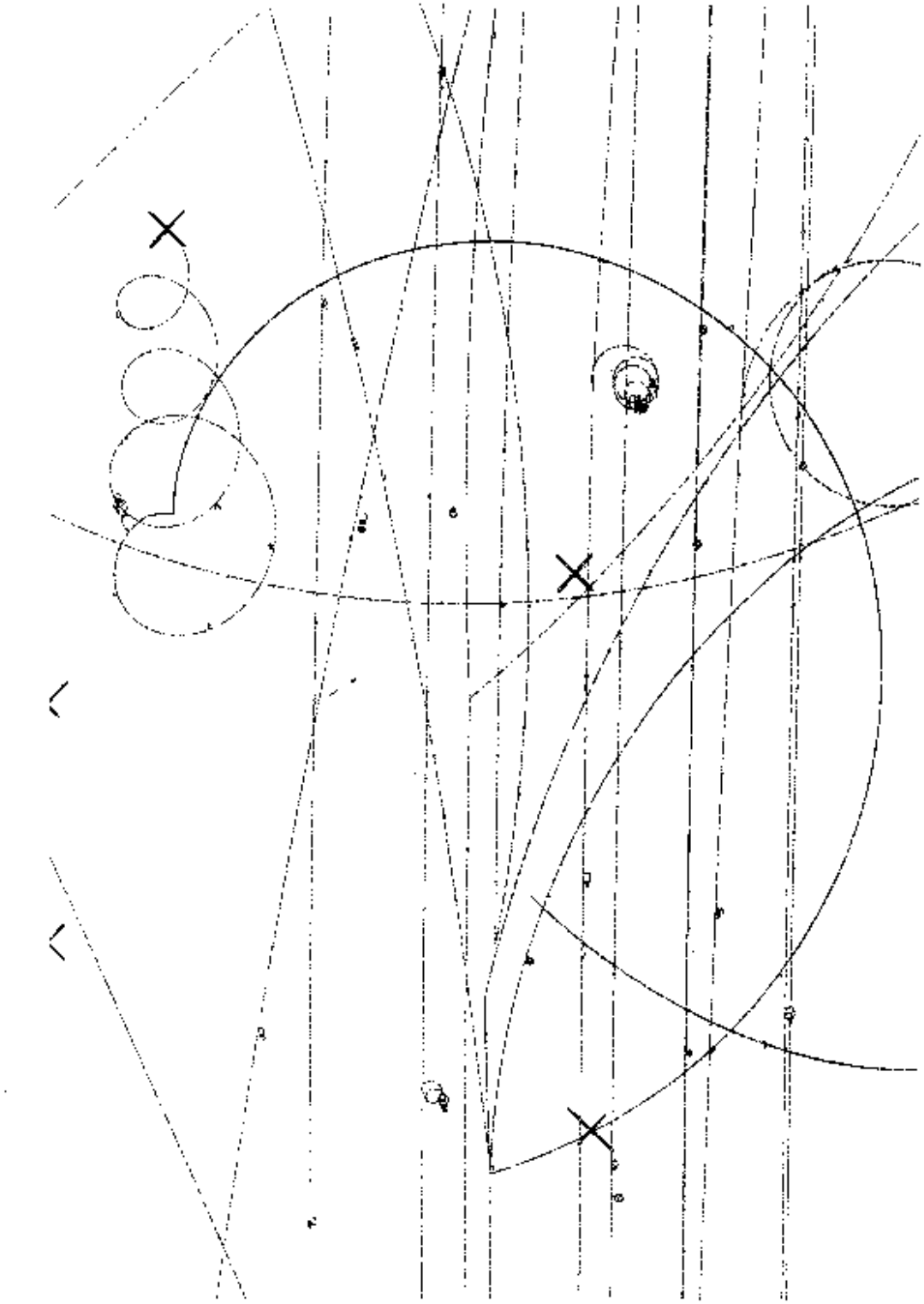
EXERCISE 3, Questions and answers on event used for bubble chamber tutorial



Bubble chamber image taken in the CERN 2m bubble chamber filled with liquid hydrogen using a beam of 8 GeV K^- particles

QUESTIONS:

1. How many charged beam particles enter the chamber?
2. In what direction is the beam moving (from the bottom to the top or vice versa)?
3. Are there any knock-on electrons?
4. What is the direction of the magnetic field?
5. How many collisions do you see?
6. How many charged particles result from each of the collisions?
7. Identify the charges of these particles.
8. What is the charge of each of the beam particles (assuming collisions are with protons)?
9. How many kinks do you see?
10. How many vees do you see?
11. How many particles result from the kinks?
12. Consider the main collision/interaction.

    a) Which of the charged particles from the collision has the lowest momentum?
    b) How do you know?

ANSWERS:

1. Probably 10. You can discuss whether all 10 are parallel, but bear in mind that this is physics and there will be a small spread in beam momenta (~1%).

   Notice that two tracks almost coincide to make what looks like one dark track, also notice that to the right of this, we have a track that is not parallel to the other beam tracks, so we reject this.

2. Bottom to top.

3. Yes – they are the small spiral tracks turning to the right in the magnetic field..

4. The magnetic fields points into paper/screen (use the Lorentz-law in vector-form).

5. Two.

6. Four from event near bottom of picture; two from event near centre.

7. For event one moving clockwise: +, - (look after kink to tell), -, + (looping track which decays).

   For event two moving clockwise: -, +.

8. Using the charge conservation law, we can determine the charge of the beam tracks. We see one negative, one positive and one neutral particle emerge from the collision. This means the total charge after the collision is 0, and therefore the total charge before the collision must also be zero. Because the target is a proton, the charge of the beam must be negative.

9. Three.

10. One – the decay of the neutral particle (a vee) from the initial collision into two charged particles, one positive and one negative.

11. One charged with an unknown (to the student) number of neutral particles.

12. a) The positive particle which starts moving to the right, turns round and kinks.

    b) This is the most curved. ($p = Bqr$)