CALVINKONG PHYSICS TUITION

www.calvinkongphysics.com 8246-5685

NAME : CLASS : DATE :

THEME : LIGHT, WAVES AND SOUND

Unit 12 LIGHT	Consolidation Worksheet 1 - Review & Discussion

1. SYLLABUS LEARNING OUTCOMES

Hello,

You have made a very important and right decision to look at this sample learning material created by Calvin Kong, a former MOE Senior Teacher in Physics with more than a decade of experience, also trained under the Research for Better Teaching, Inc. (Massachusetts) and New Teacher Centre (California).

This set of **Consolidation Worksheet (Part 1)** is designed for students to try out the structured questions (explanation and calculation) that they will face in Paper 2. Class discussions will be facilitated where students are given the chance to practice academic language, build discussion skills, and increase their understanding. It will be followed up with **Consolidation Worksheet (Part 2)**, a timed quiz where Calvin Kong can further check the understanding of his students by marking their written work.

This set of notes is designed based on numerous pedagogical research findings (theoretical) and fine-tuned based on feedback and response of students who uses them (theories put to test).

2. ASSESSMENT OBJECTIVES

A. Knowledge with Understanding

Factual knowledge that candidates may h

Questions testing these objectives wi
describe, **explain** or **outline**.

B. Handling Information and S

Apply **principles and concepts** in a

Questions testing these objectives w
calculate or **determine**.

Understanding the Assessment Objectives

It is stated clearly in the syllabus that in the National Examination, candidates will be assessed on the 2 board aspects.

A. Knowledge with Understanding

B. Handling Information and Solving Problems

More information is available online here (page 3).

While the Guided Study Notes are focused on concept attainment, Calvin Kong had planned for this learning resource to be more examination oriented. It is designed to allow students to be exposed to wide range of structured questions commonly seen in examination papers, building confidence in the process.

A. Knowledge with Understanding

FOCUS 1 – Reflection of Light	1.	recall and **use** the ter tion, including normal, angle of incid and angle of re
	2.	**state** that, fo reflection and

A. Knowledge with Understanding

Questions and most answers are given under this category. This is because from Calvin Kong's experience, he knows that for these knowledge based questions, students will get it went they read them. In cases where students need to clarify, he does allocate time for student to consult.

1. State what is meant by the follow

(a) *normal*,

Imaginary line that is perper

(b) *angle of incidence*,

The angle between incident ray and normal at the point c

(c) *angle of reflection*.

The angle between reflected ray and normal at t

2. Write down the 2nd Law of Reflection

The angle of incidence is equal to the ar

FOCUS 2 – Refraction of Light	3.	recall and **use** the t and angle of refra
	4.	recall and **apply** the
	5.	**define** refr vacuum
	6.	**expl**
	7.	id

3. State what is m

The ar

4. Define

5. When an incident ray inside an optically denser medium has an angle of incidence larger than the *critical angle*, *total internal reflection* will occur.

State what is meant by the terms

(a) *critical angle*, and

The angle of incidence in an optically denser medium for which the angle of refraction in the optically less dense medium is 90°.

(b) *total internal reflection.*

The complete reflection of a light ray inside an optically denser m
boundary with an optically less dense medium.

6. Write down the two conditions for a ray of light to undergo total i

1. The ray of light must be traveling from an optical de
   less dense medium.
2. The angle of incidence inside the denser medi
   critical angle.

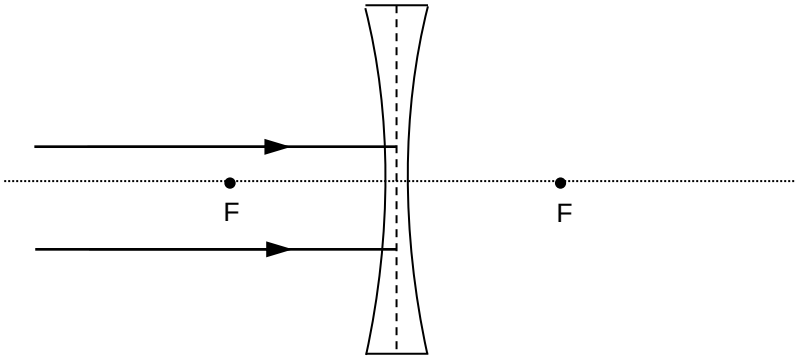
FOCUS 3 – Refraction by Thin Lenses	8.	**describe** the action of a beam of light
	9.	**define** the term fo
	10.	**draw** ray diagrams to

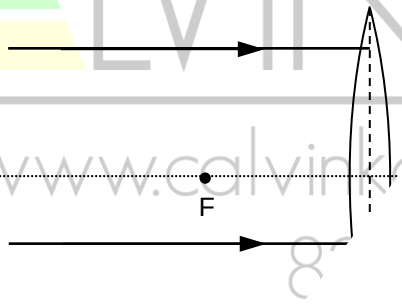
7. Describe the difference betwe
of light.

A parallel beam of l
meet at a point w
a parallel bear

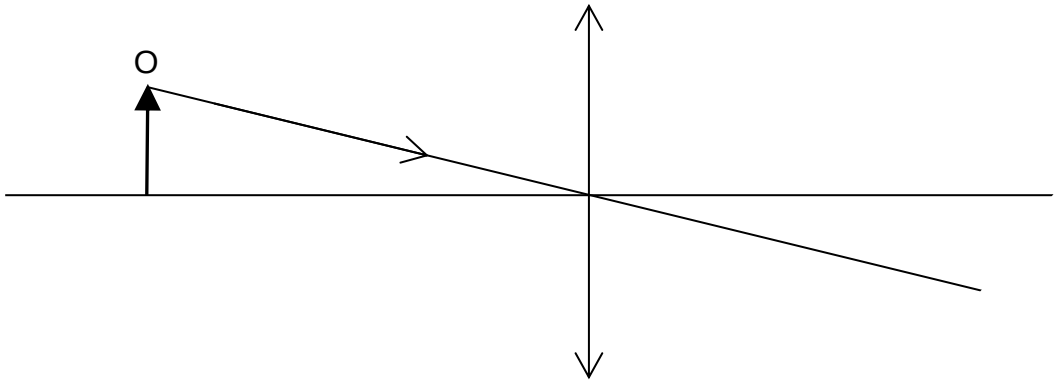
8. The following figures show parallel rays of light incident on a thin diverging and thin converging lens. The points labelled F show the principal focus on each side of the lenses.

Complete the figures to show the rays of light after they pass through the lenses.
(It can be assumed that refraction occurs at the broken line in the lens)





9. The diagram shows a ray of light from an object O that passes through a converging lens. It is drawn to <u>full scale</u>.



(a) Define the term focal length.

distance between the optical centre

(b) By drawing suitable rays, determine the position of the focal length.

Ans : (b) between 2.0 to 2.1 cm

B. Handling Information and Solving Problems

FOCUS 1 – Reflection of Light	1.	recall and **use** the terms for reflec… …mal, angle of incidence and angle of reflection
	2.	**state** that, for refle… in construct…

Common Situation 1: Minimum Mirr…

10. A pla… mirror is hung on a wall… He is …m tall and his eyes a…

wall

X is a point on his feet that is ve…

(a) On Fig. 6.1,

(i) Indicated the i…

(ii) draw the r… the incid…

(b) Calculate t…

B. Handling Information and Solving Problems

To excel in this category, students require sharp critical thinking skills.

This skill is not a natural ability for many and it requires more guidance. As such, Calvin Kong will spend approximately 75 % of teaching time on this category.

Common Situations

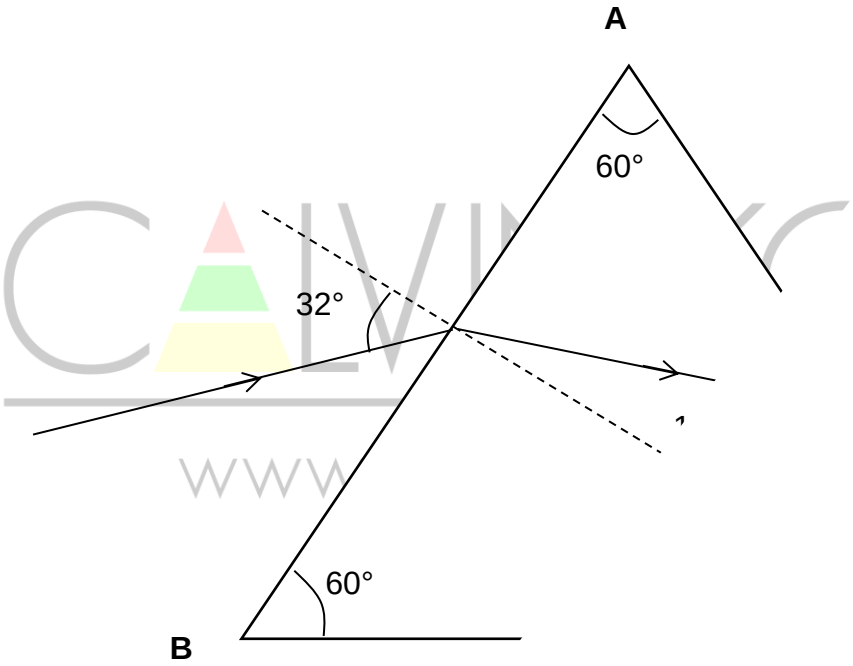
Much of the syllabus require students to be able to ***recall and apply specific concepts to new situations or to solve related problems.***

Through observation of the past year examination papers, it can be approximated that 75 % of the situations are repeated and hence predictable.

It therefore makes sense that students are taught how to apply the concepts in these common situations first before moving on to novel situations.

FOCUS 2 – Refraction of Light	3.	recall and **use** the terms for refraction, including normal, angle of incidence and angle of refraction
	4.	recall and **apply** the relationship sin i / sin r = constant to new situations to solve related problems
	5.	**define** refractive index of a medium in terms of the ratio of speed of light in vacuum and in the mediu
	6.	**explain** the terms critical angle and total internal reflection
	7.	identify the main ideas in total internal reflection and **apply** th of optical fibres in telecommunication and state the advant

11. A beam of light enters a glass prism from air. The refractive index of glass is not drawn to scale.



(a) Calculate the angle of refra

(b) On Fig. 7.1, draw the path of the light ray immediately after it reaches side **AC**. Label any relevant angles and show the calculations you have made to obtain your answer. [3’

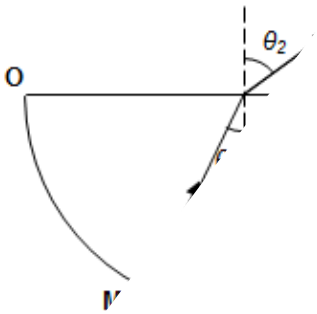
Final answers at the end of each question allows students for a quick check on their work.

Ans : (a) 19.3°

Common Situation 2: The Semi-circular Glass Prism

12. A student investigates the refraction of light wh
Fig. 4.1 shows the arrangement of the appar

A ray-box is used to direct a ray of light t
air. The ray of light is adjusted until it p
measures the angle θ_1 and θ_2. Fig. 4.



(a) The student observed that at **M**, the ray of light does not refract as it travels from air to glass. Explain why the light does not refract at **M**.

……

……

(b) Calculate the

(i) refractive index of the glass and

refractive index = ..

(ii) the speed of light in the glass in the speed of light in air is 3.0

s

(c) The critical angle for light at the glass-air bou
at the boundary changes as the student inc

……

……

……

……

……

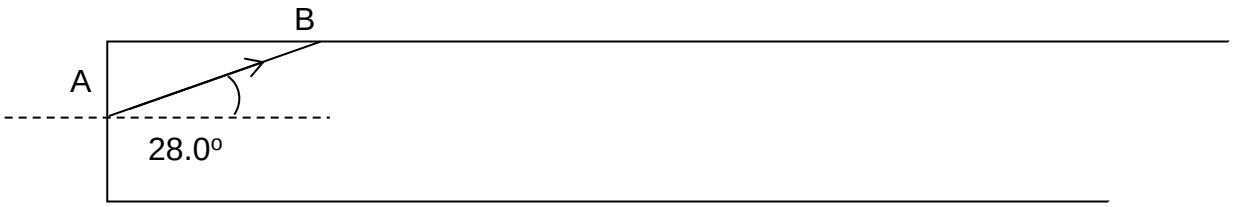
……

……

Ans: (b

Common Situation 3: The Optic Fibre

13. An optic fibre transmits data using light signals. Inside the fibre, light undergoes total internal reflection. The following diagram shows a light ray AB incident on the glass-air boundary of glass optic fibre of critical angle 48.0°.



(a) Given that the speed of light in air is 3.0×10^8 m/s, calculate the spe
glass.

speed o

(b) Consider a ray of light entering the fibre at A. Ca
A that will ensure total internal reflection of the

(c) Continue the

(d) Write dow

……

……

A

14. Fig. 11.1 shows two incident rays of light on the top facets of a diamond and a glass respectively. Diamond has a refractive index of 2.4 and glass has a refractive index of 1.5.

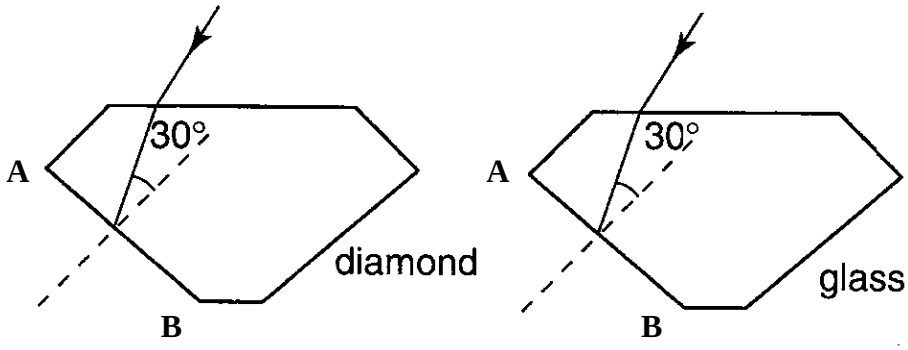


Fig. 11.1

(a) Explain why the rays of light change direction as they enter th

.....

.....

(b) Determine the critical angle for diamond.

(c) Given that the critical angle
and glass shown in Fig. 1
not required)

(d) Explain which materi

.....

.....

.....

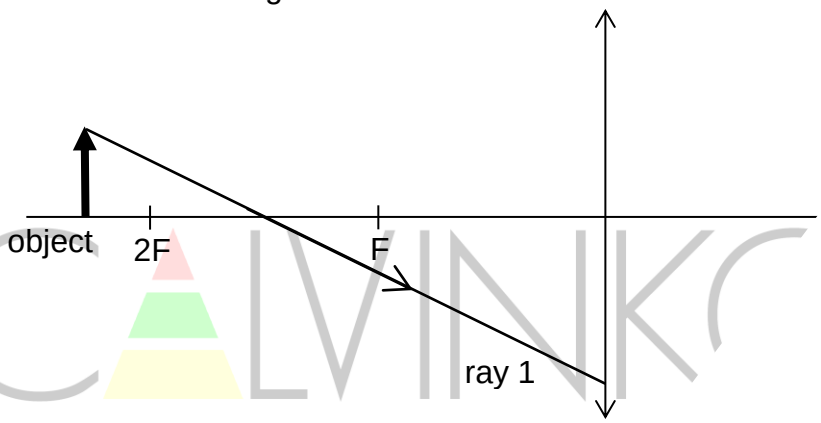
.....

.

FOCUS 3 – Refraction by Thin Lenses	8.	**describe** the action of a thin lens (both converging and diverging) on a beam of light
	9.	**define** the term focal length for a converging lens
	10.	**draw** ray diagrams to illustrate the formation of real and virtual ir object by a thin converging lens

15. ***F*** is the principal focus of a single converging lens.

(a) In the diagram below, locate the position of the object's image by d
Label the image as ***I***.



(b) Continue the path of ray 1.

(c) The object-distance is decreas
and image distance.

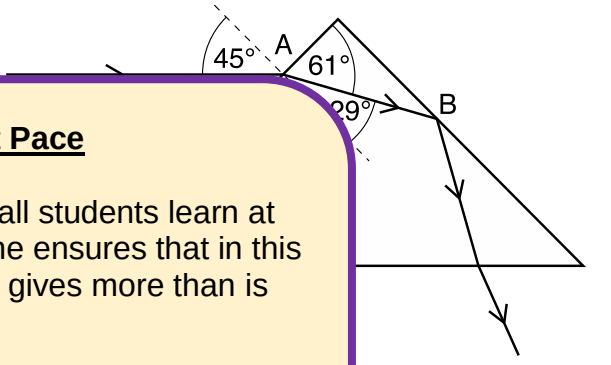
……

……

……

Further Practice

16. Fig shows the path of a ray of blue light as it passes through a right-angled glass prism



Fi

ctive index of the

refractive

(b) Explain why the ray does not emerge from the p

……

……

……

……

(c) Fig. 4.2 shows a second, ho
On Fig. 4.2, continue the p

Students Learn at Different Pace

Calvin Kong recognises that all students learn at different paces. That is why he ensures that in this Consolidation Worksheet, he gives more than is needed.

The collection of questions here allows students who were able to complete the earlier sections quickly, to accomplish even more. It can also be used as practice questions for students who needs it later. eg. before a Class Test.

17. **Fig. 11.1** shows a full-scale diagram of a spherical air bubble in water. C is the centre of the sphere. The rays of light are incident on the air bubble.

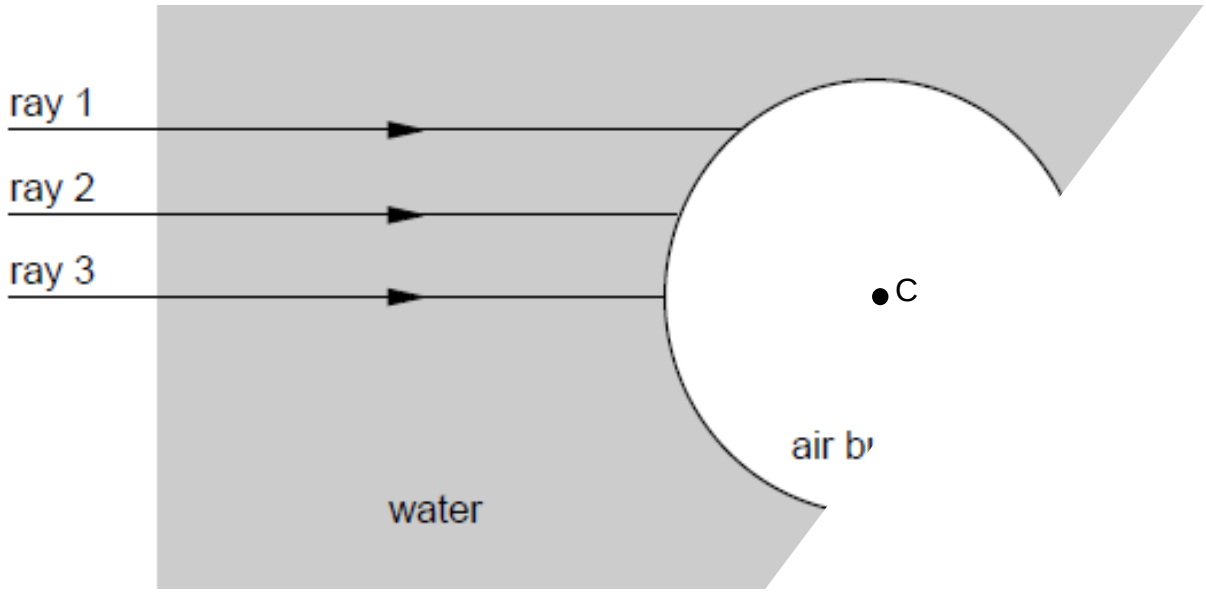


Fig. 11.1

The angle of incidence of ray 1 on the air bubble i

Ray 3 is perpendicular to the surface of the b

(a) By making appropriate measurements

(b) Complete **Fig. 11.1** to sho

(c) Calculate the refractive

18. The ray diagram in Fig. 7.1 shows an object O with its midpoint **X** indicated. One ray from point **X** is incident upon the converging lens.

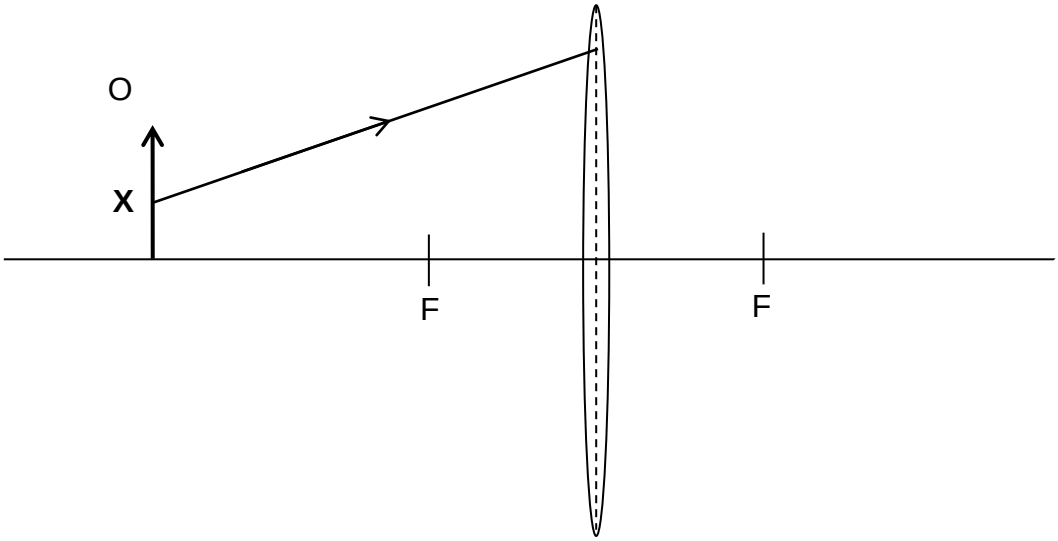


Fig. 7.1

(a) On Fig. 7.1, draw light rays to locate accurately the

(b) Complete the path of the light ray from point **X**.

(c) Describe the characteristics of the image r

……

(d) The lens is replaced to determine following change made to the le

(i) a lens with a larger

……

……

(ii) a lens of

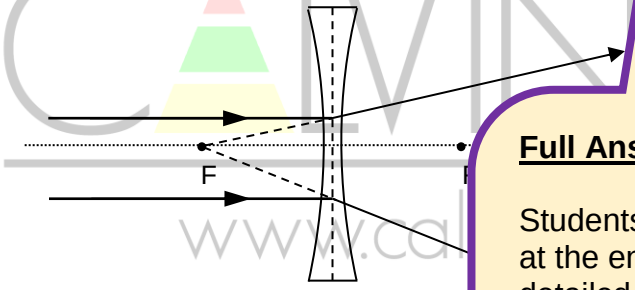
……

…

(iii)

ANSWERS

8



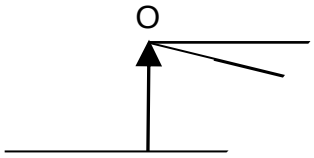
Full Answers

Students who require more than the short answers given at the end of each questions, can refer to the full, detailed answers provided at the end of this worksheet.

These answers carefully prepared by Calvin Kong, adhere closely to the National Examination Marking standards. They must also include essential steps to make it easy for students to understand the entire process.

9

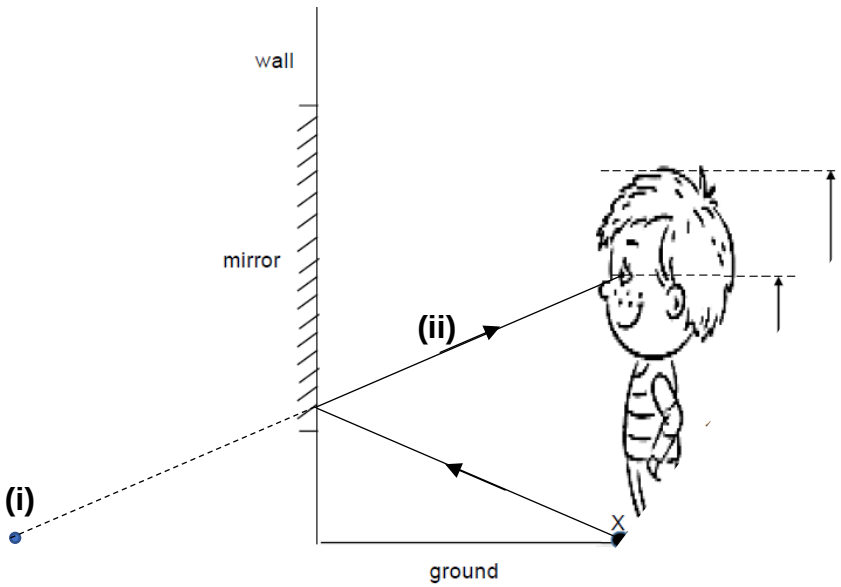
(a)



(b) M

10

(a) 2r



(b) Minimum length = $\frac{138}{2} + \frac{150 - 138}{2} = 75$ cm

11

(a) $1.6 = \frac{\sin 32°}{\sin x}$

$x = \sin^{-1}\left(\frac{\sin 32°}{1.6}\right) = 19.3^{o}$

(b)

Determine the critical angle usi

Angle of incidence at surfac
Since the angle of incider
internal reflection will o

12

(a) The ray is travelling along the normal, where the angle of incidence is zero.

(bi) $n = \frac{\sin 57°}{\sin 30°} = 1.68$

(bii) $1.677 = \frac{3 \times 10^8}{v}$

$v = 1.79 \times 10^8$ m/s

(c) When θ_1 is increased from 30° to just before 37°, the angle of r
almost 90°.
When $\theta_1 = 37°$, the angle of refraction $\theta_2 = 90°$.
When θ_1 is increased from 37° to just before 50°, the
where the angle of reflection takes the same value as

13

(a) $\sin c = \frac{1}{n} \rightarrow n = \frac{1}{\sin c}$

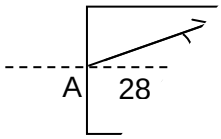
$\frac{1}{\sin c} = \frac{c}{v} \rightarrow \frac{1}{\sin 48°} = \frac{3.0 \times 10^8}{v}$

$v = (3.0 \times 10^8)(\sin 48°) = 2.23 \times 10^8$ m

(b) Need angle of incidence B to be
$\Rightarrow$ need angle of refraction at A
$n = \frac{\sin i}{\sin 42°} \rightarrow \frac{1}{\sin 48°} = \frac{s}{s}$

Then $i = \sin^{-1}\left(\frac{\sin 42°}{\sin 48°}\right)$

(c)



(d) Able

14

(a) As light travel from air to the medium, it slows down. The sudden change in speed causes the bending of light.

(b) $\sin c = \frac{1}{n} = \frac{1}{2.4}$

$c = \sin^{-1}(\frac{1}{2.4}) = 24.6^{o}$

(c)

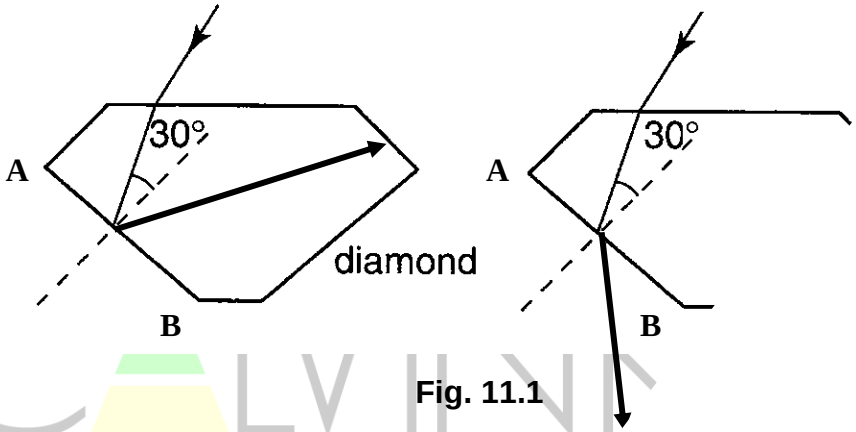
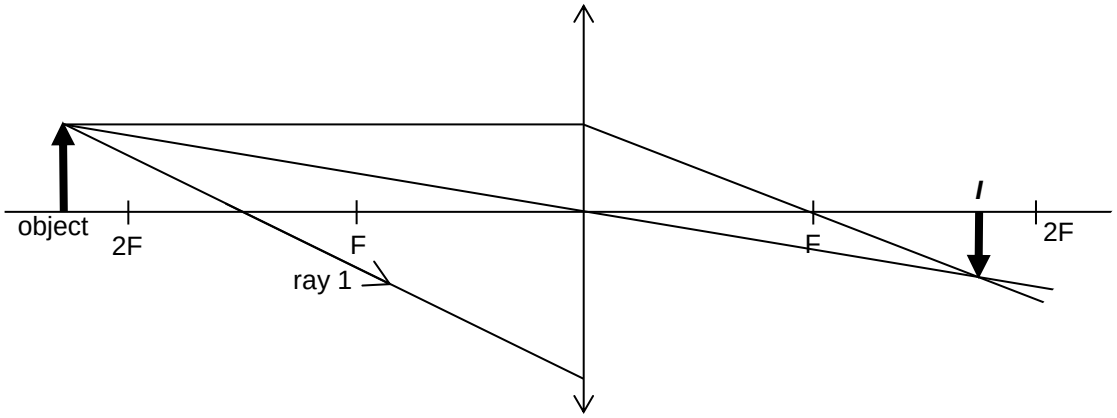


Fig. 11.1

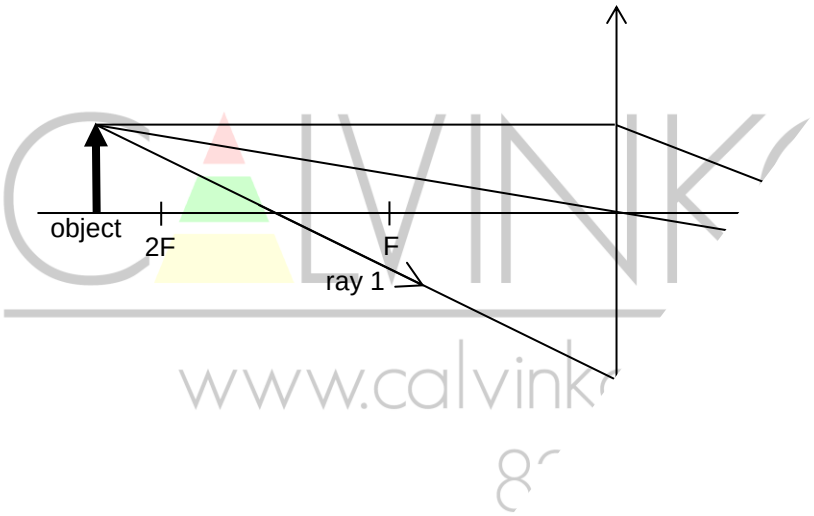
(d) Diamond has a very high refractive index
A large proportion of light will have an
critical angle and undergo total intern

15

(a)



(b)



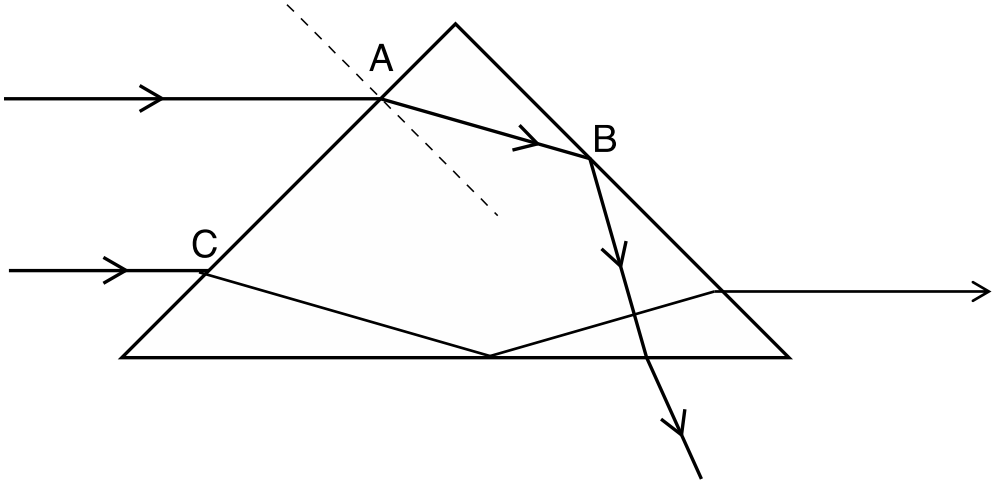
(c) Image becomes magnified
and at a distance greater than twi

16

(a) $n = \frac{\sin i}{\sin r} = \frac{\sin 45°}{\sin}$

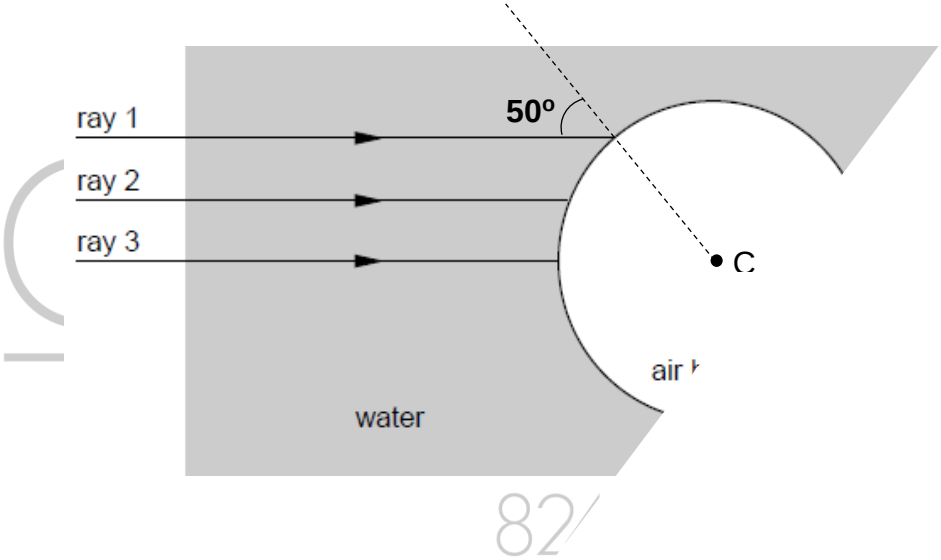
(b) The light ray
greater tha
Total inte

(c)

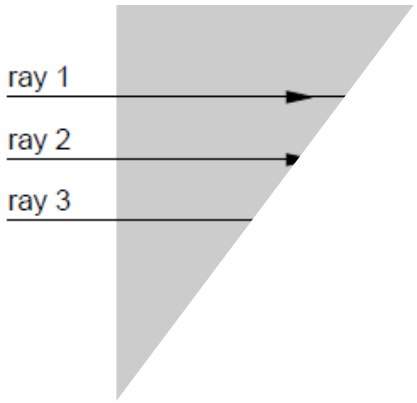


17

(a)



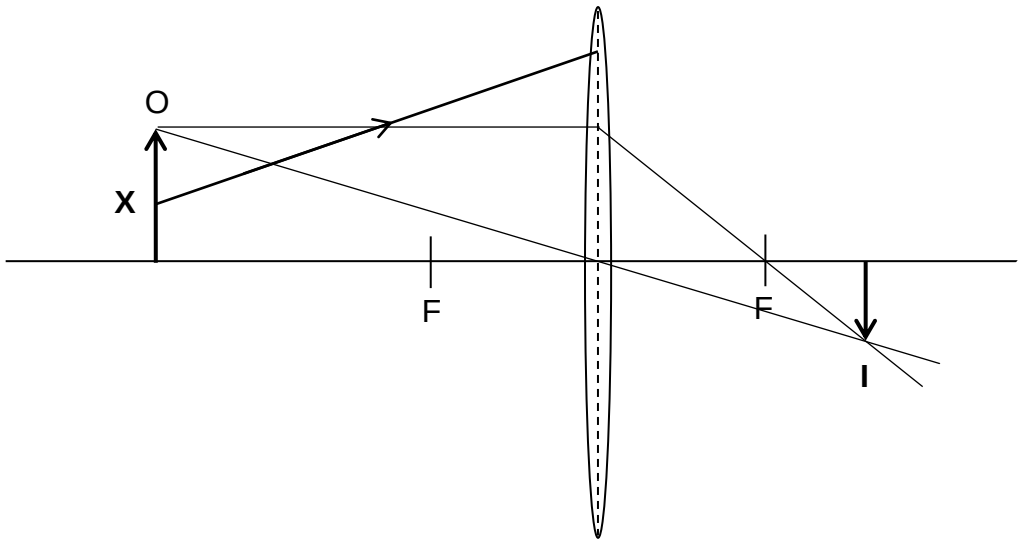
(b)



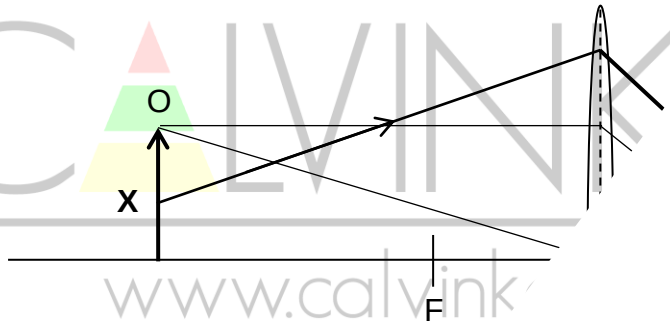
(c)

18

(a)



(b)



(c) Inverted, real, diminis

(di) Image will be br
as more light

(dii) Image b
as the

(diii) I

The End

It is recommended that you continue to look at **Consolidation Worksheet Parts 2**.