

# SNC2D PHYSICS

## LIGHT & GEOMETRIC OPTICS

- ☛ Sources of Light  
(P.392-401)

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### Sources of Light

Sources of light can be natural, such as the Sun, forest fire, and fireflies, or human-made, such as a glowing light bulb or a computer screen that has been turned on.



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### The Production of Light

The Sun and other objects that produce and emit light are **luminous**. These objects convert other forms of energy into light energy. Luminous objects produce light in several different ways.



#### LUMINOUS

- ❖ produces and emits light (i.e. Sun, burning candle, ...)

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### The Production of Light

Objects that do not produce their own light are **non-luminous**. Most objects are non-luminous, including you and your textbook.

**NOTE!**  
Non-luminous objects may appear bright because their surfaces reflect light from a luminous object. For example, the Moon appears bright because it reflects light from the Sun.



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### The Production of Light

**NON-LUMINOUS**

- ❖ does not produce light
- ❖ reflect light from other sources (i.e. Moon, stop sign, ...)



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### The Production of Light – Incandescence

Substances produce light when heated to very high temperatures. This process is called **incandescence**. As the temperature increases, the colour of the light changes from red to orange, to yellow, to white, and then to bluish-white. An example of incandescence is the glow produced by a lit candle. Incandescence also occurs in an incandescent light bulb.

**INCANDESCENCE**

- ❖ the production of light energy when an object is heated to a high temperature (i.e. burning candle, light bulb, ...)



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### The Production of Light – Incandescence

**NOTE!**  
When electricity passes through the thin, coiled wire inside the bulb, the wire becomes hot and glows. At the same time, the thermal energy produced by the wire is given off as heat. This is why these bulbs become so hot. Only a small portion of the electricity passing through the wire is converted into visible light. Most of the electricity is wasted as thermal energy.



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### The Production of Light – Electric Discharge

Every time you see a flash of lightning or walk past a lit neon sign for a business, you are seeing another form of light production. This light, known as **electric discharge**, is produced by an electric current passing through a gas. The electricity causes the gas to glow.



**ELECTRIC DISCHARGE**

- ❖ the production of light by passing an electric current through a gas
- ❖ causes the gas to glow (i.e. lightning, neon sign, ...)

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### The Production of Light – Phosphorescence

People are familiar with objects that glow in the dark, such as the dials on some wristwatches and clocks, and glow-in-the-dark stickers. These materials are coated with phosphors, special materials that give off light through a process called **phosphorescence**. Phosphors absorb light energy, primarily UV light. These materials keep some of the energy and release visible light of lower energy over an extended period of time.



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### The Production of Light – Phosphorescence

**NOTE!**  
*Because light is emitted over time, phosphorescent materials are often described as "glow-in-the-dark".*

**PHOSPHORESCENCE**

- ❖ the production of light by absorbing light energy (UV) and then releasing visible light over a period of time
- ❖ often described as "glow-in-the-dark"



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### The Production of Light – Fluorescence

*Light can also be produced when radiation is absorbed.*

**Fluorescence** occurs when a substance absorbs high-energy UV radiation and then immediately releases the energy as visible light. Highlighter pens are one common application of fluorescence.



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### The Production of Light – Fluorescence

**NOTE!**  
*The ink in these pens contains a fluorescent dye that causes the ink to glow in the presence of UV light.*

**FLUORESCENCE**

- ❖ occurs when a substance absorbs invisible UV light and converts it to visible light (i.e. highlighter, fluorescent light, ...)



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### The Production of Light – Fluorescence

**NOTE!**  
The Famous PEOPLE Players theatre company uses this concept in their costumes. The performers dress in black costumes, making them almost invisible in a dark theatre. So, anything they carry looks as though it is floating. The costumes of the singers, dancers, and puppets are covered with special colourful fluorescent paint that glows under UV light.



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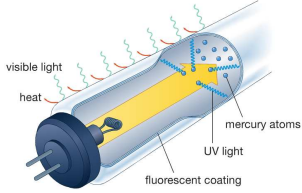
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### The Production of Light – Fluorescence

Fluorescent light bulbs also produce light by fluorescence. In a fluorescent light, a glass tube is filled with a mixture of mercury and argon gas. The inside of the glass tube is coated with a fluorescent material that absorbs ultraviolet light. When the light is turned on, electric current flows through the mercury-argon mixture and produces invisible ultraviolet light. The coating on the inside of the glass tube absorbs the ultraviolet light and immediately converts it into visible light.



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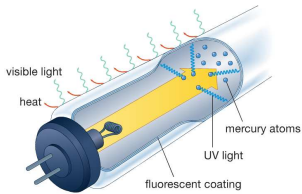
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### The Production of Light – Fluorescence

**NOTE!**  
A fluorescent light produces much less thermal energy than an equivalent incandescent light bulb. However, compact fluorescent light bulbs (CFLs) cost more to buy than incandescent bulbs. Another drawback is that the mercury in the bulbs can cause environmental pollution.



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### The Production of Light – Fluorescence

**FLUORESCENT LIGHT**

- ❖ uses fluorescence to produce light
- ❖ compared to regular light bulbs:
  - pros
    - ☞ save energy
    - ☞ last longer
  - cons
    - ☞ cost more
    - ☞ mercury in the bulbs is toxic (i.e. pollution)



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### The Production of Light – LED

The **light-emitting diode (LED)** is an even more efficient light-producing technology. When an electric current passes through an LED, it emits light. The type of light emitted depends on the material used to make the LED. Light-emitting diodes save energy, last longer, and stay cooler than both incandescent bulbs and CFLs of similar brightness. LEDs are replacing both incandescent and fluorescent bulbs in many devices.



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### The Production of Light – LED

**LED**

- ❖ light-emitting diode
- ❖ use less energy, last longer, and stay cooler



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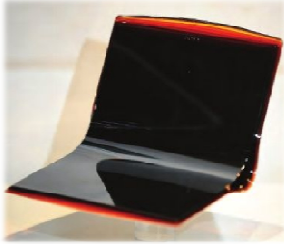
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### The Production of Light – OLED

An **organic light-emitting diode (OLED)** is a light source made of several extremely thin layers of organic molecules that use an electric current to produce light.



**OLED**

- organic light-emitting diode

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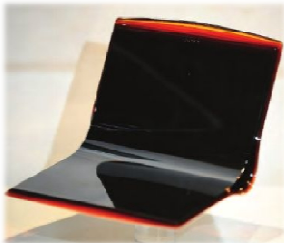
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### The Production of Light – OLED

**NOTE!**  
OLEDs use less energy than some other displays because they do not require a backlight to function. They are thinner, lighter, brighter, and more flexible. In fact, they are so flexible that OLEDs can be rolled up or embedded in fabrics or clothing. However, OLEDs are more expensive to produce than some other displays and are easily damaged by water.



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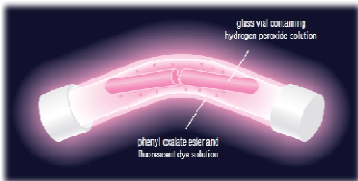
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### The Production of Light – Chemiluminescence

A light stick is made of a flexible plastic tube with a smaller tube inside. Each tube contains a different liquid chemical. When you bend a light stick, the inside tube breaks open, allowing the chemicals to mix. A chemical reaction produces visible light and a small amount of thermal energy in a process called **chemiluminescence**.



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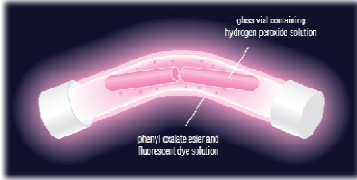
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### The Production of Light – Chemiluminescence

**CHEMILUMINESCENCE**

- ❖ the production of light from a reaction between two chemicals
- ❖ reaction gives off very little heat (useful in situations where a spark could be dangerous)



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### The Production of Light – Bioluminescence

When chemiluminescence occurs in organisms, scientists call it **bioluminescence**. Fireflies, for example, are bioluminescent. A chemical reaction within the firefly produces visible light. Bioluminescent organisms emit light to scare predators, lure prey, or attract mates.



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### The Production of Light – Bioluminescence

**BIOLUMINESCENCE**

- ❖ the production of light from a chemical reaction within an organism
- ❖ type of chemiluminescence that occurs in living things



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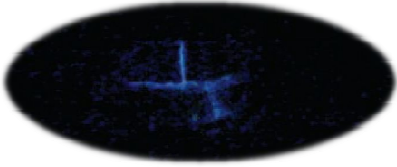
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**The Production of Light – Triboluminescence**

**Triboluminescence** is the production of light when certain crystals are scratched, crushed, or rubbed together. Striking two sugar cubes together or biting down on a wintergreen candy (see photo below) are examples of triboluminescence at work. However, triboluminescence does not appear to have any practical application at this time.



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**The Production of Light – Triboluminescence**

**TRIBOLUMINESCENCE**

- ❖ the production of light when certain crystals/materials are crushed or rubbed together (i.e. quartz, wintergreen candy)



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**✓ Check Your Learning**

1. List four different ways in which luminous objects produce light. Give an example of each.

answers will vary

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 **Check Your Learning**

2. Why do you think a light stick would be a good light source around flammable materials?

reaction gives off very little heat – thus the term, "cool lights"

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 **Check Your Learning**

3. (a) What are two reasons to replace incandescent light bulbs with CFLs or LEDs?  
(b) What are some potential problems associated with CFLs?

(a) cheaper & last longer  
(b) more expensive & toxic (risk of pollution)

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 **Check Your Learning** 

**TEXTBOOK**  
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