**Physics: 15. Electronics**

***Please remember to photocopy 4 pages onto one sheet by going A3→A4 and using back to back on the photocopier***

**Syllabus**

**OP57** Describe a diode as a device that allows current to flow in one direction only and recall that a light emitting diode (LED) requires less current than a bulb

**OP58** Set up simple series circuits using switches, buzzers, LEDs and resistors

**OP59** Measure the resistance of a light-dependent resistor (LDR) under varying degrees of brightness of light

**OP60** Identify everyday applications of the diode, including the LED, and of the LDR

**Student Notes**

In an electric circuit current flows from the positive end of the battery to the negative end.

The positive end is represented with a long solid line, and the negative end is represented with a short solid line.

**Diodes**

|  |  |
| --- | --- |
| Image | Symbol |
| http://tbn1.google.com/images?q=tbn:teLpwEKdaK93EM:http://imgs.tootoo.com/img01/products/119/365/4119365.JPG | http://tbn3.google.com/images?q=tbn:l4sXy5ZGX0BIRM:http://www.bbc.co.uk/schools/gcsebitesize/img/ph02025.gif |

**A diode is a device that allows current to flow in one direction only**

The symbol for a diode is shown on the right.

The arrow indicates the direction in which current can flow.



**Simple series circuits using diodes**

In the diagram on the right, current would normally flow in an anti-clockwise direction (from the positive end to the negative end).

In this case however current will only flow through part A, and not through part B because the diode in part B is pointing in the wrong direction.

**Light Emitting Diodes (LEDs)**

|  |  |
| --- | --- |
| Image | Symbol |
| http://tbn1.google.com/images?q=tbn:YZ2pOM4uqkOtyM:http://www.ledsupply.com/images/5mmledmed.jpg | **http://tbn1.google.com/images?q=tbn:RyVdrkZAODBl-M:http://upload.wikimedia.org/wikipedia/commons/6/60/Diod_LED_symbol.png** |

**LEDs are similar to diodes but emit light when current passes through them**

They are very important in electronics because they use very little electricity.

**Simple series circuits using LEDs**

Note that in both circuits the current flows in an anti-clockwise direction (can you remember why?).

However the LED in the second circuit is turned the wrong way around so no current will flow in the second circuit and no light will be emitted.

**Light Dependent Resistors (LDRs)**

**A LDR is a resistor whose resistance decreases with increasing light intensity**

|  |  |
| --- | --- |
| Component | Symbol |
| http://tbn3.google.com/images?q=tbn:g2qPzGKkYa4OrM:http://www.kpsec.freeuk.com/photos/rapid/ldr.jpg | http://tbn0.google.com/images?q=tbn:Kn_0kXEoI6WNYM:http://www.bbc.co.uk/schools/gcsebitesize/img/ph02024.gif |



**To measure the resistance of a LDR under varying degrees of brightness**

Connect the LDR to an ohmmeter or to a multimeter set to read resistance and slowly shield the LDR from light.

Notice that the resistance increases.

**Applications of the diode**

Almost all electronic appliances have diodes inside them which help turn alternating current into direct current.

**Applications of the LED**

LEDs used to be used primarily as indicators in electronic circuitry (e.g. as standby indicators in televisions, radios etc) but modern diodes can give out a lot of light efficiently and so are now used in many designs of flashlights.

**Applications of the LDR**

Textbooks often mention that LDRs are used to switch on street lights when it gets dark, yet this can seem confusing because the resistance of the LDR is high when it is dark so how can this be responsible for current flowing through the street-light?

What actually happens is that this reduced current is detected by a second circuit which in turn uses that information to turn on the street-light.

**Exam questions**

1. [2012]

The circuit shown in the diagram was set up by a pupil.

Component C gave out light.

1. Name components B and C labelled and shown in the diagram.
2. Give the function of component A and the function of component B.



1. [2008]

Identify the devices shown in the diagram.

1. [2008][2010 OL]

Leds are often used instead of bulbs. Give a reason for this wide application.

1. [2006 OL][2007 OL] [2010 OL]

The circuit on the right includes a resistor, a switch and an LED.

1. Will the LED light if the switch is closed?
2. Give a reason for your answer.
3. Why is it necessary to place a resistor in series with the LED?
4. [2006]

A pupil carried out an investigation into the effect of a diode on d.c. and on a.c. circuits using an LED.

The following circuits were initially set up.

1. What is observed in circuit A (the first circuit) and in circuit B (the second circuit)?
2. When the batteries in circuits A and B were replaced by 6 V a.c. supplies the LEDs glowed dimly in both circuits. Explain this observation.
3. [2010]

Look carefully at circuits A and B, then answer the questions.

1. In which circuit does the red LED light up?
2. Give a reason for your answer to (i) above.
3. Why is the resistor ‘R’ needed in both circuits?

**Light Dependent Resistors**

1. [2009][2012]
2. The diagram shows a light dependent resistor (LDR) and a graph of the resistance of the LDR against the brightness of light falling on it.

Give an everyday use for an LDR.

1. Describe an experiment to measure the resistance of an LDR under varying degrees of brightness of light.
2. Draw the circuit diagram of the experiment.
3. Explain how you would vary the brightness of the light.

You do not have to state how the brightness of the light was measured.

**Exam solutions**

1. B is a resistor, C is a light emitting diode (led)
2. A supplies electricity (electrical energy), (direct current), (DC), (energy), (power), (current)…

B controls (regulates) (reduces) current/ protects LED

1. Light emitting diodes (leds),
2. They are cheap/ can be switched on and off rapidly without ‘blowing’/ long lasting/ fit into small spaces.
3. Yes
4. It is in forward bias
5. Protect the LED / limit current flowing through LED
6. The LED in circuit A glows while the LED in circuit B does not glow
7. a.c. is alternating current, so for half the time current is flowing in the right direction and the led glows, but for the other half of the cycle the current is flowing in the wrong direction and so the led does not glow..
8. B
9. It is connected in forward bias.
10. It controls (limits) the current (without a resistor the diode would burn out).
11. To measure light intensity/ as part of a circuit to switch on (off) lights/ light sensor/ alarms/ street lights/ camera...
12. Connect the LDR to a multimeter set to measure resistance.

Note the reading on the ohmmeter when the LDR is at different distances from the light bulb.

1. See diagram
2. Move light source closer to the LDR and note that the resistance decreases.

**Electronics Questions**

1. What is the function of a diode in a circuit?
2. What is the function of a LED (Light Emitting Diode)?
3. What do the letters LDR stand for?
4. Draw the symbol for (i) ldr, (ii) led
5. Give one everyday use of (i) an led, (ii) an ldr.

**Teaching *Electronics***

**Syllabus**

**OP57** Understand that a diode is a device that allows current to flow in one direction only, and that a light emitting diode (LED) requires less current than a bulb

**OP58** Set up simple series circuits using switches, buzzers, LEDs and resistors

**OP59** Measure the resistance of a light-dependent resistor (LDR) under varying degrees of brightness of light

**OP60** Identify everyday applications of the diode, including the LED, and of the LDR

**Syllabus**

**OP57: Understand that a diode is a device that allows current to flow in one direction only, and that a light emitting diode (LED) requires less current than a bulb**

There is a nice demonstration of this on the Junior Science website (there is a link to it from thephysicsteacher.ie)

Diodes, LEDs and LDRs are all very inexpensive so purchase a sack-load of each and store them away for future use.

**OP58: Set up simple series circuits using switches, buzzers, LEDs and resistors**

Potential problems with using leds in circuits

* Busted and working leds both look the same
* Contrary to what the text-books (and exam question) state, a.c. doesn’t seem to be dimmer than d.c. (I don’t know why).
* It’s not obvious but the long leg is connected to the positive end of the battery or power-supply.
* In forward bias the circuit will burn out at approx 3 volts
* This will also occur if the power-supply is a.c.
* Be careful when arranging the led in series with other devices – the potential difference across the led may ‘blow’ it.
* Order 50 leds at a time per teacher (they’re cheap).

**OP59: Measure the resistance of a light-dependent resistor (LDR) under varying degrees of brightness of light**

* This assumes that students will know how to use a multimeter; this shouldn’t be taken for granted, but hopefully if students have followed the worksheet on Ohm’s Law they will remember.
* Connect the LDR to the multimeter and notice that the resistance increases dramatically when you cover it with your hands.

**OP60: Identify everyday applications of the diode, including the LED, and of the LDR.**

* Textbooks often mention that LDRs are used to switch on street lights when it gets dark, yet this can be confusing because the resistance of the LDR is high when it is dark so how can this be responsible for current flowing through the street-light.

What actually happens is that this reduced current is detected by a second circuit which in turn uses that information to turn on the street-light.

* There is a nice demonstration of leds used in 7-segment displays in the Junior Science link mentioned above.
* Many flash-lights now use a number of leds rather than the traditional filament bulb.