Physics

Question	Maximum Mark	Mark Awarded
#1	7	
#2	10	
#3	12	
#4	12	
#5	13	
#6	13	
#7	14	
#8	14	
#9	14	
Total	109	

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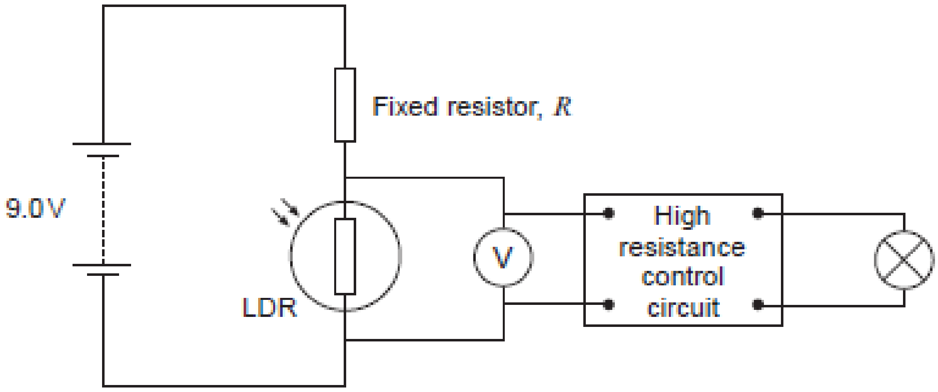
#1

1. (a) An engineer investigates the use of a light dependent resistor (LDR) as a light sensor in a potential divider circuit. He designs the following sensing circuit to operate a 230 V lamp in the dark.



The control circuit draws a negligible current. During his research, the engineer determines the following facts:

The control circuit requires at least 4.0 V to activate.
The LDR the engineer intends to use has a resistance of 2.4 kΩ at the light intensity required to switch the lamp on.

(i) Explain how the current in the LDR changes as the light intensity decreases. [2]

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(ii) Determine a suitable value for the fixed resistor R, which would allow the lamp to be switched on. [3]

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(b) When installing the circuit, the engineer made the mistake of placing the lamp near to the LDR. The engineer noted that, when in the dark, the lamp kept turning on and off repeatedly rather than staying on. Explain why this was the case. [2]

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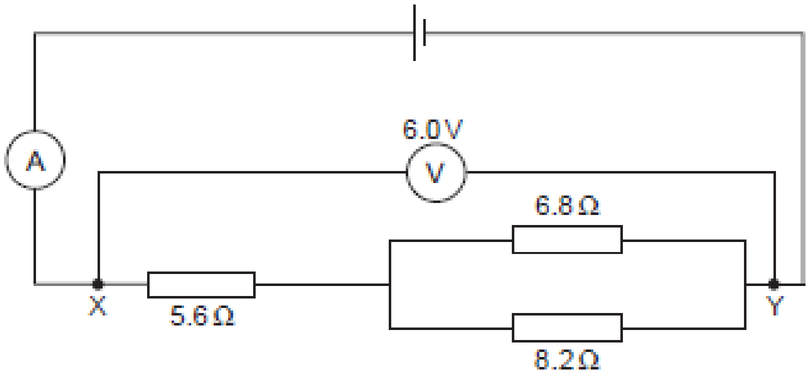
Question taken from Eduqas examination paper 842102, June 2018

#2

2. A circuit is set up as shown.



(a) In the circuit shown, the potential difference between X and Y is 6.0 V. Explain what this statement means. [2]

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(b) (i) Determine the reading on the ammeter if it has an instrument resolution of ± 0.01 A. [4]

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(ii) Calculate the potential difference across the 8.2 Ω resistor. [2]

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(iii) Calculate the power dissipated in the parallel resistor combination. [2]

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#3

6. *(a)* Define the *capacitance* of a capacitor. [1]

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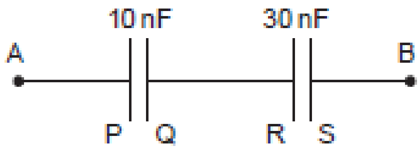
(b) Two capacitors, initially uncharged, are arranged in series as shown. When a battery is connected across A and B, the charge on plate P is found to be +75 nC.



(i) Write down the charges on each of the plates Q, R and S. Give a reason for your answer to the charge on plate S. [3]

Charge on Q: ....

Charge on R: ....

Charge on S: ....

Reason:

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(ii) Calculate the pd across A and B. [2]

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(iii) A Physics student makes the following comment:

For capacitors in series, a capacitor of higher capacitance stores more energy than a capacitor of smaller capacitance.

By considering this combination of capacitors, investigate whether or not the student is correct. [2]

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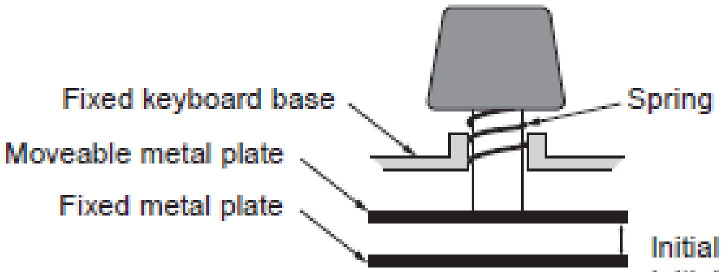
(c) Some computer keyboards work on the principle of varying capacitance. When a key is pressed, a spring is compressed and the separation of two parallel metal plates is decreased. The computer responds if the increase in capacitance of the plates is 0.20 pF or more.
The diagram shows how a single key is constructed.



Initial separation of plates = 5.2×10^{-3} m
Initial capacitance = 0.27 pF
Plate area = 1.6×10^{-4} m^2

The designers of a keyboard require that the increase in capacitance of 0.20 pF occurs when a force of 0.20 N is exerted on a key. Different springs are available, of spring constant 90 N m^{-1}, 120 N m^{-1} and 150 N m^{-1}. Determine which (if any) of these springs would be suitable in meeting the designer's requirements. The capacitor is filled with air. [4]

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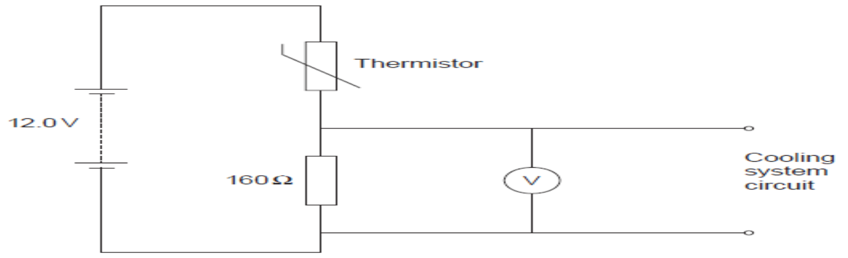
Question taken from Eduqas examination paper 842102, June 2018

#4

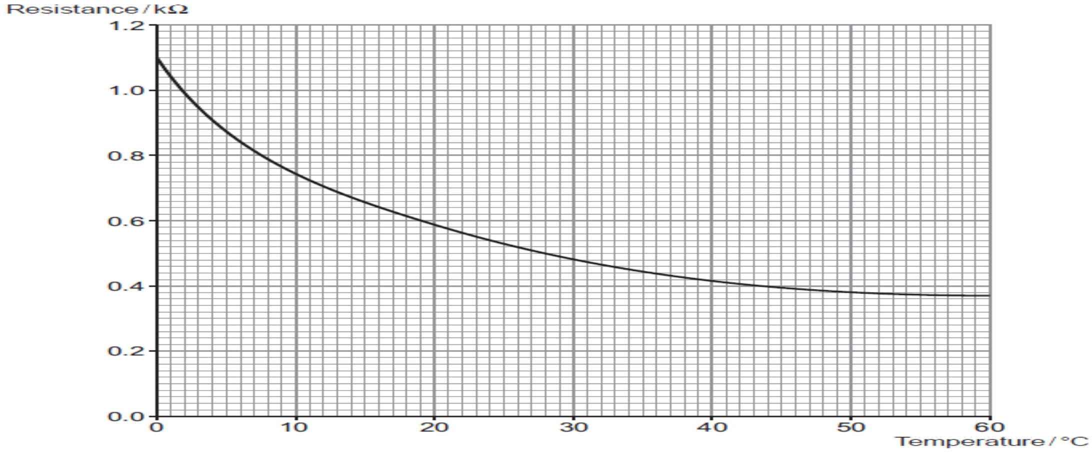
(a) Define the *potential difference* across two points in an electric circuit. [1]

(b) The diagram shows a possible control circuit for a cooling system. It consists of a battery of emf 12.0 V and negligible internal resistance connected in series with a thermistor and a 160 Ω fixed resistor. The voltmeter and cooling system circuit have very high resistances.



Calculate the resistance of the thermistor when the voltmeter reads 2.4 V. [3]

(c) The graph shows how resistance varies with temperature for this thermistor.



(i) The reading on the voltmeter increases when the temperature of the thermistor increases. Explain why this is the case. [2]

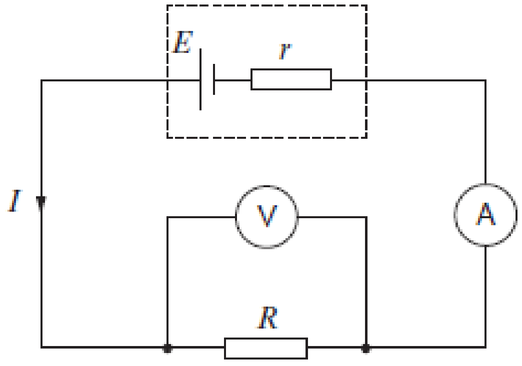
(ii) The cooling system can only be activated when the voltage across the 160 Ω resistor rises above 2.8 V. An engineer suggests that this thermistor and resistor combination is suitable to use in a car cooling system and should activate when the temperature reaches 30 °C. Check this claim. [4]

(d) The arrangement can also be used as a basis for a thermometer. By considering the shape of the graph on page 3 discuss whether this thermistor arrangement would be more effective at measuring changes in temperature between 0 °C and 10 °C or between 50 °C and 60 °C. [2]

Question taken from Eduqas examination paper 842102, June 2017

#5

1. The following circuit shows a cell of emf, E, and internal resistance, r, connected to a resistor of resistance, R.



(a) An equation which can be applied to the above circuit is:

$$V = E - Ir$$

Explain this equation in terms of energy. [4]

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(b) Two students, Kiera and Tom, set up a circuit using two identical cells in series, each with an emf of 1.5 V, to power a small heating coil. The heating coil dissipates power at the rate of 1 050 mW and the pd across the coil is 2.5 V.

Calculate:

(i) the internal resistance of each cell; [3]

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(ii) the energy dissipated in each cell in **one minute**. [2]

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(c) The students note that the cells get hot when the heater is switched on for long periods. Tom believes that adding an identical heating coil in parallel with the original would halve the energy dissipated in each cell. Kiera disagrees. She believes that the energy dissipated would increase by a factor of 3 if a coil is added in parallel. Investigate whether Kiera or Tom or neither of them is correct. [4]

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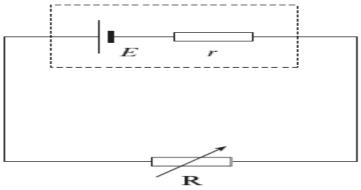
Question taken from Eduqas examination paper 842102, June 2019

#6

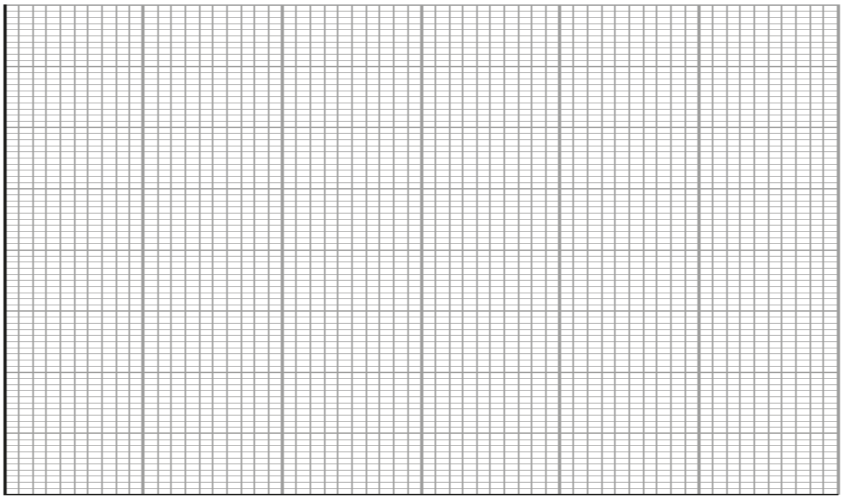
Abigail investigates how the power dissipated in a variable resistor varies as its resistance is altered. The diagram shows the circuit that Abigail uses (meters not shown). The variable resistor is connected to a battery of emf, E, and internal resistance, r.



Abigail obtains the following data as the resistance is varied from 0.5 Ω to 6.0 Ω.

Resistance, R / Ω	Power dissipated in R / W
0.5	2.5
1.0	3.3
2.0	3.8
3.0	3.8
4.0	3.7
5.0	3.6
6.0	3.5

(a) Plot a graph of power dissipated in R (on the y-axis) against resistance (on the x-axis) and draw a smooth curve through the data. [3]



(b) The emf of the battery is 6.0 V and the resistance, R, is now set at **4.5 Ω**.

(i) State what is meant by an *emf* of 6.0 V. [2]

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(ii) Calculate the current through the battery using data from your graph. [3]

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(iii) Calculate the internal resistance, r, of the battery. [3]

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(c) Abigail repeats the experiment but with a battery of the same emf but smaller internal resistance. Explain how the graph would change. [2]

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Question taken from Eduqas examination paper 842002, June 2017

#7

2. *(a)* (i) State what is meant by *electric current*. [1]

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(ii) Show that the unit of resistance, the ohm (Ω), can be expressed as: [2]

$$\mathrm{J\,s\,C^{-2}}$$

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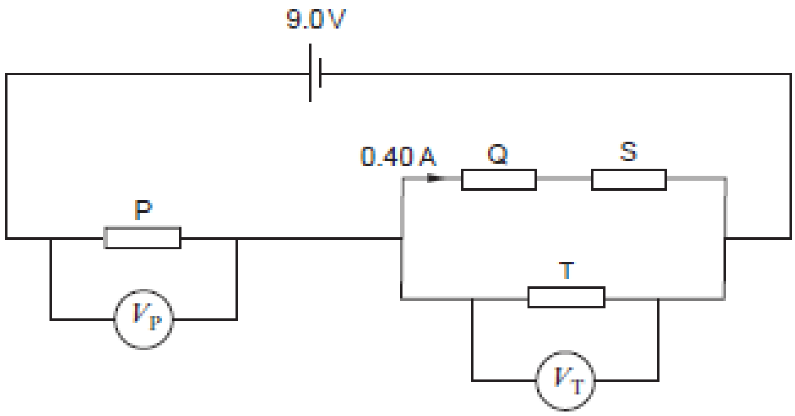
(b) The following circuit shows an arrangement of identical resistors labelled P, Q, S and T connected to a fixed pd of 9.0 V. V_P and V_T are the pds across P and T respectively. There is a current of 0.40 A in Q and S.



(i) Show that $V_P = 1.5\ V_T$. [2]

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(ii) Hence or otherwise show that the values given in the diagram are consistent with the resistance of each resistor being 4.5 Ω. [3]

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(c) Show that the total energy dissipated per second in the whole circuit is 15 times more than the energy dissipated per second in resistor Q. [3]

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(d) Resistor T is now removed from the circuit. Explain the effect this will have on the ratio calculated in part *(c)*. [3]

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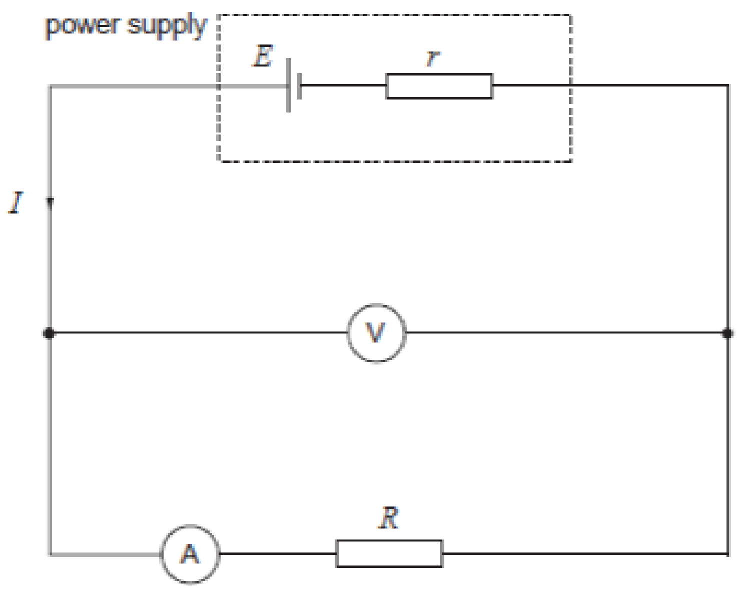
Question taken from Eduqas examination paper 842102, June 2018

#8

5. Zhang Li sets up the following circuit and uses a spreadsheet to analyse her data as the load resistance, R, is varied.



	A	C	D	E	F
1					
2	Emf, E	Load resistance, R	Current, I	pd across R, V	Internal resistance, r
3	V	Ω	A	V	Ω
4	1.5	1.4	0.94	1.32	0.19
5	1.5	3.3	0.43	1.42	0.19
6	1.5	4.7	0.31	1.46	0.13
7	1.5	5.6	0.26	1.46	....
8	1.5	8.0	0.19	1.49	0.17

(a) Zhang Li uses 3 resistors of values 3.3 Ω, 4.7 Ω and 5.6 Ω, to create various load resistance values. Show clearly how the value in cell C4 (column C and row 4) is obtained. [3]

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(b) (i) Zhang Li uses the spreadsheet formula = $\frac{A4 - E4}{D4}$ to determine the internal resistance in cell F4. Explain in terms of energy why this is a valid method. [6]

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(ii) Determine the internal resistance value for cell F7. [2]

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(iii) Zhang Li can choose between 4.7 Ω resistors with power ratings of 0.25 W or 0.50 W. Justify, numerically, which resistor power rating she should use in the circuit. [3]

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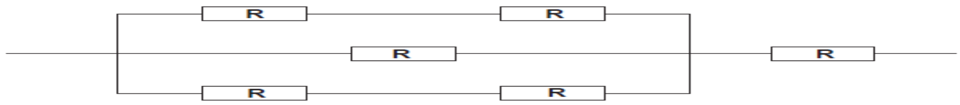
Question taken from Eduqas examination paper 842002, June 2019

#9

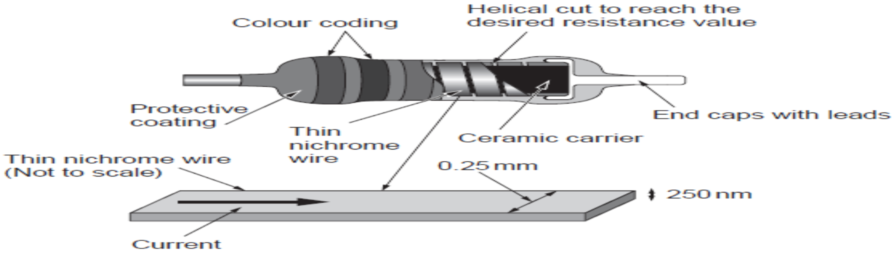
(a) The resistor network shown consists of six identical resistors, each of value **R** Ω.



(i) Determine, **in terms of R**, the total resistance of the network. [3]

(ii) **Draw a circle** around the resistor which dissipates the greatest power when a pd is applied across the arrangement. Explain your answer. [2]

(b) The alloy nichrome is commonly used to make 'Metal Film Resistors'. A cross-section through such a resistor is shown. The value of the resistor is determined by the length of the nichrome wire used in it.



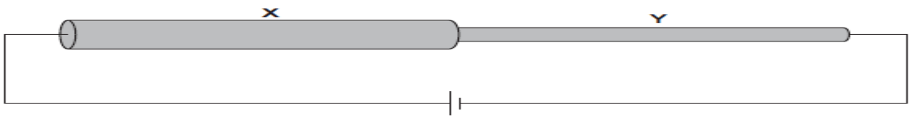
The wire used in such a resistor has a rectangular cross-section as shown. Determine the length of nichrome wire required to make a 2.0 kΩ resistor.
[Resistivity of nichrome = 1.20×10^{-6} Ω m] [2]

(c) The current I through a wire is related to the drift velocity, v, of free electrons through the wire by the equation:

$$I = nAve$$

(i) State the meaning of n. [1]

(ii) Two pieces of nichrome wire, **X** and **Y**, are joined end to end and connected to a battery as shown. The wires are of the same length but the diameter of **X** is **double** that of **Y**.



The table below shows the ratios of the values of n, I and v in the two wires. Write in the table the value of each ratio, giving an explanation for each of your answers.
Space is provided for calculations. [3]

Ratio	Value	Explanation
$\frac{n_X}{n_Y}$		
$\frac{I_X}{I_Y}$		
$\frac{v_X}{v_Y}$		

(iii) Wire **Y** is replaced with another wire **Z** of the same cross-sectional area as **Y** but double the length and made of a material with resistivity half that of **X**. Calculate the ratio:

$$\frac{\text{Power dissipated in wire } \mathbf{Z}}{\text{Power dissipated in wire } \mathbf{X}}$$

[3]

Question taken from Eduqas examination paper 842102, June 2017