**Reflection and Mirrors Questions**

**Question 1:**

aa. The **angle of incidence** is defined as the angle between the \_\_\_\_ and the \_\_\_\_.

a. reflected ray, surface b. incident ray, surface

c. incident ray, normal d. reflected ray, normal

e. incident ray, reflected ray

**Question 2:**

aa. The **angle of reflection** is defined as the angle between the \_\_\_\_ and the \_\_\_\_.

a. reflected ray, surface b. incident ray, normal

c. incident ray, surface d. reflected ray, normal

e. incident ray, reflected ray

**Question 3:**

aa. Diffuse reflection is different than regular (or specular) reflection. In diffuse reflection, light \_\_\_\_\_; this is not the case for regular reflection. Select all that apply.

a. reflects off a smooth surface

b. does follow the law of reflection

c. does not follow the law of reflection

d. rays within a narrow beam become scattered in different directions

e. ... nonsense! None of these apply.

**Question 4:**

aa. In the diagrams at the right, ray A would reflect and follow the law of reflection. In comparison, ray B would \_\_\_\_\_.

a. not reflect at all

b. not follow the law of reflection

c. also reflect and follow the law of reflection

**Question 5:**

aa. Which one of the following phenomena is best explained by the diffuse reflection of light rays? Select all that apply.

a. A glare results when reading from the glossy pages of a fancy magazine.

b. On a calm day, clear images of distant objects can be seen in a body of water.

c. You can look into the bathroom mirror and groom yourself in preparation for the day.

d. When reading from your Physics textbook, light from page is scattered in many directions.

e. When driving at night on dry pavement, the headlights of oncoming cars are scattered, making the entire road visible.

**Question 6:**

aa. The diagrams below show a microscopic view of light rays reflecting off a surface.



Which one of the diagrams below best depicts the phenomenon of diffuse reflection?

**Questions 7-9:**

Identify whether the following phenomena are attributable to diffuse reflection (**DR**) or specular reflection (**SR**):

aa. A lacquered tabletop produces a glare of the lamp bulb in the overhead light.

a. **DR** b. **SR**

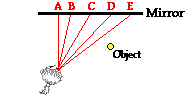
aa. Light from the overhead lights strikes your body and reflects towards all your classmate's eyes.

a. **DR** b. **SR**

aa. The image of a mountain can be clearly seen in the calm waters of a lake.

a. **DR** b. **SR**

**Question 10:**

aa. Consider the diagram at the right, Suzie is positioned in front of a mirror and viewing an object (a lit bulb) in the mirror. At which location must Suzie sight in order to view the image of the object?

**Questions 11-12:**

aa. The images of objects viewed in plane mirrors are referred to as \_\_\_\_\_ images.

a. real b. virtual c. imaginary d. make-believe

aa. (Continued from previous question.) … Such images are located \_\_\_\_\_ the mirror.

a. behind b. in front of c. on the surface of

**Question 13:**

aa. Which of the following statements are true of plane mirror images? Select all that apply.

a. The location of an image is different for different observers.

b. All observers (regardless of their locations) will sight at the same image location.

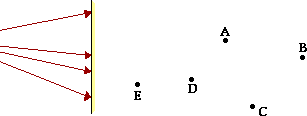
c. Observers at different locations will sight along different lines at the same image.

d. Every image is located on the mirror surface and at the same location for different observers.

e. Every image is located on the mirror surface, but at a different location for different observers.

**Question 14:**

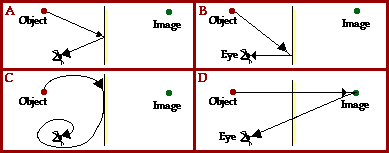
aa. The diagram below depicts the path of four incident rays emerging from an object and approaching a mirror. Five lettered locations are shown on the opposite side of the mirror.



Which location is representative of the image location?

**Question 15:**

aa. Which one of the following accurately depicts the path of light from object to eye?



**Question 16:**

aa. If an object is located 4.2 meters in front of a plane mirror, then the image is located \_\_\_\_.

a. on the mirror surface b. 2.1 meters in front of the mirror surface

c. 2.1 meters behind the mirror surface d. 4.2 meters behind the mirror surface

e. 8.4 meters behind the mirror surface

**Question 17:**

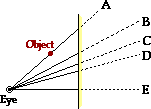
aa. The image of an object as formed by a plane mirror is located \_\_\_\_.

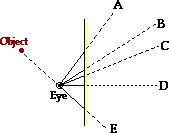
a. on the mirror surface

b. behind the mirror surface

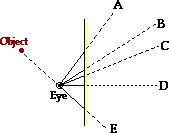
c. in front of the mirror surface

**Question 18:**

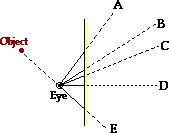
aa. Along which line of sight must the eye look in order to see the image of the RED object?

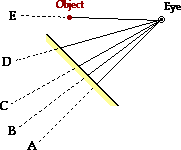
**Question 19:**

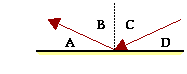
aa. Along which line of sight must the eye look in order to see the image of the RED object?

**Question 20:**

aa. Along which line of sight must the eye look in order to see the image of the RED object?

**Question 21:**

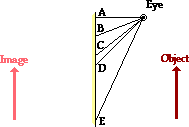
aa. Along which line of sight must the eye look in order to see the image of the RED object?

**Question 22:**

aa. The diagram at the right depicts a ray of light reflecting off a planar surface. The angle of incidence is depicted by angle \_\_\_\_\_.

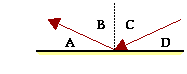
**Question 23:**

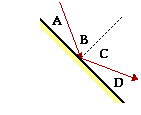
aa. An *arrow object* is positioned in front of a plane mirror as shown.



Along which line of sight must the eye look in order to see the topmost part of the image (i.e., the arrowhead)?

**Question 24:**

aa. The diagram at the right depicts a ray of light reflecting off a planar surface. The angle of reflection is depicted by angle \_\_\_\_\_. Enter the letter into the blank.

**Questions 25-26:**

aa. The diagram at the right depicts a ray of light reflecting off a planar surface. The angle of incidence is depicted by angle \_\_\_\_\_, …

a. A b. B

c. C d. D

aa. (Continued from the previous question.) … and the angle of reflection is depicted by angle \_\_\_\_\_.

a. A b. B

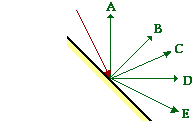
c. C d. D

**Question 27:**

aa. Which of the dashed lines in the diagram below are normal lines? Include all that apply.



**Question 28:**

aa. The diagram below depicts a ray of light (drawn in red) approaching a planar surface. Which one of the green rays (labeled with a letter) is representative of the reflected ray?

**Question 29:**

aa. Which of the following are TRUE of diffuse reflection? Select all that apply.

a. Light does NOT follow the law of reflection.

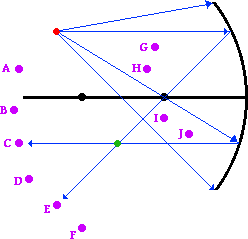
b. Results in the formation of a clear and focused image.

c. Occurs when light reflects off a microscopically rough surface.

d. Light rays within a narrow beam become scattered in many directions.

e. ... nonsense! None of these are TRUE

**Question 30:**

aa. An object (in RED) and its corresponding image position are shown. The two standard incident and reflected rays are shown. A third and fourth incident ray are shown; these last two rays represent rays striking the extreme edges of the mirror. They will reflect and pass through the image position. Several labeled eye positions are shown. From which positions will the unaided eye be able to view the image of the object? List all that apply.

**Question 31:**

aa. Telescopes often use mirrors to view the images of distant objects. Of course, those images will be upside down. How can the inverted image of the telescope be turned right-side up?

a. Simply turn the telescope around so that the mirror is upside down.

b. The only means of doing this is to view the image standing on your head.

c. Place a second concave mirror so that it is located beyond the focal point of the first.

d. Place a plane mirror at the end of the telescope tube; turn it sideways to cause up-down reversal.

e. Place a second convex mirror at the end of the telescope tube; these always produce upright images.

**Question 32:**

aa. **Spherical aberration** is a problem encountered by spherical mirrors. The result of spherical aberration is that images viewed in mirrors \_\_\_\_\_\_.

a. are blurred and fuzzy

b. don't look anything like the object

c. are too small to make out fine detail

d. can only be seen from specific locations

e. are always inverted and thus, hard to read

**Question 33:**

aa. One means of correcting for the problem of spherical aberration while maintaining the same image properties is to \_\_\_\_\_.

a. use a plane mirror

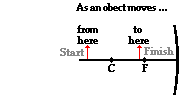
b. use a parabolic mirror

c. use a spherical mirror with a smaller focal length

d. stand further away from the mirror when viewing the image

e. simply focus one's eyesight at a different location other than the image location

**Questions 34-37:**

aa. As an object is moved from a starting location that is *beyond* the center of curvature towards the focal point of a concave mirror, the image \_\_\_\_\_\_; …

a. is a real image the entire time

b. is a virtual image the entire time

c. changes from a real image (Start) to a virtual image (Finish)

d. changes from an inverted image (Start) to an upright image (Finish)

aa. (Continued from the previous question.) … and the image size \_\_\_\_\_; …

a. decreases b. increases c. remains the same

aa. (Continued from the previous question.) … and the image orientation is \_\_\_\_\_; …

a. is upright the entire time b. is inverted the entire time

aa. (Continued from the previous question.) … and the image location \_\_\_\_\_.

a. steadily moves further from the mirror

b. steadily moves closer to the mirror

c. changes from in front of the mirror (Start) to behind the mirror (Finish)

**Question 38:**

aa. When an object is placed at the center of curvature of a concave mirror, the image is \_\_\_\_\_.

a. a virtual image

b. not visible from any location

c. clearly visible for a person located in the right position

**Question 39:**

aa. When an object is placed at the focal point of a concave mirror, the image is \_\_\_\_\_.

a. a virtual image

b. not visible from any location

c. clearly visible for a person located in the right position

**Question 40:**

aa. Suppose that a candle is placed at the focal point of a concave mirror. Light rays from the tip of the candle flame will approach the mirror at a variety of angles. Each ray will reflect from the mirror. What would be observed of the reflected rays?

a. They travel parallel to each other.

b. They diverge or grow further apart.

c. They eventually converge or come closer together.

**Question 41:**

aa. Suppose that a candle is placed between the focal point and the surface of a concave mirror. Light rays from the tip of the candle flame will approach the mirror at a variety of angles. Each ray will reflect from the mirror. What would be observed of the reflected rays?

a. They travel parallel to each other.

b. They diverge or grow further apart.

c. They eventually converge or come closer together.

**Question 42:**

aa. Suppose that a candle is placed at the center of curvature of a concave mirror. Light rays from the tip of the candle flame will approach the mirror at a variety of angles. Each ray will reflect from the mirror. What would be observed of the reflected rays?

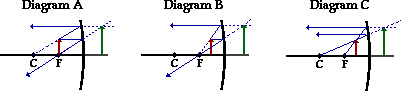
a. They travel parallel to each other.

b. They diverge or grow further apart.

c. They eventually converge or come closer together.

**Question 43:**

aa. The following diagrams are ray diagrams, showing how to locate the image (in GREEN) of an *arrow object* (in RED).



Which of these diagrams are correctly drawn? List the letters of all that apply.

**Questions 44-47:**

Suppose that you placed a candle flame at a location between the focal point and the surface of a concave mirror.

aa. The image of the candle flame would be located \_\_\_\_\_.

a. beyond C b at C c. between C and F

d. in front of C e. behind the mirror

aa. The image type would be \_\_\_\_\_.

a. real b. virtual

aa. The image orientation would be \_\_\_\_\_.

a. upright b. inverted

aa. The image size would be \_\_\_\_\_.

a. larger than b. smaller than c. the same size as

**Questions 48-51:**

Suppose that you placed a candle flame between the focal point and the center of curvature of a concave mirror.

aa. The image of the candle flame would be located \_\_\_\_\_.

a. beyond C b at C c. between C and F

d. in front of C e. behind the mirror

aa. The image type would be \_\_\_\_\_.

a. real b. virtual

aa. The image orientation would be \_\_\_\_\_.

a. upright b. inverted

aa. The image size would be \_\_\_\_\_.

a. larger than b. smaller than c. the same size as

**Questions 52-55:**

Suppose that you placed a candle flame at a location *beyond* the center of curvature of a concave mirror.

aa. The image of the candle flame would be located \_\_\_\_\_.

a. beyond C b at C c. between C and F

d. in front of C e. behind the mirror

aa. The image type would be \_\_\_\_\_.

a. real b. virtual

aa. The image orientation would be \_\_\_\_\_.

a. upright b. inverted

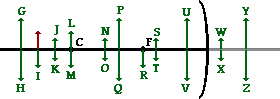
aa. The image size would be \_\_\_\_\_.

a. larger than b. smaller than c. the same size as

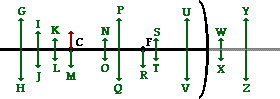
**Questions 56-59:**

In the following diagrams, an arrow object (in RED) is placed in front of a concave mirror in a specific *region* along the principal axis. Several images with varying locations, sizes and orientations are shown (in GREEN). Match the correct image (and corresponding characteristics) to the given object location. Enter the answers in the provided blanks.

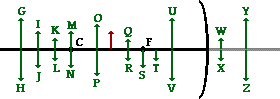
aa. Image \_\_\_\_\_ has the correct image characteristics.



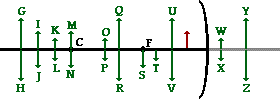
aa. Image \_\_\_\_\_ has the correct image characteristics.



aa. Image \_\_\_\_\_ has the correct image characteristics.



aa. Image \_\_\_\_\_ has the correct image characteristics.



**Question 60:**

aa. **TRUE**  or **FALSE**:

When a bundle of light undergoes diffuse reflection, each individual ray in the bundle of light rays fails to follow the law of reflection.

a. True b. False

**Question 61:**

aa. **TRUE**  or **FALSE**:

Light is totally reflected at all boundaries.

a. True b. False

**Question 62:**

aa. **TRUE**  or **FALSE**:

The reflected direction (at a boundary) of parallel incoming light rays depends on the identity of the boundary 's material (i.e., whether the material is glass, diamond, water, etc.).

a. True b. False

**Question 63:**

aa. **TRUE**  or **FALSE**:

Whether or not a light ray undergoes specular or diffuse reflection depends on the incident ray and its angle.

a. True b. False

**Question 64:**

aa. **TRUE**  or **FALSE**:

When driving at night, it is easier to see when it is raining due to more diffuse reflection.

a. True b. False

**Question 65:**

aa. **TRUE**  or **FALSE**:

Angles of incidence and reflection are always measured from the normal.

a. True b. False

**Question 66:**

aa. **TRUE**  or **FALSE**:

Real images are formed by reflected rays which diverge from the mirror.

a. True b. False

**Question 67:**

aa. **TRUE**  or **FALSE**:

Virtual images can NOT be formed by concave mirrors.

a. True b. False

**Question 68:**

aa. **TRUE**  or **FALSE**:

Real images can NOT be formed by convex mirrors.

a. True b. False

**Question 69:**

aa. **TRUE**  or **FALSE**:

Convex mirrors can create images that are either magnified or reduced in size.

a. True b. False

**Question 70:**

aa. **TRUE**  or **FALSE**:

Virtual images do not exist; that is, when looking in a mirror at a virtual image, one would not be able to see it.

a. True b. False

**Question 71:**

aa. A ray of light originating at the object position and passing through the focal point on the way to the mirror will reflect and \_\_\_\_\_.

a. pass through the center of curvature

b. pass through the focal point

c. travel parallel to the principal axis

d. travel perpendicular to the principal axis

**Question 72:**

aa. If the object position (**do**) is greater than twice the focal length, then the image will be \_\_\_\_\_. Select all that apply.

a. real b. virtual c. upright d. inverted

e. reduced in size (smaller than the object)

**Question 73:**

aa. If the object is placed at any position between the center of curvature and the focal point, then the image will be \_\_\_\_\_. Select all that apply.

a. real b. upright c. inverted d. virtual

e. magnified in size (bigger than the object)

**Questions 74-77:**

Plane mirrors produce virtual images. Curved mirrors can produce both real and virtual images.

aa. A **virtual image** is formed when reflected rays from a mirror surface are \_\_\_\_\_.

a. diverging b. converging c. traveling parallel to each other

aa. A **real image** is formed when reflected rays from a mirror surface are \_\_\_\_\_.

a. diverging b. converging c. traveling parallel to each other

aa. Virtual images are always located \_\_\_\_\_\_.

a. on the surface of the mirror

b. behind the surface of the mirror

c. in front of the surface of the mirror

aa. Real images are always located \_\_\_\_\_\_.

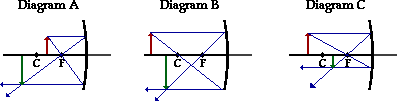
a. on the surface of the mirror

b. behind the surface of the mirror

c. in front of the surface of the mirror

**Question 78:**

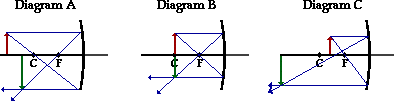
aa. The following diagrams are ray diagrams, showing how to locate the image (in GREEN) of an *arrow object* (in RED).



Which of these diagrams are correctly drawn? List the letters of all that apply.

**Question 80:**

aa. The following diagrams are ray diagrams, showing how to locate the image (in GREEN) of an *arrow object* (in RED).



Which of these diagrams are correctly drawn? List the letters of all that apply in alphabetical order with neither commas nor spaces. If none apply, then type **Z** into the answer box.

**Question 81:**

aa. Real images have some characteristics that are different than virtual images. Which of the following characteristics are always true of real images formed by mirrors and never true of virtual images formed by mirrors? Select all that apply.

a. Magnified in size

b. Located behind the mirror

c. Can be projected onto a screen

d. Located on the object's side of the mirror

e. Further from the mirror than the object is from the mirror

**Question 82:**

aa. Focal length values can be positive or negative depending on whether a mirror is concave or convex. A concave mirror will have a \_\_\_\_\_ focal length and a convex mirror will have a \_\_\_\_\_ focal length.

a. positive, negative b. negative, positive

c. positive, positive d. negative, negative

e. nonsense! Mirrors are not that predictable to make these conclusions.

**Questions 83-86:**

aa. Image distances can be positive or negative depending upon whether an image is real or virtual. A real image will be located \_\_\_\_\_ the mirror

a. on the object's side of b. behind

aa. (Continued from the previous question.) … and will have a \_\_\_\_\_ image distance. …

a. positive b. negative

aa. (Continued from the previous question.) … A virtual image will be located \_\_\_\_\_ the mirror …

a. on the object's side of b. behind

aa. (Continued from the previous question.) … and will have a \_\_\_\_\_ image distance.

a. positive b. negative

**Questions 87-88:**

aa. Image heights can be positive or negative depending upon whether an image is upright or inverted. An upright image will have a \_\_\_\_\_ image height…

a. positive b. negative

aa. (Continued from the previous question.) … and an inverted image will have a \_\_\_\_\_ image height.

a. positive b. negative

**Questions 89-93:**

The **magnification value** describes the size of the image relative to the object. It is the ratio of the image height to the object height. Since the image height can be either positive or negative value, the magnification can also be a positive or negative value. Read the following descriptions and determine whether the magnification is positive or negative. (**NOTE:** The object height is always a positive value.)

aa. An inverted image will have a \_\_\_\_\_ magnification value.

a. positive b. negative

c. positive or negative (impossible to conclude)

aa. A virtual image will have a \_\_\_\_\_ magnification value.

a. positive b. negative

c. positive or negative (impossible to conclude)

aa. An image produced on the opposite side of the mirror will have a \_\_\_\_\_ magnification value.

a. positive b. negative

c. positive or negative (impossible to conclude)

aa. If an object is located beyond the focal point of a concave mirror, the image that is produced will have a \_\_\_\_\_ magnification value.

a. positive b. negative

c. positive or negative (impossible to conclude)

aa. A convex mirror will produce an image that has a \_\_\_\_\_ magnification value.

a. positive b. negative

c. positive or negative (impossible to conclude)

**Questions 94-97:**

Try this one at home …

aa. Find a shiny spoon and look at your image using the back side of the spoon (the side you don't eat with). The image of your face is \_\_\_\_\_, …

a. upright b. inverted

aa. (Continued from the previous question.) … and \_\_\_\_\_, …

a. magnified in size b. reduced in size

aa. (Continued from the previous question.) … and \_\_\_\_\_.

a. better-looking than I am b. as gorgeous as I am

c. an ugly duckling d. quite a sight to look at

e. a spitting image of myself

aa. In this situation, the spoon is serving as a \_\_\_\_\_ mirror.

a. concave b. convex

**Question 98:**

aa. Convex mirror images are different than concave mirror images in that the image formed by a convex mirror \_\_\_\_\_\_. Select all that apply.

a. is always a real image

b. is always magnified in size

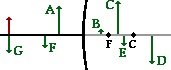
c. could be (but may not be) magnified in size

d. is always located on the opposite side of the mirror

e. could be (but may not be) located on the opposite side of the mirror

**Question 99:**

aa. An *object arrow* (in RED) is placed in front of a convex mirror as shown in the diagram below.



Which image (drawn and labeled in GREEN) represents the approximate location, size and orientation for such an object position?

**Question 100:**

aa. Virtual images (as created by mirrors of all types) are different than real images in that \_\_\_\_. Select all that apply.

a. real images are located on the object's side of the mirror; virtual images are not.

b. real images can be seen when looking in a mirror; a virtual image cannot be seen.

c. virtual images are always inverted; real images can be either upright or inverted.

d. virtual images are always reduced in size; real images can be magnified or reduced.

e. ... nonsense! None of these are explain the difference.

**Question 101:**

aa, If any type of mirror produces an image that is real, then that image MUST also be \_\_\_\_\_. Select all that apply.

a. upright

b. virtual

c. reduced in size

d. located on the object's side of the mirror

e. located at a position where reflected light rays actually converge

**Question 102:**

aa. If any type of mirror produces an image that is virtual, then that image MUST also be \_\_\_\_\_. Select all that apply.

a. real

b. upright

c. reduced in size

d. located on the object's side of the mirror

e. located at a position where reflected light rays actually converge

**Question 103:**

aa. Which of the following will always form a virtual image? Select all that apply.

a. Plane mirror b. Convex mirror c. Concave mirror

d. None of these will always result in the formation of a virtual image.

**Question 104:**

aa. In which of the following situations will a real image be formed? Select all that apply.

a. Plane mirror: Object located nearby the mirror.

b. Convex mirror: Object located far away from mirror.

c. Concave mirror: Object located at the center of curvature.

d. None of these will result in the formation of a real image.

**Question 105:**

aa. In which of the following situations will a virtual image be formed? Select all that apply.

a. Plane mirror: Object located nearby the mirror.

b. Convex mirror: Object located far away from mirror.

c. Concave mirror: Object located beyond the focal point.

d. None of these will result in the formation of a virtual image.

**Question 106:**

aa. A man walks into a diner and orders a bowl of soup. The soup arrives. The man hangs a napkin from the neckline of his shirt, picks up the soup spoon and begins to eat the soup. On each scoop, he leans over the bowl so as to catch any of the precious overspill in the bowl. As he enjoys his soup, he becomes intrigued by the following thought:

On each scoop, I am consuming the soup that is in the spoon. But better than that, I am also consuming the virtual images of the soup that still lies in the bowl.

Quite obviously, the man \_\_\_\_\_.

a. should have ordered a salad instead

b. understands the physics of convex mirrors

c. needs to schedule a visit with a good *shrink*

d. needs to *get a life* if that's what he thinks about

e. needs to be taught that spoons don't really create virtual images

f. probably should watch his calories if he's eating that much soup

**Question 107:**

aa. Any ray of incident light that heads towards the focal point of a convex mirror will \_\_\_\_\_ and \_\_\_\_\_.

a. reflect, pass through the focal point

b. reflect, travel parallel to the principal axis

c. reflect, pass through the center of curvature

d. cross through the mirror, travel parallel to the principal axis

e. cross through the mirror, pass through the center of curvature

**Question 108:**

aa. Any ray of incident light that is traveling parallel to the principal axis and strikes a convex mirror will \_\_\_\_\_ and \_\_\_\_\_.

a. reflect, travel in a direction in line with the focal point

b. reflect, travel in a direction in line with the center of curvature

c. cross through the mirror, pass through the center of curvature

d. cross through the mirror, pass through the focal point

e. nonsense! No such prediction can be made.

**Question 109:**

aa. Rays of light that originate from the same point and reflect off a **convex mirror** will \_\_\_\_\_\_.

a. always diverge b. always converge

c. sometimes converge and sometimes diverge (depending on the object location)

**Question 110:**

aa. Rays of light that originate from the same point and reflect off a **concave mirror** will \_\_\_\_\_\_.

a. always diverge b. always converge

c. sometimes converge and sometimes diverge (depending on the object location)

**Question 111:**

aa. An image produced by a **convex mirror** is \_\_\_\_\_\_.

a. always a real image b. always a virtual image

c. either real or virtual, depending on the object location

**Question 112:**

aa. An image produced by a **concave mirror** is \_\_\_\_\_\_.

a. always a real image b. always a virtual image

c. either real or virtual, depending on the object location

**Question 113:**

aa. An image produced by a **convex mirror** is \_\_\_\_\_\_.

a. always an upright image b always an inverted image

c. either upright or inverted, depending on the object location

**Question 114:**

aa. An image produced by a **concave mirror** is \_\_\_\_\_\_.

a. always an upright image b. always an inverted image

c.either upright or inverted, depending on the object location

**Question 115:**

aa. An image produced by a **convex mirror** is \_\_\_\_\_\_.

a. reduced in size

b. magnified in size

c. the same size as the object

d. magnified, reduced or the same size, depending on the object location

**Question 116:**

aa. An image produced by a **concave mirror** is \_\_\_\_\_\_.

a. reduced in size

b. magnified in size

c. the same size as the object

d. magnified, reduced or the same size, depending on the object location

**Question 117:**

aa. Convex mirrors are used on cars for the passenger-side rear-view mirror. The advantage of using a convex mirror is that a convex mirror \_\_\_\_\_.

a. provides a wide *field of view*, thus enhancing the driver's view of the side

b. gives the illusion of an object being farther away than they really are

c. won't *catch* snow during a snow storm like a concave mirror would do

d. reduces the size of images, thus allowing a driver to see the entirety of the car behind them

**Question 118:**

aa. Consider the diagram at the right. The angle of incidence is denoted by angle \_\_\_\_.

a. A b. B c. C

d. D e. E ab. F

**Question 119:**

aa. Consider the diagram at the right. The angle of reflection is denoted by angle \_\_\_\_.

a. A b. B c. C

d. D e. E ab. F

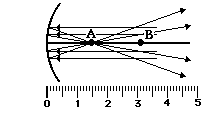
**Question 120:**

aa. Consider the diagram at the right. The concave side of the mirror in the diagram is the \_\_\_\_\_\_\_ (right, left) side.

a. Right Side b. Left Side

c. Nonsense! It is impossible to tell without knowing where the object is located.

**Questions 121-123:**

aa. A diagram of a curved mirror is shown at the right. The center of curvature is point \_\_\_\_\_ on the diagram.

a. A b. B

c. Neither of these

aa. The focal point is point \_\_\_\_\_ on the diagram.

a. A b. B

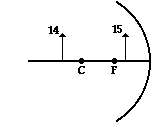
c. Neither of these

aa. The focal length (as measured in cm) for this mirror is approximately \_\_\_\_\_\_\_\_ cm.

a. 0.8 b. 1.6 c. 2.4 d. 3.2

e. impossible to tell without knowing the object location.

**Questions 124-125:**

As we begin discussing the mathematics of curved mirrors, we will begin using symbols **do** and **di** and **ho** and **hi** to denote the object and image distances and heights and **M** to represent the image magnification.

aa. Consider object 14 in the diagram at the right. It's image will have a \_\_\_\_ **di** value and a \_\_\_\_ M value.

a. +, - b. -, - c. -, + d. +, +

aa. Consider object 15 in the diagram at the right. It's image will have a \_\_\_\_ **di** value and a \_\_\_\_ M value.

a. +, - b. -, - c. -, + d. +, +

**Question 126:**

aa. An image location is a location \_\_\_\_.

a. from where light originates

b. where all incident rays intersect with the mirror surface

c. where any incident ray intersects with the mirror surface

d. from where reflected light appears to or actually does diverge

**Question 127:**

aa. Incident light rays traveling parallel to the principal axis of a concave mirror reflect and \_\_\_\_.

a. pass through the focal point

b. pass through the center of curvature

c. travel parallel to each other

d. ... nonsense! Such light rays would never undergo reflection

**Calculations and Long Answers**

**Question 128:**

aa. If an object is located 5.3 meters in front of a plane mirror, then the image is located \_\_\_\_\_\_\_\_\_\_ meters from the object.

**Question 129:**

aa. If an incident ray of light makes an angle of 39.0 degrees with the mirror surface then the angle of reflection is \_\_\_\_\_\_°.

**Question 130:**

aa. If an incident ray of light makes an angle of 24° with the mirror surface then the angle of reflection is \_\_\_°.

**Question 131:**

aa. A concave mirror has a radius of curvature of 18 cm. The focal length of the mirror is \_\_\_\_\_\_ cm.

**Question 132:**

aa. A 5.2-cm tall object is placed varying distances from a concave mirror as shown in the table below. The mirror has a focal length of 40.0 cm. For each object location, determine the corresponding image location, image height and magnification. Include a negative sign where appropriate.

|  |  |  |  |
| --- | --- | --- | --- |
| **Object**  **Distance (cm)** | **Image**  **Distance (cm)** | **Image**  **Height (cm)** | **Magnification** |
| 120.0 |  |  |  |
| 80.0 |  |  |  |
| 60.0 |  |  |  |
| 20.0 |  |  |  |

**Question 133:**

aa. A convex mirror has a focal point located at a position that is 21.4 cm from the surface of the mirror. (You decide for yourself whether f is + or -.) An object is placed 58.7 cm from the surface of the mirror.

a. Find the image distance (in cm).

b. Determine the magnification of the image for this object distance.

**Question 134:**

aa. A convex mirror has a focal point located at a position that is 21.4 cm from the surface of the mirror. (You decide for yourself whether f is + or -.)

a. Find the image distance (in cm) for an object distance of 21.4 cm.

b. Determine the magnification of the image when the object is located 21.4 cm away from the above mirror. Enter your answer accurate to the third decimal place.

**Question 135:**

aa. What is the focal length (in cm) of a convex mirror that creates a virtual image 15.8 cm from the mirror when the object is located 25.6 cm from the mirror surface?

**Question 136:**

aa. A concave mirror has a focal length of 22.9 cm. Determine the image distance (in cm) for an object located 68.7 cm from the mirror surface.

**Question 137:**

aa. A concave mirror has a focal length of 22.9 cm. Determine the image distance (in cm) for an object located 45.8 cm from the mirror surface.

**Question 138:**

aa. A concave mirror has a focal length of 22.9 cm. Determine the image distance (in cm) for an object located 33.6 cm from the mirror surface.

**Question 139:**

aa. A concave spherical mirror has a radius of curvature of 42.9 cm.

a. Find the image distance (in cm) for an object distance of 15.6 cm.

b. Determine the magnification of the image when the object is located 15.6 cm away from the above mirror. Enter your answer accurate to the third decimal place.

**Question 140:**

aa. A convex mirror is used to prevent *five-finger discounts* in a department store. The mirror has a radius of curvature of -0.536 m.

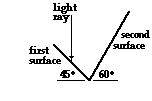
a. Determine the image distance (in cm) of a customer who is located 8.46 m from the mirror.

b. Determine the magnification of the image of the customer who is located 8.46 m from the mirror. Enter your answer to the fourth decimal place.

**Question 141:**

aa. The real image formed by a curved mirror is observed to be 3 times larger than the object height when the object is 32.8 cm in front of a mirror. What is the focal length (in cm) of the mirror?

**Question 142:**

aa. The current unit is sometimes referred to as *geometric optics*. There is a considerable amount of geometric thinking involved in understanding light reflection.

Without measuring any actual angles, use the information in the diagram at the right and some geometric principles to determine the angle of incidence at the second surface. State the angle and explain in words how you determined the angle.

**Question 143:**

aa. The diagrams below show three incident rays. For each incident ray, draw the three corresponding reflected rays on the diagrams. Place arrowheads upon all your rays.

