ملخص وأوراق عمل درس Illumination منهج انسباير

المزيد من الملفات بحسب الصف الثاني عشر المتقدم والمادة فيزياء في الفصل الأول

Illumination

لا تنسوا الاشتراك في مجموعة الواتساب والتليجرام

لمتابعة كل جديد والرد على الاستفسارات

مع تمنياتي لكم بالنجاح والتفوق

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اضغط على اللينك ضغطة واحدة للدخول الى المجموعة

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Light

What is Light?

Light is electromagnetic radiation like radio waves and microwaves. It can be represented in two forms:

1. A wave consisting of changing electric and magnetic fields.
2. Very small particles called "photons".

Path of Light

Does light always travel in straight lines? How can we observe this in daily life?

Yes, light always travels in straight lines. This is evident when sunlight enters through a small window in straight lines, visible due to dust particles in the air.

Note:

When an opaque object blocks the path of light, it prevents its passage and creates a shadow. This further proves that light travels in straight lines.

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Picture Clarification!

- Sun rays penetrate through the forest between the trees.
- These rays appear as straight bright lines because dust in the air reflects the light, making its path visible.
- If there is no dust, we would not see light as lines, but only the illuminated area.
- Also, dense trees block light from some areas, resulting in clear shadows beside the trees.

Light Ray Model

States that light is represented as a ray traveling in a straight line in all directions, but changes direction only when interacting with a barrier, and continues traveling in straight lines.

How does light interact with any barrier?

1. By reflection (e.g. sunlight enters through a window and falls on a mirror in the room, you notice that light reflects and lights another area in the room.)
2. By refraction (e.g. sunlight enters through a window and falls on a glass of water; you notice the light's direction changes inside the water and appears broken.)

What is the difference between reflection and refraction?

- Reflection: Light bounces back when it hits a reflective surface.
- Refraction: Light bends when it passes from one transparent medium to another with different density (air to water).

Sources of Light

1. Luminous source

- The sun is the main source of light
- Fire, flames, sparks
- Fireflies (a type of insect)
- Artificial sources (lamps, laser beams)

2. Illuminated source

- The moon
- The sea
- Trees
- The Earth

From the previous examples, we conclude:

Luminous sources: objects that emit light by themselves.
Illuminated sources: objects that do not emit light by themselves but appear illuminated because they reflect light from a luminous source.

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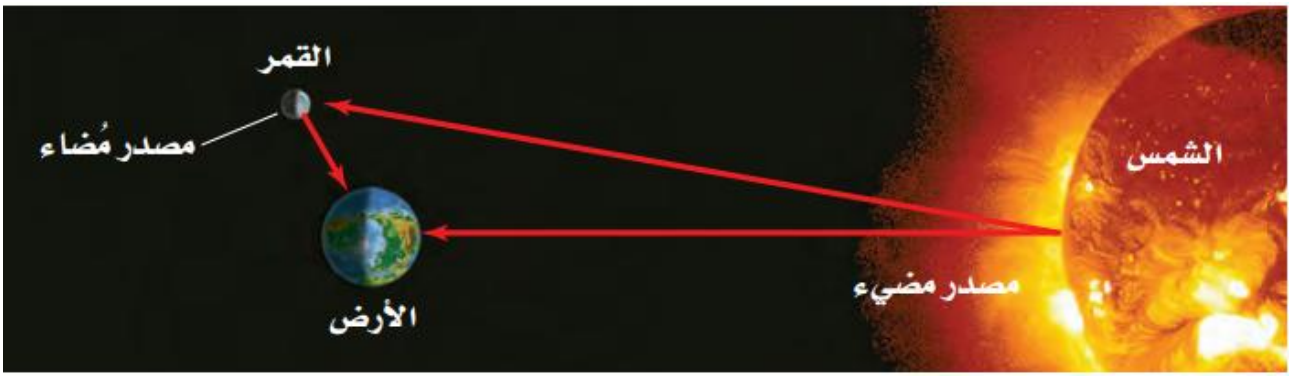
Difference between sunlight and moonlight?

- The sun produces light by itself because it is a luminous source (it radiates light and heat due to nuclear reactions inside it).
- The moon does not produce light itself because it is illuminated, actually it is opaque; what makes us see it bright is sunlight hitting the moon's surface, which reflects that light back to our eyes so we see it lit.



Light and Matter

Any object upon which light falls can do three things:

1. Transmit light (transparency/transmission)
2. Reflect light
3. Absorb light

Based on these three processes, materials are classified into:

1. Transparent objects: transmit most of the light.
2. Translucent objects: transmit some light but scatter it, so the image is not clear.
3. Opaque objects: do not transmit light, reflect part and absorb the rest.

Important Notes:

- No object transmits 100% of the light. Even transparent materials absorb and reflect a little.
- Opaque objects typically absorb more light than transparent and translucent ones.
- All three types absorb and reflect light but in different proportions according to several factors.

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Explaining with Pictures:

1. Transparent glass container (left): You see the candle clearly because the glass lets most light pass directly. Note: Although transparent, some light is still reflected from the surface of the glass.
2. White translucent container (middle): Light from the candle reaches your eyes but the candle's details appear blurry. The reason is: it lets some light pass but as light travels inside it gets scattered and the image becomes unclear.
3. Opaque pottery container (right): You see no candle at all because the object absorbs and reflects the incident light and doesn't allow it to pass.

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Amount of Light

If you are sitting and light is shining on you from across the room, what factors determine its brightness?

Factors determining brightness:

1. The amount of light emitted by the light source (luminous flux)
2. The distance between the source and your eyes
3. The angle at which light rays hit your eyes

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(P) Luminous flux

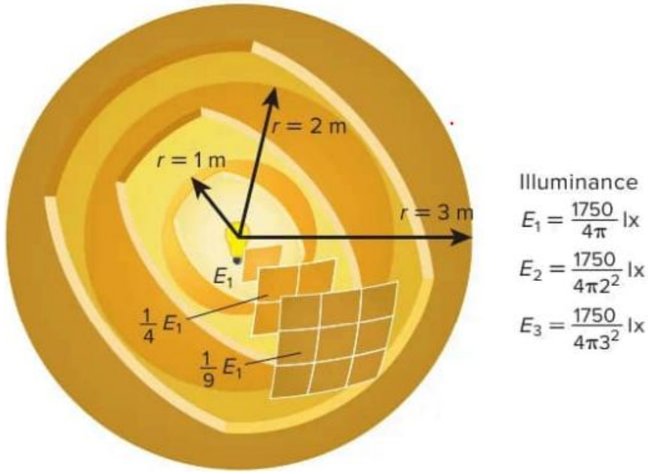
- The rate at which light is emitted from the luminous source.
- Measured in lumens (Lm)

(E) Illuminance

- The rate at which light falls on a unit area surface.
- Measured in lux (Lx), where **E = P / A and 1 Lx = 1 Lm/m^2**

Let’s prove that illuminance decreases as the distance increases!

In the following example:
- Light source (lamp)
- Surrounded by spherical surfaces with radius r = 1, 2, 3
- Luminous flux for this lamp: 1750 lumens
- **Calculate illuminance:**



Given:
P = 1750 lm
Assume the lamp is a point source radiating evenly.
Surface area of sphere: **A = 4πr^2**
Application:
At r = 1 m: E = 1750 / (4π(1)^2) ≈ 139 lx
At r = 2 m: E = 1750 / (4π(2)^2) ≈ 34.8 lx
At r = 3 m: E = 1750 / (4π(3)^2) ≈ 15.5 lx

Conclusion:
Illuminance is inversely proportional to the square of distance

$$\boldsymbol{E \propto \frac{1}{r^2}}$$

If distance doubles, illuminance becomes a quarter; if tripled, it becomes 1/9th, and so on (inverse square law).

Total light hitting the surface depends only on the luminous flux, not the distance.

In summary: If luminous flux increases, illuminance increases proportionally; when distance doubles, illuminance decreases to a quarter (because of the inverse square law).

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Light Intensity
- Light intensity is the luminous flux falling on one square meter from within a sphere of radius one meter.
- Measured in candela (Cd)

$$\mathbf{I = P / 4\pi}$$

Surface Lighting

When is using the illuminance law accurate in practice?

1. If the source is a point, i.e. much smaller than the distance to the surface (like a very small torch)

2. If the distance is large enough to consider the source as a point

3. Light from the source is perpendicular to the surface

4. Light spreads evenly in all directions

5. No obstacles or reflections (direct light from source to surface)

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Speed of Light

The idea that light travels at a finite (not infinite) speed has existed for more than 2400 years. In the 17th century, scientists proved that light speed is finite and much greater than sound speed. However, measuring it was difficult because light travels extremely fast and time on Earth is less than human reaction time.

Danish scientist Ole Rømer was the first to measure light's speed:

- Based on observations of Io (one of Jupiter's moons)
- Noticed Io appears late when Earth moves away from Jupiter and early when Earth moves closer
- Concluded light takes time to travel, proving speed is finite
- Estimated light needs 22 minutes to cross Earth's orbit diameter, with a time difference of 13 seconds per cycle
- Using Earth's orbit diameter, he estimated light's speed as 2.2 x 10^8 m/s
- Less than the real value, but it proved light's speed is finite

Michelson's measurements:

- Albert Michelson (American scientist) took precise measurement
- Measured round-trip time between two mountains in California, 35 km apart
- The accepted result: 2.99796 x 10^8 m/s

1	What is Light?
2	What are the two models of light? Explain each one.
3	How does light Travel?
4	What evidence have you observed that light travels in a straight line?
5	When light hits an object, what are the main processes that can occur?
6	What is light? A. Electromagnetic radiation B. Electric waves C. Longitudinal waves D. Electric conduction
7	When does light no longer travel in a straight line? A. When it loses power B. When there is electrical interference C. When it hits a boundary D. When there is magnetic interference

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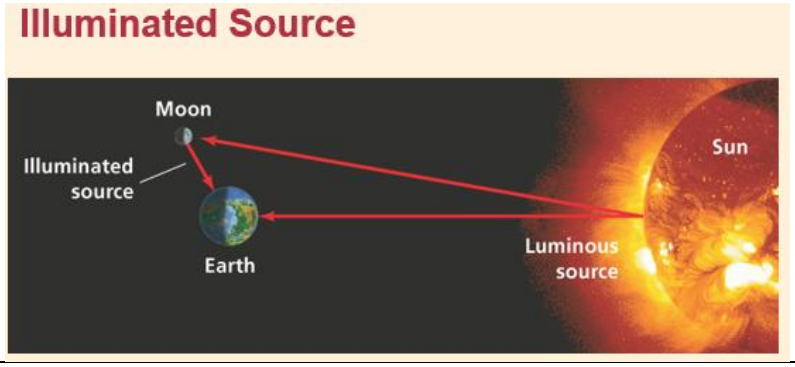
8 What are the sources of light



9 What are types of Mediums?

10 Windows in a home usually give a clear view of what is outside. Which term describes this type of window?

A. Opaque
B. Transparent
C. Translucent
D. Reflector

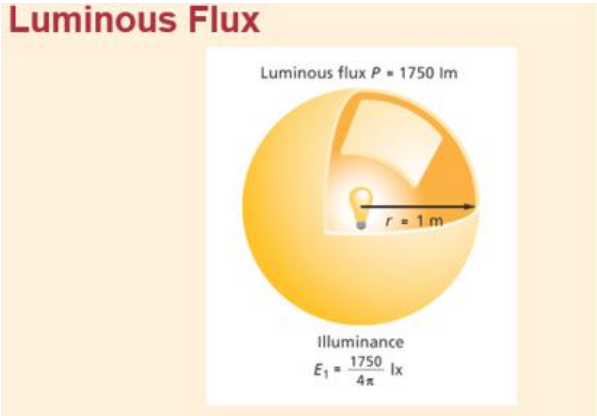
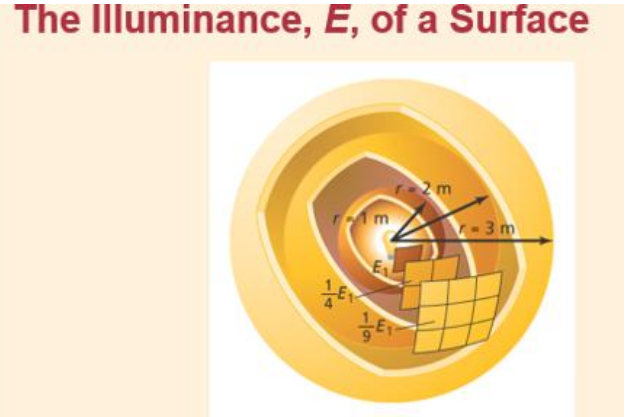
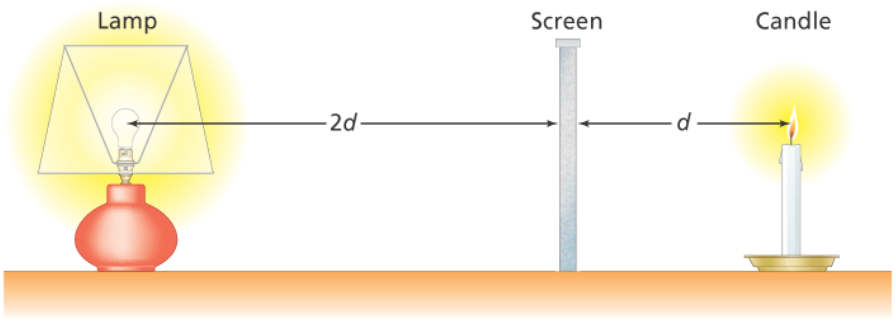
11 Compare and contrast the behavior of light rays hitting opaque, translucent, and transparent materials by filling in the table below.

	Opaque Material	Translucent Material	Transparent Material
Absorb	Some light		
Reflect		Some light	
Transmit			Most light

Point-Source Illuminance

If an object is illuminated by a point source of light, then the illuminance at the object is equal to the luminous flux of the light source divided by the surface area of the sphere whose radius is equal to the distance the object is from the light source.

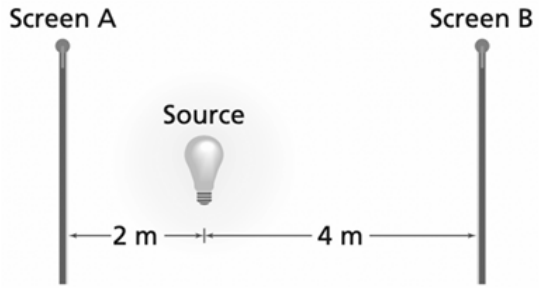
$$E = \frac{P}{4\pi r^2}$$

	 
	
12	How are distance and illumination related?
13	Define Luminous Flux and its unit?
14	How does distance affect a star's brightness?

15	Which is the correct formula for point-source illuminance? A. $E = P/4\pi r$ B. $E = 4P\pi r$ C. $E = 4\pi r^2$ D. $E = P/4\pi r^2$
16	Which best describes the relationship between distance and illuminance? A. $E \propto r$ B. $E \propto 1/r$ C. $E \propto r^2$ D. $E \propto 1/r^2$
17	Define illuminance and state the units that are used for illuminance.
18	Describe what luminous intensity is a measure of and what its relationship is to illuminance.

19

The figure below shows an incandescent lamp that emits a luminous flux of 2200 lm and is placed between two screens.



a. Complete the table below by finding the illuminance at screens A and B (show your work).

Illuminance at screen A	
Illuminance at screen B	

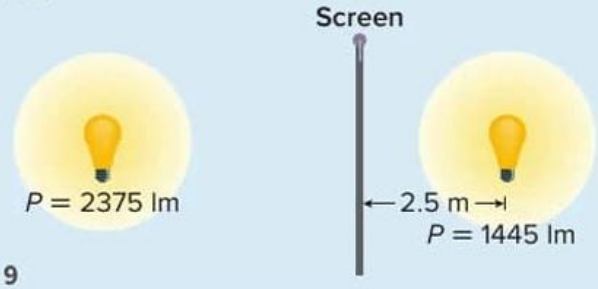
b. What is the ratio (E_B/E_A) of the illuminance at screen B to the illuminance at screen A?

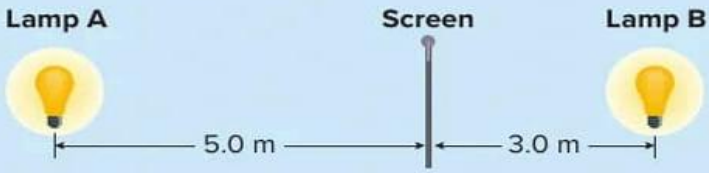
20

A lamp is moved from 30 cm to 90 cm above the pages of a book. Compare the illumination on the book before and after the lamp is moved.

21

Draw a graph of the illuminance produced by a lamp with a luminous flux of 2275 lm at distances from 0.50 m to 5.0 m.

22	A 64-cd point source of light is 3.0 m away from a painting. What is the illumination on the painting in lux?
23	A screen is placed between two lamps so that they illuminate the screen equally, as shown in **Figure 9.** The first lamp emits a luminous flux of 1445 lm and is 2.5 m from the screen. What is the distance of the second lamp from the screen if the luminous flux is 2375 lm?  Figure 9
24	What is the illumination on a surface that is 3.0 m below a 150-W incandescent lamp that emits a luminous flux of 2275 lm?
25	A public school law requires a minimum illuminance of 160 lx at the surface of each student's desk. An architect's specifications call for classroom lights to be located 2.0 m above the desks. What is the minimum luminous flux that the lights must produce?
26	Why might you choose a window shade that is translucent? Opaque?
27	Does one lightbulb provide more or less illuminance than two identical lightbulbs at twice the distance? Explain.

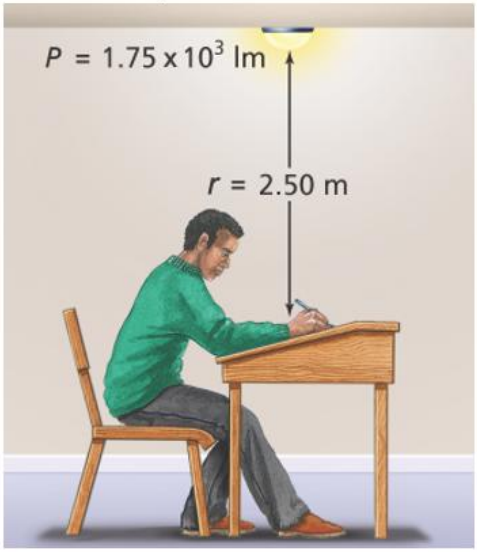
28	**Luminous Intensity** Two lamps illuminate a screen equally from distances shown in **Figure 11.** If Lamp A is rated 75 cd, what is Lamp B rated?  Figure 11
29	**Distance of a Light Source** A lightbulb illuminating your computer keyboard provides only half the illuminance that it should. If it is currently 1.0 m away, how far should it be to provide the correct illuminance?
30	**Distance of Light Travel** How far does light travel in the time it takes sound to travel 1 cm in air at 20°C?
31	**ILLUMINATION OF A SURFACE** What is the illuminance on your desktop if it is lit by a 1750-lm lamp that is 2.50 m above your desk?
32	**Distance of Light Travel** The distance to the Moon can be found with the help of mirrors left on the Moon by astronauts. A pulse of light is sent to the Moon and returns to Earth in 2.562 s. Using the defined value for the speed of light to the same precision, calculate the distance from Earth to the Moon.

33

Critical Thinking The correct time taken for light to cross Earth's orbit is 16.5 min, and the diameter of Earth's orbit is 2.98×10^{11} m. Calculate the speed of light using Roemer's method. Does this method appear to be accurate? Why or why not?

34

What is the illumination on your desktop if it is lit by a 1750-lm lamp that is 2.50 m above your desk?



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What is the objective of the ray model of light?

to study whether light is a particle

to study how light interacts with matter

to study whether light is a wave

to study whether light is a corpuscle

36	**If the distance of a book from the lamp is increased from 1 m to 3 m, what will be the change in the illuminance on the surface of the book?** Illuminance will decrease by three times. Illuminance will increase by three times. Illuminance will increase by nine times. Illuminance will decrease by nine times.
37	**A bulb and a candle are kept 6 m apart from each other, and the luminous intensity of the bulb is four times greater than that of the candle. Where should a screen be placed in between the candle and the bulb so that the illuminance on the bulb side of the screen is the same as the illuminance on the candle side of the screen?** A. The screen should be placed at a distance of 1 m from the bulb. B. The screen should be placed at a distance of 1 m from the candle. C. The screen should be placed at a distance of 2 m from the bulb. D. The screen should be placed at a distance of 2 m from the candle.
	WAVE SPEED EQUATION $c = f\lambda$ $\text{speed of light} = \text{frequency} \times \text{wavelength}$
	How was the speed of light determined?