Answers to Chapter 11

11.1 – What is Light?

#1 Radiation (light) does NOT need a medium to travel through. Conduction needs a solid medium and convection needs liquid or gas medium to travel through.

#2 Maxwell predicted light would be a coupling of electricity and magnetism. He also predicted light would NOT require a medium to travel through. He also predicted the speed light would travel at. (1864)

#3 Proof for 'electromagnetic' waves were given by Heinrich Hertz who discovered low-energy radio waves (1887) and Konrad Roentgen who discovered X-rays (1895)

#4 EM rays lowest → highest energy:
Microwaves → infrared light → red light → X-rays → gamma rays

#5 Sunscreen protects us from Ultraviolet (UV) rays given off by the sun.

#6 7 Colours of visible light are summarized by ROYGBIV (red, orange, yellow, green, blue, indigo & violet)

#7 It is helpful to view the universe using the whole EMR spectrum because each kind of EMR wave gives us different information. An analogy would be that visible light allows us to see an arm, but X-ray radiation allows us to see the bone that's broken.

#8 EMR Devices I'll use: Refer to Table 1 but generally : microwave ovens (to heat food), radio (to listen to music), cell phones, etc.

#9 X-rays → baggage screening
UV light → vitamin D
Radio waves → radar
Infrared light → DVD remote
Microwaves → telecommunications
Gamma rays → cancer treatment
Visible light → theatre, concert effects

#10 Can generate with: travels very fast, no mass, travels in straight line, has electric and magnetic properties, visible light can be seen by human eye

#11 Using a triangular prism, white light can be split into the 7 colours. Finding the correct angle at which to enter the prism takes a little experimentation.

11.2 How is Light Produced?

1 Luminous → stars - because they produce their own light
Non-luminous → planets, moons – because they reflect light only. They do not produce their own light.

2 The incandescent lightbulb is not very efficient because only 5 – 10% of the energy going into the filmament actually produces light. The rest of the energy produces heat energy (which you don't really

want from a **light**bulb.

3 Electric discharge is a method of producing light by sending electricity through a gas.

4 Phosphorescence is the gradual emission of visible light. Flourescence is the immediate emission of visible light. Both do occur when the material absorbs ultraviolet light.

5
a) Flourescent brighteners do not make clothes actually cleaner. They contain fluorescent chemicals they emit light when UV hits them. Everyday light has some UV light, so in the presence of light, the fluorescent chemicals on clothes glow a little.
b) These fluorescent chemicals are not needed to clean the clothes and if they have negative impacts, it is best not to use them.

6. Flourescent materials will not glow if illuminated by a lower energy infrared light. This phenomenon is unique to the energy present in ultraviolet light. (different light or EMR have different energy levels.

7. Chemiluminescence is called cold light because light is emitted but practically NO heat is emitted unlight incandescent light.

8 A light stick is a good idea in a potentially explosive environment because it does not give off heat. Heat can cause an explosion. NO heat means no explosion.

9 Bioluminescence in animals makes the animal or part of the animal more visible. Organisms might do this to scare away a predator, to lure (attract) prey or to attract a mate. Fireflies light up to attract a mate.

10. LED's do not have a filament whereas an incandescent lightbulb does. LED's do not produce much heat whereas incandescent lightbulbs do produce heat; therefore the LED's are more efficient.

11.3 Laser Light

1 Laser light is different than light from a flashlight.
- Laser light is all one wavelength, one energy level whereas white light from a flashlight contains all the visible light wavelengths / energy levels.
- Laser light is one colour and will not separate when going through a prism. White light is many colours (ROYGBIV)and will separate when going through a prism.
- Laser light is more intense that white light from a lightbulb because laser light is all in unison.
- Lightbulbs emit light in all directions whereas laser light emits light in a small single beam.
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2 Green light entering a prism will leave as green light. There are no other colours for it to separate into. (it will refract as it enters the prism however!)

3
a) Laser light travels in a small, very straight ray of light so it will reach the moon and back. Also, this light travels very fast so it does not take long to reach the moon and reflect back.
b) Whitelight from a searchlight tends to spread out and would not stay in the small, intense ray. It would not reach the moon.

4 You should never look directly into a laser beam because it is intense light and could damage your eye. (intense = lots of energy)

11.4 – Ray Model of Light

1 a) Mirrors are made of glass and a reflective back (silver or aluminum)
b)The reflective silver or aluminum is the actual working part of mirror. The reflective back reflects the light. The transparent glass simply supports the reflective back.

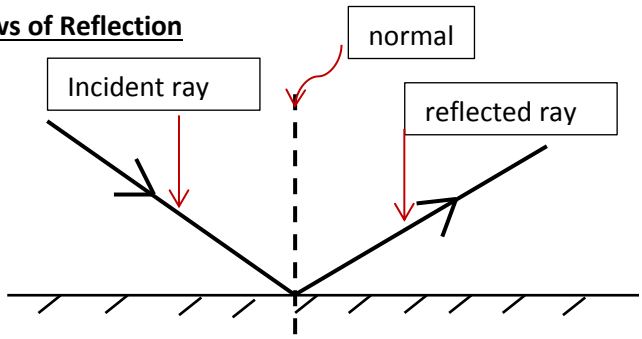
2 Geometric optics – is using rays of light to discover how light behaves in certain situations (ie: off a plane mirror).

3 Textbook = opaque
Frosted glass = translucent
Single sheet of thin tissue paper = translucent
Clean sheet of glass = transparent
A rock = opaque
Clean air = transparent
Apple juice = transparent
Sunglasses = transparent

4 Traditionally, plane mirrors are used to see oneself.

11.6 – The Laws of Reflection

1



2 Laws of Reflection
- The angle of incidence = angle of reflection
- The incident ray, the reflected ray and the normal are all in the same plane.
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3 a) specular reflection occurs off a smooth surface and results in a clear image.
b) diffuse reflection occurs off a rough surface and does not result in a clear image.

4 a) I would want to paint school walls such that they exhibited diffuse reflection. You wouldn`t want clear images off of our walls and you wouldn`t want `glare`.
b) Mate paint results in diffuse reflection.

5 a) The angle of reflection would be 32°
b) The angle of incidence would be 47°
c) If the incident ray was 40° from the reflecting surface, then it would be 50° to the normal. So the

reflected angle would be 50° from the normal

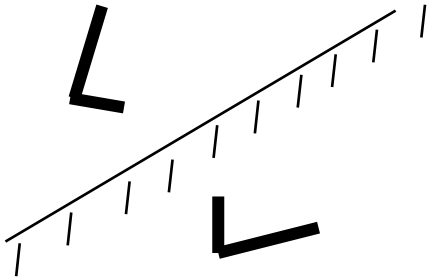
11.7 – Images in a Plane Mirror

1 A virtual image is an image that is created with imagined light. Your optic centre puts it together. It cannot be captured on a screen.

2 S = same, A = upright, L = behind the mirror, T = virtual

3 I can`t figure out how to do this on computer. See me for this.

5

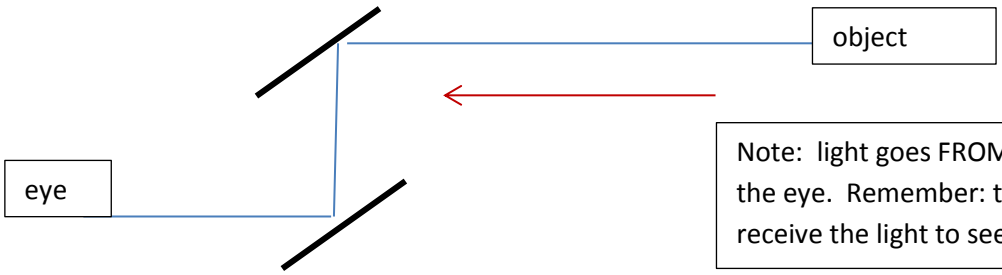


Generally this is the idea. You need to use a ruler and measure equal perpendicular lines. See Figure 8 on page 491

7 Emergency vehicles like ambulances often write the word (ambulance) backwards on their front so that drivers see the word properly in their rear view mirror. The rear view mirror would of course reverse the word and put it back to normal for the driver.

9 Yes, you can see your whole body: top of head and the feet.

11



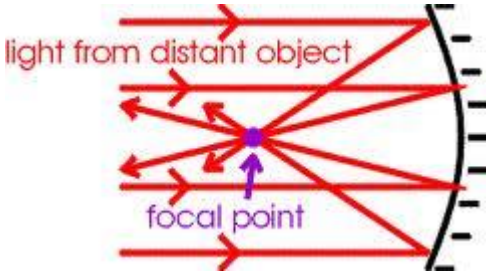
Note: light goes FROM object to the eye. Remember: the eye must receive the light to see.

11.9 – Images in a Curved Mirror

1 Convex mirrors can be used to see around corners (security)

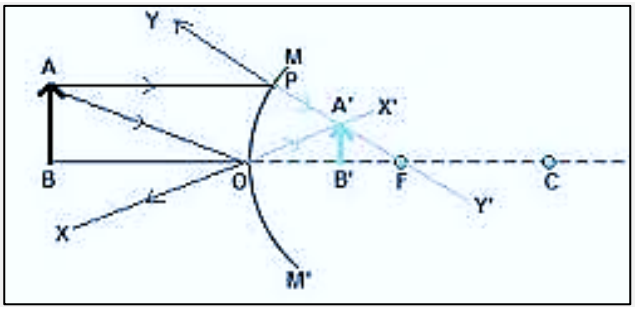
2 A real image is created with actual light. You can catch it on a screen or piece of paper. A virtual image is created with imagined light – your optic centre of brain creates it. You cannot catch it on a screen.

3 You find the focal point experimentally. Simply aim 3 parallel rays at the mirror. These rays must be parallel to the principle axis. Where they intersect is the focal point.



5 A make-up or shaving mirror is a concave mirror. The image (your face) must be between the focal point and the mirror (we say *inside the focal point*). Then your image will be upright (important – you don`t want to be upsidedown) and larger (which is what you want!)

6 A diverging mirror always diverges (spreads out) the light. So the reflected light will never meet. The optic centre will image the light meeting behind the mirror…thus a virtual image.



7 a) The mirror is convex – you can see that it bulges outward.
b) B) The image is located <u>behind the mirror</u>. (it always is with a convex lens)
c) It is a virtual image.
d)

10 a) Convex mirror are located on sharp corners in parking garage so you can see if there is a car around the corner before you bump into it!