# How does my camera work?

# What we will look at today

- What is a camera?
- Common light path
- Lenses
- Aperture
- Shutter
- Image plane
- Why do cameras vary so much in size?
- Types of camera
- Possible future directions

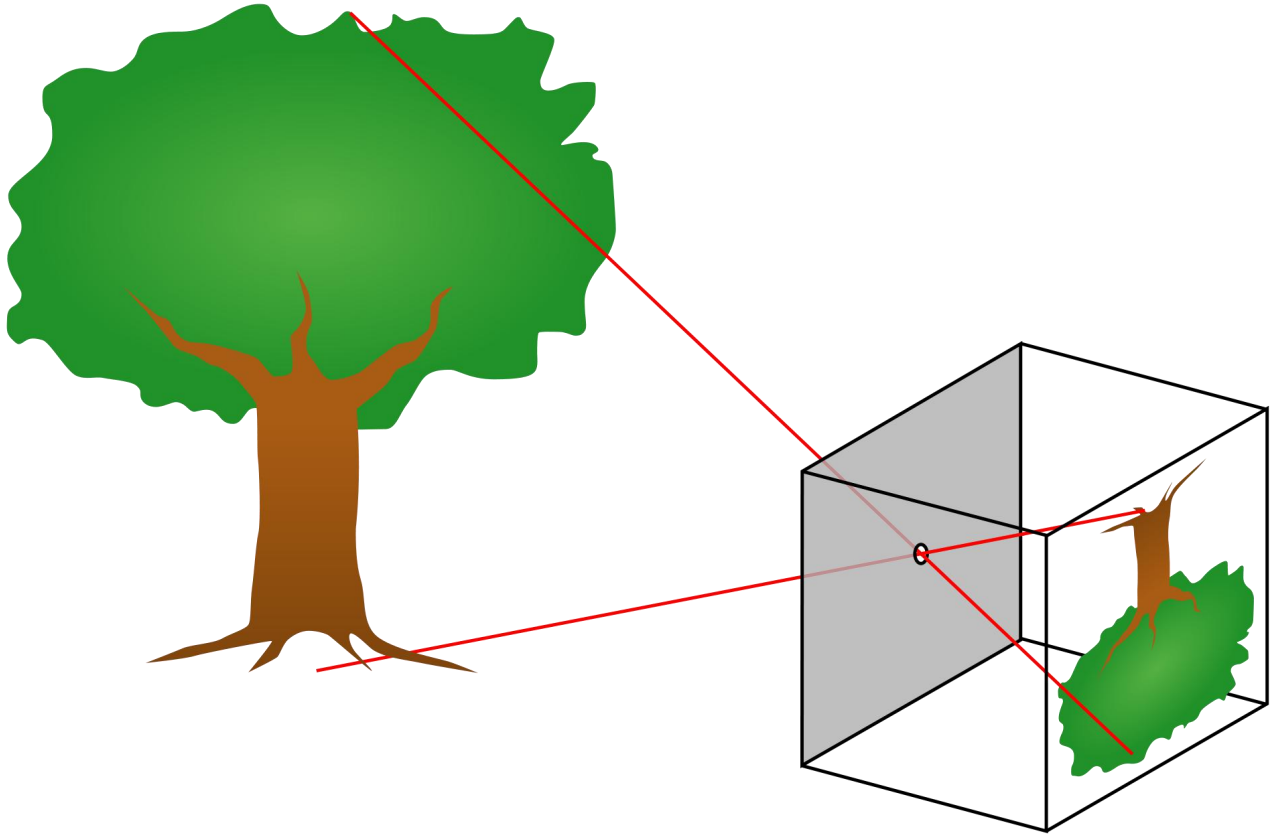
# What is a camera?

- Perhaps you have wondered what is going on inside that picture-taking box that you just held up to your eye, or out at arm's length, to capture a photograph?

- The camera is, in its simplest form, a box that allows light to enter and strike a light-sensitive surface. This surface is either a frame of film or a digital sensor. The simplest form of camera is a pinhole camera. It may have only one moving part, or none at all.

- Or, the camera can have dozens of moving parts like the modern film or digital single-lens reflex (SLR or DSLR) camera.

# Pinhole Camera



# DSLR


Canon
EOS
1000D
CANON ZOOM LENS EF-S 18-55mm
STABILIZER ON/OFF
KenRockwell.com

# A common path for light

- Modern cameras, more or less, work similarly to produce a photograph. Obviously, some are more complex than others, but, in general, light travels a similar path once it meets the camera.

- Lens
- Aperture
- Shutter
- Image Plane

- How the image is viewed on the camera by the photographer, through an optical or electronic viewfinder or electronic screen is one characteristic that differentiates between types of cameras.

# Lens

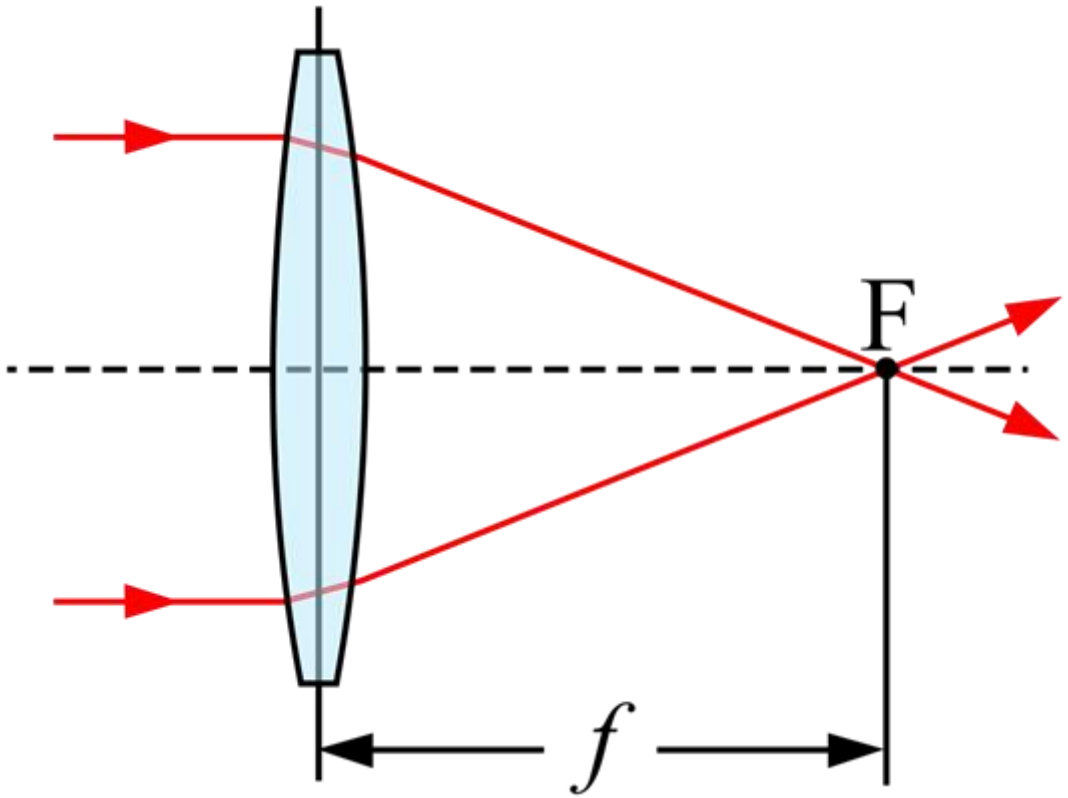
- Light first enters a lens. This is an optical device made from plastic, glass, or crystal that bends the light entering the lens toward the image plane. The lens has a certain number of optical elements. These are arranged together in groups. If you look at lens specifications, you will see a mention of the number of elements and groups in a given lens. Some groups only have one element.

- Some lenses have fixed focus; others have movable elements that allow the photographer to control focus. On these lenses, one or more elements can change position to focus the light precisely at the image plane.

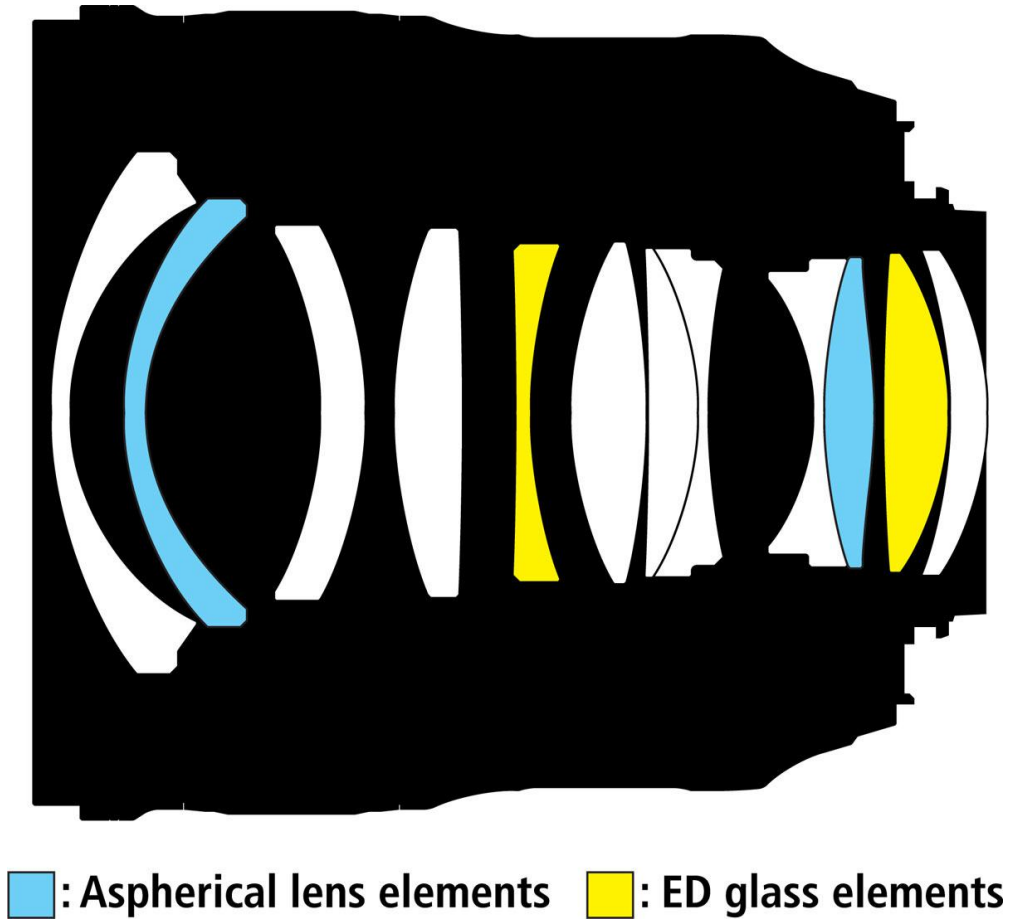
- The lens's field of view is determined by its focal length. This is the length, in millimeters, from the rear nodal point of the lens to the image plane. Some lenses have fixed focal lengths (known as 'prime' lenses), while others have adjustable focal lengths. Those that can change focal length are known as "zoom lenses."

- ( A nodal point is one of the two points in a compound optical system, located so that a light ray directed through the first point will leave the system through the second point, parallel to its original direction. Also called axial point .)

# Simple Lens



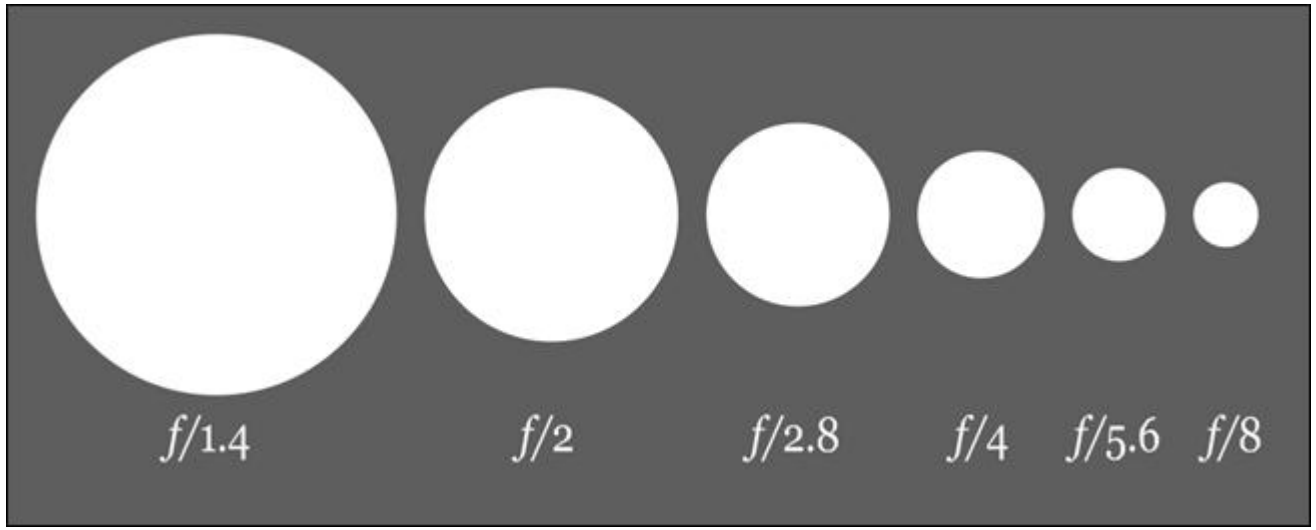
# Zoom Lens



# Aperture

- Technically, a part of the lens, the aperture is the size of the opening of the lens. Many designs have variable diaphragms that control how much light passes through the lens, and are not unlike that of the eye’s pupil. The diaphragm will have a certain number of blades that diminish or expand the size of the aperture as needed. Some lenses have a fixed aperture whose size cannot be adjusted.

# Aperture (or f stop)



# The shutter

- Many cameras have a device that opens and closes to let light impact the image plane for a predetermined amount of time. This is the shutter and it works much like your opening and closing eyelids—if you had your eyes closed more than open!
- The shutter is a complex mechanical (or electrical) system. Mechanical cameras may have leaf or focal-plane shutters. The leaf shutter opens and closes like the aperture diaphragm and the focal-plane shutter uses “curtains” that work a little like garage doors but in today's cameras usually move in the vertical plane.
- More related to the image plane than the shutter today, some digital cameras employ 'electronic shutters' that can either turn the digital sensor on and off globally in rapid fashion or activate one row of pixels at a time across the frame.

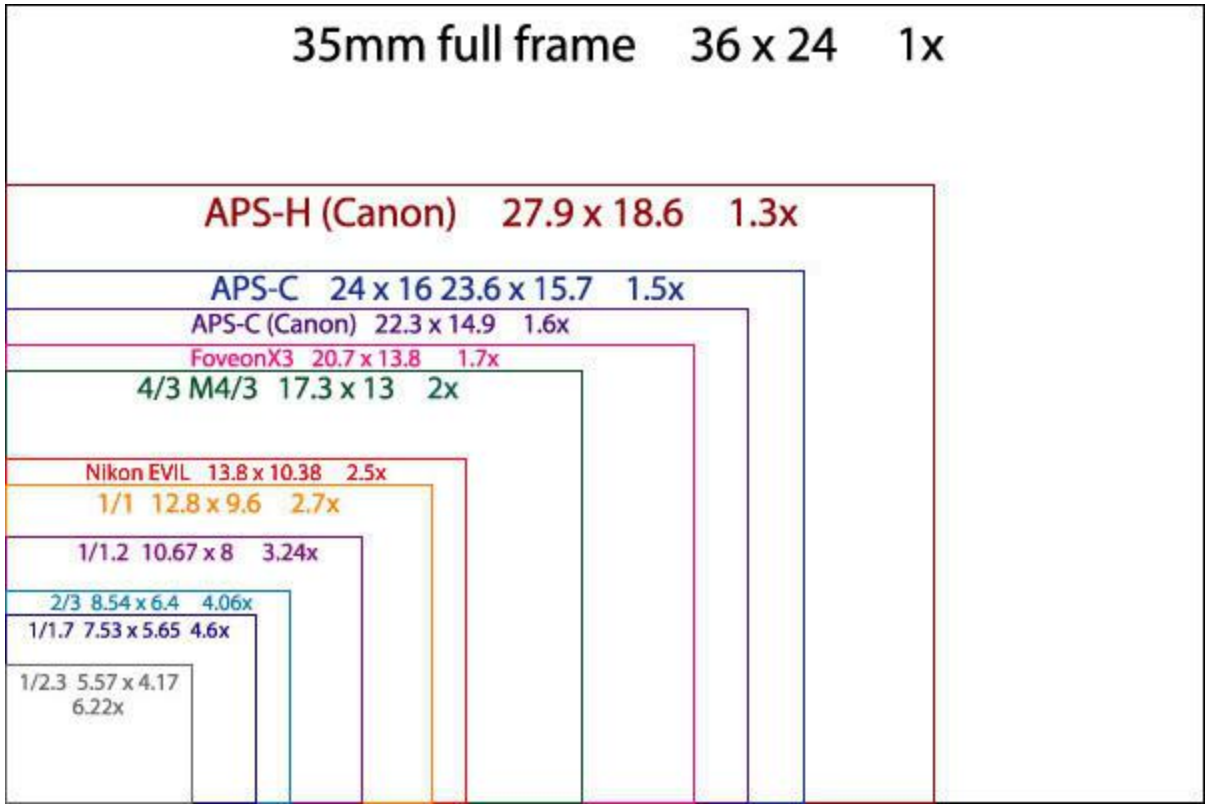
# Image Plane

- After light passes through the lens aperture and is allowed to travel through an open shutter, it strikes the image plane. At the image plane is light-sensitive chemical-based film or a digital sensor on which the projected image is recorded. This plane’s position inside the camera is often marked by this symbol: "Φ" painted or engraved somewhere on the camera body, often on the top plate.
- This image is upside down and reversed left to right. Cameras employ various means to correct this before ordinary mortals look at the image.

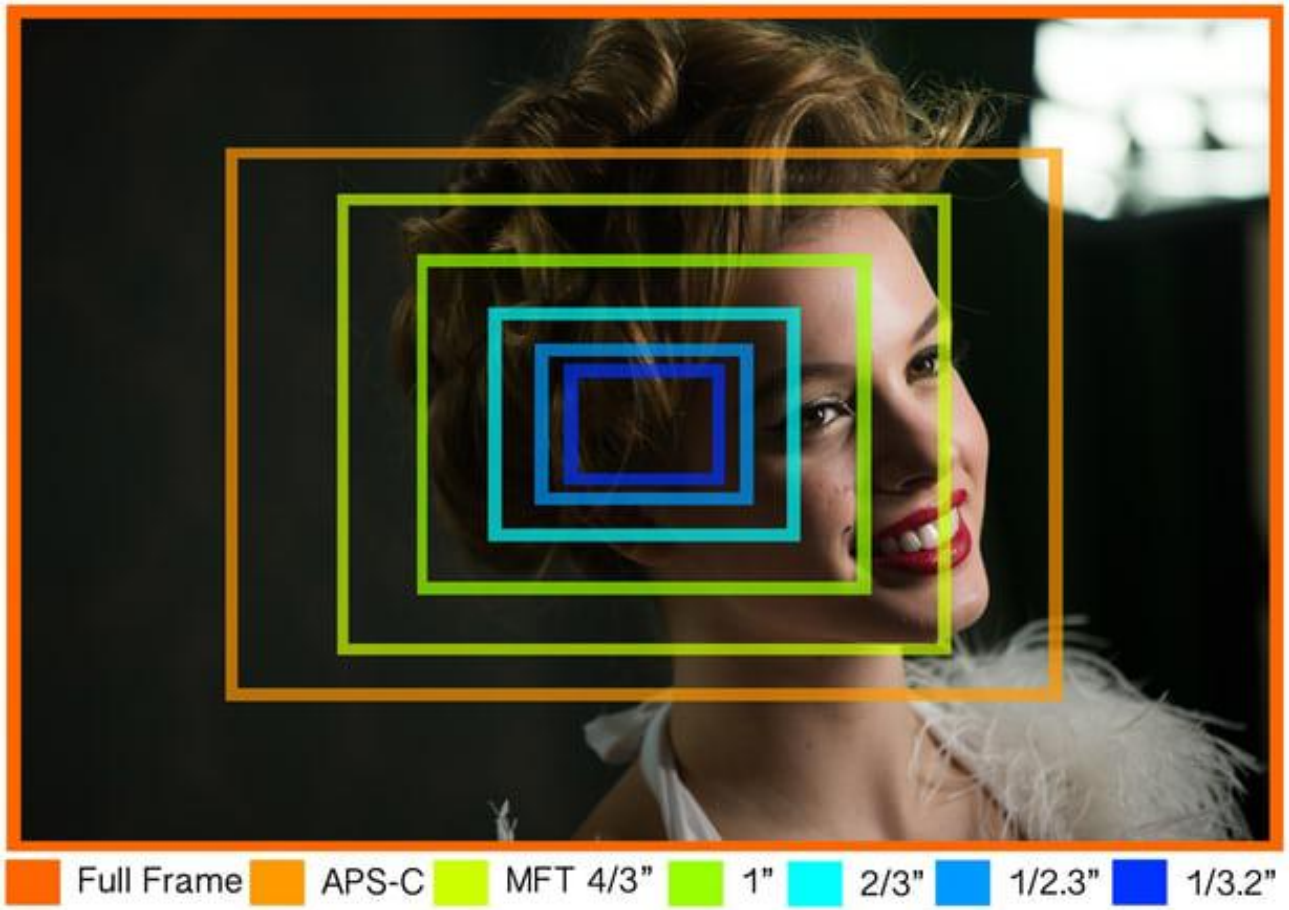
# Why are cameras so varied in size ?

- All lenses produce circular images
- The bigger the lens the larger the image it produces
- The image that the lens produces must completely encircle the sensor in the camera
- The sensors vary in size

# These are some of the sensors in today's cameras



# If all lenses were the same size



# The size of the sensor dictates the size of the camera

- If the camera has a small sensor then it only needs a small lens to produce the image necessary to cover the sensor completely.

- The smaller the lens the closer the sensor can be placed to the lens and still focus properly

- The mountings for the lens and sensor can be smaller, thus the camera body can be more compact.

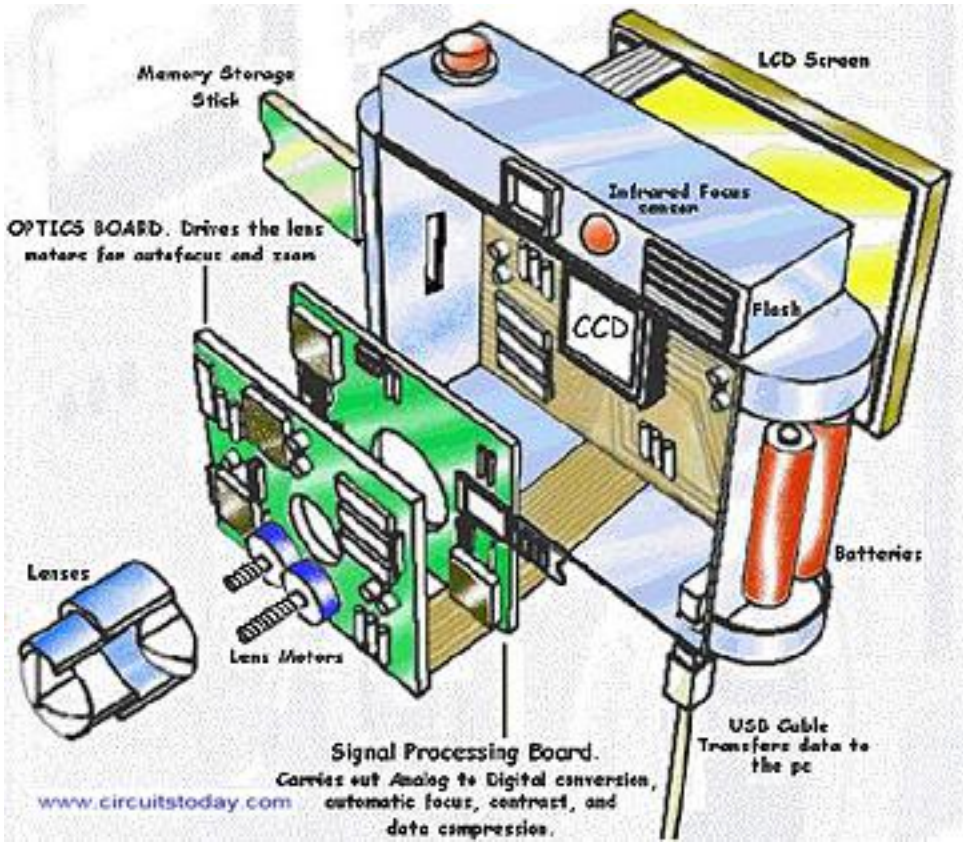
# Why don't all cameras use the small sensors?

- The sensors hold huge numbers of pixels, even the smallest have many megapixels in their specification
- Small sensors with the same number of pixels as a larger sensor will have relatively smaller photosites generating the electrical signals which the camera processes in order to provide the image to record to the card and to furnish the rear viewing screen.
- Smaller electrical signals need more amplification to be useful
- The more the signals are amplified the greater will be the 'noise' evident in the final image from the camera.
- In general the size of the sensor determines the quality of the images the camera produces.

# Point and Shoot Cameras

- Point-and-shoot (PAS) cameras are generally the most simple of modern cameras. The most basic PAS cameras have fixed focal length lenses, non-adjustable apertures, and a basic shutter design. More advanced PAS cameras may incorporate zoom lenses, variable apertures, and a combination of mechanical focal-plane shutters and electronic shutters.
- Therefore, the light path through a PAS camera is very simple. To see the light that is coming through the lens, the digital PAS camera will have an electronic screen at the rear of the camera that shows the true image impacting the image plane. Or, on some digital and film PAS cameras, there is a separate optical viewfinder that, when you look through it, displays a representation of the lens's field of view.
- Today, there are several genres of PAS cameras ranging from pocket sized to superzooms, and there are newer PAS cameras that feature larger digital sensors, but they then often become a less 'compact' camera. Some PAS cameras are built to be water-, freeze-, dust-, and shockproof. Smartphone cameras are, in fact, very tiny PAS cameras.

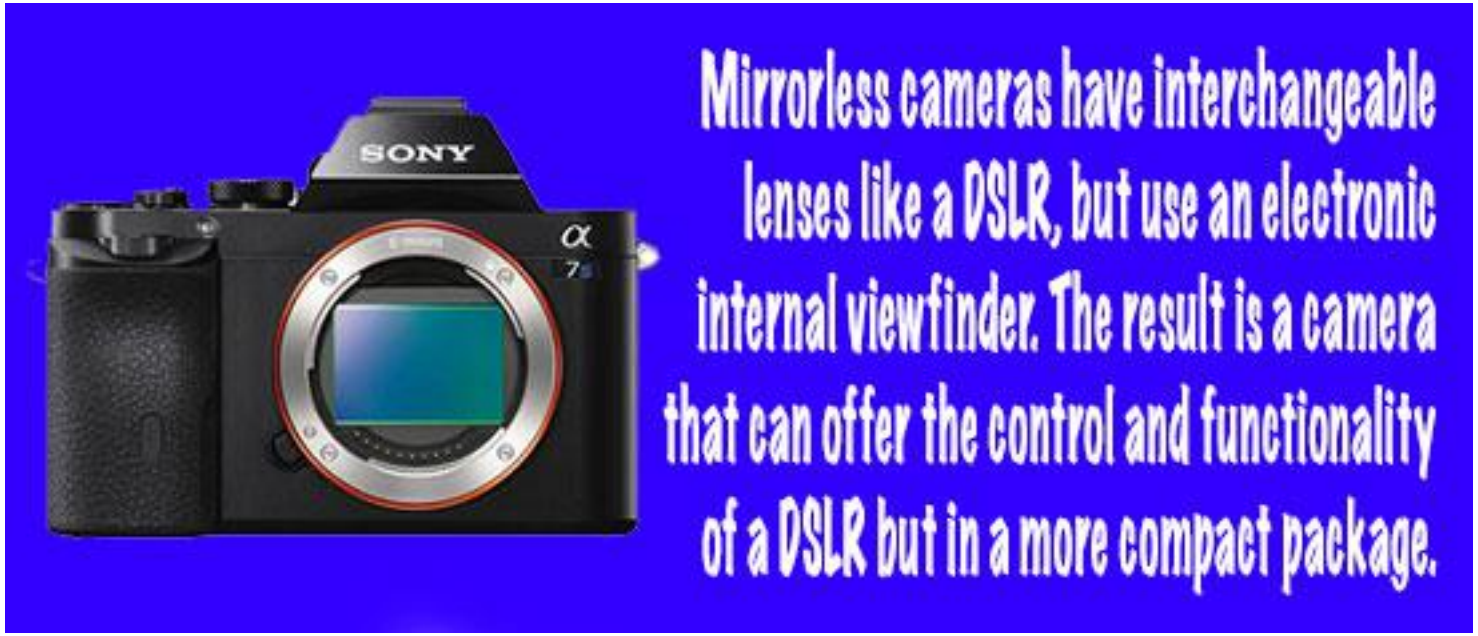
# Point and Shoot camera



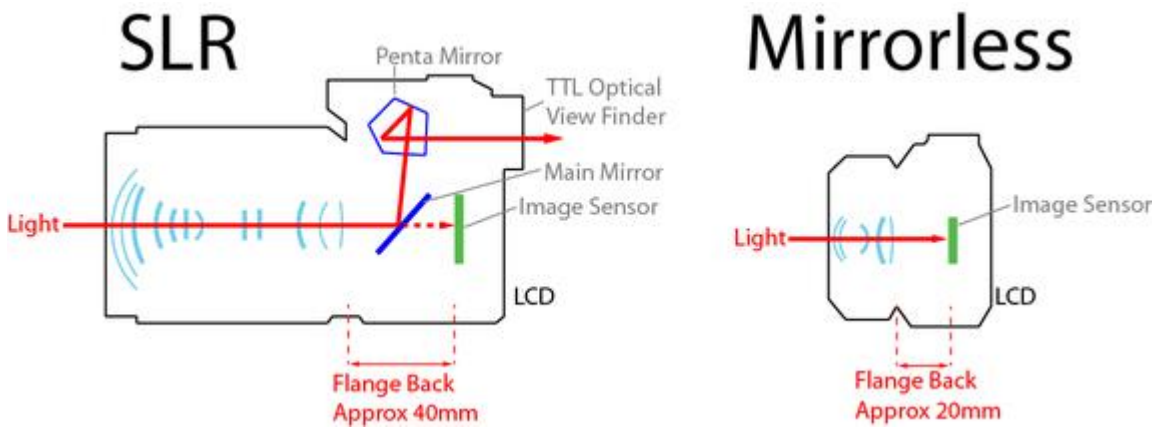
# Mirrorless or CISC Cameras

- Today's digital mirrorless cameras, also known as compact interchangeable-lens system cameras (CISCs), have identical optical paths as PAS cameras, with the exception of having lenses that can be removed and replaced with other lenses of different focal lengths.
- The term "mirrorless" comes from the fact that the cameras have similar functionality to DSLR cameras in that they can change lenses, but do not contain the reflex mirror and optical viewfinder that define the SLR.
- Mirrorless cameras can also feature electronic viewfinders (EVFs) and LCD screens, whilst some have optical viewfinders. (Think Leica!) However, unlike SLR cameras, the optical viewfinders on the mirrorless camera do not look directly through the camera's lens.

# Mirrorless or CISC camera



# D-SLR and CISC camera comparison



# Finally, the SLR or DSLR

- One of the primary benefits of the SLR camera is the ability to look through the camera's lens to see exactly what the film or sensor will be seeing when the shutter is opened. How does the SLR "interrupt" the light and redirect it to a viewfinder?
- The light path to the image plane is similar to that of other cameras, but in between the lens and the shutter lies a mirror that blocks the light from reaching the shutter. This is the reflex mirror (the "R" in SLR). Light enters the lens and then strikes a silvered mirror inside the camera housing. It is reflected up toward a glass pentaprism at the top of the camera which flips it left to right and top to bottom and directs it toward the rear of a camera through an optical viewfinder. Below the pentaprism is a focusing screen that can superimpose information over the image.
- In 'entry level' DSLRs the glass pentaprism is often replaced by a hollow metal pentamirror. This is cheaper and lighter but produces a less bright image in the viewfinder.

# Using an SLR or DSLR

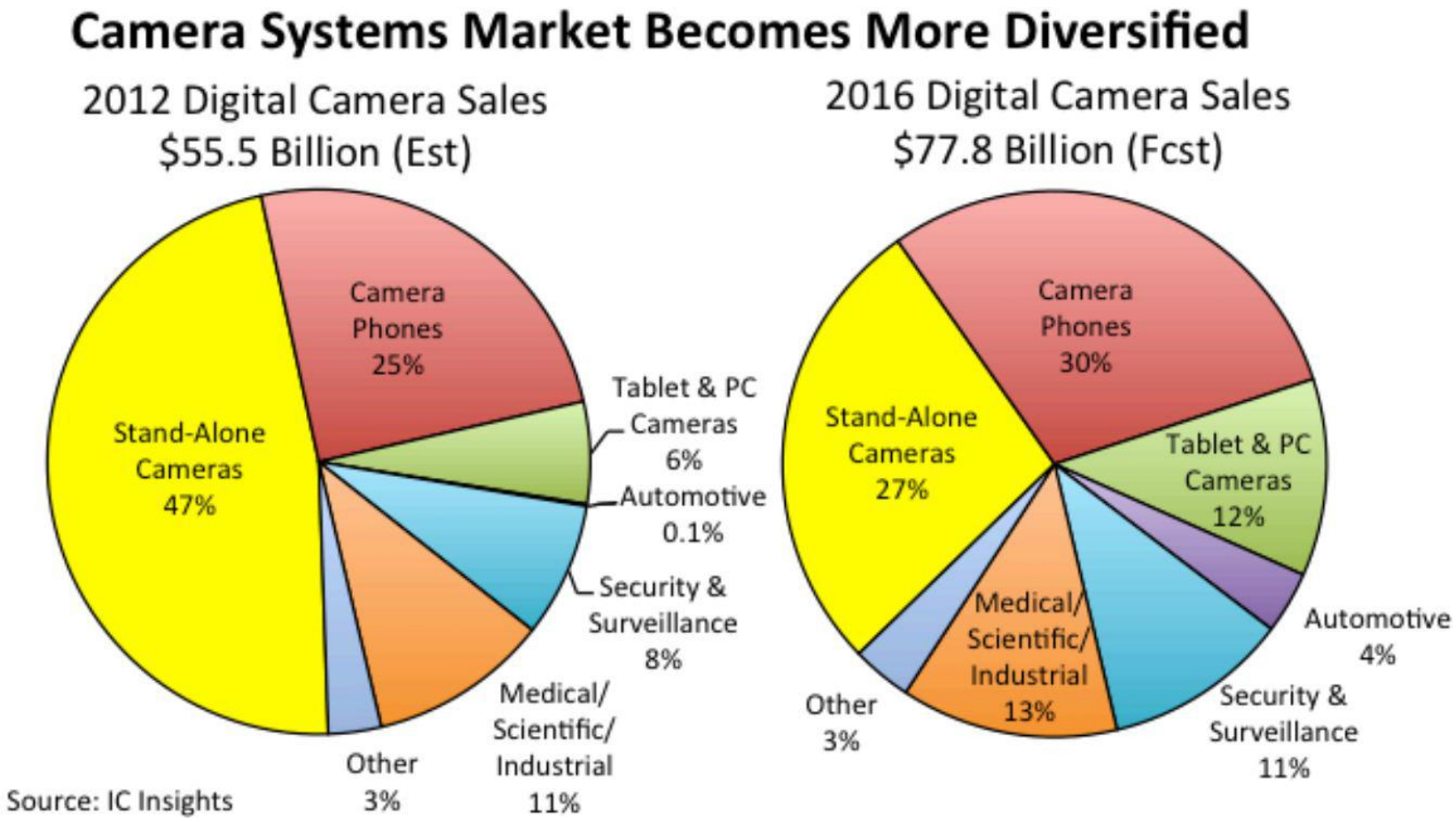
- The photographer composes the image through the viewfinder, and when the shutter release is depressed, that mirror flips up, out of the light's path, the shutter opens, and then the light travels to the image plane.

- When it comes to manual focus, the SLR is easy. Basically, you just determine focus by looking through the viewfinder as it shows the image that is being transmitted through the lens. Autofocus is more complicated and involves a transparent part of the reflex mirror, a secondary mirror behind the reflex mirror, and autofocus sensors in the bottom of the camera.

# The Future

- Is an unknown country, however economic pressures will likely result in:
- the reduction of the number of PAS cameras as they are replaced by smart phones, this is already happening quite rapidly
- the proliferation of 'advanced' compact (and not so compact) cameras
- the gradual replacement of DSLR cameras by 'Mirrorless' CISCs, even for the likes of Canon and Nikon who are not noted for their rates of innovation in camera design. eg. the Canon EOS M series.
- Significant change in the balance of the overall market place.

# Changes in camera sales over last four years



# Thank you for listening !!

- Don't spend any effort worrying about what I have said just now, simply take good photographs, it is these which you will keep and get pleasure from the memories which they will evoke.
- The equipment is merely a means to an end.
- Whatever camera you use enjoy using it!