

ADAMBOTS

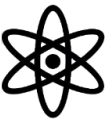
Team 245

**Basic Camera
Training**





Different Type of Shots We Take for Robotics

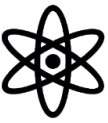


Group shots after winning awards

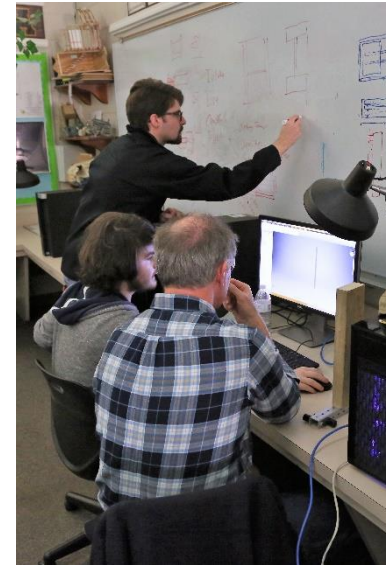




Different Type of Shots We Take for Robotics



Candid shots in the pits, stands, or build room

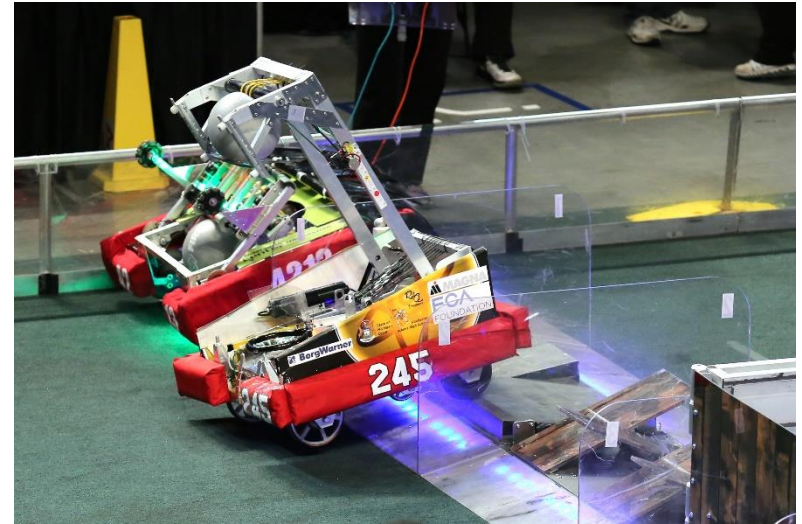
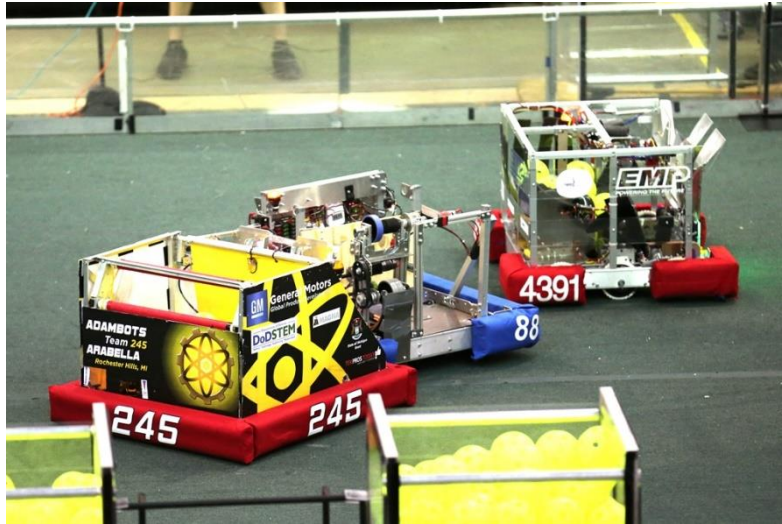




Different Type of Shots We Take for Robotics

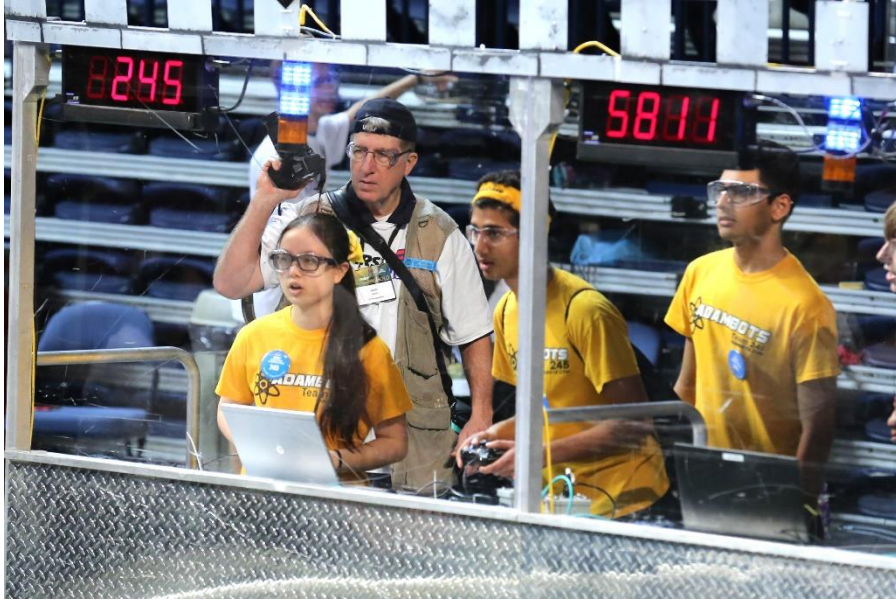


Shots of robot on the field



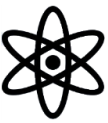
⚛️ Different Type of Shots We Take for Robotics ⚛️

⚛️ Shots of team on the field and/or stands





Different Type of Shots We Take for Robotics

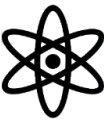


✧ Shots of team members dancing





Fundamental Function of a Camera

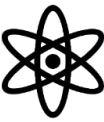


A Camera has 2 fundamental functions:

- Deliver light (or total photons) from subject image to photo sensor that is correct for sensitivity settings of sensor to provide a proper Exposure
- Ensure light from image is properly focused at plane of photo sensor



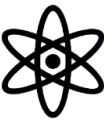
Taking Pictures at Robotics Events



- ✿ **Photographing robotic competition events is often a difficult task**
 - **Lighting is often dark and is not uniform**
 - **Robots are a “Moving target”**
 - **People are often not standing still**
 - **Often cannot get that close to where the action is**
- ✿ **These conditions often make it difficult to take good pictures**



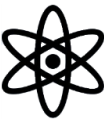
Basic Camera Settings



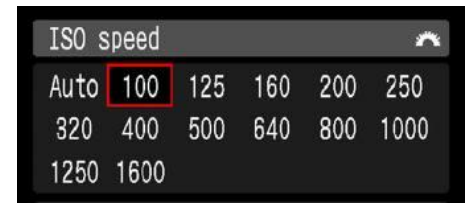
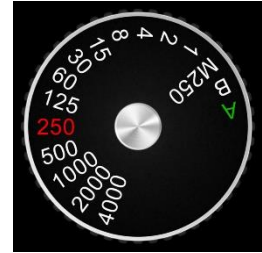
- ✿ **Need to select camera settings that are best for each type shot**
- ✿ **Basic Camera Settings:**
 - Shutter Speed
 - Aperture or size of opening for light
 - ISO Speed or light sensitivity
 - Focus distance
- ✿ **These basic camera settings combine to control exposure for the image and provide a sharp image to the photo sensor**



Photographic Exposure:

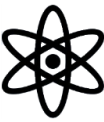


- ✿ **Exposure of a photograph is proper when amount of light gathered from target image matches sensitivity setting of photo sensor**
- ✿ **Independent variables for exposure**
 - **Shutter speed:**
 - Controls amount of time light is delivered to the sensor
 - **Lens Aperture:**
 - Controls area that light passes through on its way to the sensor
 - Referred to as the f-Stop setting
 - **Sensitivity of the Sensor:**
 - Controls how much light is required to deliver a proper electronic charge from the sensor itself





Photographic Exposure: Analogy

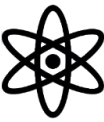


- ✿ **Fill a 2 Gallon container with water from a hose**
- ✿ **Can deliver 2 Gallons of water with any combination of these 3 independent factors:**
 - **Hose diameter** **Analogous to Aperture or F-Stop**
 - Larger diameter hose will reduce time needed to fill the bucket
 - **Water velocity** **Analogous to Sensitivity of Sensor**
 - Higher water velocity will reduce time required to fill the bucket
 - **Time water valve is open** **Analogous to Shutter Speed**
 - Time water valve is open depends on combination of previous factors to achieve 2 gallons in the bucket





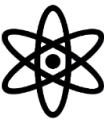
Photographic Exposure: Analogy



- ✳️ **Any combination of factors will deliver 2 Gallons of water to bucket with same end result**
- ✳️ **Any combination of camera shutter speed, f-Stop, and sensor sensitivity can also deliver same amount of light to the sensor.....**
- ✳️ **But resulting image captured by the sensor is significantly impacted by specific values of above 3 independent variables**
- ✳️ **Key to taking good photos is choosing camera settings that best match the subject you want to capture**
 - This requires:
 - Knowing impact changing photo settings have on resulting photo image
 - Knowing technical limitations of your camera
 - Knowing how minimum shutter speed that is appropriate for the photo you are going to take



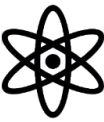
Exposure Variables: Shutter Speed



- ✿ **This is simply amount of time shutter is open allowing light to fall on the sensor**
- ✿ **Range of shutter speeds provided by most cameras:**
 - Fastest: Up to 1/2000th of a second
 - Slowest: As long as you hold the shutter button (Called Bulb)
- ✿ **Key consideration for selection of shutter speed**
 - Both Subject and Camera must remain still for time shutter is open
 - Movement of either subject of camera will give you a blurry image



Exposure Variables: Limits on Shutter Speed



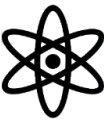
✱ **It is difficult for a person to hold a camera steady in their hands for shutter speeds below $1/30^{\text{th}}$ to $1/60^{\text{th}}$ of a second with a “normal” 50 mm focal length lens**

- Shooting hand held at speeds below this will most likely produce a blurry image with camera shake noticeable in image
- Can mount camera on a tripod to steady camera that can allow shooting at speeds slower than $1/30^{\text{th}}$ of a second if subject in your image is not moving
 - Good for studio based portraits and landscape images, but not good for action shots where your subject is moving





Exposure Variables: Limits on Shutter Speed



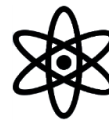
* Focal length of lens being used for photo also impacts minimum acceptable shutter speeds

- Higher zoom magnification settings (200, 400, 600 mm effective focal length) make it more difficult to hold the camera steady enough to produce a sharp image
 - Any hand shake with a 50 mm lens will be magnified 8x if shooting at a 400 mm lens
 - This shows up in the resulting image
- Rule of thumb is not to use a shutter speed below 1 over the focal length:
 - Minimum recommended shutter speeds with a 300 mm lens should be $1/300^{\text{th}}$ of a sec
 - Minimum speeds for a 50 mm Lens would be $1/50^{\text{th}}$ of a second
- A tripod can allow slower shutter speeds with a higher zoom rates but....
 - Tripods are not immune to introducing camera shake at higher zooms
 - Your finger releasing the shutter can introduce shake on a tripod mount

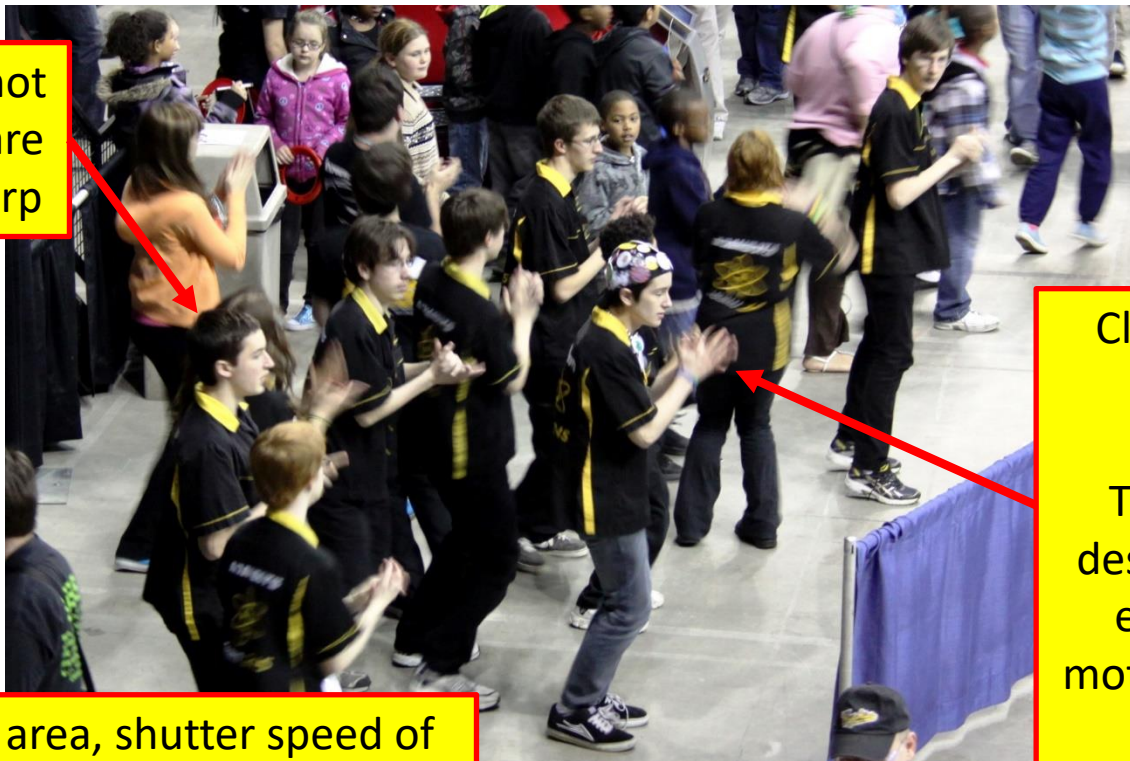




Example of Shutter Speed Too Slow for Action



Heads were not moving and are relatively sharp



Clapping hands are a Blur

This is okay if this is desired effect but is an example of subject motion in with a shutter speed too slow

Team in Dark area, shutter speed of $1/25^{\text{th}}$ needed to make exposure



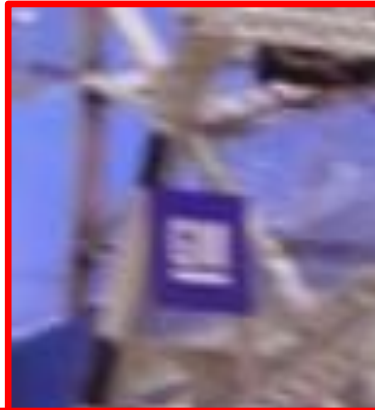
Example of Camera Shake at 100 mm Focal Length Zoom



1/150 Sec



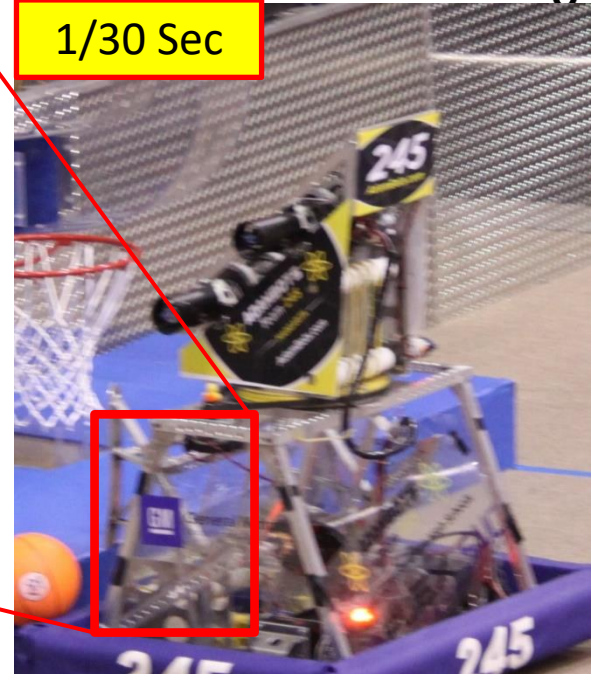
Sharp Focus + Steady Camera Platform + Higher Shutter Speed



Top & Bottom of bar Under GM and G Itself is More sharp than side edges

Focus issue would give equal blur on both axes

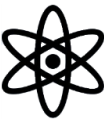
1/30 Sec



Camera Shake on Horizontal Axis: Zoom Too high, 1/30th Shutter Speed is too slow



Exposure Variables: Limits on Shutter Speed



✿ **Can capture crisp images of moving subjects with slower shutter speeds if you Pan, or move camera following movement of the subject**

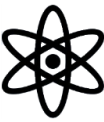
- Works best if subject is moving across your field of view
 - Does not work if your subject is moving towards or away from you where distance changes for period when the shutter is open
- Panning gives an image where moving subject remains sharp and in focus but objects in the non-moving stationary background are blurred
- Panning requires a steady hand along the horizontal axis while twisting middle of your body along the vertical axis
 - Practice is required to deliver a proper image when panning with a subject



Panning Shot:
Body of Robot is Sharp
Wheel Spokes are Blurred
Background is Blurred



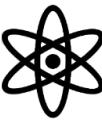
Example of a Bulb Shot



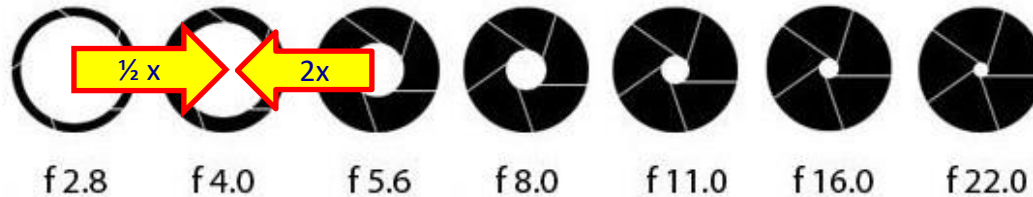
- ✿ **Bulb Exposure keeps the shutter open for as long as the shutter button is depressed**
- ✿ **Often used for shots of fireworks:**
 - Dark background that will not show detail
 - Cannot determine when firework will explode
 - Camera on Tri-pod
 - High f/stop value for good depth of field
 - Aim camera where fireworks are expected, open shutter with Bulb, and release after firework fades



Exposure Variables: f/Stop or Aperture



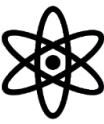
- * f/Stop or Aperture identifies amount of light gathering capability of the lens
- * Every camera lens has an Iris inside that functions same way as Iris in your eye controls diameter of your pupil
- * f/Stop is defined as Ratio of Focal length of lens divided by Diameter of opening in the lens



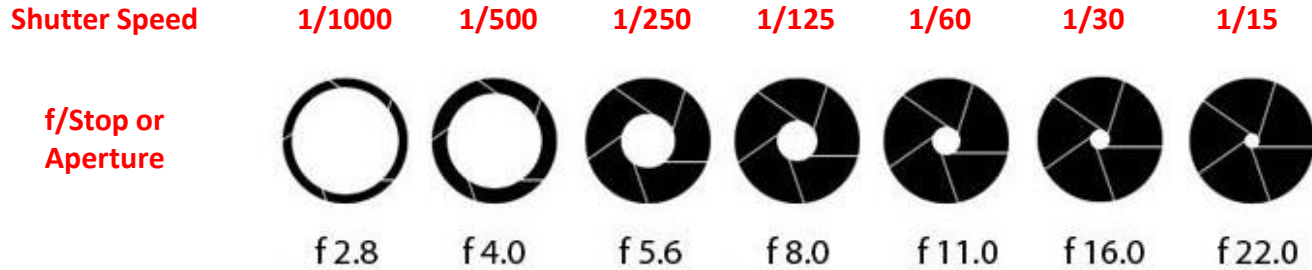
- * f/Stop number sequence above relates to a 50% decrease in light gathering capability for the setting to the left
 - f/4.0 lets in 2x more light as f/5.6
 - f/4.0 lets in 1/2 the light as f/2.8



Exposure Variables: Equal Light Combinations of Shutter Speed and Aperture



- ✳️ These combinations of shutter speed and aperture allow same amount of light to hit the camera sensor

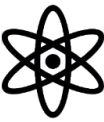


- ✳️ However, Image result for same subject taken with f 2.8 will look much different than one taken with f/22

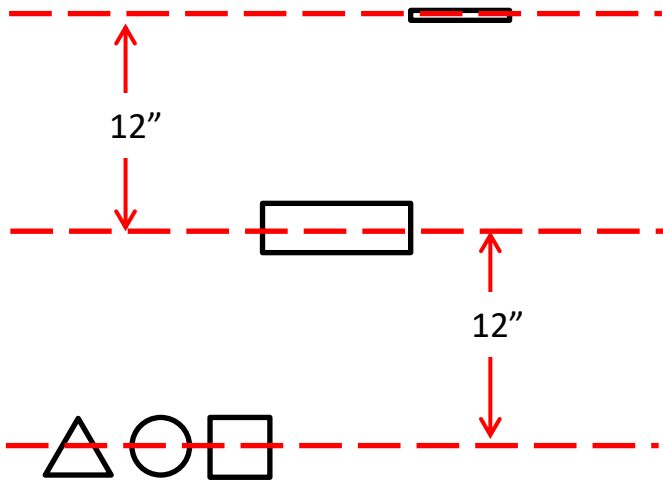
- Amount of image that remains in focus will vary with changing f/stop
- This is called depth of field



Depth of Field Example:



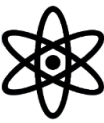
✱ Test Set up with 3 targets in view



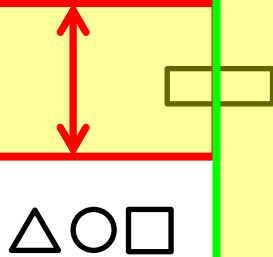
75 mm Focal length Lens at 6 Feet distance to Middle target



Depth of Field: f2.8 vs f22



* Focus point is on square trophy in the middle



f2.8 Very narrow depth of field
FIRST Award and Medal are out of focus

F22 Very deep depth of field
All targets are in focus



Depth of Field for f/Stop and Focal Length can be Calculated



Depth of field calculators available on the internet

Camera type needed to identify size of sensor

Focal length of lens

Selected f/stop

Distance to subject

Camera, film format, or circle of confusion Canon 5D (Mark II, Mark III)		Subject distance 12 ft
Focal length (mm) 50	Selected f-stop f/11	Depth of field
Subject distance 12 feet	<input type="button" value="Calculate"/>	Near limit 8.05 ft Far limit 23.5 ft Total 15.5 ft
		In front of subject 3.9 ft (26%) Behind subject 11.5 ft (74%)
		Hyperfocal distance 24.3 ft Circle of confusion 0.03 mm

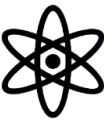
Closest In Focus Distance

Farthest In Focus Distance

Range of Sharp Focus



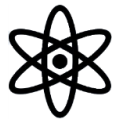
Use of f/Stop to Control Depth of Field



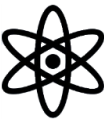
✿ **Selecting aperture to control depth of field is a tool in creative tool box of the photographer**

- Portrait with face in focus but background in soft focus is achieved by using a lower f/stop value
- This automatically shifts attention to subject's face in the photo as opposed to softer elements in the out of focus background





Use of f/Stop to Control Depth of Field



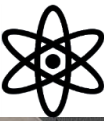
✿ **Selecting aperture to control depth of field is a tool in creative tool box of the photographer**

- A photo of couple standing in front of an interesting landscape or structure is shot with a larger f/stop value
- Subject of this photo is both the couple and background and both need to be in focus for the photo to be successful

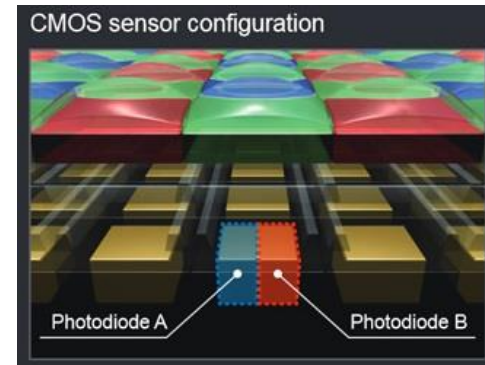
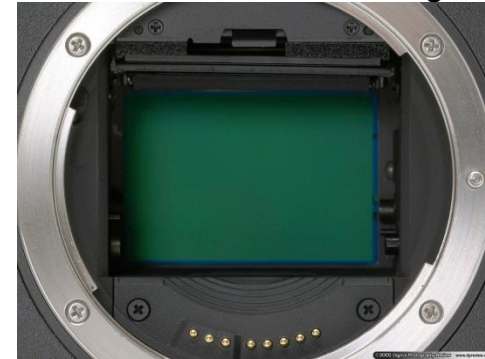


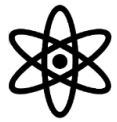


Exposure Variables: Photo Sensor

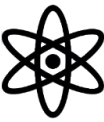


- ✳️ **Photo sensor is a Semi-Conductor based device called a CCD (Charge-Coupled Device) or a CMOS (Complementary Metal-Oxide Semiconductor)**
 - Both sensor types convert light into electrons
- ✳️ **CCD area is divided into millions of unique Pixel sensor groups**
- ✳️ **Each pixel sensor group has a Red-Blue-Green sensor that delivers a stream of electrons proportional to RGB content of the light**
- ✳️ **Sensitivity of Pixel sensor can be changed to require less light to deliver the same RGB electric charge**





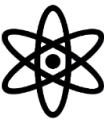
Exposure Variables: Photo Sensor Sensitivity



- ✳️ **Photo sensor sensitivity is adjusted by changing amplification of charge received from individual pixel groups**
 - Amplification of signal from sensor is not a perfect process
 - Noise levels of signal at high amplification levels degrade image quality
- ✳️ **Amount of image quality reduction is unique to each camera hardware**
- ✳️ **Amplification of higher price/content cameras is better and improves image quality for higher sensitivity settings**
 - Each camera has a unique maximum sensitivity setting that will deliver acceptable image quality for Non-Cropped images
 - This varies from camera to camera



Exposure Variables: Photo Sensor Sensitivity



- ✱ **ISO Speed settings of camera controls amplification factor for light hitting the sensor**
- ✱ **Higher ISO speeds indicate a higher sensitivity or amplification factor for the sensor**
 - A doubling of ISO speed is a doubling of sensitivity
- ✱ **ISO speed settings for majority of cameras:**

100 200 400 800 1600 3200 6400 12800

Lower End Cameras
May not Offer these
ISO Speeds

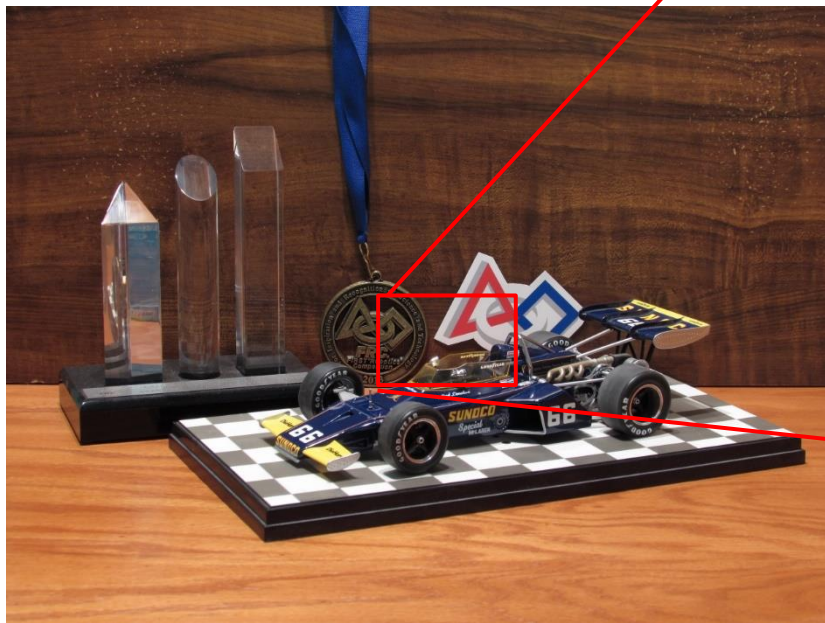
- ✱ **ISO Speeds work with shutter speed and f/stop to manage light and adjust to achieve proper exposure**



Image at 100 ISO



Full Frame Image



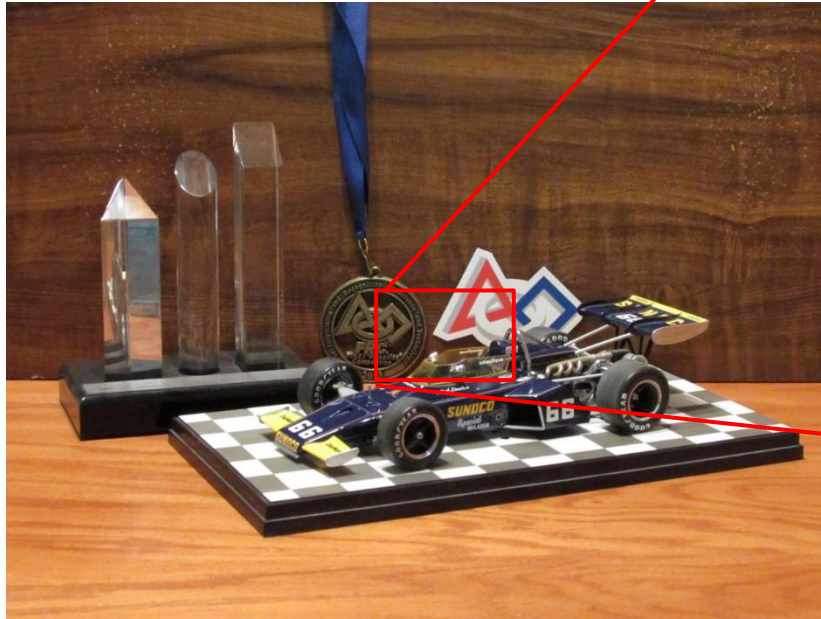
Zoomed Portion



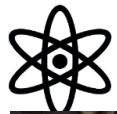
Image at 3200 ISO



Full Frame Image



Zoomed Portion



Comparison of Zoomed Images at 100 and 3200 ISO



100 ISO

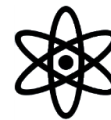


3200 ISO

Full Frame images may be acceptable at 3200 ISO, but image at higher zoom/crop range may not be acceptable



Constant Exposure Combinations of ISO Speed, Shutter Speed and f/Stop for Same Lighting

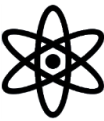


Combinations of f-Stop, Shutter Speed, and ISO-Speed for a consistent Exposure for the Same Lighting					
Constant ISO-Speed of 400		Constant Shutter Speed 1/250		Constant f-Stop of 8.0	
f-Stop	Shutter Speed	f-Stop	ISO-Speed	Shutter Speed	ISO-Speed
2.8	1/2000	2.8	50	1/30	50
4.0	1/1000	4.0	100	1/60	100
5.6	1/500	5.6	200	1/125	200
8.0	1/250	8.0	400	1/250	400
11	1/125	11	800	1/500	800
16	1/60	16	1600	1/1000	1600
22	1/30	22	3200	1/2000	3200
32	1/15	32	6400	1/4000	6400

Any Combination of f/Stop, Shutter Speed, and ISO Speed from this table will provide the same exposure value



All Light is not Created Equal: Color Temperature



* Light from different sources has different color temperature

- Incandescent lights provide a yellow / orange or warm light
- Fluorescent lights provide a cooler more white type light
- Sunlight gives a much whiter spectrum

* The human eye somewhat compensates for different color temperatures and delivers a filtered image to the brain

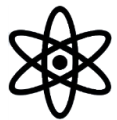
- Colors appear "Normal" under most lighting conditions

* Sensor in camera captures light as it is and raw image from sensor will have a different color tone depending on color temperature of the light

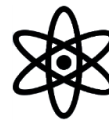
* Cameras have built in filters that compensate for known color temperature conditions and deliver an image with natural image color balance

* Must select the proper color balance for color temperature illuminating the source

Temperature	Source
1700 K	Match flame, low pressure sodium lamps (LPS/SOX)
1850 K	Candle flame, sunset/sunrise
2400 K	Standard incandescent lamps
2550 K	Soft white incandescent lamps
2700 K	"Soft white" compact fluorescent and LED lamps
3000 K	Warm white compact fluorescent and LED lamps
3200 K	Studio lamps, photofloods, etc.
3350 K	Studio "CP" light
5000 K	Horizon daylight
5000 K	Tubular fluorescent lamps or cool white/daylight compact fluorescent lamps (CFL)
5500 – 6000 K	Vertical daylight, electronic flash
6200 K	Xenon short-arc lamp ^[3]
6500 K	Daylight, overcast
6500 – 9500 K	LCD or CRT screen



Built in Color Temperature Settings:



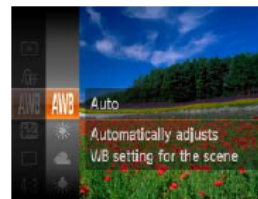
- ✿ Cameras have built in color temperature settings to use when shooting in different lighting
- ✿ AUTO mode generally produces good results
- ✿ Example photos on next slide show difference in color balance for Incandescent or Tungsten light conditions when shot using different built-in filters


Still Images








Movies

Adjusting White Balance

By adjusting white balance (WB), you can make image colors look more natural for the scene you are shooting.



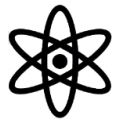
- Press the  button, choose [AWB] in the menu, and choose the desired option (p.22).
- The option you configured is now displayed.

 AWB	Auto	Automatically sets the optimal white balance for the shooting conditions.
	Day Light	For shooting outdoors in fair weather.
	Cloudy	For shooting in cloudy conditions, in the shade, or at twilight.
	Tungsten	For shooting under ordinary incandescent (tungsten) lighting and similarly colored fluorescent lighting.
	Fluorescent	For shooting under warm-white (or similarly colored) or cool-white fluorescent lighting.
	Fluorescent H	For shooting under daylight fluorescent and similarly colored fluorescent lighting.
	Custom	For manually setting a custom white balance (p.57).

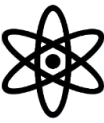


Built in Color Temperature Settings Under Tungsten Light



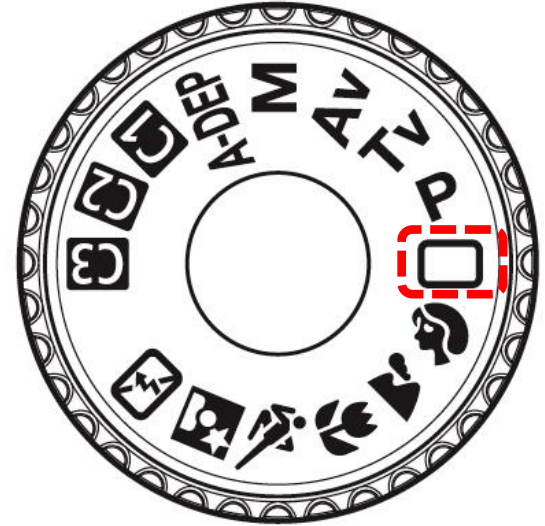


Available Exposure Modes on Most Cameras



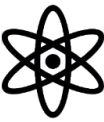
❁ AUTO:

- Camera selects speed, f/Stop, ISO-Speed based on light levels, focus distance, and focal length based on pre-programmed optimum setting map
- User has no control over other functions of the camera in AUTO mode
- This is true “Point and Shoot” mode



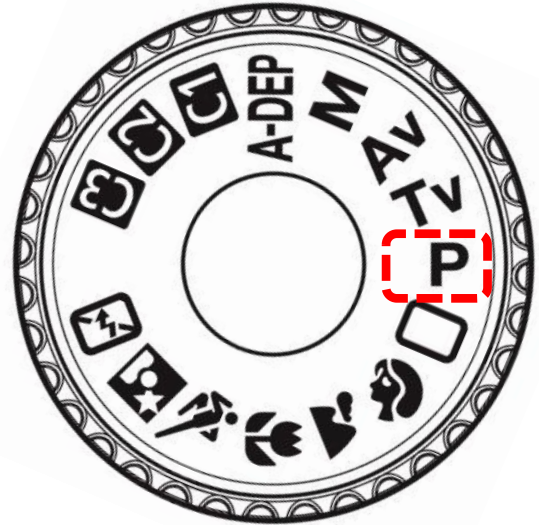


Available Exposure Modes on Most Cameras



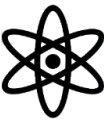
P or Program:

- Allows user control over white balance, ISO-Speed, Flash
- Shutter speed and f/Stop settings are selected based on optimum programmed settings
- This is partial “Point and Shoot” mode offering some freedom for the user



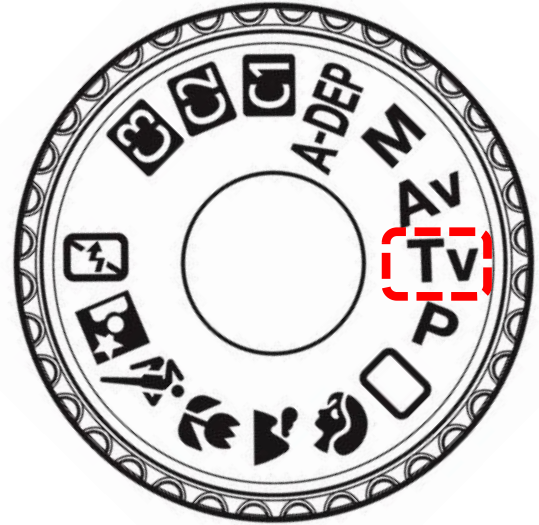


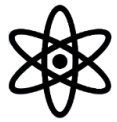
Available Exposure Modes on Most Cameras



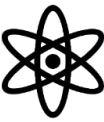
✱ Tv or Shutter Priority:

- User selects shutter speed and aperture automatically adjusts for proper exposure
- User has control over all settings other than aperture



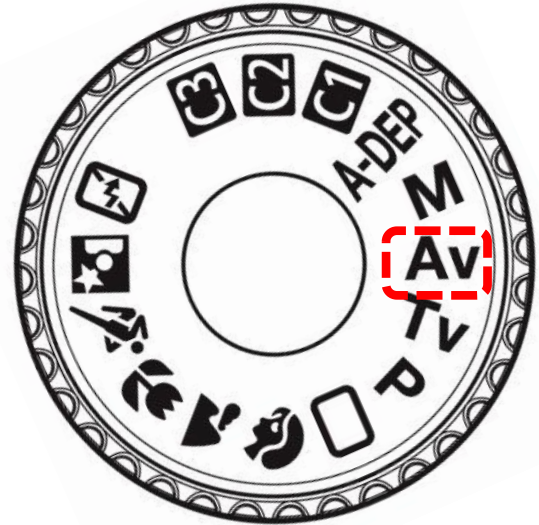


Available Exposure Modes on Most Cameras



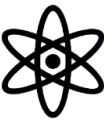
⚙️ Av or Aperture Priority:

- User selects f/stop and shutter speed automatically adjusts for proper exposure
- User has control over all settings other than shutter speed



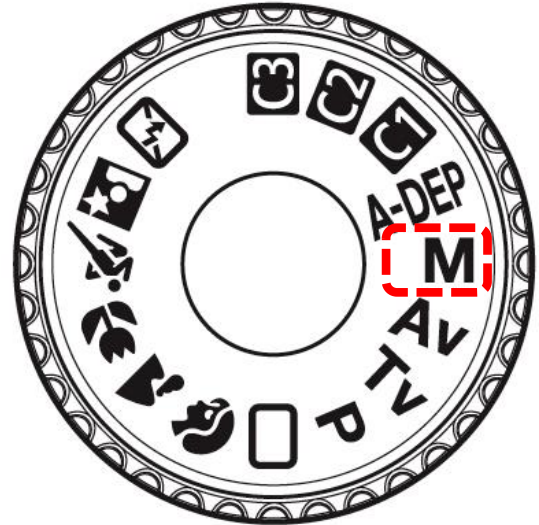


Available Exposure Modes on Most Cameras



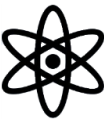
❁ Manual Setting of both Shutter Speed and Aperture:

- User selects f/stop and shutter speed automatically adjusts for proper exposure
- User has control over ALL settings



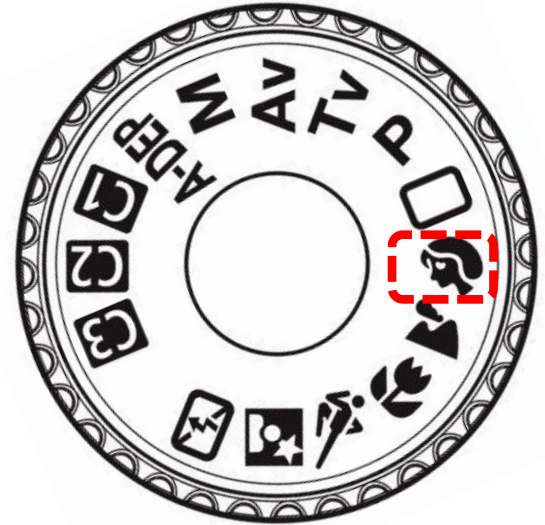


Available Exposure Modes on Most Cameras



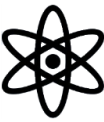
Portrait Mode:

- Drives exposure towards larger opening, lower f/Stop openings to blur background
- User has control over limited settings





Available Exposure Modes on Most Cameras



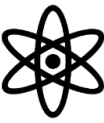
✿ Landscape Mode:

- Drives exposure towards smaller opening, larger f/Stop openings to blur background
- User has control over limited settings





Available Exposure Modes on Most Cameras



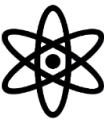
Macro Mode:

- Enables focus at smaller distance for extreme close-ups based on limitations of lens
- User has control over limited settings



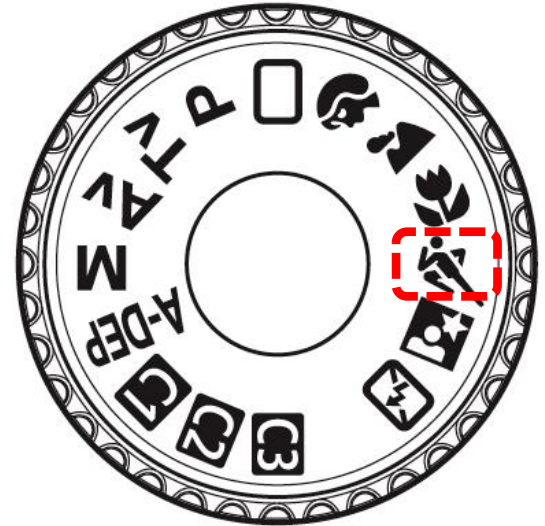


Available Exposure Modes on Most Cameras



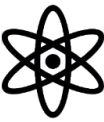
Sports/Action Mode:

- Drives exposure towards faster shutter speeds and smaller f/Stop values to freeze motion and increase depth of field
- User has control over limited settings





Available Exposure Modes on Most Cameras



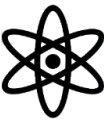
❁ Backlight Mode:

- Engages flash at reduced power settings to illuminate face of subject when posed in front of a lighter background
- User has control over limited settings



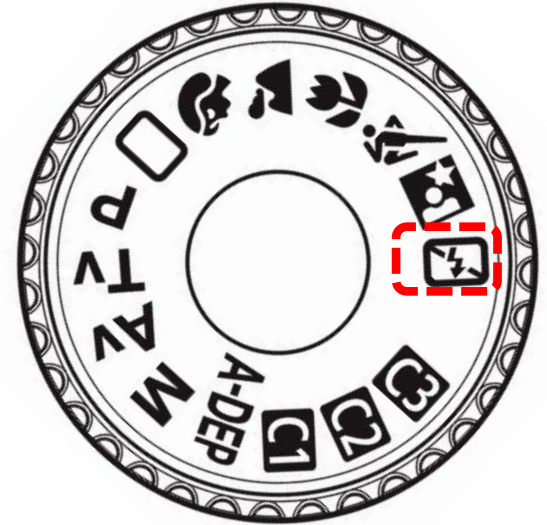


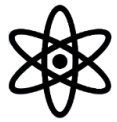
Available Exposure Modes on Most Cameras



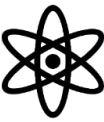
No Flash Mode:

- Suppresses flash in darker settings to allow increased flexibility of exposure
- User has control over limited settings





Examples of Issues with Exposure:



Photos can be either Under-Exposed, Over-Exposed, or will have correct exposure for the image

➤ Under-Exposed images:

- Image is much darker than desired
- Not enough light hitting the sensor, or sensor sensitivity was too low for light conditions

➤ Over-Exposed images

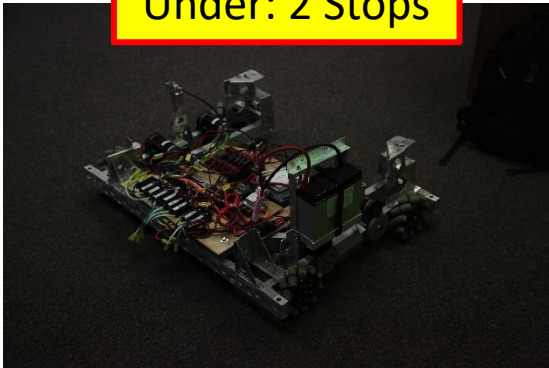
- Image is much lighter than desired
- Too much light hitting sensor that overloads circuit and image quality falls



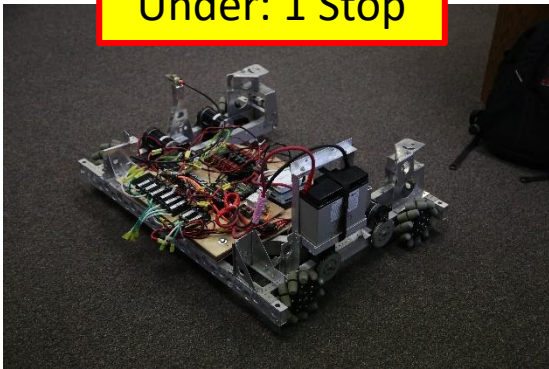
Over and Under Exposure:



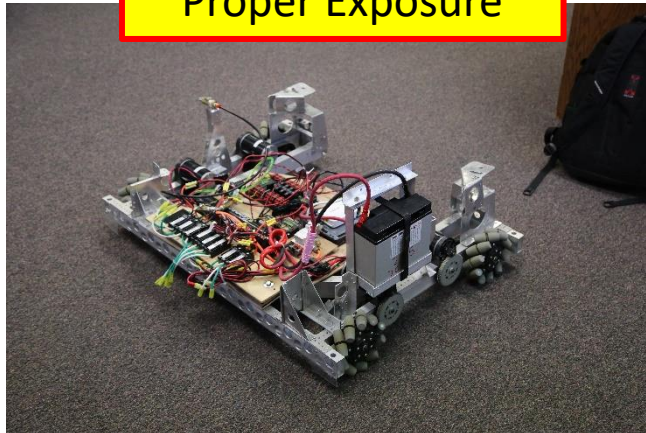
Under: 2 Stops



Under: 1 Stop



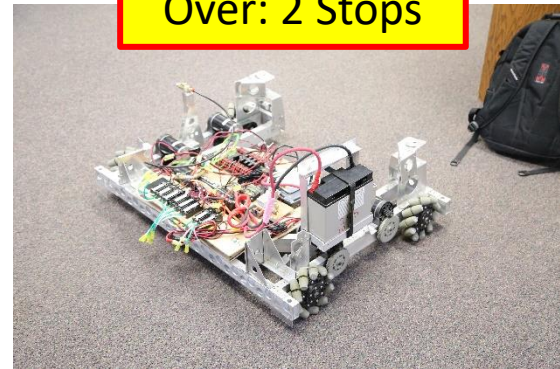
Proper Exposure



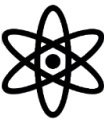
Over: 1 Stop



Over: 2 Stops



Shooting with Flash

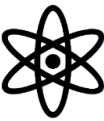


- ✿ **Flash can be used to provide/enhance illumination when ambient lighting is not sufficient**
- ✿ **Can use built in flash or separate flash units attached to hot shoe mount on top of the camera**
 - Built in flash typically have lower light capacity
 - These sometimes “Pop Up” automatically based on camera settings when ambient light is insufficient
 - Stand alone flash units have higher light capability
 - These can function in Auto mode but usually require more attention





Limitation of Built in Flash



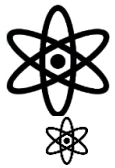
Flip-up flash on cameras usually have limited range



More powerful stand alone flash would wash out subjects in front while subjects in back would be more properly exposed

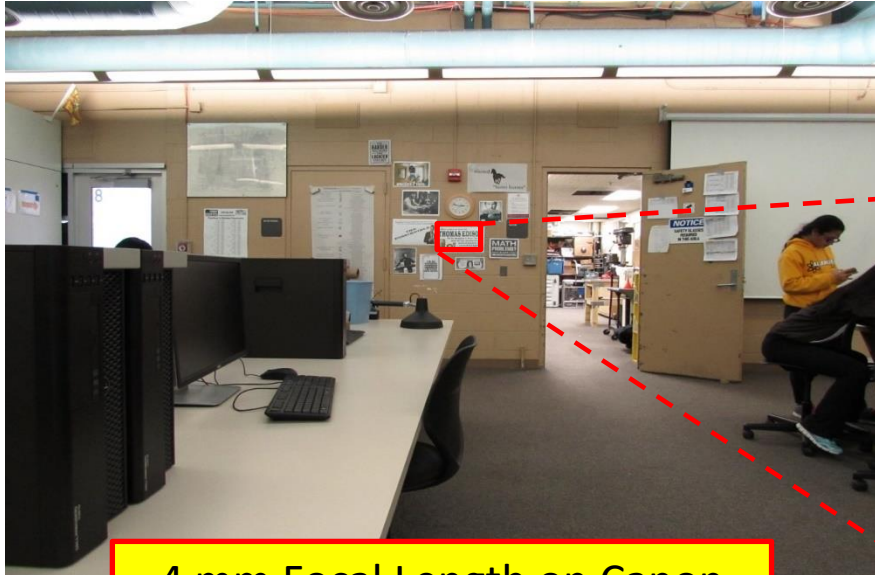


Is usually best to use ambient light



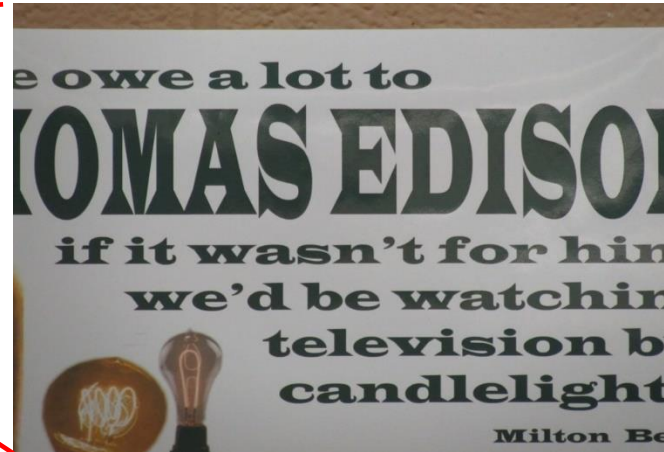
Range of Zoom

Zoom Lens can provide a wide range of telephoto, magnification effect: 25x in this example



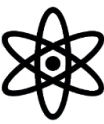
4 mm Focal Length on Canon SX510HS: Widest Angle

129 mm Focal Length on Canon SX510HS: Max Optical Zoom





Lighting is the Primary Consideration for Taking Photos



Must always be aware of lighting when taking photos



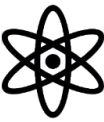
Outdoor settings utilizes the Sun

- Take photos with the sun behind you for the best composition
- This can sometimes make it difficult on your subjects.....





Picture Taking Technique: Avoiding Camera Shake



✿ **Make sure shutter speed is appropriate to avoid camera shake**

✿ **Follow rule of Thumb:**

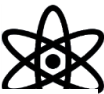
- Shutter speed should be not slower than 1/focal length
 - 100 mm focal length should use shutter speed faster than 1/100th
- Don't shoot slower than 1/60th when Handheld unless taking extra care to steady the camera



Proper Technique for an SLR



Picture Taking Technique: Avoiding Camera Shake



Your stance will impact how still you can hold the camera

- Stand with your feet apart, elbows/arms locked against your body, and camera against your face while looking through viewfinder

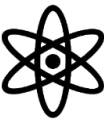


pixelpluck.com

Somewhat more difficult if camera does not have a viewfinder and uses the screen on back to compose your image



Picture Taking Technique: Avoiding Camera Shake



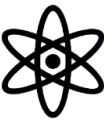
Steady your body by leaning against a wall or fixed feature if lighting is low and a slow shutter speed is only way to get an acceptable exposure

- Stand with elbows resting on a steady, fixed object





Exposure Variables: Recommended Shutter Speed

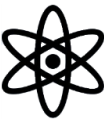


✿ Recommended shutter speeds for these conditions:

- **Posed group shots: 1/80th to 1/150th**
 - Subject is not moving and these speeds will freeze smaller movements of subject people and is easy for you to keep the camera still
 - Also allows a higher f-stop value that increases depth of field to keep all rows of the group in focus
- **Candid People Shots: 1/100th to 1/200th**
 - People are often not purposefully holding still for candid shots and a higher shutter speed is better for freezing their motion
 - Timing to catch the “moment” for candid shots often occurs with little notice and a faster shutter speed allows you to capture the moment without taking time to purposely
Calm yourself to minimize camera shake
 - Also applies to reaction shots of drive team when shooting with the media pass allowing closer access to the field



Exposure Variables: Recommended Shutter Speed



Recommended shutter speeds for these conditions:

- **Action shots of robots on the field using a shorter focal length zoom setting: $1/200^{\text{th}}$ to $1/300^{\text{th}}$**
 - **Robot is moving and you need to freeze movement to get a sharp image**
- **Any shots using longer zoom lens: $1/300^{\text{th}}$ to $1/500^{\text{th}}$**
 - **Need to freeze action on the field but also need to account for minimizing camera shake at longer focal length lens setting**
 - **Applies to shots of robots on the field and also of people at a longer distance**