

37C

FILM EXPOSING AND PROCESSING

37.1 INTRODUCTION

In the previous lesson, you have learnt about the photography and different types of cameras. Now, you must be anxious to know about the use of the camera to take a photo of your friend, places around you or a beautiful tree in your garden to keep a record. The process begins with the loading of a camera with a film of an appropriate size. Before loading of a camera, you must read the manual provided with the camera and follow all the instructions step by step with all care. You have studied in physics about the formation of real image with the help of convex lens. You can see this image on a screen, like a white cloth or white wall, which is not transparent. In photography, we make this real image on a film with the help of a camera lens. Illumination of the image depends on the illumination of the object or subject. When the light from the sources like sun, flash, bulb, etc. or any other illuminating source of energy like X-rays, Gamma rays etc., falls on light sensitive surface in the form of film, it reacts with the surface and a latent (invisible) image is formed on it. You can retain the latent image on the film by a technique which you may call it as developing and fixing.

In this lesson, you will learn about the details of the film, film exposing, film processing and printing.

37.2 OBJECTIVES

After studying this lesson, you will be able to :

- *explain the structure and characteristics of the film;*
 - *describe the process of exposing the film;*
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- mention the importance of filters in the process of film exposing;
- describe the processing method of the exposed film; and
- explain the method of making prints (positives) on photographic papers.

37.3 THE PHOTOGRAPHIC FILM

In the previous lesson you have already learnt about the camera lens which produces a sharp image on the film. Film is a photosensitive surface, coated on a base of a glass or plastic/cellulose sheet, which is transparent. The function of the photographic film is to record the image formed on it by the camera lens. The photographic film is very sensitive to light. Let us study the structure of the photographic film.

37.3.1. Structure of the film

The photographic film consists of the following three constituents :

- (i) Base, (ii) Emulsion and (iii) Special coating
- (i) **Base** : Base of the photographic film on which the photosensitive material is coated are:
 - (a) Glass plates
 - (b) Plastic or cellulose

Base is coated with following layers one over the other as shown in Figs 37.1 and 37.2

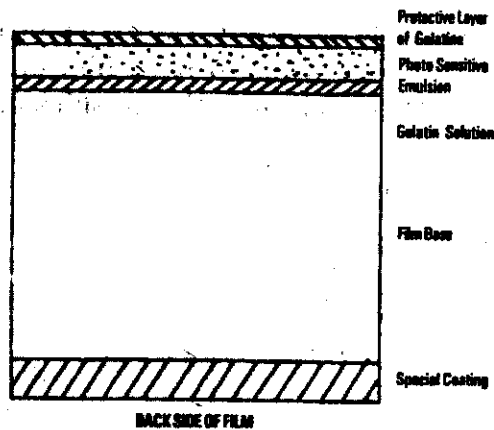


Fig 37.1 : Cross section of Black & White film

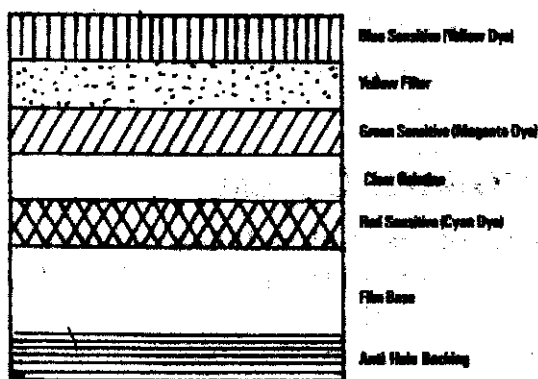


Fig. 37.2 : Cross section of coloured film

(ii) **Emulsion** : For black and white negatives, emulsion used is a mixture of silver bromide or silver iodide with gelatin and silver nitrate, while for the paper, the emulsion used is a mixture of silver chloride or silver bromide with gelatin. Grains of silver halides are nearly 5×10^{11} to 8×10^{11} grains/cm². Photosensitivity of silver halides is maximum for silver iodide and then silver bromide. Silver chloride is least sensitive. Gelatin is a transparent and colourless material like gum. Solution of gelatin is coated as substratum on one side of base material of the film due to its sticking property with base as well as photosensitive emulsion.

In case of coloured film, the emulsion has three layers as shown in Fig. 37.2. The first layer on base is sensitive to the blue colour, second layer (middle layer) is sensitive to the green colour and the third layer (final year) is sensitive to red colour. In between the first and the second layer, there is a thin layer of yellow filter. For other colours, these three colours work together.

(iii) **Special Coating** : Due to flexible and thin base of the film, it bends on drying of gelatin on one side. In order to save film curling, its backside is coated with thin layer of gelatin, so that both the sides of the base have same thickness of gelatin.

37.3.2 Types of films

Basically, the films are of two types

- (i) Black and White (B/W), and
- (ii) Coloured.

Again each type of the above films is of two types :

- (i) Negative film.
- (ii) Positive (slide) film/reversal film.

37.3.3 Characteristics of phototgraphic film

Basically, the characteristic of the film is the property of the emulsion, which are divided in two parts as follows :

- i) Physical properties like presenting power, grain and graininess.
- ii) Chemical properties like high or low speed and colour sensitivity.

Here we will restrict ourselves to the chemical properties only.

(i) **Film Speed** : The term film speed is used in terms of film's sensitiveness to light. Fast films need less exposing time as it is more sensitive to light, while slow film like plate or cut film or X-ray film needs more exposing time as it is less sensitive to light.

In order to measure the film speed, the following units are used:

- (a) American Standard Association (A.S.A.)
- (b) Deutsche Industry Norman (D.I.N.)
- (c) Scheiver (S.C.H)
- (d) British Standard Association (B.S.A.)
- (e) International Standard Organisation (I.S.O.)

In modern age, units A.S.A and D.I.N. are used at international level.

In unit A.S.A., if speed of the film is doubled, then the film is 2 times more sensitive and hence, exposing time is reduced by 50%.

In unit D.I.N., if speed of the film increases by 30 then the film is 2 times more sensitive and hence, exposing time is reduced by 50%.

If the film speed is 100 A.S.A. then it means that if shutter speed of the camera is set at 100 then in bright sun light at 12 noon, aperture number required will be 16 for normal exposing.

On the basis of the speed, the films are popularly classified as follows:

- (a) **High speed films or fast films** : - Films faster than 300 A.S.A.
- (b) **Medium speed films** : Films with speed between 200 A.S.A. to 300 A.S.A. speed:
- (c) **Slow speed films or slow films** : Film with speed below 200 A.S.A.

For big enlargememts, slow speed films are good, because the grains are fine and have more penetrating power. Fast speed films have less penetrating power and are used for moving objects, press-photography, action or high-speed race as well as for photos in dim light.

ii) **Colour Sensitivity** : Emulsion used for coating has different sensitiveness for different colours or wave-lengths of light. Sun light consists of seven colours i.e. violet, indigo, blue, green, yellow, orange and red with their wave-lengths range from 4000 \AA to 7200 \AA . Ultraviolet and infrared lights are not visible to our eyes but photographic emulsion is sensitive to them. Silver halides are sensitive to wave-lengths ranging from 2000 \AA to 5000 \AA . According to colour sensitiveness, the films are catagorised as follows :

(a) **Panchromatic film** : (Pan=for all; chromatic=colours) Emulsion of the panchromatic film is sensitive to all colours. This film is sensitive to ultraviolet and infrared rays, hence it can be used for infrared photography for scientific and industrial purposes. These films are known as all colour films.

(b) **Orthochromatic film** : In sun light spectrum, the sensitiveness of the emulsion of the orthochromatic film extends from blue area to green area and to an extent upto yellow area also. It is blind for red colour. Very fast orthochromatic films are good for studio photos of men and women, landscapes and marriage photographs. This film is used for hair-like bone fractures so the prefix "ortho" is used in this film.

(c) **Ordinary film** : Emulsion of the ordinary film is sensitive to blue and violet colours, So ordinary film is also called colour blind film. Red light affects this film very little. But sky and blue flower come white in the print.

Presently, the films available in the market are sensitive to all colours. These may be put under the category of panchromatic films.

INTEXT QUESTIONS - 37.1

1. State whether the following statements are **TRUE** or **FALSE**

- a) Fast film gives fine details in the photograph.
- b) The bigger size of the grains of silver halides in emulsion make the film more sensitive.
- c) Higher the A.S.A. speed rating, the faster the film reacts to light.
- d) Film speed refers to the speed at which the film can be moved inside the camera.

2. What makes a photographic film fast or slow?

3. Write the speeds of the commonly used photo films.

4. Write the important character of a panchromatic film.

37.4 FILM EXPOSING

When the film is exposed to light, it is termed as film exposing. For a good photograph, the film must be correctly exposed. Newly purchased film is called un-exposed-film and after taking the snaps, it is called exposed-film.

While taking a photograph you must remember a word **FAST**, which helps you to remember the sequence of the various steps :-

F - Focussing of a lens.

A - Aperture setting as per light condition and depth of field.

S - Shutter speed setting as per movement of the object and exposure value number.

T - Turn to next frame to avoid over exposing and to get ready for next exposure.

37.4.1 Factors Affecting the Film Exposing

To control correct exposing, the knowledge of the following factors is important.

1. **Subject Related** : Latitude, Month of the Year, Day-Time, Season, Type of Subject.
2. **Camera and Films Related** : Aperture/Stop, Film Speed, Filter and Development.

Types of the subject : When the background of the subject is white or snow or sand or water, the exposing time is very less. Tables 37.1 and 37.2 give the correct idea of the exposing of the film.

Table 37.1 : Film speed verses subject condition

Subject Condition	50 ASA	100 ASA	200 ASA	400 ASA
	18 DIN	21DIN	24 DIN	27 DIN
Clear Sky	f=11	16	22	32
Sun Partially obscured hazy	f=8	11	16	22
Clear sky in the shade	f=5.6	8	11	16
Over cast	f=4	5.6	8	11
Rainy weather poor light	f=2.8	4	5.6	8

Table 37.2 :

Subject	Bright Sun	Hazy Sun	Cloudy Sun	Cloudy Sun
Cloudy Dull				
Seashore, Sand, Snow	f 22	16	11	8
Landscape	f16	11	8	5.6
Distant Groups	f11	8	5.6	4
Portraits in the shade	f8	5.6	4	2.8

(Aperture setting with 400 A.S.A. film and time setting t=250 in winter)

While taking a photo of a function or a building illuminated with coloured light, long exposure or B-setting is required, because flash will not help in capturing details of the colours.

37.4.2 Filters

In photography, the filters are used to stop undesired light rays from falling on the sensitive surface of the film. Thus, the filters sieve the light, so that naturality, beauty and originality comes in the photo. The filters in photography are coloured as well as colourless.

(i) Filters used in Black and White Photography

Normally, these filters are made of the gelatin paper, which is very thin and delicate sheet. Therefore it is kept between two glass plates to save it from tearing and scratching. Colourless or ultraviolet (U.V.) filter is not only a simple glass but it contains some material which protects the film by absorbing U.V. rays, which affect it adversely. Generally, filters used are U.V., light yellow, dark yellow, orange and red. As U.V. filter is colourless, it can be used permanently with the lens, because it not only works as a filter to reduce haziness but protects the costly lens from scratches and dust.

When sun light passes through a coloured filter, then that particular colour of filter is less effective on the film and the supplementary colours predominate. Light yellow filter shows the presence of the clouds in the blue-sky and makes the photo beautiful. Similarly, the filter of an orange colour darkens the sky more, while the filter of red colour makes the sky much more black with white clouds in the blue-sky and makes the photo beautiful. When light passes through coloured filters, its intensity decreases and so exposure is to be increased. A number is marked on the filter as the filter factor for correcting the exposure. If the filter factor is 4X, then it means 4 times more exposure is needed, so a shutter speed of 1/100 sec. is to be corrected as 1/25 sec. or stop number f/11 is to be corrected as f/5.6.

For different subjects, use of the coloured filters and their effect is shown in Table 37.3.

Table 37.3 : Coloured filters and their effects in case of different subjects.

Subject	Effect	Filter
Blue sky	Natural	Yellow
	Dark	Red
Sea surface & sky	Normal	Yellow
	Dark colour of water	Orange
Sunset	Normal/Natural	Yellow
Distant Landscape	Normal/Natural	Yellow
	To reduce haziness	Orange
Special Greenery	Natural	Yellow
Orange Red colour	To reduce colour	Yellow. Green
	for details	Red
Stone, Wood, Sand	Natural/Normal	Yellow
Ice, Sunlight	For details	Orange

(ii) Filters used in the Colour Photography

Coloured and U.V. filters are also used in colour photography. Coloured filters should not be used in negative films. Filters reduce the intensity of the image in the negative and hence, that colour of filter appears dark on the positive print.

Basic colours are red, green and blue and their supplementary colours are cyan, magenta and yellow as shown in Fig. 37.3 & Fig 37.4

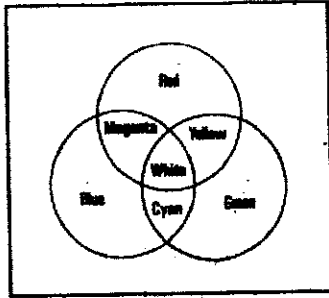


Fig 37.3: Additive method of colours

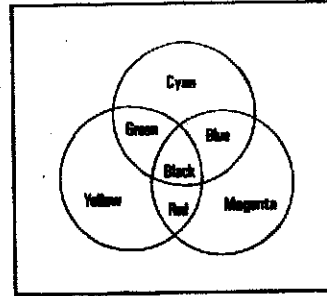


Fig 37.4 : Subtractive method of colours

Thus, a yellow filter will absorb blue and red filter will absorb both blue and green. A skylight or U.V. filter is used to absorb U.V. and violet light.

37.4.3 Aperture or Diaphragm Stop (f-number) and Shutter Speed Relationship

The amount of light passing through a lens is controlled by the diaphragm/aperture. This you have studied with cameras in lesson-36. The diaphragm has two functions : to control the amount of light reaching the film and to control the depth of focus.

While the diaphragm controls the quality of light entering the camera according to the size of its adjustable diameter, the shutter controls the quality of light by the length of time during which the light is allowed to enter the camera. Table 37.4 shows the relation between f-numbers and shutter speed.

Table 37.4 : Speed of film 400 A.S.A (t =250) A.S.A in Winter

EV/t	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1S	2S	4S
18	f=22											
17	f=16	22										
16	f=11	16	22									
15	f=8	11	16	22								
14	f=5.6	8	11	16	22							
13	f=4	5.6	8	11	16	22						
12	f=3.5	4	5.6	8	11	16	22					
11	f=	3.5	4	5.6	8	11	16	22				
10	f=		3.5	4	5.6	8	11	16	22			
9	f=			3.5	4	5.6	8	11	16	22		
8	f=				3.5	4	5.6	8	11	16	22	
7	f=					3.5	4	5.6	8	11	16	22
6	f=						3.5	4	5.6	8	11	16
5	f=							3.5	4	5.6	8	11
4	f=								3.5	4	5.6	8
3	f=									3.5	4	5.6
2	f=										3.5	4
1	f=											3.5

Photo Electric Exposure-meter

It is a device for measuring quantity of light required for exposing the film correctly. It reads exposure value for a given speed of film according to light conditions, as our eyes can not make accurate recording of the changes in light conditions.

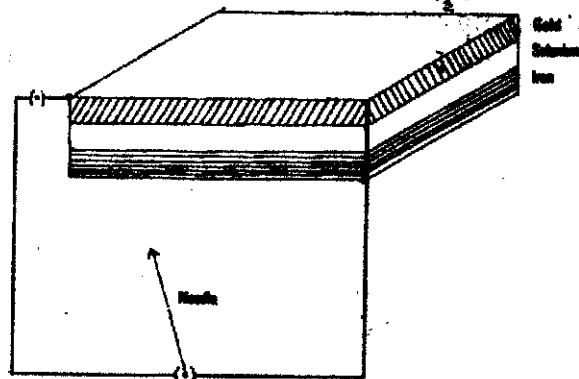


Fig 37.5 : Photo Electric Exposure Meter

An exposure meter consists of sensitive current measuring meter, (Fig 37.5) connected to a selenium cell. Thus, the deflection of the meter needle indicates the intensity of the light incident on the selenium cell. The scale of the meter indicates the exposure value (EV) numbers for given speed of the film,

Use of Electronic Flash Gun

It is a device used for throwing light on the subject to be photographed in night or dim-light. Exposing time is nearly $1/1000$ sec, so it can even take photograph of a moving object. When charged condenser discharges through flash tube, it flashes shutter speed of $1/125$ sec. In case of focal plane shutter, shutter time $1/25$ or $1/30$ sec is to be set. Now a days a very light and compact flash gun is available which uses 4 pencil cells only. Many of the electronic flash guns throw fixed amount of light on the subject after setting film speed and distance range of the subject.

In brief we can say that the following steps are to be followed in order to expose a photographic film.

- i) opening camera and loading the film
- ii) viewing the picture through view finder.
- iii) setting the distance of the subjects from the lens of camera.
- iv) setting the lens aperture/f-number
- v) setting the shutter speed
- vi) locking the shutter speed
- vii) clicking the shutter
- viii) unloading the film

INTEXT QUESTIONS - 37.2

(1) State whether the following statements are TRUE or FALSE :

- a) Depth of focussing decreases as f -number increases.
- b) If filter factor is $2X$ then $f/8$ will be changed to $f/16$.
- c) When the aperture number is increased, the shutter speed must be decreased in order to get same exposure.

(2) A camera lens, already set at $f/4$, is changed to $f/8$. Has the aperture increased or decreased and by what factor?

.....

(3) A camera lens, set at exposure time $t=200$ is changed to $t=100$. By what factor does the light entering the camera increase or decrease?

.....

(4) For greater depth of field, choose $f/11$, $f/8$ or $f/5.6$.

.....

(5) An object requires exposure time $t=125$ and $f=16$. For the same exposure, what will be the exposure time, when the camera lens is reset at $f=11$?

.....

37.5 PROCESSING OF THE EXPOSED FILM

The processing of an exposed film involves the following three steps :

- i) Developing
- ii) Fixing
- iii) Washing and Drying

Developing : When silver halide is exposed to light, it reacts with it and is reduced to silver (invisible) and thus, latent image is formed on the film. Now, in the first stage exposed film is placed in a chemical solution, called the developer in a darkroom. The function of the developer is to reduce the light affected grains on the exposed film to metallic silver. Silver in this form is black and thus, it is possible to see the image on the film. Thus, whatever we see on the developed film is just the opposite of the original scene, opposite in black and white, colour and contrast. That is why on developing a film, we get negatives, one each for each frame of the film.

When the film development is complete, the film is taken out of the developer and is put in a stop bath. The use of stop bath, prevents the fixer from being contaminated by developer. A dilute solution of acetic acid is commonly used for a stop bath. 20ml of acetic acid is added to 1 litre of water to make stop bath. For films, stop bath with 3% alum is also used.

Different types of the developers are used for the films and the papers of different companies. Three types of developers are used for developing a black and white film, these are ;

(a) Simple Developer (B/W), (b) Fine Grain Developer (B/W), and (c) Monobath Developer (B/W). Developers for coloured films are different.

Fixing : In the second stage, the film is carried through fixing. When we expose the film, light from the original scene generally does not affect all the light sensitive grains on the film. These grains stay on the film even after the film has been developed. These light sensitive grains would thus, ruin the negative by turning dark, if exposed to light. To prevent this, the developed film is immersed in another solution called the fixer and the process is called fixing. Fixer removes these unaffected light-sensitive grains. Now the negative has no longer light sensitive gelatin, making the negative less likely to be scratched. Sodium thiosulphate solution, commonly known as hypo, is used as fixer. Potassium meta bisulphite may also be added to hypo to stop the developer action. In order to make fixer, first dissolve 200 grams of hypo in one litre of water and then dissolve 20 grams of potassium meta bisulphite.

Washing and Drying : In the third stage, the film is finally washed in running water for about half an hour to remove any chemicals remaining on it in open light. Film can also be washed in still water, provided water is changed completely every few minutes. Even after washing the film emulsion is still highly sensitive to touch. The film should be hung with the help of a clip in a warm, dry, dust-free room for at least an hour or so.

37.5.1 Methods of Film Processing of B/W films

For film development, following two methods are commonly used:

- (1) Tray Development
- (2) Tank Development

Processing of the coloured negative film is just like the processing of the black and white negative film. In B/W film, one sensitive layer is developed while in coloured film three sensitive layers are developed. Usually coloured developer formula C-41 is used for coloured films and other solutions are same as for B/W films. Developing tank is preferred for processing, as 35 mm films are commonly used now-a-days.

The colours on the film are complementary colours of red, green and blue i.e. cyan dye, magenta dye and yellow dye respectively.

INTEXT QUESTIONS - 37.3

1. State whether the following statements are TRUE or FALSE :

- (a) The function of the film developer is to affect grains of silver halide on the exposed film into metallic silver.
- (b) Stop bath is a weak solution of sodium thio-sulphate.
- (c) Exposed film is developed before fixing.

2. What is the action of the film developer on the exposed film?

.....

3. Name the correct sequence of various steps involved in film processing?

.....

4. What is sodium thio-sulphate solution commonly known as? What role does it play in the film processing?

.....

5. Name the two methods which are commonly used for the film development.

37.6 PRINTING

If you look through a B/W negative, everything that was white (light) in the original scene is black (dark) on the negative and vice versa. Similarly, if you look at coloured negative, colours of the original scene appear as complimentary colours. In order to make true picture, which resembles the original scene, another process called printing is carried out on a photographic paper.

Photographic Paper : It is a paper on which the prints are obtained from negatives. For B/W prints, chloride and bromide papers are used. These papers are coated with a emulsion containing silver chloride and silver bromide respectively, which are also sensitive to light.

When photographic paper is exposed to light coming through the negative, a latent image is produced on the paper. On paper developing, which is very similar to film developing, latent image becomes visible.

INTEXT QUESTION - 37.4

(1) State whether the following statement is TRUE or FALSE :

(a) The same photographic paper can be used for B/W negative as well as colour negative for prints.

(2) Name two types of colour films. Which of the two, produces transparent positive, called slides?

37.7 WHAT HAVE YOU LEARNT

- Photographic film is a strip of celluloid, one side of which is coated with a light sensitive emulsion. Silver chloride, silver bromide and silver iodide, suspended in the emulsion make it sensitive to light.
- Photographic films are available with varying speeds. Film speed is expressed in A.S.A. number or D.I.N. degree
- The aperture and hence, the f-number and the shutter speed together decide the amount of light falling on the film.
- For a lens, decrease in its aperture increases the depth of field.
- Exposing the photographic film means allowing calculated amount of light to strike the film through the camera lens.
- Film processing is done to make latent image on the exposed film visible. As a result, negative images (or negative) are produced.
- Various steps involved in film processing are development, a stop-bath, fixing, washing and drying.
- The developer reduces the light affected grains of silver halides on the exposed

film to metallic silver.

- There are two methods of film development : tray development and tank development.
- Printing paper used for making prints is sensitive to light.
- Silver chloride paper is used for making B/W contact prints and silver bromide paper is used for enlarged prints.
- For making a print, the photographic paper is exposed through the negative and then developed.
- There are three primary colours viz red, blue and green, and there are three complementary colours viz. cyan, magenta and yellow.
- There are two processes of producing desired colours viz. the additive process and subtractive process.
- Colour negative film appears very similar to a black and white film, where as a colour reversal film produces transparent positives, called slides.
- Colour films and photography paper are both coated with three layers of light sensitive emulsion, each layer being sensitive to one of the primary colours.

37.8 : TERMINAL QUESTIONS

1. What do you understand by film size and film speed?
2. What role do filters play in photography?
3. What is the relationship between exposure time (or shutter speed) and f-number.
4. What do you mean by film processing? List the various steps involved in the processing of an exposed film.
5. What are the functions of developer and fixer on the exposed film.
6. What are the various steps involved in the making of black & white contact prints.

CHECK YOUR ANSWERS

INTEXT QUESTIONS - 37.1

1. (a) F; (b) T; (c) T;
2. Size of grain of silver halides in the emulsion. Larger the grain, faster the film.
3. A.S.A & D.I.N.
4. All colors film.

INTEXT QUESTIONS - 37.2

1. (a) F; (b) T; (c) T; (d) F.

2. increases, gets doubled.

3. increases four times

4. $t = 250$

1. (a) T (b) F (c) T

2. to reduce high affected grains of silver halide into metallic silver.

3. developing, stop bath, fixing, washing and drying.

4. hypo, removes off the left out (unexposed) high sensitive grains from the film.

5. Tray development and tank development.

INTEXT QUESTIONS 37.4

1. (a) F

2. (a) Negative film (b) positive film, the later produces slides.
