrease.

B The current through X will decrease and the currents through Y and Z will increase.

C The current through X will increase and the currents through Y and Z will remain unaltered.

D The currents through X, Y and Z will all decrease.

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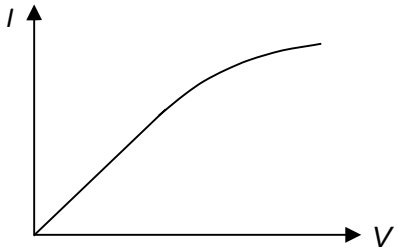
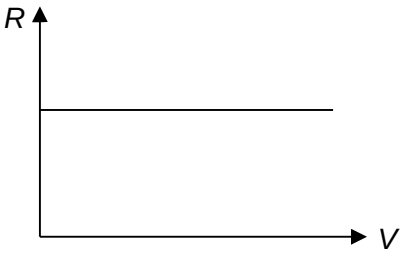
5 The current *I* flowing through a component varies with the potential difference *V* across it as shown.

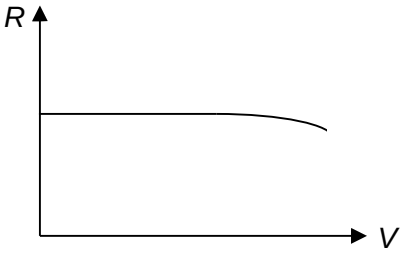


Which graph best represents how the resistance *R* varies with *V*?

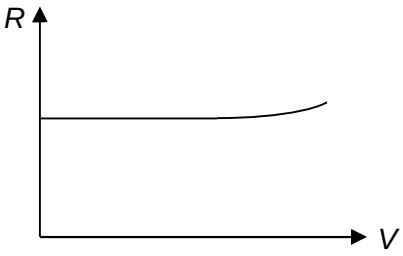
A



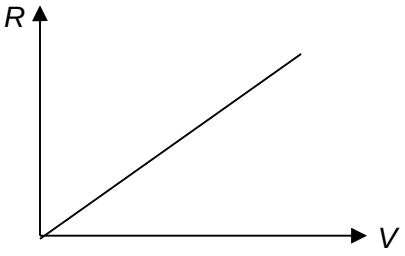
B



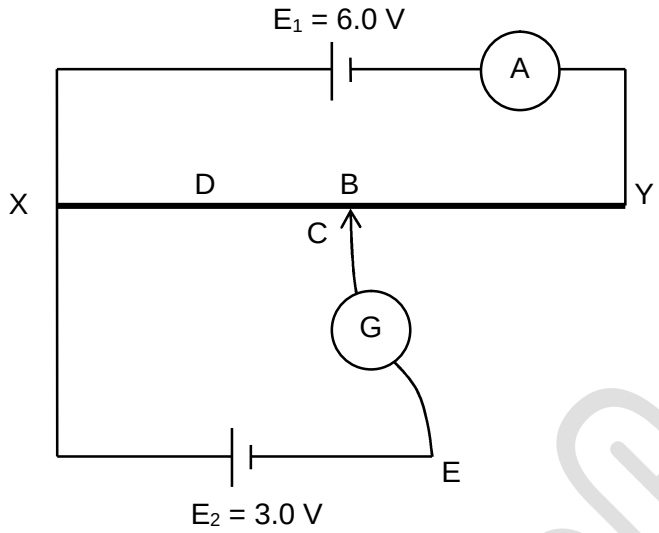
C



D



6 A cell of emf E_1 = 6.0 V and negligible internal resistance is connected to a uniform resistance wire XY. Another cell of emf E_2 = 3.0 V and negligible internal resistance is connected as shown. When the movable contact C is placed at B, there is no current in the branch CE.

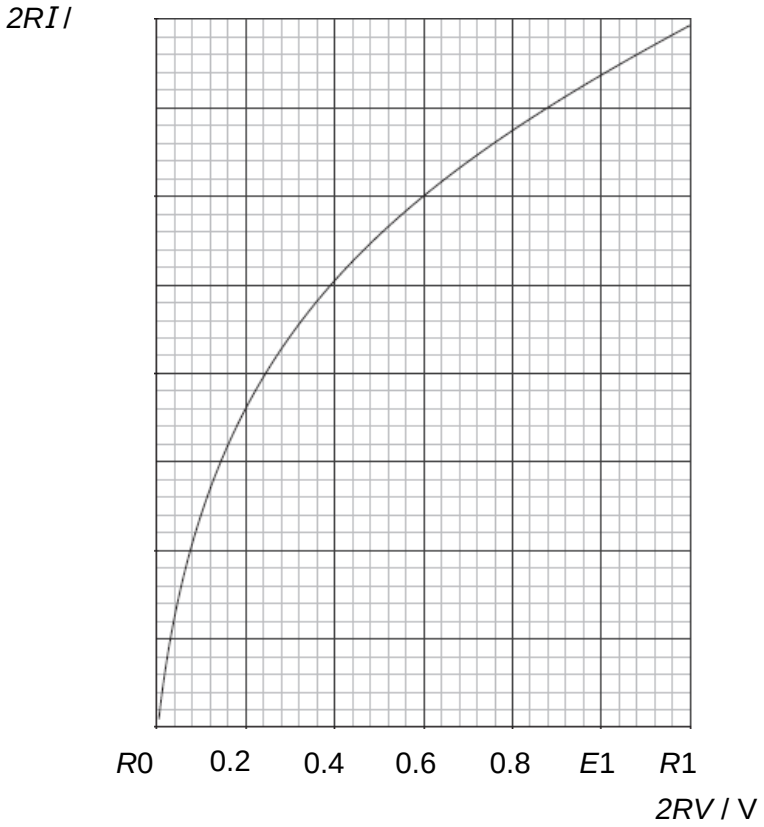


The contact C is then moved to point D.

What will be the direction of current in the branch CE and the change in current reading of the ammeter A?

	direction of current in branch CE	change in current reading in ammeter A
A	C → E	decrease
B	C → E	increase
C	E → C	decrease
D	E → C	increase

7 The graph below shows the variation with current *I* of the potential difference *V* across an electronic component.



Which of the following statement is correct?

A The electric component is a diode.

B The resistance is increasing with increasing potential difference.

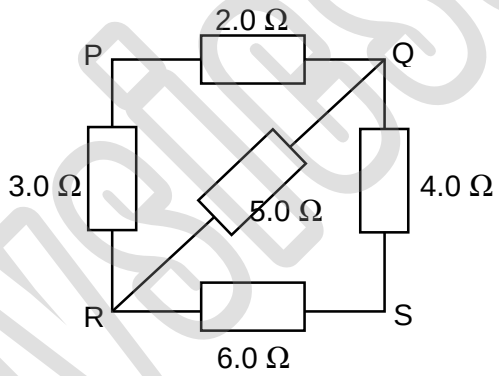
C The resistance of the component is 950 Ω when the potential difference is 0.60 V.

D When the potential difference is 0.60 V, the power dissipated at the component is 0.90 W.

8 A strain gauge consists of a length of wire with uniform cross-sectional area. Its resistance is 4.000 kΩ. It is attached to a gas container. When the container expands, the strain gauge changes its dimensions. Its length increases by 2.0% and diameter reduces by 1.0 %. What is the new resistance of the strain gauge?

A 3.842 kΩ **B** 4.121 kΩ **C** 4.163 kΩ **D** 4.897 kΩ

9 The diagram shows a network of five resistors



What is the effective resistance between P and S?

A 1.9 Ω **B** 2.1 Ω **C** 2.5 Ω **D** 3.6 Ω

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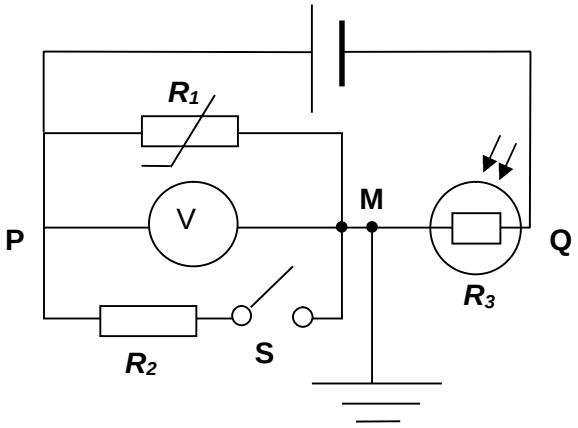
10 A thermistor R_1 is connected to a battery of constant e.m.f. with negligible internal resistance as shown in the figure.



Which of the following actions will cause an increase in the potential difference V measured by the voltmeter? Assume that the voltmeter has infinite resistance.

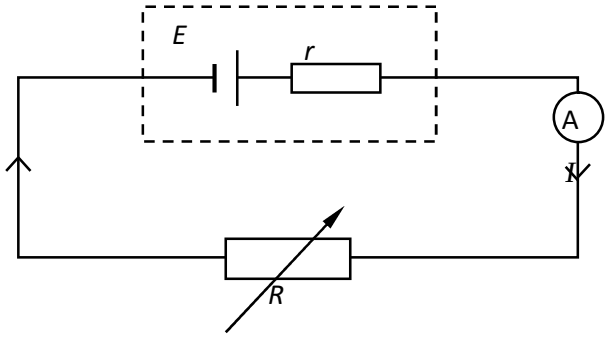
A Close switch S

B Increase the light intensity at R_3 with S open

C Remove the earth connection at M with S open

D Increase the temperature of the thermistor with S open

11 A battery of e.m.f. *E* and internal resistance *r* delivers a current *I* through a variable resistance *R*.



R is set at two different values and the corresponding currents *I* are measured using an ammeter of negligible resistance.

R / Ω	*I* / A
1.0	3.0
2.0	2.0

What is the value of internal resistance *r* and e.m.f. *E*?

	E / V	*r* / Ω
A	3.0	1.0
B	3.0	2.0
C	6.0	1.0
D	6.0	2.0

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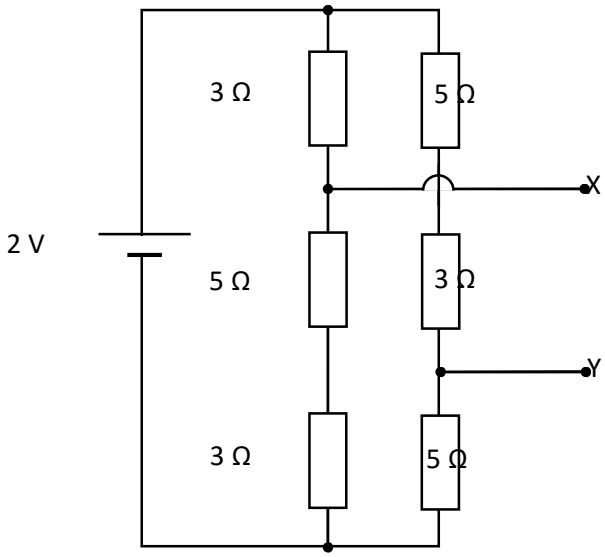
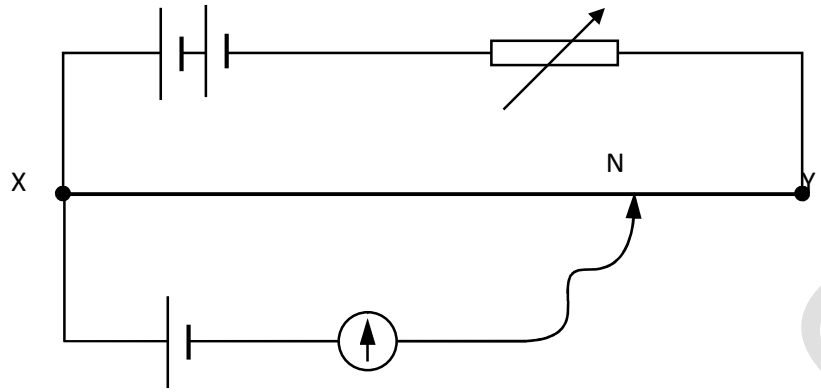
12 Six resistors are connected to a 2 V cell of negligible internal resistance.



What is the potential difference between terminals X and Y?

A 2/3 V **B** 32/143 V **C** 64/143 V **D** 98/143 V

13 In the potentiometer circuit below, the moveable contact is placed at N on the bare wire XY, such that the galvanometer shows zero deflection.



The resistance of the variable resistor is now increased.

What is the effect of this increase on the potential difference across the wire XY and on the position of the moveable contact for zero deflection?

	potential difference across XY	position of moveable contact
A	increases	nearer to X
B	increases	nearer to Y
C	decreases	nearer to X
D	decreases	nearer to Y

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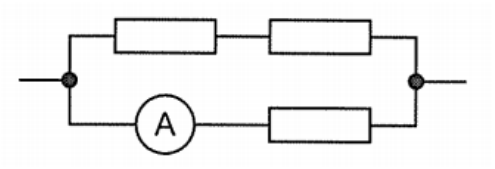
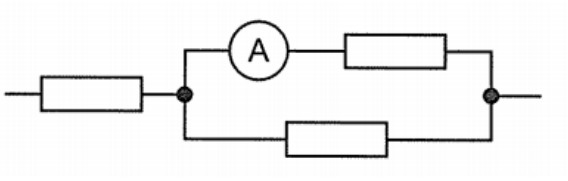
14 Four different arrangements of identical resistors are connected to the same constant voltage power supply. An ammeter of negligible resistance is connected as shown in each arrangement. In which arrangement will the ammeter show the minimum reading?

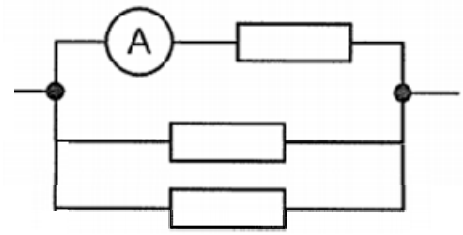
A



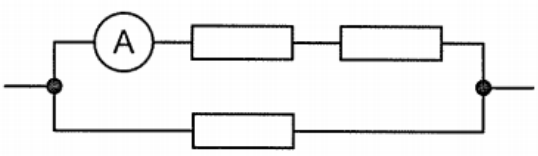
B



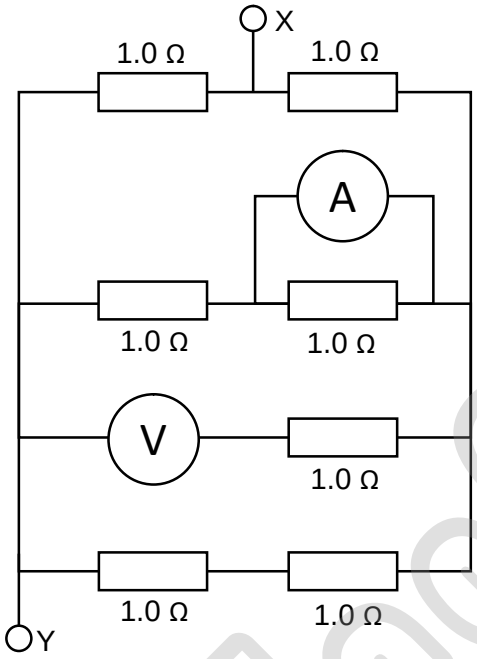
C



D



15 For the bizarre circuitry shown below, what is the effective resistance between points X and Y? Assume all components are ideal.



A 0.750 Ω

B 0.625 Ω

C 0.600 Ω

D 0.500 Ω

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WORKED SOLUTIONS

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1 Ans: **C**

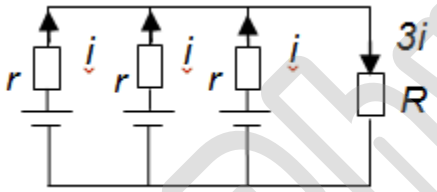
From the IV graphs determine R when current is 6.0 A; R=1.2 Ω
When current is 5.0 A; R= R1 =1.6 Ω
Using equation E=IR+Ir
Substituting corresponding values of I and R
Determine E and r
OR
E=IR+Ir = E=V+Ir
Substituting corresponding values of V and I
Determine E and r

2 Ans: **C**

Let the potential difference across the supply be V
Before W is removed the potential drop across each resistor is the same

Hence power dissipated in each is the same and is the current through each resistor is equal to $\frac{V}{2R}$ as the total resistance the circuit is R
When W is removed, total resistance in circuit increases 1.5 R
Hence the total current in the circuit is $\frac{2V}{3R}$
The current through X is $\frac{2V}{3R}$ and that through each of Y and Z is $\frac{V}{3R}$
Thus the potential drop across X increases and that across each of Y and Z decreases, hence the power dissipated in X will increase and that in each of Y and Z will decrease.

3 Ans: **C**



Fraction of total power lost

$$= \frac{\text{Power lost by internal resistance}}{\text{Power lost by internal resistance+ Power of external resistor } R}$$

$$= \frac{i^2r + i^2r + i^2r}{i^2r + i^2r + i^2r + (3i)^2R} = \frac{r}{3R + r}$$

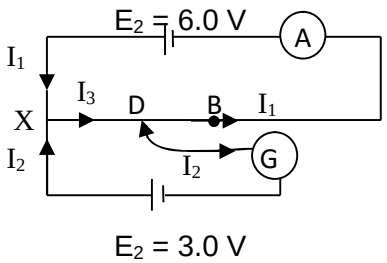
4 Ans: **A**

Original distribution of resistance across the two loops in the circuit is R/2 to R/2 i.e. 1:1. The new distribution is R to R/2 i.e. 2:1.
Due to the new distribution of resistance, the voltage across X will increase (2/3 V) and the voltage across Y and Z will decrease (1/3 V). Since current is V / R, and R is constant, the increase in voltage across X will cause an increase in current through X while the decrease in voltage across Y and Z will cause a decrease in current through Y & Z.

5 Ans: **C**

Resistance is the inverse of I/V ratio.

6 Ans: **A**



When C is connected at D, the pd across XD will take on the pd of 3.0 V. The pd across DY will then also be 3.0 V as the pd across XY is 6.0 V. The current through the ammeter is V_{CY}/R_{CY}. When C is shifted from B to D, R of CY will increase, while the voltage across CY remain the same, the current through the ammeter will decrease.
$V_{XD} = V_{DY} = 3$ V. Since $R_{XD} < R_{DY}$ => $I_3 > I_1$.
At node X, I_1 and I_2 combine to give a higher current I_3.
Direction of current in branch CE is C → E.
Extension question:
What if C is shifted to the right of B?

7 Ans: **B**
The resistance is increasing with increasing p.d. Hence, it cannot be a diode.

The resistance of the component is 400 Ω when the potential difference is 0.60 V. (*R* = ratio of *V* to *I*.)

When the p.d. is 0.60 V, the power dissipated is 0.90 mW.

8 Ans: **C**

$R \propto \frac{L}{A} \propto \frac{L}{d^2}$, $L_2 = 1.02\ L_1$, and $d_2 = 0.99\ d_1$

$$\frac{R_2}{R_1} = \frac{L_2}{L_1}\left(\frac{d_1}{d_2}\right)^2 = 1.02 \times \left(\frac{1}{0.99}\right)^2 = 1.0407$$

$R_2 = 4.163$ kΩ

9 Ans: **D**

When a p.d. is applied across PS, the potential at Q = potential at R. Therefore, there is no potential difference across the 5.0 Ω resistor and it should not be considered when determining the effective resistance.

Hence,

$$\frac{1}{R_{eff}} = \frac{1}{2.0 + 4.0} + \frac{1}{3.0 + 6.0}$$

$R_{eff} = 3.6$ Ω.

10 Ans: **B**

By potential divider principle, voltmeter reading increase when effective resistance across thermistor is increased or resistance R_3 is reduced. Greater light intensity reduces the resistance of the LDR.

11 Ans: **C**

12 Ans: **D**

13 Ans: **D**

14 Ans: **B**

15 Ans: **B**

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