Problem 1

To determine the image formed by a convex or concave lens, the following rules are followed:

i) Any ray approaching the lens parallel to its axis is bent so that it passes through the focal point of a convex lens or extrapolates back to the focal point on the same side of a concave lens.

ii) Any ray going through the middle of the lens continues in its original direction.

iii) Any ray going through the focal point and to the lens is bent such as it emerges parallel to the axis of the lens. For a concave lens, the ray is drawn as going through the focal length after the lens, but it actually emerges parallel.

An example of the image formed by a convex lens:

[Diagram of a convex lens with ray diagrams]

An example of the image formed by a concave lens:

[Diagram of a concave lens with ray diagrams]
(a) [5 pts] Consider a converging lens (with positive focal length). Draw at least two light rays incident upon the lens and the corresponding outgoing rays and show where the image (if any) is formed. In each case, indicate if the image is real or virtual or no image.

- Light source is infinitely far away

![Diagram of light rays incident upon a converging lens with infinitely far away source, showing point image is real.]

Point image is real.

- Light source is at a distance $d_o = f$

![Diagram of light rays incident upon a converging lens with source at distance $d_o = f$, showing no image is formed.]

No image is formed.

- Light source is at a distance $d_o < f$

![Diagram of light rays incident upon a converging lens with source at distance $d_o < f$, showing image is virtual.]

Image is virtual.
(b) [5 pts] Repeat part (a) for a diverging lens.

Point image is virtual.

Image is virtual.

Image is virtual.