10. (a) $f = +20\,\text{cm}$ (positive, because the mirror is concave); $r = 2f = 2(+20\,\text{cm}) = +40\,\text{cm}$; $i = (1/f - 1/p)^{-1} = (1/20\,\text{cm} - 1/10\,\text{cm})^{-1} = -20\,\text{cm}$; $m = -i/p = -(-20\,\text{cm}/10\,\text{cm}) = +2.0$. The image is virtual and upright. The ray diagram would be similar to Fig. 35-8(a) in the textbook.

(b) The fact that the magnification is 1 and the image is virtual means that the mirror is flat (plane). Flat mirrors (and flat "lenses" such as a window pane) have $f = \infty$ (or $f = -\infty$ since the sign does not matter in this extreme case), and consequently $r = \infty$ (or $r = -\infty$) by Eq. 35-3. Eq. 35-4 readily yields $i = -10\,\text{cm}$. The magnification being positive implies the image is upright; the answer is "no" (it's not inverted). The ray diagram would be similar to Fig. 35-6(a) in the textbook.

(c) Since $f > 0$, the mirror is concave. Using Eq. 35-3, we obtain $r = 2f = +40\,\text{cm}$. Eq. 35-4 readily yields $i = +60\,\text{cm}$. Substituting this (and the given object distance) into Eq. 35-6 gives $m = -2.0$. Since $i > 0$, the answer is "yes" (the image is real). Since $m < 0$, our answer is "yes" (the image is inverted). The ray diagram would be similar to Fig. 35-8(c) in the textbook.

(d) Since $m < 0$, the image is inverted. With that in mind, we examine the various possibilities in Figs. 35-6, 35-8 and 35-9, and note that an inverted image (for reflections from a single mirror) can only occur if the mirror is concave (and if $p > f$). Next, we find i from Eq. 35-6 (which yields $i = 30\,\text{cm}$) and then use this value (and Eq. 35-4) to compute the focal length; we obtain $f = +20\,\text{cm}$. Then, Eq. 35-3 gives $r = +40\,\text{cm}$. As already noted, $i = +30\,\text{cm}$. Yes, the image is real (since $i > 0$). Yes, the image is inverted (as already noted). The ray diagram would be similar to Figs. 35-9(a) and (b) in the textbook.

(e) Since $r < 0$ then (by Eq. 35-3) $f < 0$, which means the mirror is convex. The focal length is $f = r/2 = -20\,\text{cm}$. Eq. 35-4 leads to $p = +20\,\text{cm}$, and Eq. 35-6 gives $m = +0.50$. No, the image is virtual. No, the image is upright. The ray diagram would be similar to Figs. 35-9(c) and (d) in the textbook.

(f) Since $0 < m < 1$, the image is upright but smaller than the object. With that in mind, we examine the various possibilities in Figs. 35-6, 35-8 and 35-9, and note that such an image (for reflections from a single mirror) can only occur if the mirror is convex. Thus, we must put a minus sign in front of the "20" value given for f. Eq. 35-3 then gives $r = -40\,\text{cm}$. To solve for i and p we must set up Eq. 35-4 and Eq. 35-6 as a simultaneous set and solve for the two unknowns. The results are $i = -18\,\text{cm}$ and $p = +180\,\text{cm}$. No, the image is virtual (since $i < 0$). No, the image is upright (as already noted). The ray diagram would be similar to Figs. 35-9(c) and (d) in the textbook.

(g) Knowing the mirror is convex means we must put a minus sign in front of the "40" value given for r. Then, Eq. 35-3 yields $f = r/2 = -20\,\text{cm}$. The fact that the mirror is convex also means that we need to insert a minus sign in front of the "4.0" value given for i, since the image in this case must be virtual (see Figs. 35-6, 35-8 and 35-9). Eq. 35-4 leads to $p = +5.0\,\text{cm}$, and Eq. 35-6 gives $m = +0.8$. No, the image is virtual. No, the image is upright. The ray diagram would be similar to Figs. 35-9(c) and (d) in the textbook.

(h) Since the image is inverted, we can scan Figs. 35-6, 35-8 and 35-9 in the textbook and find that the mirror must be concave. This also implies that we must put a minus sign in front of the "0.50" value given for m. To solve for f, we first find $i = +12\,\text{cm}$ from Eq. 35-6 and plug into Eq. 35-4; the result is $f = +8\,\text{cm}$. Thus, $r = 2f = +16\,\text{cm}$. Yes, the image is real (since $i > 0$). The ray diagram would be similar to Figs. 35-9(a) and (b) in the textbook.