68. (a) The top surface area is that of a circle $A_o = \pi r^2$. Since the problem directs us to denote this as "a" then the radius is

$$r = \sqrt{\frac{a}{\pi}} \ .$$

The side surface of a cylinder of height h is $A_c = 2\pi r h$. Therefore, the total radiating surface area is

$$A = A_o + A_c = a + 2\pi \left(\sqrt{\frac{a}{\pi}}\right) h = a + 2h\sqrt{\pi a} \ .$$

Consequently, Eq. 19-38 leads to

$$P_i = \sigma\varepsilon A T^4 = \sigma\varepsilon T^4 \left(a + 2h\sqrt{\pi a}\right) \ .$$

(b) Packing together N rigid cylinders as close as possible into a large cylinder-like arrangement can involve some subtle mathematics, which we will avoid by simply assuming that (perhaps due to the fact that these "cylinders" are certainly not rigid!) they somehow become a large-radius (R) cylinder of height h. With the top surface area being Na, the large radius is

$$R = \sqrt{\frac{Na}{\pi}} \ .$$

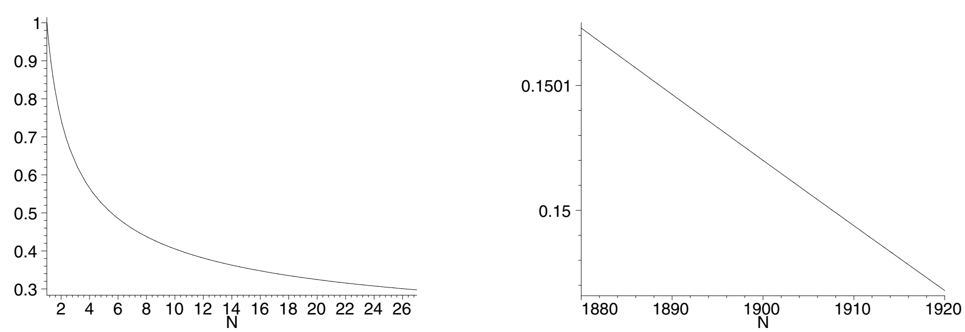
The side surface of the large-radius cylinder is $A_c = 2\pi R h$. Therefore, the total radiating surface area is

$$A = A_o + A_c = Na + 2\pi \left(\sqrt{\frac{Na}{\pi}}\right) h = Na + 2h\sqrt{N\pi a} \ .$$

Consequently, Eq. 19-38 leads to

$$P_h = \sigma\varepsilon A T^4 = \sigma\varepsilon T^4 \left(Na + 2h\sqrt{N\pi a}\right) \ .$$

(c) The graphs below shows P_h/NP_i (vertical axis) versus the number of penguins N (horizontal axis).



(d) This can be estimated from the graph, in which case we $N \approx 5$, or algebraically solved for (in which case $N = 5.53$ which should be rounded to 5 or 6).

(e) From the graph, we estimate $N \approx 10$. If we algebraically solve for it, we get $N = 10.4$ which should be rounded to 10 or 11.

(f) From the graph, we estimate $N \approx 26$. If we algebraically solve for it, we get $N = 26.2$ which should be rounded to 26.

(g) A graph over the appropriate range is not shown above (but would be straightforward to generate). If we algebraically solve for it, we get $N = 154.8$ which should be rounded to 150 or 160.

(h) From the second graph above, we estimate N is slightly more than 1900. If we algebraically solve for it, we get $N = 1907.65$ which should be rounded to 1900.