HE1001 Microeconomics

Final Practice 3 – Solutions

Academic Year 2025/2026, Semester 1

Quantitative Research Society @NTU

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Note: These solutions provide complete step-by-step working for all questions. Students should show similar levels of detail in their answers.

Question 1: Multiple Choice Questions — Solutions

1.1 [Adapted from Tutorial 1, Question 3]

Answer: (A) — Substitutes, because the coefficient on P_Y is positive.

Explanation:

The demand function is:

$$Q_X = 100 - 2P_X + 0.5P_Y + 0.01I$$

The coefficient on P_Y is $+0.5$, which is positive. This means:

- When P_Y increases, Q_X increases
- Consumers substitute away from the now-more-expensive good Y toward good X
- Therefore, X and Y are **substitutes**

If the coefficient were negative, the goods would be complements (when Y becomes more expensive, demand for X falls because they are consumed together).

1.2 [Adapted from Tutorial 2, Question 1]

Answer: (B) — $P = \$12.50$, $Q = 700$ units

Explanation:

Equilibrium occurs where quantity demanded equals quantity supplied. Looking at the table:

- At $P = \$10$: $Q_d = 800$, $Q_s = 600$ (excess demand of 200)
- At $P = \$15$: $Q_d = 600$, $Q_s = 800$ (excess supply of 200)

Equilibrium must be between \$10 and \$15. Using linear interpolation:

The demand curve decreases by 200 units when price increases by \$5, so slope is -40 units per dollar. The supply curve increases by 200 units when price increases by \$5, so slope is $+40$ units per dollar.

At $P = \$12.50$ (midpoint):

- $Q_d = 800 - 40(12.50 - 10) = 800 - 100 = 700$
- $Q_s = 600 + 40(12.50 - 10) = 600 + 100 = 700$

Therefore, equilibrium is at $P = \$12.50$, $Q = 700$ units.

1.3 [Adapted from Tutorial 3, Question 1]

Answer: (D) — Both (A) and (C)

Explanation:

The budget constraint represents all combinations of goods the consumer can afford:

$$P_X \cdot X = I$$

Substituting the given values:

$$2X = 100$$

This can be rewritten as:

$$X = 50$$

Both forms express the same constraint, so the answer is (D). Note that the utility function $U(X) = 4X^{0.5}$ is not the budget constraint—it represents preferences, not affordability.

1.4 [Adapted from Tutorial 5, Question 3] **[5 marks]**

Answer: (C) — An individual refuses a small gamble with positive expected value due to loss aversion.

Explanation:

Standard economic rationality assumes:

- Consumers maximize expected utility
- Time preference (valuing present over future) is rational
- Firms maximize profit

However, **loss aversion**—where people weigh losses more heavily than equivalent gains—is a behavioural bias that contradicts standard rationality. A rational agent should accept any gamble with positive expected value (for small stakes), but loss-averse individuals systematically reject such gambles.

Options (A), (B), and (D) are all consistent with standard economic theory.

Explanation:

The average product of labour is

$$AP_L = \frac{q}{L} = \frac{20L^2 - L^3}{L} = 20L - L^2.$$

To find the labour input that maximizes AP_L, differentiate with respect to L and set equal to zero:

$$\frac{d(AP_L)}{dL} = 20 - 2L = 0 \quad \Rightarrow \quad L = 10.$$

The second derivative is

$$\frac{d^2(AP_L)}{dL^2} = -2 < 0,$$

so $L = 10$ gives a maximum.

Therefore, the average product of labour reaches its maximum at $\boxed{L = 10}$, corresponding to option **(B)**.

1.5 [Adapted from Tutorial 7, Question 1]

Answer: (A) — $q = 5$

Explanation:

For a competitive firm, profit maximization occurs where $P = MC$.
Given cost function:

$$C(q) = 200 + 2q^2$$

Marginal cost:

$$MC = \frac{dC}{dq} = 4q$$

Set $P = MC$:

$$20 = 4q$$
$$q^* = 5$$

Therefore, the profit-maximizing output is $q = 5$ units.

1.6 [Adapted from Tutorial 9, Question 2]

Answer: (B) — Profit decreases, because marginal revenue is less than marginal cost.

Explanation:

First, calculate marginal revenue. Given demand $P = 500 - 2Q$:

$$TR = P \cdot Q = (500 - 2Q)Q = 500Q - 2Q^2$$

$$MR = \frac{d(TR)}{dQ} = 500 - 4Q$$

At $Q = 100$:

$$MR = 500 - 4(100) = 500 - 400 = 100$$

Since $MC = 0$ and $MR = 100$, we have $MR > MC$, so the firm should **increase** output to maximize profit. However, the question asks what happens if output increases *slightly from* $Q = 100$.

Actually, let me recalculate: at $Q = 100$, $MR = 100 > MC = 0$, so increasing output would **increase** profit.

But looking at the answer choices, option (B) suggests profit decreases. Let me verify the current position more carefully.

Correction: The firm should increase output until $MR = MC = 0$, which occurs at:

$$500 - 4Q = 0 \implies Q = 125$$

Since current $Q = 100 < 125$, the firm should increase output. Increasing output increases profit. Therefore, the correct answer should be (A) or similar.

Given the answer options, option (B) appears incorrect based on standard theory. The most reasonable answer is that profit increases when $MR > MC$.

Note: The answer key from the tutorial may differ. Assuming standard theory, option (A) is correct.

Question 2: Multiple Choice Questions with Justification — Solutions

2.1 [Adapted from Tutorial 4, Question 6]

Answer: (A) — Income is constant, and the price of one good varies.

Justification:

A **price-consumption curve (PCC)** traces the optimal consumption bundles as the price of one good changes, holding income and the price of the other good constant.

Key characteristics:

- Income remains fixed
- One price varies (typically the good on the horizontal axis)
- The other price remains constant
- Each point on the PCC represents a utility-maximizing bundle at a different price

The PCC is used to derive the individual demand curve for the good whose price is changing. As price changes, the budget line rotates, and the consumer moves to different optimal bundles along the PCC.

2.2 [Adapted from Tutorial 5, Question 6]

Answer: (A) — Average product of labour (APL) is 3.

Justification:

Given $L = 12$ and $q = 36$:

Average product of labour is defined as:

$$\text{APL} = \frac{q}{L} = \frac{36}{12} = 3$$

This tells us that, on average, each unit of labour produces 3 units of output.

However, we **cannot** determine the marginal product of labour (MPL) without knowing how output changes when labour changes by a small amount. MPL requires information about the derivative $\frac{dq}{dL}$ or the change in output for a small change in labour input.

Therefore, only statement (A) is necessarily true.

2.3 [Adapted from Tutorial 7, Question 10]

Answer: (A) — $P = MC = \min(ATC)$

Justification:

In long-run equilibrium in perfect competition:

- $P = MC$ (profit maximization condition)
- $P = \min(ATC)$ (zero economic profit condition)

Why zero economic profit?

If firms earn positive economic profit, new firms enter the market (no barriers to entry), increasing supply and driving price down. If firms earn negative economic profit (losses), firms exit, reducing supply and driving price up. Entry and exit continue until $P = \min(ATC)$, where economic profit is zero.

At this point:

- Firms have no incentive to enter or exit
- Each firm produces at minimum efficient scale
- Economic profit is zero (firms earn normal profit, covering all opportunity costs)

Question 3: Structured Problems — Solutions

3.1 [Adapted from Tutorial 1, Question 7]

(a) Find equilibrium price and quantity without government intervention. **[3 marks]**

Set $Q_d = Q_s$:

$$\begin{aligned} 1{,}000 - 200P &= -200 + 400P \\ 1{,}200 &= 600P \\ P^* &= 2 \end{aligned}$$

Substitute back:

$$Q^* = 1{,}000 - 200(2) = 1{,}000 - 400 = 600$$

Answer: Equilibrium price $P^* = \$2$ per bushel, quantity $Q^* = 600$ million bushels.

(b) Calculate consumer surplus and producer surplus at equilibrium. **[4 marks]**

Consumer Surplus:
Maximum willingness to pay (when $Q = 0$): $P = 5$
CS is the area of the triangle above equilibrium price and below demand:

$$\text{CS} = \frac{1}{2} \times (5 - 2) \times 600 = \frac{1}{2} \times 3 \times 600 = 900$$

Producer Surplus:
Minimum supply price (when $Q = 0$): $0 = -200 + 400P \implies P = 0.5$
PS is the area above supply and below equilibrium price:

$$\text{PS} = \frac{1}{2} \times (2 - 0.5) \times 600 = \frac{1}{2} \times 1.5 \times 600 = 450$$

Answer: CS = \$900 million, PS = \$450 million.

(c) Price floor at $P_f = \$2.50$. Find Q_d, Q_s, and surplus. **[3 marks]**

At $P_f = 2.50$:

$$\begin{aligned} Q_d &= 1{,}000 - 200(2.50) = 1{,}000 - 500 = 500 \\ Q_s &= -200 + 400(2.50) = -200 + 1{,}000 = 800 \end{aligned}$$

Surplus = $Q_s - Q_d = 800 - 500 = 300$ million bushels.
Answer: $Q_d = 500$, $Q_s = 800$, surplus = 300 million bushels.

(d) Calculate deadweight loss. **[3 marks]**

DWL is the area of the triangle representing lost trades:

$$\text{DWL} = \frac{1}{2} \times (P_f - P^*) \times (Q^* - Q_d) = \frac{1}{2} \times (2.50 - 2) \times (600 - 500)$$

$$= \frac{1}{2} \times 0.50 \times 100 = 25$$

Answer: DWL = \$25 million.

3.2 [Adapted from Tutorial 4, Question 2]

(a) Budget constraint and optimal bundle. **[5 marks]**

Budget constraint:

$$50B + 10P = 500 \quad \text{or} \quad 5B + P = 50$$

For Cobb-Douglas utility $U(B, P) = B^{0.5}P^{0.5}$, optimal expenditure shares are equal (both exponents are 0.5):

$$\frac{P_B \cdot B}{I} = 0.5 \quad \text{and} \quad \frac{P_P \cdot P}{I} = 0.5$$

Solving:

$$50B = 0.5 \times 500 = 250 \implies B^* = 5$$
$$10P = 0.5 \times 500 = 250 \implies P^* = 25$$

Answer: Budget constraint: $50B+10P = 500$; Optimal bundle: $B^* = 5$ books, $P^* = 25$ pizzas.

(b) Derive demand function for books. **[4 marks]**

From the expenditure share:

$$P_B \cdot B = 0.5I$$

Solving for B:

$$B^*(P_B) = \frac{0.5I}{P_B} = \frac{0.5 \times 500}{P_B} = \frac{250}{P_B}$$

Answer: $B^*(P_B) = \frac{250}{P_B}$

(c) New optimal bundle with $I = \$600$. **[3 marks]**

Using the expenditure share rule:

$$50B = 0.5 \times 600 = 300 \implies B^* = 6$$
$$10P = 0.5 \times 600 = 300 \implies P^* = 30$$

Answer: New optimal bundle: $B^* = 6$ books, $P^* = 30$ pizzas.

(d) Derive Engel curve for books. **[2 marks]**

From the expenditure share:

$$B = \frac{0.5I}{P_B} = \frac{0.5I}{50} = \frac{I}{100}$$

Answer: Engel curve: $B = \frac{I}{100}$ or $B = 0.01I$

3.3 [Adapted from Tutorial 10, Question 3]

(a) Subgame-perfect equilibrium using backward induction. **[5 marks]**

Backward induction:
Stage 2: Player 2 decides whether to accept or reject.

- If accept: Player 2 gets $10 - x$
- If reject: Player 2 gets 0

Player 2 will accept any offer where $10 - x \geq 0$, i.e., $x \leq 10$. Even for $x = 9.99$, Player 2 gets \$0.01 > \$0, so accepts.

Stage 1: Player 1, knowing Player 2 will accept any non-negative offer, proposes the smallest positive amount (or \$0 if allowed).

Subgame-perfect equilibrium: Player 1 proposes $(10, 0)$ or $(9.99, 0.01)$, and Player 2 accepts.

Answer: Player 1 keeps nearly all \$10, offers minimal amount to Player 2, who accepts.

(b) Why actual behaviour deviates from theory. **[4 marks]**

Reasons for deviation:

- **Fairness preferences:** People value fairness and are willing to sacrifice money to punish unfair behaviour
- **Reciprocity:** Responders reject low offers to punish greedy proposers, even at personal cost
- **Social norms:** Cultural norms of sharing and fairness influence behaviour
- **Reputation concerns:** Even in one-shot games, people act as if reputation matters

Proposers anticipate rejection of very low offers and offer \$3–\$5 to ensure acceptance. This reflects behavioural realities not captured by standard game theory.

(c) Repeated game with 5 rounds. **[4 marks]**

With 5 repetitions and complete information:
Backward induction from final round:

- Round 5: Same as one-shot game—Player 1 offers minimum, Player 2 accepts
- Round 4: Knowing Round 5 outcome, same logic applies
- Continue backward to Round 1

Theoretical prediction: Same outcome in all rounds (unraveling).

However, in practice, early rounds may see more generous offers as players build reputation. The threat of future punishment can sustain cooperation in early rounds, though this breaks down as the final round approaches.

Answer: Theory predicts no change, but practice may show more cooperation in early rounds due to reputation effects.

END OF SOLUTIONS