1. (a) Mr. Big's budget constraint is: \( C = (24-H) \times w \times (1-t) \), where \( C \) is his total consumption and \( H \) is the leisure he enjoys. The budget constraint says his consumption cannot exceed his after-tax income from working \((24-H)\) hours. Alternatively, it can be rewritten as: \( w \times (1-t) \times H + C = 24 \times w \times (1-t) \), where the right-hand side is his total after-tax income if he chooses to work to the full capacity in terms of the time he could use, which is 24 hours a day, and the left-hand side says he can allocate this income among two "goods"—leisure and consumption. Note that the after-tax wage rate, \( w \times (1-t) \), can be thought of as opportunity cost or "price" of leisure. Below is a graph containing this budget constraint LM.

(b) Mr. Big's optimal choice of consumption and leisure is reached at point A, the tangency point of indifference curve to the budget constraint, where the marginal rate of substitution of consumption for leisure is equal to the price of leisure (over the price of consumption, which is 1).

(c) A decrease in the tax rate \( t \) increases the price of leisure, makes the budget line rotate out around point L and become steeper. The new budget line is now LM\(_2\). Let's say the new optimal choice is reached at a point like B, where Mr. Big enjoys less leisure and works more hours.
(d) (e) The graph below shows how a tax cut can lead to a decrease in hours worked. The change of Mr. Big's choice from A to the new optimal point C can be broken down into an income and a substitution effect. The line $L_1M_1$ shows the substitution effect, the change in the budget line that would occur if relative prices shifted but the level of utility remained the same. The substitution effect alone causes a shift from A to A'. The shift in the budget constraint from $L_1M_1$ to $LM_2$ shows the income effect, the change that results from changing the amount of income but leaving relative prices unchanged. The income effect alone causes a shift from A' to C. The substitution effect (shift from A to A') makes Mr. Big consume less leisure when the price of leisure goes up, but the income effect in this case is big enough to push his consumption of leisure all the way up to point C, where he consumes more leisure than he originally does at A. Notice that we draw the graph so that at point C, Mr. Big consumes more of both leisure and consumption than at point A'. This means that both leisure and consumption are normal goods—their consumption rises when income rises.

2. The firm hires labor up to the point where the marginal revenue product of labor equals the wage. The **marginal revenue product** of labor is the increased revenue from the addition of one unit of labor, holding the other inputs fixed. It is equal to the marginal product of labor times the marginal revenue, where the **marginal product of labor** is the extra output from a unit increase in labor, and the **marginal revenue** is the increase in revenue from the last unit of product sold. In the case of a perfectly competitive firm, where the firm is a price-taker, marginal revenue equals the price of the product. The marginal revenue product of labor tells us the benefit brought to the firm by the last unit of labor it hires, and the wage is the cost of this last unit of labor. The firm keeps hiring labor if the marginal revenue product of labor exceeds wage because this increases its profit. The marginal revenue product of labor (eventually) decreases with the increase in labor, holding the other inputs constant, because of the "law of diminishing returns". When the labor hired reached the point where the marginal revenue product of labor equals the wage, the firm stops hiring since more labor is not going to increase its profit. Below is a graph showing the firm's demand curve for labor. When the wage rate increases, demand for labor decreases; and when the wage rate decreases demand for labor goes up.
3. (a) (b) The isocost curve plots the combinations of inputs that cost the same amount. Its slope indicates the relative prices of the inputs. We can plot many isocost curves, one for each level of expenditure. Lower isocost curves represent lower expenditures on inputs. Costs along line C'C' in the graph below are lower than cost along CC.

(c) (d) Isoquants plot the different combinations of inputs that produce the same quantity of output. Many different isoquants can be drawn, each representing one particular level of output. Higher isoquants represent higher levels of production. The slope of isoquant indicates the marginal rate of technical substitution, i.e., the amount of extra input required when another input is reduced by a unit so that the final output remains the same.

Cost-minimizing firms chooses the highest isoquant that can be reached with a given isocost curve, which is the isoquant tangent to the isocost curve.

4. We have a cost function $C(Q) = a + bQ^2$, where the marginal cost is $2bQ$.

--- Fixed cost = $a$. Costs that do not depend on output.
--- Average cost = $C(Q)/Q = a/Q + bQ$. Total costs divided by output.
--- Variable cost = $bQ^2$. Costs that depend on output.
--- Average fixed cost = $a/Q$. Total fixed cost divided by output.
--- Average variable cost = $bQ$. Total variable cost divided by output.