# Principles for Photography

1. Camera
2. Filters
3. Photographic materials
4. Processing black-white emulsion
5. Contact printing
6. Projection printing

# 1.1 Lens of Camera

- With the help of sketches, define the following terms:
  - focal length
  - F-number
  - Illuminance
  - Angle of view
  - Resolution power
  - Depth of focus

# LENSES

- Primary function –

gather light rays from object space and bring them to focus in image plane

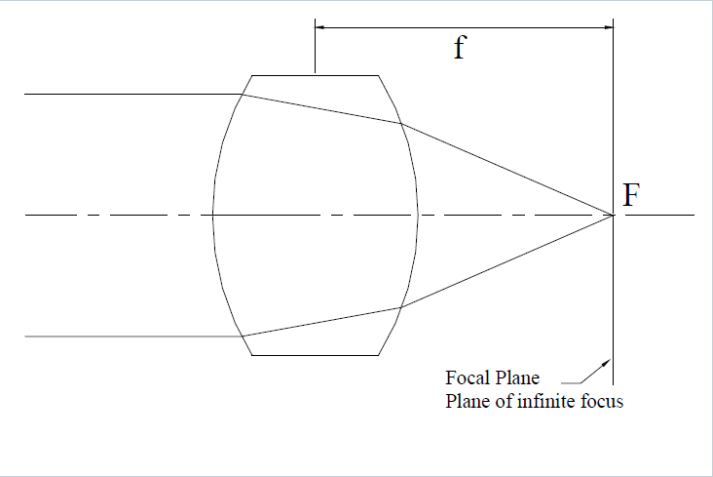
- Employs principles of refraction

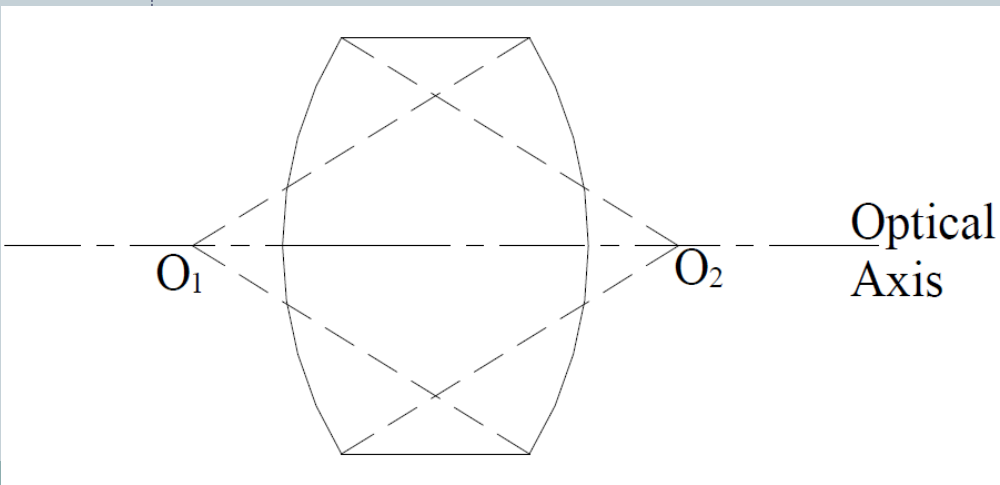
f – focal length

F – focal point of lens

- Optical axis

Line joining centers of curvature of spherical surfaces of lens



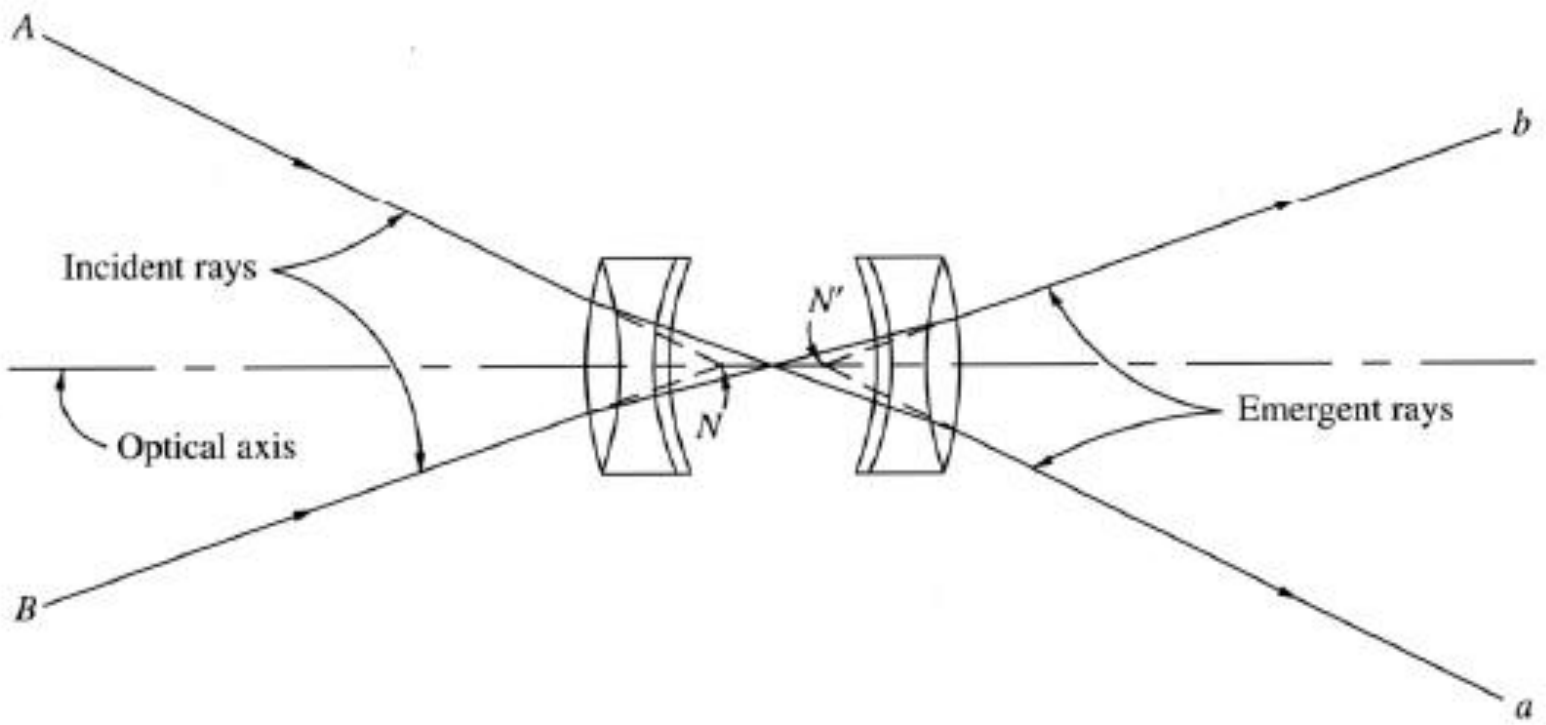



# LENS FORMULA

- Relationship of
- object distance, o,
- and image distance,
- i, to focal length, f,
- of converging lens

$$\frac{1}{o} + \frac{1}{i} = \frac{1}{f}$$

# NODAL POINTS



# RESOLUTION & DEPTH OF FIELD

**Resolution (resolving power)**

- Ability of lens to show detail
- Line pairs or modulation transfer function
- Good resolution important
  - Sharp & clear for precise measurements & accurate interpretative work

**Depth of Field**

- Range in object distance accommodated by lens without introducing significant image deterioration
- Can be increased by reducing aperture
- Shorter focal length – greater depth of field

# ILLUMINANCE

- Brightness or amount of light received per unit area
- Meter-candle (1m·cd) – illumination of standard candle at 1 meter
- Proportional to amount of light passing through lens
- opening during exposure

- Proportional to area of opening

-Area of opening is $(\pi d2)/4$ -- illuminance proportional to $d^2$, the square of diameter of opening

# BRIGHTNESS FACTOR

- Normally, object distances long so $1/o \Rightarrow 0$
- Then i = f and at center, illuminance proportional to $1/f^2$ and the two qualities may be combined so that illuminance is proportional to $d^2/f^2$
- Square root called brightness factor

$$\sqrt{\frac{d^2}{f^2}} = \frac{d}{f} = \text{brightness factor}$$

# f-STOP

- Inverse of brightness factor > f-stop = f/d
- Ratio of focal length to diameter of aperture
- Aperture increase > f-stop number decreases and illuminance increases, requiring less exposure time
- Used for expressing lens speed or “light gathering” power of lens

# APERTURE-SHUTTER RELATIONSHIP

- Exposure time set by shutter speed
- Illuminance regulated by varying f-stop

- Controlled by diaphragm

- Larger diaphragm opening

  - Faster exposures

  -Less depth of field

  - Lens distortion more severe

- Faster shutter speed

- Reduce image motion

- Nominal f-stop settings

  1, 1.4, 2.0, 2.8, 4.0, 5.6, 8.0,11, 16, 22, 32

- F stop of 1-occurs when aperture diameter equals

  lens focal length

- Each succeeding nominal f-stop

  halves aperture

# APERTURE-SHUTTER RELATIONSHIP

- Example: d1 = f, where d1 = aperture diameter

$$\frac{f}{d_1} = 1 = f - \text{stop} \qquad A_1 = \frac{\pi d_1^2}{4}$$

- Aperture reduced to d2

$$A_2 = \frac{A_1}{2} = \frac{\pi d_2^2}{4} = \frac{\pi d_1^2}{2(4)}$$

$$\therefore d_2 = \frac{d_1}{\sqrt{2}} \qquad \text{and} \qquad f\text{–stop} = \frac{f\sqrt{2}}{d_1} = 1\sqrt{2} = 1.4$$

# APERTURE-SHUTTER RELATIONSHIP

**Example**

- Photographic film optimally exposed with f-stop of f-4 & shutter speed of 1/500 sec. What is correct f-stop if shutter speed changed to 1/1,000 sec?

**Solution**

- Total exposure is diaphragm area (Ai) times shutter speed (ti)

$$A_1 t_1 = A_2 t_2 \qquad \Rightarrow \qquad A_2 = A_1 \left( \frac{t_1}{t_2} \right)$$

$$A_1 = \frac{\pi d_1^2}{4} \qquad A_2 = \frac{\pi d_2^2}{4}$$

$$d_1 = \frac{f}{f\text{–stop}} = \frac{f}{4}$$

$$\frac{\pi d_2^2}{4} = \left[\frac{\pi f^2}{4(4^2)}\right]\left(\frac{1/500}{1/1000}\right) = \left[\frac{\pi f^2}{4(16)}\right]\left(\frac{1000}{500}\right)$$

$$\frac{f^2}{d_2^2} = \left[\frac{4(16)}{\pi}\right]\left(\frac{\pi}{4}\right)\left(\frac{500}{1000}\right)$$

$$\frac{f}{d_2} = \sqrt{\frac{(16)(500)}{1000}} = 2.8 = f\text{–stop}$$

# 1.2 shutter assembly

- Consists of:
- Shutter
- diaphram

# 2. Filters

Functions:

- Allow only certain wavelengths of energy through
- lens
- Ex: haze filter blocks haze
- Atmospheric haze ⇒ caused by scattering of ultravioletand short blue wavelengths
- Protects lens

# Types of Filters

1. Colour filters
2. Filter in aerial photography

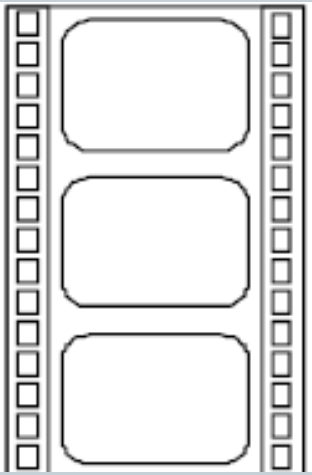
# 3. Photographic Materials

Consists of two parts

1. Sensitive layer (EMULSION)
2. The support

# Emulsion contains light-sensitive silver halide crystals

- When exposed to light, bond between silver & halide weaken
- Emulsion has latent image
- When latent image developed, areas of emulsion exposed to intense light turn to free silver & become black

# 3.1 Properties of photographic materials

A. Photographic properties
B. Physical properties

# 3.1.1 Photographic properties

Sensitometric properties

a) Densisty
b) Contrast
c) Photosensitivity
d) Spectral sensitivitiy of emulsion

# FILM DENSITY

- Degree of darkness of developed emulsion
- Greater density, darker the emulsion
- Found by comparing intensity of light upon film to that which pass through film (transmitted light)

$$D = \log\left(\frac{\text{incident intensity}}{\text{transmitted intensity}}\right)$$

- Intensity of human eye non-linear ⇒ use base 10 logarithm so density nearly proportional to perceived brightness

# CHARACTERISTIC CURVE

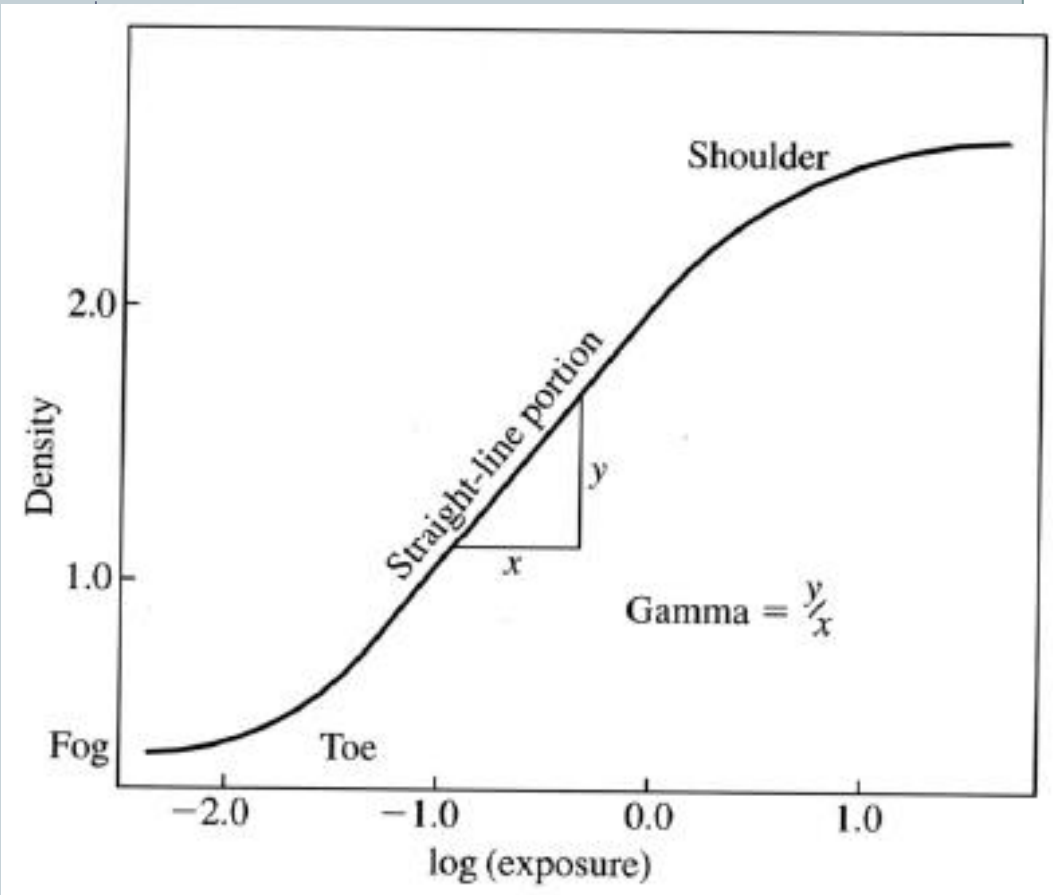
- D-log E curve or H- and D curve
- Plot of density versus logarithm of exposure
- Lower part, concave up

- Toe region

- Upper part, concave down

- Shoulder region

- Straight line in middle



# PHOTOGRAPHIC FILM

- As sensitivity & grain size increase, image becomes coarse & sharpness (resolution) reduced

- Sensitivity expressed as AFS (Aerial Film Speed)
  - Determined by point on characteristic curve where density is 0.3 unit above fog density

  - For films not used in aerial photography> ISO (International Standards Organization) number used to indicate film sensitivity or speed for regular photographic films

# 3.1.2 physical properties

a) Photographic film
b) Photographic plates
c) Photographic paper

# 4. Processing black and white emulsion

Five steps:

1. Developing
2. Stop bath
3. Fixing
4. Washing
5. Drying

# Developing

- Exposed emulsion placed in developer solution
- Silver halide grains reduced to free black silver
- Free silver produces blacks and shades of grey of which the image is composed

# Stop bath

- When proper darkness and contrast of the image have been attained in the developing stage> stop action

- Acidic solution neutralises the basic developer solution

# Fixing

- Not all silver halide grains are turned to free black silver
- Undeveloped grains could later turn black upon exposure to light>ruin the image
- Undeveloped silver halide grains dissolved out in fixing solution

# Washing

- Emulsion washed in clean running water to remove any remaining chemicals
- If not removed> chemicals could cause spotting or haziness of the image

- Modern equipment >automatically perfoms entire five-step darkroom procedure nonstop
- Result>Negative

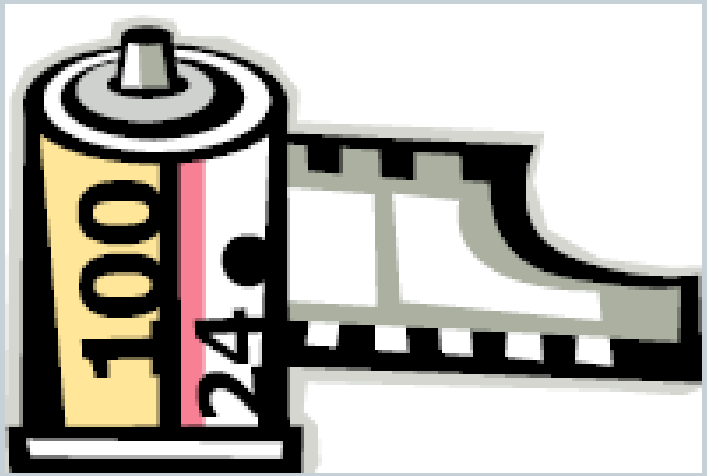
# Drying

- Emulsion dried to remove water from emulsion and backing material

# PHOTOGRAPHIC FILM

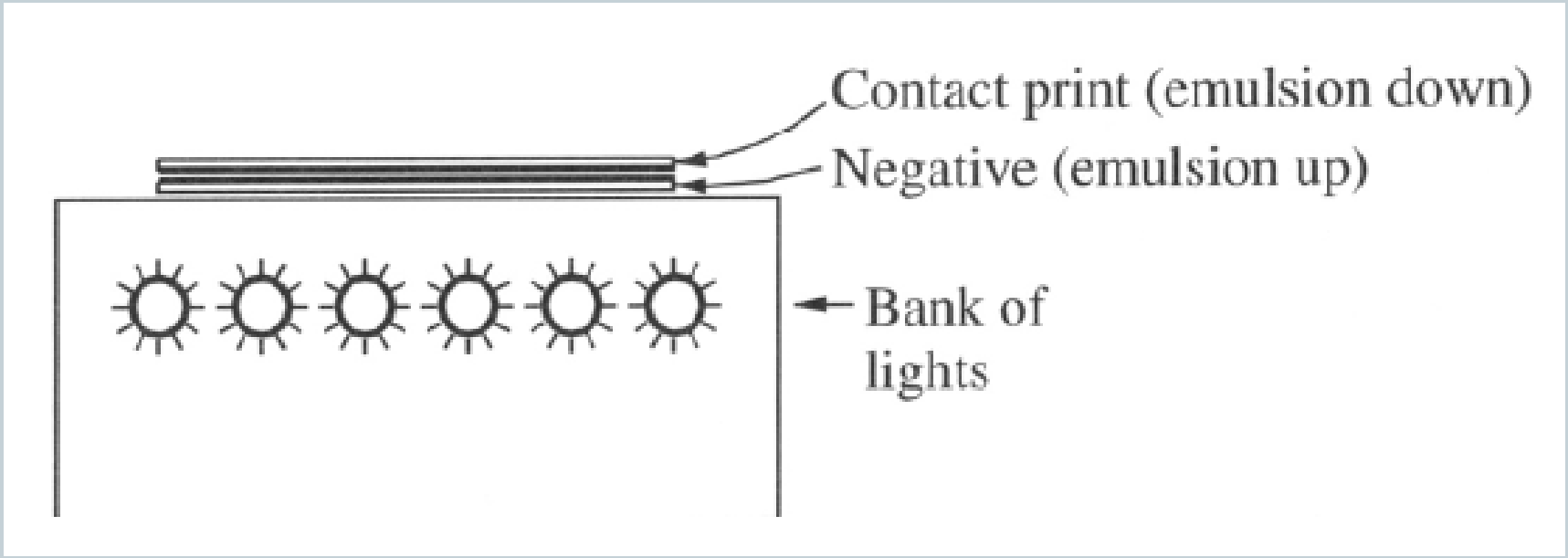
- Negative
- Reversed tone and
- geometry from original
- scene

- Positive
- ☐ Correct tone & geometry by
- using negative
- ☐ Can use printing paper,
- plastic film, glass plate
- ☐ Called diapositive in
- photogrammetry



# 5. Contact Printing

- Direct process of making a photo positive from a negative



# 6. Projection printing

- Photographic enlargement or reduction
  -used to make positives at enlarged
  or reduced scale from aerial negative

# Assignment

# Assignment 2

1. Briefly explain the difference between physical and geometric optics.
2. An object located 1.8 m in front of a thin lens has its image in focus 72.5 mm from the lens of the other side. What is the focal length of the lens?
3. An object is located 12 m in front of a thin lens having a focal length of 50.0 mm. At what image distance will the object's image be in perfect focus?
4. A camera lens can accommodate object distances ranging from 1.2 m to infinity. If the local length of the lens is 38 mm, what is the corresponding range of image distances?
5. Explain why the lens camera replaced the early pinhole camera.
6. Define the photographic terms illuminance, aperture, emulsion, latent image and fog.

7. A camera with a 50.0 mm focal length lens has the f-stop set at 4. A 50.0-mm cylindrical extension is inserted between the lens and the camera body, increasing the nominal image distance from 50 to 100-mm. What true f-stop corresponds to the original setting of 4?
8. Prepare a table of lens aperture diameters versus nominal f-stop settings ranging from f-1 to f-32 for a 70.0-mm focal length lens.
8. An exposure is optimum at a shutter speed of 1/250s and f-8. If it is necessary to change the shutter speed to 1/500s, what should be the corresponding f-stop, to retain optimum exposure?
9. A camera has a focal length of 35.0 mm. its f-stop settings range from f-1.4 to f-22. What is the maximum diameter of the aperture? Minimum diameter?

10. An exposure is optimum at a shutter speed of 1/1000 s and f-5.6. to increase the depth of field, it is necessary to expose at f-22. What is the required shutter speed to retain optimum exposure?
11. What is the relationship between film speed and emulsion grain size?
12. What is the relationship between resolution and emulsion grain size?
13. Explain how the slope of the straight-line proportion of -log curve relates to contrast?
14. Explain when and why a safe light can be used in a darkroom.
15. Explain a haze filter is used on aerial cameras.