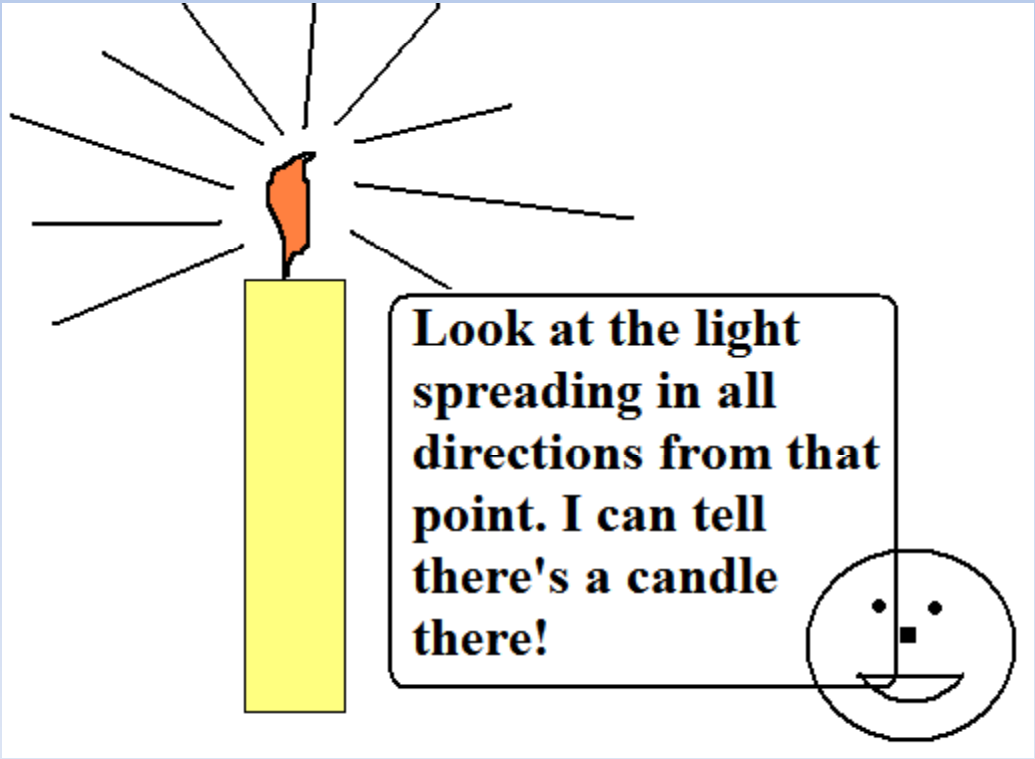
Traditional: 12-05
Themed: 03-02

Law of reflection and ray tracing

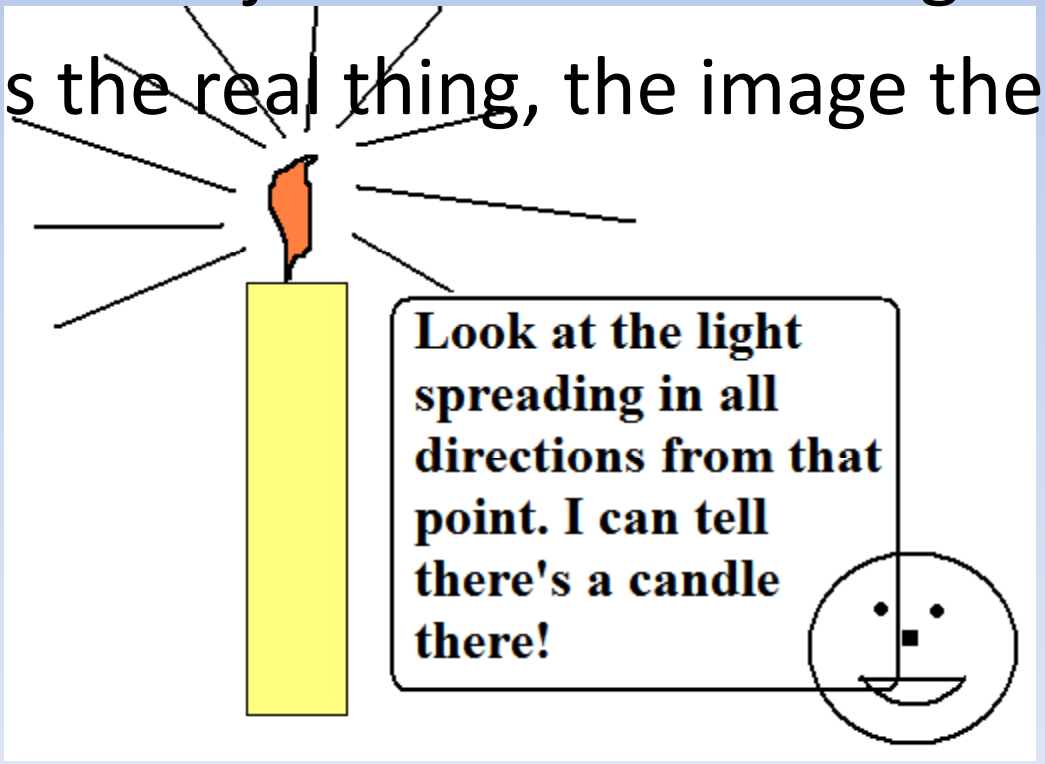
Mirrors..Why do I think there's a man behind the mirror who looks like me?

- Our brain believes that light travels in straight lines, spreading in all directions from a point of origin



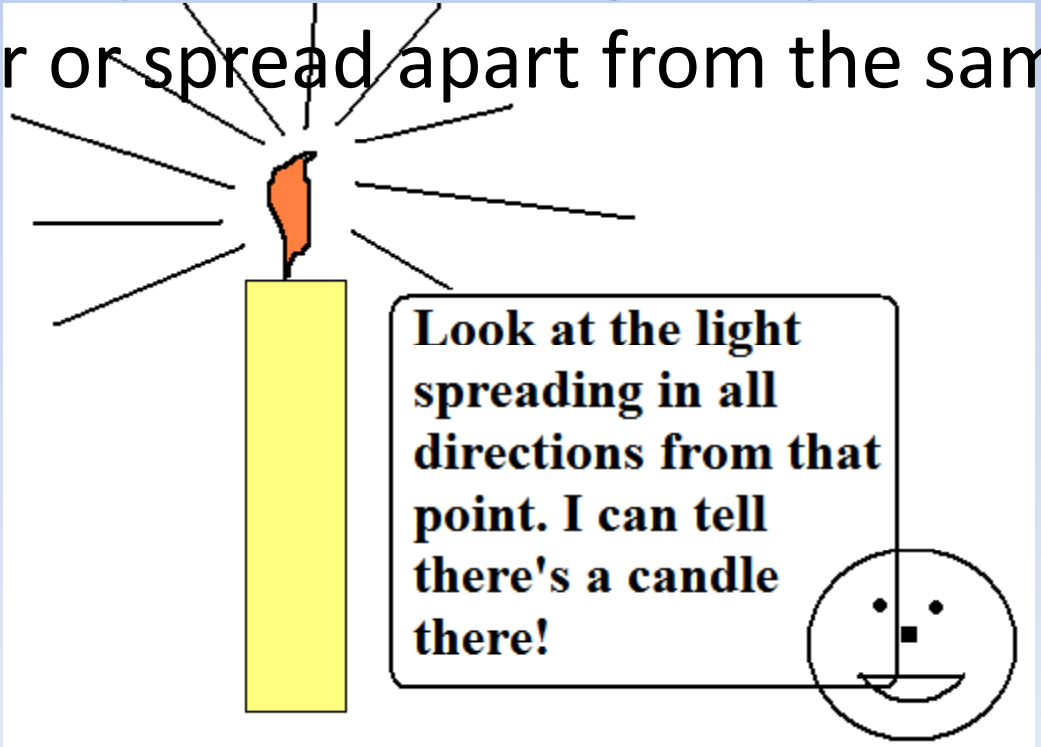
Mirrors

- If it SEEMS to us that light is spreading out from some point in space we believe an object is at that point
- The “apparent” object is called an image
- The object is the real thing, the image the “fake”



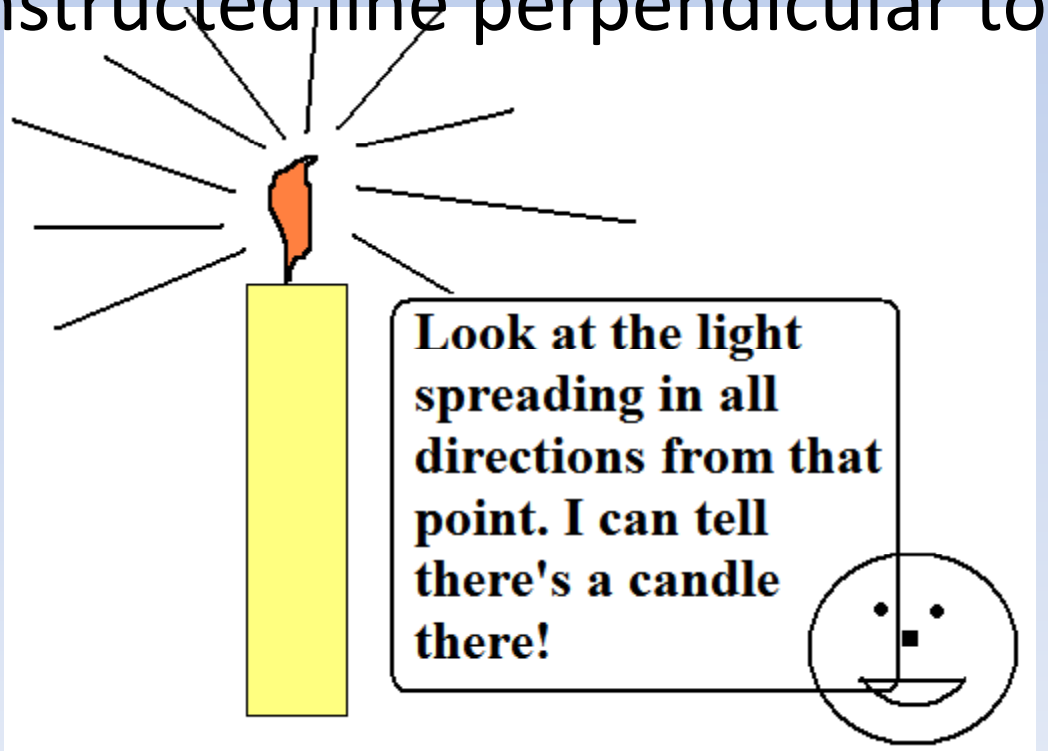
Mirrors

- We see where images form by tracing the way light rays bounce off of mirrors
- Mirrors must be polished smoothly so they have specular reflection (NOT diffuse)
- An image will only form if the light rays all come together or spread apart from the same point



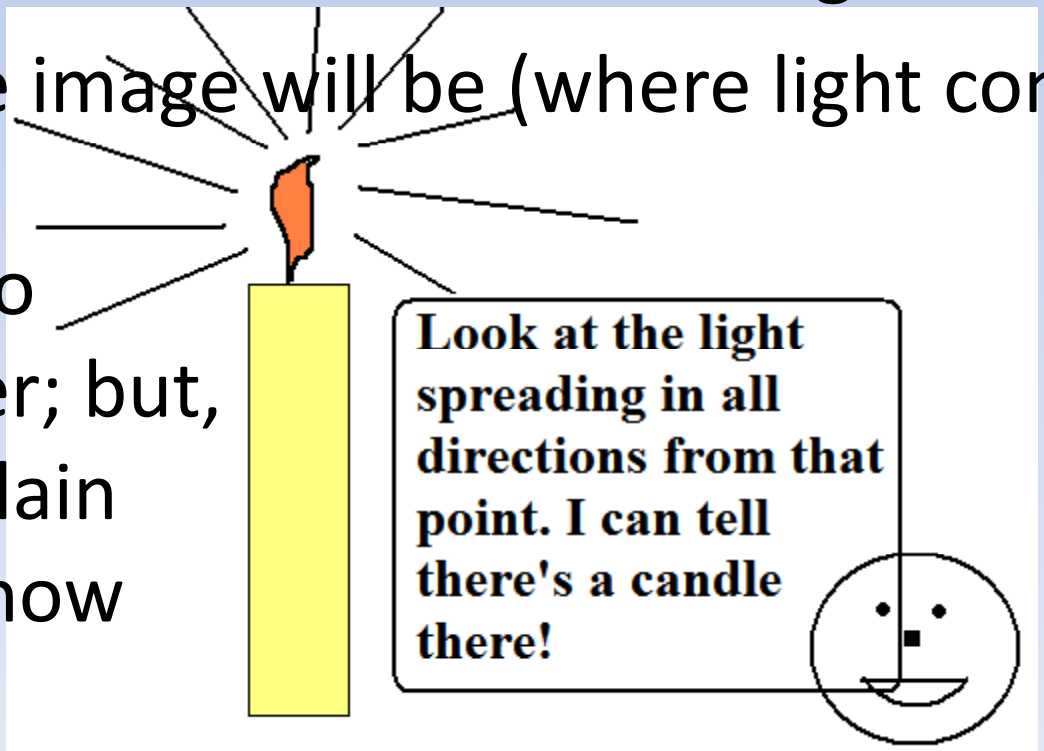
Mirrors

- Law of reflection (specular reflection)
  - Angle of incidence = Angle of reflection
- Angles are measured relative to a “normal”
- We’ll use normals in refraction optics too, know it
- A normal is a constructed line perpendicular to a surface



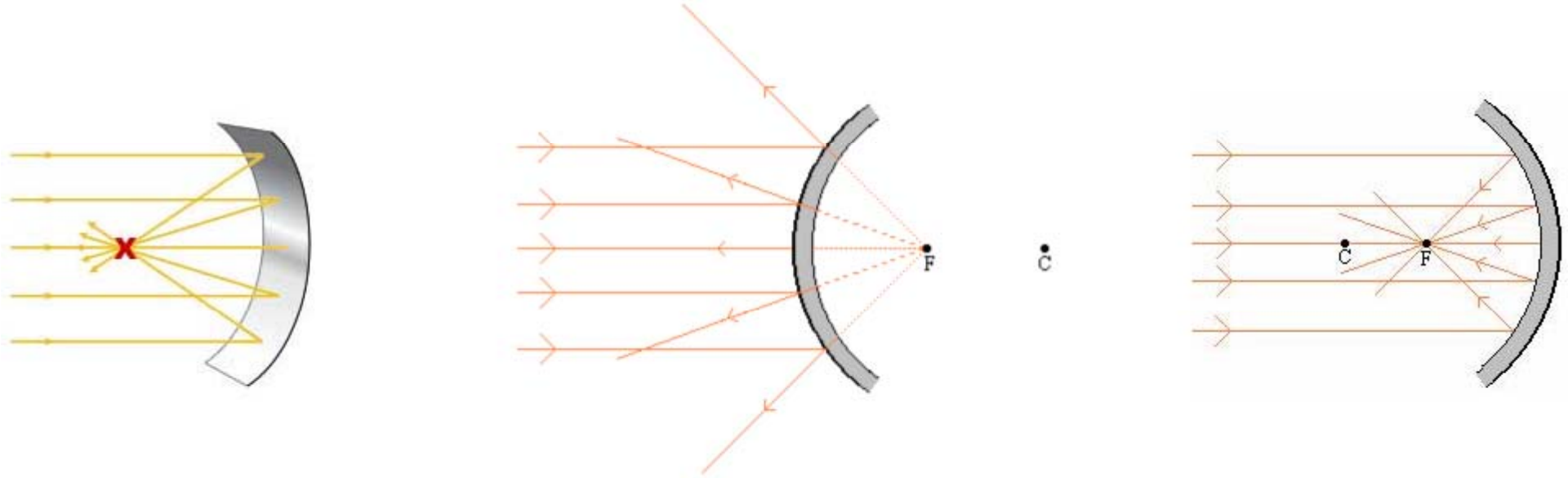
Mirrors – Ray Tracing

- Pick a point on the object
- Light rays moving in all possible directions from that point
- Find a couple EASY rays and use law of reflection to see where they intersect AFTER bouncing off mirror
- This is where the image will be (where light comes together)
- We'll apply this to curved mirrors later; but, we'll start with a plain old flat mirror for now



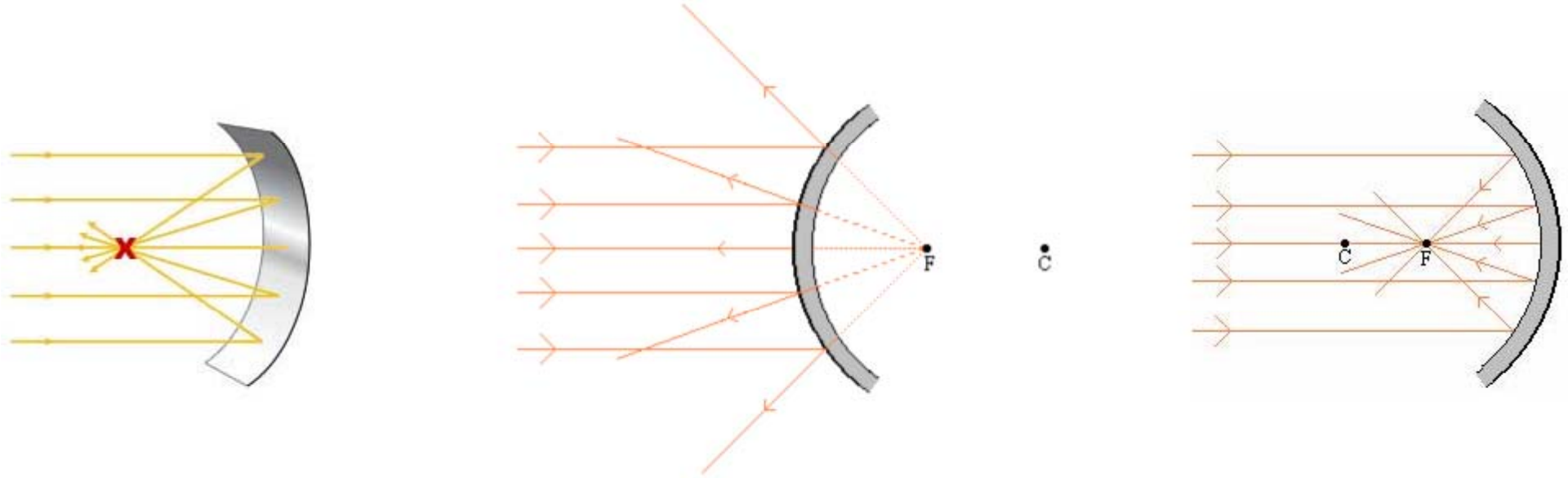
Mirrors – Ray Tracing

- Three mirror types
  - Flat, the non-distorting type you use all the time (Mag. = 1)
  - Convex (like back of spoon)
  - Concave (spherical section, like a “cave”, front of spoon):
    - REFLECTED light rays converge for THIS mirror ONLY (Flat/convex diverge)
- Cool properties
  - Focal point, half way between mirror and center pt.
  - Horizontal light rays reflect through focal point
  - Center point: ray bounces straight back



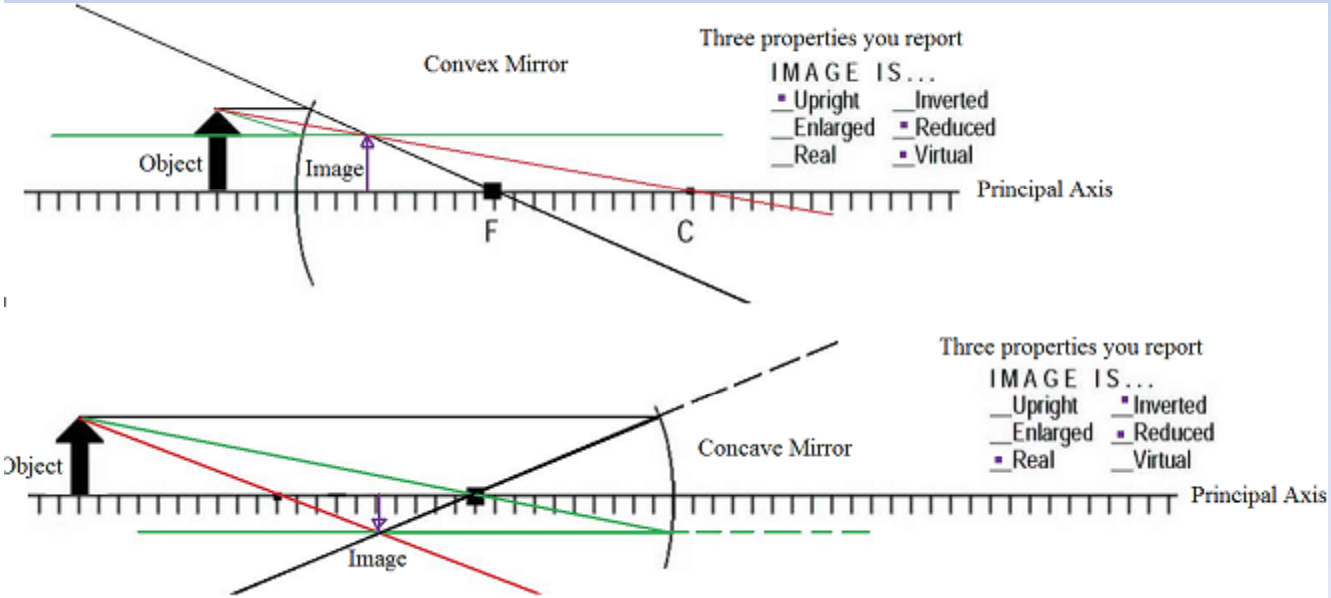
Mirrors – Ray Tracing

- Goal:
  - Start with a single point of light (candle flame tip)
  - Find single post-reflection point where light re-converges, or appears to
  - The is where the image (of candle flame tip) SEEMS to be
  - Two lines intersect at a pt, so pick two easiest rays
- Could use protractor & find angles (too hard!)
- Use Two easiest of 3 principal rays (straight edge is all)
- Three principal rays:
  - Focal ray: passes through focal point, reflects horizontally
  - Horizontal ray: Comes in horizontally, reflects through Focal point
  - Center ray: passes through center point, reflect through <u>same</u> point



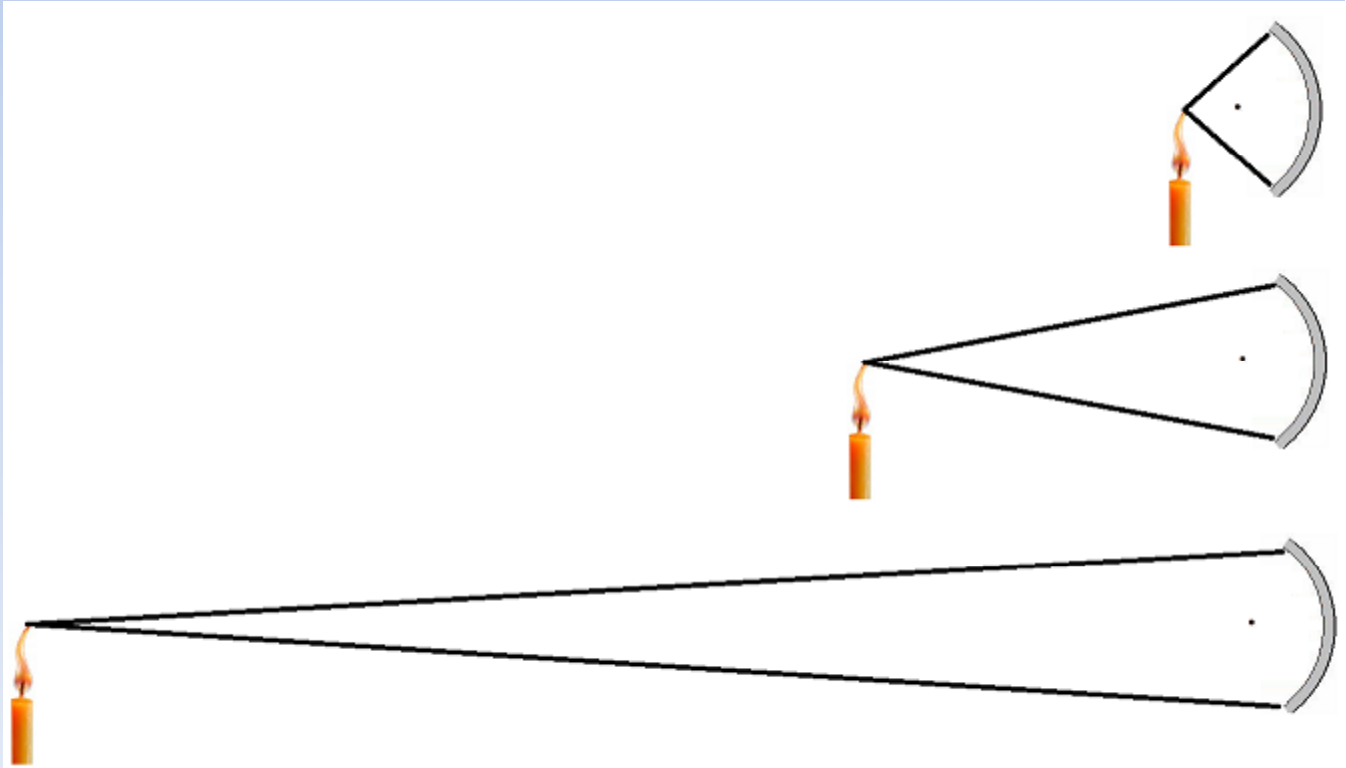
Mirrors – Ray Tracing

- Important stuff
  - Bottom of plane (line) candle is on is “principal axis”
  - We analyze only TIP of candle flame
  - Draw TWO SIMPLEST principal rays, intersection is where image of tip of candle flame defines image location
  - Always show arrows for images & base on “PA”
  - Identify three image properties (u/I, E/R, R/V)
  - Convex mirror is “boring”, all images have same properties
  - Real image: When light “really” comes together (can project image)
  - Virtual image: When light doesn’t really come together (can’t project)



Mirrors – Ray Tracing

- Cool properties is why its easy to use parallel light examples
- For any distant light, rays come in nearly parallel
- Pick a point on the object
- Look at light rays below, notice how lines get MORE parallel at candle gets more distant?
- A **distant object** sends horizontal rays to a mirror
- Try some in your packet!

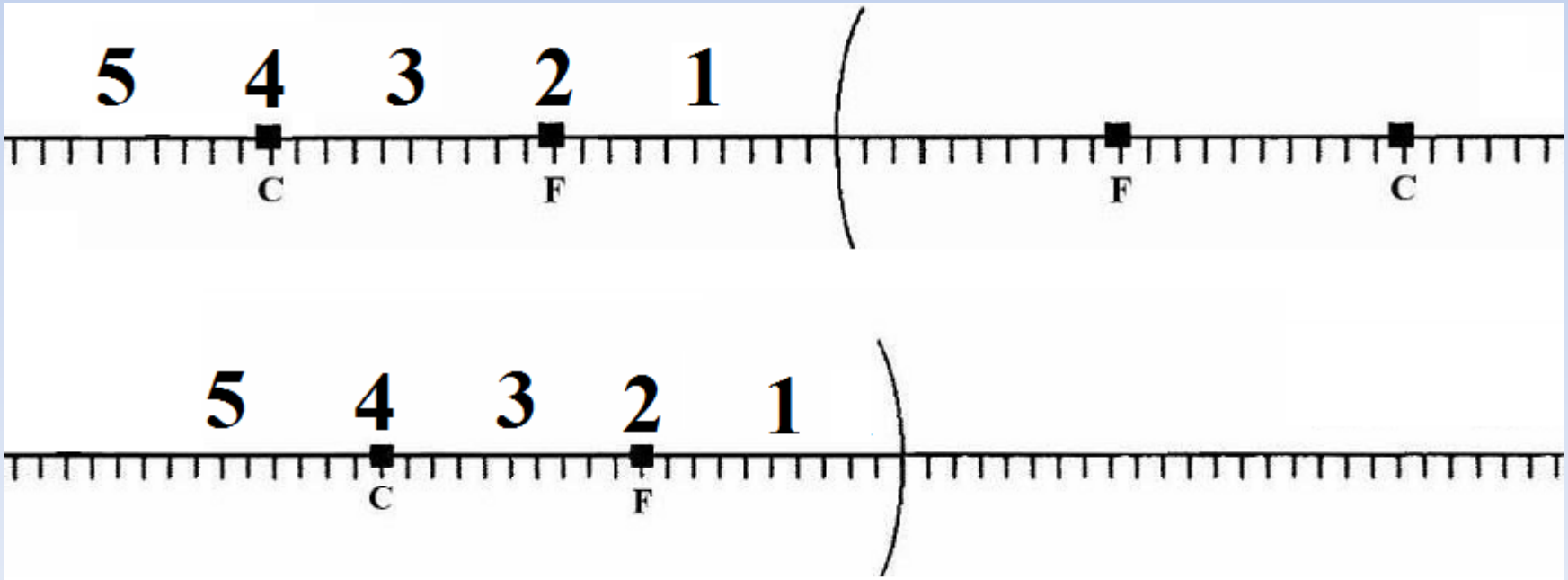


Mirrors – Some useful applications

- Car side mirrors (objects in mirror may be closer than they appear)
  - Increase field of view with convex mirror
- Headlights: Put light bulb in focal point and create a focused beam!
  - How cool is that!
- Make-up mirrors (which kind can enlarge!)
- Mirror to start a fire (which kind can converge light rays!)

Themed **ONLY** Cheat Sheet

- **Themed** gets a 3” x 5” cheat sheet on this test
- Make it soon, get used to it (part of cheat sheet)
- Use simulation to make results table:
  - 5 locations x 3 properties
  - For both mirrors (convex, concave)
  - Here are the five regions…can you do it yet? More help?



More Table Hints?

- OK, I'll give you some more hints, but I won't do it all for you!
- First though, know flat mirrors too (up, same size, virtual)
- **Meaning of regions**: 1: Object relatively close to mirror surface; 2: Object on focal pt. 3: Object between focal and center; 4: Object on center; 5: Object beyond center
- Possible Table Format (5 regions x 3 properties)
- Go to simulation and start discovering!

Region	Up/Inverted?	Enlarged/Reduced?	Real/Virtual
1)Close			
2)Focal			
3)Focal-center			
4)Center			
5)Beyond center (far)			