Applications to work done by a force

1. The linear density of a 15 m long rod is \( \frac{22.5}{\sqrt{x + 1}} \) kg/m, where \( x \) is measured in meters from one end of the rod. Find the mass of the rod? (ans: 9)

2. An aquarium 3 m long, 6 m wide, and 1 m deep is full of water. Find the work (in J) needed to pump half of the water out of the aquarium. (Use the facts that the density of water is 1000 kg/m\(^3\) and \( g \approx 9.8 \).) (Ans: 22050)

3. A force of 10 lb is required to hold a spring stretched 4 in. beyond its natural length. How much work (in inches-pound) is done in stretching it from its natural length to 9 in. beyond its natural length? (Ans: 405/4)

4. If 432 J of work are needed to stretch a spring from 8 cm to 14 cm and another 580 J are needed to stretch it from 14 cm to 19 cm, what is the natural length of the spring? (Ans: 2)

5. If 132 J of work are needed to stretch a spring from 9 cm to 12 cm and another 588 J are needed to stretch it from 12 cm to 19 cm, what is the natural length of the spring? (Ans: 5cm)

6. A heavy rope, 40 ft long, weighs 0.8 lb/ft and hangs over the edge of a building 110 ft high. How much work is done in pulling the rope to the top of the building? (Ans: 640 ft-lb)

7. A tank is full of water. Find the work required to pump the water out of the outlet. Round the answer to the nearest thousand (Ans: \( W = 2,463,000 \) J)

8. A spring has a natural length of 22 cm. If a force of 15 N is required to keep it stretched to a length of 32 cm, how much work is required to stretch it from 22 cm to 40 cm? (Ans: 2.43 J)

9. If 90 J of work are needed to stretch a spring from 8 cm to 13 cm and another 294 J are needed to stretch it from 13 cm to 20 cm, what is the natural length of the spring? (Ans: 6 cm)

10. A bucket that weighs 5 lb and a rope of negligible weight are used to draw water from a well that is 70 ft deep. The bucket starts with 50 lb of water and is pulled up at a rate of 10 ft/s, but water leaks out of a hole in the bucket at a rate of 0.5 lb/s. Find the work done in pulling the bucket to the top of the well. (Ans: 3,727.5 ft-lb)
11. The tank shown is full of water. Given that water weighs 62.5 lb/ft$^3$ and $R = 7$, find the work required to pump the water out of the tank. (Ans: 117,859 ft-lb)

12. A heavy rope, 20 ft long, weighs 0.6 lb/ft and hangs over the edge of a building 100 ft high. How much work is done in pulling the rope to the top of the building? (Ans: 120 ft-lb)