1. The map scale of 1:100,000 tells you that 1 map inch = 100,000 earth inches.

   a. $X \text{ ft} = 1 \text{ map inch} \times \frac{100{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} = \frac{100{,}000 \text{ ft}}{12} = 8{,}333 \text{ ft}$

   $\boxed{1 \text{ map inch} = 8{,}333 \text{ ft}}$

   b. $X \text{ mi} = 7 \text{ map inches} \times \frac{100{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{(7 \times 100{,}000)}{(12 \times 5280)} \text{ mi} = \boxed{11 \text{ mi}}$

   OR, we already know from (a) that 1 map inch = 8,333 ft and we can use this to revise the scale: $X \text{ mi} = 1 \text{ map inch} \times \frac{8{,}333 \text{ ft}}{1 \text{ map inch}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{8{,}333}{5{,}280} \text{ mi} = 1.6 \text{ mi}$

   new scale: 1 map inch = 1.6 mi

   $X \text{ mi} = 7 \text{ map inches} \times \frac{1.6 \text{ mi}}{1 \text{ map inch}} = \boxed{11 \text{ mi}}$

   c. $X \text{ mi} = 3.8 \text{ map inch} \times \frac{100{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{(3.8 \times 100{,}000)}{(12 \times 5280)} \text{ mi} = \boxed{6 \text{ mi}}$

   OR in (b) we determined that 1 map inch = 1.6 mi, so:

   $X \text{ mi} = 3.8 \text{ map inch} \times \frac{1.6 \text{ mi}}{1 \text{ map inch}} = \boxed{6 \text{ mi}}$

2. You have a topographic map with a scale of 1:50,000.

   a. $X \text{ ft} = 1 \text{ map inch} \times \frac{50{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} = \frac{50{,}000 \text{ ft}}{12} = 4{,}167 \text{ ft}$

   $\boxed{1 \text{ map inch} = 4{,}167 \text{ ft}}$

   b. $X \text{ mi} = 5 \text{ map inches} \times \frac{50{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{(5 \times 50{,}000)}{(12 \times 5280)} \text{ mi} = \boxed{4 \text{ mi}}$

   OR, we already know from (a) that 1 map inch = 4,176 ft and we can use this to revise the scale: $X \text{ mi} = 1 \text{ map inch} \times \frac{4176 \text{ ft}}{1 \text{ map inch}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{4{,}176}{5{,}280} \text{ mi} = 0.8 \text{ mi}$

   new scale: 1 map inch = 0.8 mi

   $X \text{ mi} = 5 \text{ map inches} \times \frac{0.8 \text{ mi}}{1 \text{ map inch}} = \boxed{4 \text{ mi}}$

   c. $X \text{ mi} = 1.5 \text{ map inch} \times \frac{50{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = \frac{(1.5 \times 50{,}000)}{(12 \times 5280)} \text{ mi} = \boxed{1 \text{ mi}}$

   OR in (b) we determined that 1 map inch = 0.8 mi, so:

   $X \text{ mi} = 1.5 \text{ map inch} \times \frac{0.8 \text{ mi}}{1 \text{ map inch}} = \boxed{1 \text{ mi}}$

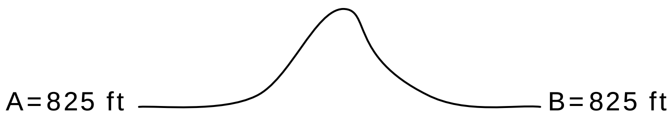
   d. $X \text{ km} = 15 \text{ map cm} \times \frac{100{,}000 \text{ cm}}{1 \text{ map cm}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} = \frac{(15 \times 100{,}000)}{(100 \times 1000)} \text{ km} = \boxed{15 \text{ km}}$

   OR

   $X \text{ km} = 15 \text{ map cm} \times \frac{100{,}000 \text{ cm}}{1 \text{ map cm}} \times \frac{1\text{k m}}{100{,}000 \text{ cm}} = \boxed{15 \text{ km}}$

3. 10 ft. Going from the 850 ft index contour to the 900 ft index contour takes five lines; 50/5=10; each line is 10 ft away from its neighboring lines.

4.



5. 875 ft

6. 905 ft

7. 825 ft

8. 830 ft; B has an elevation of approximately 825 ft. Since the contour lines that X points to are closed, they must be higher in elevation than B. You can have neighboring contour lines with the same elevation, and when you do, the space between them is either a bit lower or a bit higher than the elevation of the two contour lines.

9. In question (1) we determined that 1 map inch = 8,333 ft and thus 1 graph inch = 8,333 ft. Once we know this, we replace the 1 on the left side of the equal sign with our vertical exaggeration:
10 graph inches = 8,333 ft.
Then divide both sides of the equal sign by 10:
1 graph inch = 833 ft

10. A is 0 ft and B is 140 ft.

11. Since I'm going to be calculating several distances from this map, I'm going to convert the map scale first:
$\text{X mi} = 24{,}000 \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = 0.38 \text{ mi}$ Converted scale is: 1 in = 0.38 mi
A and B are 3/8 inch apart, or 0.375 inches apart.
$\text{X mi} = 0.375 \text{ map inches} \times \frac{0.38 \text{ mi}}{1 \text{ map inch}} = \boxed{0.14 \text{ mi}}$

12. $\text{Gradient} = \frac{\Delta \text{ elevation}}{\text{distance}} = \frac{140 \text{ ft}}{0.14 \text{ mi}} = \boxed{1000 \text{ ft/mi}}$

13. C is 140 ft and D is 300 ft; 300 – 140 = 160 ft = Δ elevation
C and D are 1.75 inches apart
$\text{X mi} = 1.75 \text{ map inches} \times \frac{0.38 \text{ mi}}{1 \text{ map inch}} = 0.67 \text{ mi}$

$\text{Gradient} = \frac{\Delta \text{ elevation}}{\text{distance}} = \frac{160 \text{ ft}}{0.67 \text{ mi}} = \boxed{239 \text{ ft/mi}}$

14. E is 280 ft and F is 580 ft; 280 – 580 = 300 ft = Δ elevation
E and F are 7/8 inch apart or 0.875 inches apart.
$\text{X mi} = 0.875 \text{ map inches} \times \frac{0.38 \text{ mi}}{1 \text{ map inch}} = 0.33 \text{ mi}$

$\text{Gradient} = \frac{\Delta \text{ elevation}}{\text{distance}} = \frac{300 \text{ ft}}{0.33 \text{ mi}} = \boxed{909 \text{ ft/mi}}$

15. G is 580 ft and H is 740 ft; 740 – 580 = 160 ft = Δ elevation
G and H are 1 1/8 inch apart or 1.125 inches apart.

$$X \text{ mi} = 1.125 \text{ map inches} \times \frac{0.38 \text{ mi}}{1 \text{ map inch}} = 0.43 \text{ mi}$$

$$\text{Gradient} = \frac{\Delta \text{ elevation}}{\text{distance}} = \frac{160 \text{ ft}}{0.43 \text{ mi}} = \boxed{372 \text{ ft/mi}}$$

16. The contour lines are closest between A and B and the gradient is steepest here. The contour lines between E and F are also pretty close, but not as close as between A and B, and the gradient between E and F is a bit less than the gradient between A and B. The contour lines between C and D are the most widely spaced and the gradient here is the least.

17. The map scale is 1:24,000, or 1 map inch equals 24,000 earth inches. Convert the right side of the map scale to feet:

$$X \text{ ft} = 1 \text{ map inch} \times \frac{24{,}000 \text{ in}}{1 \text{ map inch}} \times \frac{1 \text{ ft}}{12 \text{ in}} = \frac{24{,}000 \text{ ft}}{12} = 2000 \text{ ft}$$

Converted scale: 1 inch = 2000 feet

(a) For a 5X vertical exaggeration, replace the 1 on the left side of the scale with a 5: 5 inches = 2000 ft. Then, divide both sides of the equal sign by 5: 1 inch = 400 ft.

(b) For a 15X vertical exaggeration, replace the 1 on the left side of the scale with a 15: 15 inches = 2000 ft. Then, divide both sides of the equal sign by 15: 1 in = 133 ft.

(c) For a 25X vertical exaggeration, replace the 1 on the left side of the scale with a 25: 25 inches = 2000 ft. Then, divide both sides of the equal sign by 25: 1 inch = 80 ft.

18. This is just a sketch; it is not to scale. The point is whether you can visualize that the slope has breaks in it.