Question 35.9
(a) yes (b) no (c) yes (d) no; frequency is always only energy dependent, but since the speed changes by a factor of n_i/n_r, so must the wavelength ($\lambda = c/f$); the direction changes according to snell's law, which means there is no change if the angle of incidence is zero.

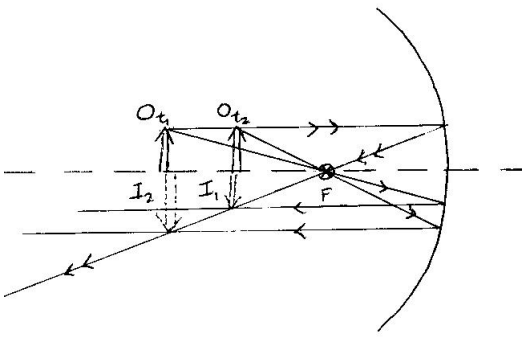
Question 35.19
Heat radiating off a hot blacktop road creates a pocket of warmer temperatures for a few meters above the road (with the highest temps just above the surface). Since the index of refraction is inversely proportional to temperature (b/c hotter air is less dense), this warm pocket results in a similar (but negative) gradient in the index value of the air, with lowest values nearest the road. These gradients are substantial enough for this effect to be non-negligible (though small), meaning that any light entering this pocket will be continuously and noticeably refracted upward (i.e. bent back toward the sky by each new layer of hotter, lower-n air) until it leaves the pocket or is absorbed (or, much less often, reflected) by the road. So light from just above the horizon will enter the pocket at a shallow enough angle such that it follows a very shallow u-shaped path and never reaches the road, traveling back upward (also at a shallow angle) until it interacts with some other surface. If this surface happens to be your windshield–and subsequently your eyes–you will see light from the sky coming at you at from the road a little ways out in front of you; thus it appears as if the light is reflected off the road, as it would be by water; this is the first association your mind makes; hence, the road appears to be covered in water.

Question 36.1
The image will be real and inverted as long as the object is positioned beyond the focal length. For objects inside the focal length, the image will be virtual and upright (and magnified).

Question 36.2
The image will always be virtual and upright (and diminished). The object can't be beyond the focal length because the focus is behind the mirror.

Question 36.5
(i) The mirror is (c) concave; (ii) the focal length is (c) 30cm; the image of an object at the focus of a concave mirror is "in focus at infinity."

Question 36.6
Using two rays per object, the object is shown at two different times, it is easy to see that the image moves farther as the object moves toward the focus.



Question 36.7
Since object and image distance, focal length, and radius are all positive in front of a mirror, and upright images have positive height and magnification:
(i) (a)+ (b)- (c)- (d)- (e)+ (f)+ (g)+
Since object distance is positive in front of a lens, image distance is positive behind, focal length is positive for converging lenses, and the same conventions apply for height and magnification as with mirrors:
(ii) (a)+ (b)+ (c)+ (d)+ (e)- (f)-
(iii) (a)+ (b)- (c)+ (d)- (e)- (f)+

Question 36.8
The person should (c) aim below the fish. The light from the fish will refract *toward* the fisherman as it leaves the water, which means the light heading straight toward the fisherman while still underwater will end up passing behind him, and light originally traveling ahead of him will end up at his eyes, thereby making the fish look further out in front of him (see diagram on quiz 10, part (c) for a visual).

Question 36.11
The answer is (d) the entire image is still visible, but dimmer. As demonstrated in lab/class, light leaving every point on an object will travel through every point on the lens; therefore, any small portion of the lens "contains" an entire image of the object, but with proportionally less intensity. So obscuring part (or most) of the lens will decrease the intensity of the image, but will still recreate the entire image.

Question 36.16
Chromatic aberration results from different wavelengths of light being refracted at slightly different angles because of the index of refraction of the material causing the refraction. Since reflected light never travels through the reflecting surface, refractive concerns never come into play, so all wavelengths of light follow the same path upon reflection; therefore, there can be no aberration.