1.) Sparke & Gallagher Problem 2.20. (DM rotation curve & enclosed mass).
   [In your sketch of \( V(r) \), please indicate \( a_H \) and \( V_H \).]

2.) Sparke & Gallagher Problem 5.8. (rotation curve & spider diagram of plummer sphere). [You can either make the rotation curve and velocity field diagram with a computer or draw by hand, but if you choose the latter please draw things carefully!]

3.) Choose a spiral galaxy inclined between 30 and 75 degrees from the THINGS sample (Walter et al., 2008, AJ, 136, 2563), which is a sample of nearby late-type galaxies for which they have obtained high quality HI maps with the VLA. Determine the direction of the angular momentum vector for this galaxy by doing the following:

   Find a high quality optical image of the galaxy which is good at showing dust lanes and spiral arms (u,g,B bands may be best) from, e.g., http://cosmo.nyu.edu/hogg/rc3/ or a printed atlas.

   a.) Hand in a copy of the velocity field map. Label the approaching and receding sides, and the kinematic major & minor axes. (The kinematic major axis is the curve which runs through nucleus and goes in the direction of the largest velocity gradient. The kinematic minor axis is the locus of points having \( V_{\text{los}} = V_{\text{sys}} \), the velocity of the nucleus.) Are the kinematic axes perpendicular at all radii?

   Describe any non-circular motions in the velocity field. What type of feature might explain these non-circular motions? (e.g., bar, warp, spiral density wave, nuclear outflow, tidal interaction, etc.)

   b.) Hand in a copy of the optical image. Does dust extinction appear stronger on one of the 2 sides of the major axis? If so, label the near and far sides of the galaxy on the image. If not, explain why you cannot determine the near and far sides with this technique and go to part c.

   Use the optical image to estimate the position angle of the major axis (line of nodes) and the inclination angle (of the disk plane relative to the plane of the sky). Does the position angle of the major axis measured from the optical image agree with that from the velocity field?

   \textit{Note the position angle convention used by astronomers: the position angle is measured counterclockwise from North!}
c.) Inspect the spiral arms in the optical image. Assuming that spiral arms trail, can you identify the rotational direction (clockwise or counterclockwise) of the galaxy? If so, label the rotational direction on the image. If not, explain why you cannot determine the rotational direction with this technique and go to part d.

d.) Do i, ii, or iii, depending on your success in b and c.

i.) If you COULD determine the near and far sides from the dust distribution, but COULD NOT determine the rotational direction from the spiral arm pattern, then determine the rotational direction from knowing both the approaching & receding sides, and the near & far sides.

ii.) If you COULD NOT determine the near and far sides from the dust distribution, but COULD determine the rotational direction from the spiral arm pattern, then determine the near & far sides from knowing both the approaching & receding sides, and the rotational direction.

iii.) If you could determine BOTH the near and far sides, and the rotational direction, then the galaxy geometry is overdetermined. Is the rotational direction inferred from knowing both the approaching & receding sides and the near & far sides consistent with that inferred from the spiral arm pattern?

e.) Give the direction of the angular momentum vector for this galaxy. The direction of the angular momentum vector can be specified with the following 2 angles: the position angle on the sky of the projection of the angular momentum vector, and the angle of the angular momentum vector relative to the plane of the sky (specify whether this vector points toward or away from us!).