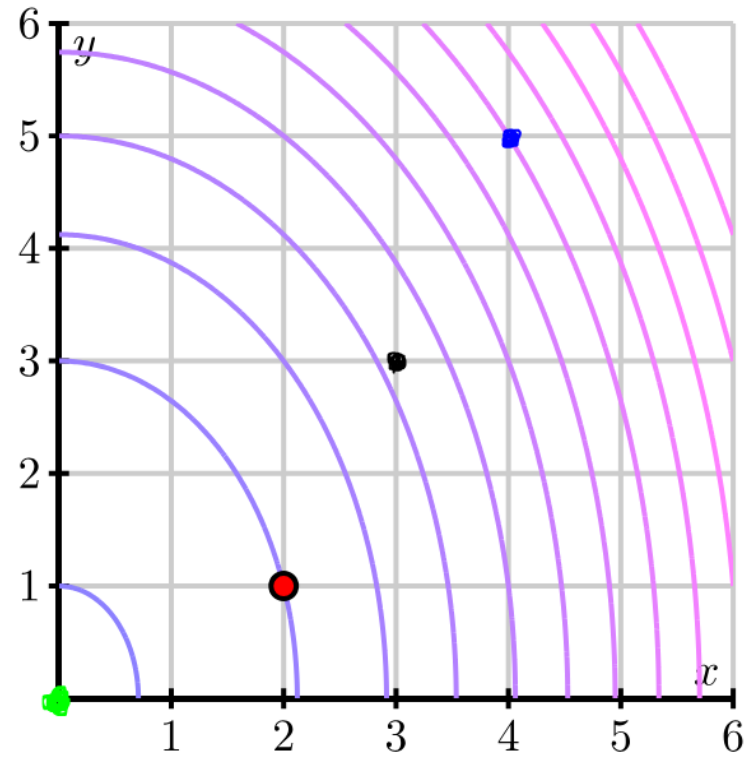


**Checkpoint: Directional derivatives**

The function  $T(x,y) = 30 - x^2 - y^2$  measures the temperature, in degrees Celsius, at a given point  $(x,y)$  on a heated metal plate, where  $x$  and  $y$  are measured in centimeters. An ant is walking on this plate in a straight line from the point **[TYPO FIX: (2,1)]** to the point  $(4,5)$ . Here's a contour plot with some relevant points highlighted.



- How fast is the temperature under the ant's feet changing at the beginning of its journey? Give units.
- How fast is the temperature under the ant's feet changing when it's halfway through its journey? (Hint: if you draw this out you'll see that this is at the point  $(3,3)$ .)
- The ant reaches  $(4,5)$  and decides to walk directly back to the origin. Now how fast is the temperature under the ant's feet changing?