Consider a firm with the following total cost function: \( TC(Q) = Q^3 - 20Q^2 + 200Q \), where output is measured in thousands (i.e., 1,000 = 1 etc).

(1) Derive the average total cost function.
(2) Derive the marginal cost function.
(3) What is the average total cost of producing five thousand units of output?
(4) What is the marginal cost of producing five thousand units of output?
(5) Given your answers to the two previous questions, what will happen to average total cost as output is marginally increased? Explain your answer.
(6) What is the average total cost of producing twenty thousand units of output?
(7) What is the marginal cost of producing twenty thousand units of output?
(8) Given your answers to the two previous questions, what will happen to average total cost as output is marginally increased? Explain your answer.
(9) What is the capacity of this firm?
(10) What is the average total cost of output at capacity?
(11) Show graphically the average total, and marginal cost functions. Be sure to indicate the points mentioned above.

Suppose instead the total cost function is given by: \( TC(Q) = 20Q^2 + 200Q + 1000 \)

(12) Derive the average total cost function.
(13) Derive the marginal cost function.
(14) What is the average total cost of producing five thousand units of output?
(15) What is the marginal cost of producing five thousand units of output?
(16) Given your answers to the two previous questions, what will happen to average total cost as output is marginally increased? Explain your answer.
(17) What is the average total cost of producing twenty thousand units of output?
(18) What is the marginal cost of producing twenty thousand units of output?
(19) Given your answers to the two previous questions, what will happen to average total cost as output is marginally increased? Explain your answer.
(20) What is the capacity of this firm?
(21) What is the average total cost of output at capacity?
(22) Show graphically the average total, average variable and marginal cost functions. Be sure to indicate the points mentioned above.