MCQ's

1. b
2. d
3. d
4. d
5. c
6. c
7. b

Long Question A.

a)

Let x be the consumer who is indifferent between buying from Firm A at 0 and Firm B at 2.

Indifferent consumer:

$$p_a + tx = p_b + t(2 - x)$$

$$p_a + tx = pb + 2t - tx$$

$$2tx = p_b - p_a + 2t$$

$$x = \frac{p_b - p_a + 2t}{2t}$$

Demand for A:

$$q_a = 0.5N * \frac{p_b - P_a + 2t}{2t}$$

$$q_a = 0.5N * \frac{P_b - P_A + 2t}{2t}$$

$$q_a = 0.25N * \frac{P_b - P_A + 2t}{t}$$

$$q_a = \frac{(0.25N)}{t}(p_b - P_a + 2t)$$

Demand for B

$$q_b = \frac{0.25N}{t}(p_a - p_b + 2t)$$

b)

Profit:

$$\pi_a = \frac{P_A 0.25N}{t}(p_a - p_b + 2t)$$

Differentaite

$$\frac{d\pi_a}{dp_a} = \frac{0.25N}{t}(p_b - p_a + 2t) + p_a * \frac{0.25N}{t}(-1)$$

$$\frac{d\pi_a}{dp_a} = \frac{0.25N}{t}(pb + 2t - 2pa)$$

FOC:

$$p_b + 2t - 2_{pa} = 0$$

$$P_a = 0.5_b + t$$

And because of symmetry

$$P_b = 0.5_a + t$$

c)

The two BR functions:

$$P_a = 0.5_b + T$$

&

$$P_b = 0.5_a + T$$

Hence,

$$P_a = t + 0.5(t + 0.5_a)$$

$$p_a = t + 0.6t + 0.25p_a$$

$$0.75_a = 1.5_t$$

$$p_a^* = 2t$$

By symmetry

$$B_b^* = 2t$$

When T=0.25

$$P^* = 0.25$$

When T=0.5

$$P^* = 0.5$$

$$\pi_a = 1 * 0.5N = 0.5N$$

A higher travel cost makes the two stores less close substitutes. Consumers care more about distance and become less willing to switch for a small price difference. That softens competition. Each firm gets a more captive customer base around its location, so it can charge more without losing as many buyers.

d)

Firm B follows its best response:

$$P_b = t + 0.5p_a$$

Fimrs A profit

$$\pi_a = p_a * \frac{n(p_b - p_a + 2t)}{4t}$$

$$\pi_a = p_a * \frac{N(t + .05p_a) - p_a + 2t}{4t}$$

$$\pi_a = p_a = \frac{(3t - p.5p_a)}{4t}$$

$$\frac{d\pi_a}{dp_a} = \frac{n(3t - p_a)}{4t}$$

$$3t - p_a = 0$$

$$P_a^s = 3t$$

Then firm B sets following:

$$P_b = t + 0.5(3t)$$

$$= 2.5t$$

T=0.5

$$p_a = 1.5$$

$$p_b = .125$$

$$q_a = \frac{0.25N}{0.5}(1.25 - 1.5 + 1)$$

$$q_a = 0.5N * 0.75 = 0.375N$$

$$\pi_a = 1.5 * 0.375N = 0.5625N$$

$$q_b = 0.625N$$

$$\pi_b = 1.25 * 0.625N = 0.78125N$$

In the simultaneous game with t = 0.5, Firm A earned 0.5N. As leader it earns 0.5625N. By moving first it commits to a higher price and induces Firm B to respond rather than jointly determining prices at the Nash intersection. So the leadership position benefits Firm A, even though Firm B still earns more in absolute terms because the follower ends up serving the larger share of consumers.

e)

Left side

$$\pi_L = \frac{P_m - p_a + t}{2t} = \frac{0.5}{t}(P_m - p_a + t)$$

Right side

$$\pi_r = \frac{P_b - p_m + 3t}{2t} = \frac{0.5}{t}(p_b - p_m + 3t)$$

Demand

$$q_m = 0.5N(x_r - x_l)$$

$$q_m = 0.25 * \frac{\big((p_b - p_m + 3t) - (p_m - p_a + t)\big)}{t}$$

$$q_m = \frac{0.25N}{t}(p_a + p_b - 2p_m + 2t)$$

The middle store is attractive because it is physically closer to many consumers than either edge store. It wins demand on both sides of the street, not just one side. But its demand still depends on price relative to both incumbents, because it must convince consumers on the left

to leave A and consumers on the right to leave B. That is why its demand depends positively on both Pa and pb and negatively on its own price.

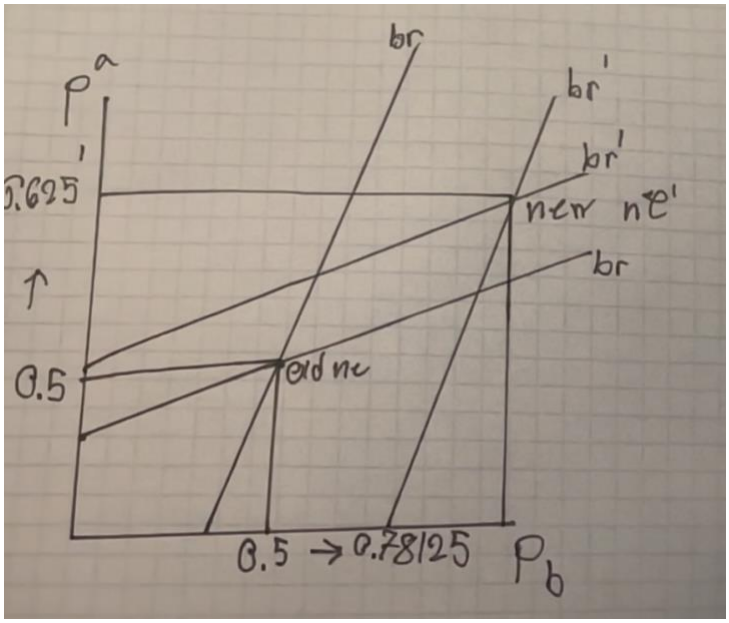
F)

If the middle store is owned by an independent Firm C, that store prices aggressively to maximize its own profit alone. It does not care if it steals demand from A. If the middle store is owned by Firm A, then A internalizes cannibalization between its own two stores. That makes the middle store less aggressive than an independent entrant would be. So B is hurt in both cases, but hurt more when the middle store belongs to an independent Firm C.

Firm B's profits will fall, and its because Firm B now faces a much closer rival than before. The new middle store competes directly for the consumers near the center and also steals some of the consumers who previously were willing to travel farther right. That makes Firm B's residual demand smaller and more price sensitive.

The key difference is whether the middle store treats sales stolen from A as a gain or as partly shifting revenue within the same firm. Independent entry creates an extra aggressive rival. Multi store ownership softens that aggression because one firm now cares about total joint profit across its own locations. That is why B dislikes both scenarios, but dislikes independent entry the most.

G)



Long Question B)

A)

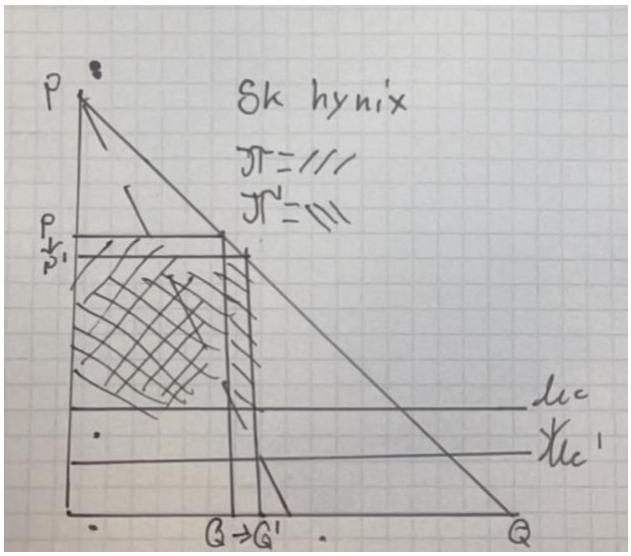
Two important characteristics are bandwidth / performance and energy efficiency / compatibility with a given GPU architecture. Vertical differentiation can be illustrated by bandwidth and overall performance. For example, page 14 shows that HBM4 has much higher bandwidth, more layers, more capacity, and better energy efficiency than HBM3,

which in turn is above HBM2. Horizontal differentiation can be illustrated by how well a specific HBM works with a specific GPU design and by design tradeoffs across suppliers within the same generation. The papers states that HBMs are not homogeneous even within a generation and that qualification matters for each GPU buyer.

In vertical differentation, if one HBM has clearly higher bandwidth, more capacity, and better energy efficiency, most buyers would prefer it at the same price. That is a classic quality ladder. Horizontal differentiation matters because not every buyer values the same bundle equally and not every HBM works equally well with every GPU architecture. A supplier may be stronger for Nvidia qualification, while another may fit better elsewhere. So HBM competition is not just who is best overall, but also who is the best match for a particular buyer and chip design. That is why both vertical and horizontal differentiation matter at the same time.

b)

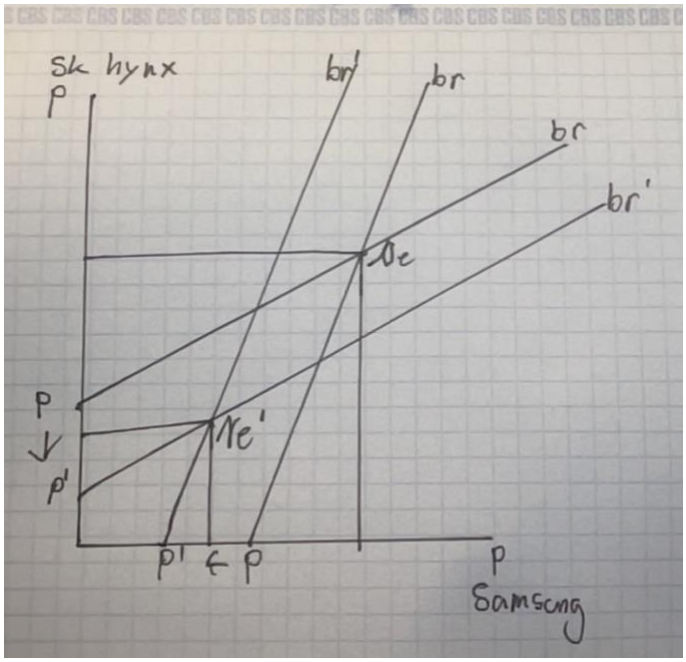
A higher yield means fewer detective units in each batch thus the marginal cost of usable HB. Production costs falls, hence the MC shifts downard. The firm does not suddenly have more demand because customers love the product more. Instead, it wastes less output and gets more sellable chips from the same production process. That makes each usable HBM cheaper to supply, which is exactly the kind of change that lowers marginal cost. As a monopolist, SK Hynix will not pass the whole benefit on to buyers. It keeps part of the gain through higher margin and uses part of it to expand output. So the pricing situation becomes more favorable and profits clearly rise.



c)

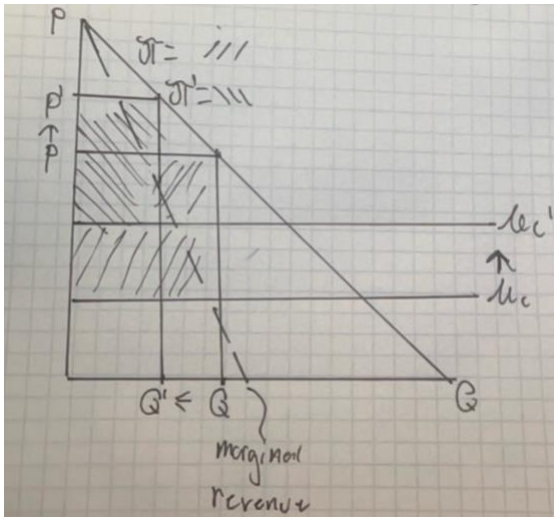
SK Hynix's yield improvement lowers its marginal cost, so for any given Samsung price, SK Hynix wants to set a lower price than before in order to win more business. That shifts SK Hynix's best response downward. Samsung's best response also shifts downward because Samsung now faces a stronger rival and has to respond more aggressively. The new Nash equilibrium has a lower SK Hynix price, and Samsung is also pushed toward a lower price. SK Hynix's profit can still rise because it has much lower cost.

Lower yield loss means SK Hynix can price more aggressively without sacrificing profitability, so Samsung faces a tougher opponent. That can push prices down in the market. Even though SK Hynix may charge a lower price than before, it is still better off because its cost has improved. SK Hynix turns a production improvement into a strategic advantage.



d)

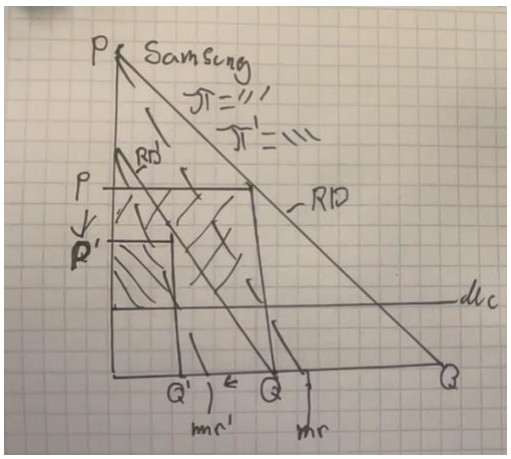
Improving the product shifts a firm's demand outward and may allow higher price or higher share, but it also requires fixed and sunk R and D spending. When the market is very small, the extra operating profit from improving the product is also small because there are not many units over which to earn the gain. So the increase in profit is less likely to cover the sunk development cost. That is why in a small niche market, no firm wants to invest heavily in upgrading first. The file articles support this directly, page 11 says the market was long considered niche and page 14 shows aggregate HBM market revenue was only about $1.5 billion in 2020. The problem was not that firms were incapable of improving HBM2. The problem was that the payoff looked too small relative to the effort. If you spend heavily on R and D in a tiny niche market, even a good commercial outcome may not generate enough extra profit to justify the increased costs. That is the core economic logic. The firms likely expected that any quality race would be expensive and the total pie was just not big enough to make the race worthwhile. So the small market size acted like a brake on innovation, not because innovation had no value, but because the value was too limited to support the cost. This is highlighted in the graph, where reisdual demand remains fixed, and marginal costs increases where they have to charge a higher pirce at a lower quantity, thus resulting in lower profits.

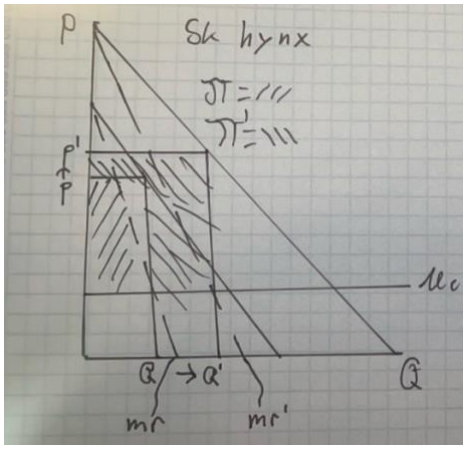


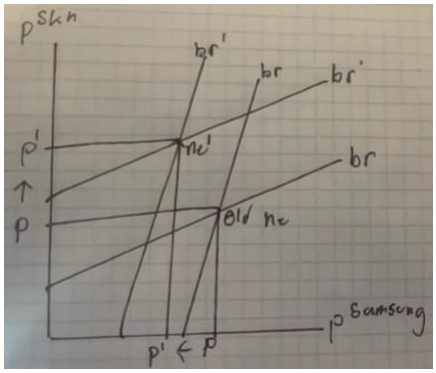
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e)

SK Hynixs improved product, think of it as a vertical differentiation, shifts its own residual demand outward because buyers value its product more and Nvidia approval makes it a stronger match for major demand. Sk hynix residual demand shifts outward because buyers value its product more, and nvidias approval makes it a stronger match for demand. Samsung's residual demand shifts inward, which forces them to lower price and quantity, thus leading to a lower pfoti. In best response terms, SK Hynix's best response shifts upward because it can now sustain a higher price for any given rival price. Samsung's best response tends to shift downward because it becomes the weaker product. The equilibrium therefore moves toward a higher SK Hynix price and lower Samsung price.







f)

SK Hynix already has the stronger product, qualification, buyer relationships, and market share, shown on page 14 where it holds about 54.1 percent in 2025 versus Samsung's 26.2 percent and Micron's 19.7 percent. That means SK Hynix starts from a stronger demand position, or market shares, and can fund further R and D and process improvements from a larger profit base. Samsung and Micron are trying to improve while already behind in quality perception, buyer trust, and supply position. Their demand is weaker and their improvement has to be larger just to close the gap, not even to get ahead.

Catching up is difficult because the leader has cumulative advantages. SK Hynix is not only ahead in product quality, it is ahead in buyer relationships, qualification, supply scale, and learning from production. Those advantages reinforce each other. Large sales generate more experience and more cash for R and D, which helps maintain the lead. Buyers also become more comfortable with the proven leader, especially in a technically demanding market where qualification matters a lot. So Samsung and Micron are not competing on a level field. They are trying to close a moving gap while the leader keeps improving too. This is also shown in the graph from 5), where if, they keep upon improving they will maintain and grow at a pace where competitors will be able to follow.

g)

As demand for GPUs and thus HBMs grows, the market becomes large enough to support more R and D and more product improvement races. For Micron, a bigger market raises the potential return from investing to improve HBM4 or later generations. If Micron remains behind, profit may still rise in absolute terms simply because the whole market is much

larger. But if Micron uses the larger market to justify stronger R and D and quality improvement, its demand position can also improve and profits can rise more strongly. Provided information supports the scale effect directly, showing HBM market revenue moving from about $1.5 billion in 2020 to $38 billion in 2025 and an estimated $58 billion in 2026.

A growing market changes the economics of innovation. In a small market, being the third player may not justify a major catch up effort. In a much larger market, even a modest gain in share can be worth a lot of money, so bigger R and D bets start to make sense. That is why Micron's profits can rise even if it does not become the leader. The pie itself is growing fast. But the deeper point is that large market growth can transform a follower from a passive participant into a more serious strategic competitor, because the returns to improvement become high enough to justify the sunk costs. In other words, growth does not automatically make Micron a winner, but it gives Micron a much better chance to make catching up economically worthwhile. A future growth for the market leads to overall more demand for everybody. Taken into consideration how challenging production is, even for a firm with small market shares with an increase in demand will lead to growth. This leads to an increase in residual demand, which allows them to increase price and quantity, thus leading to an incraese in profits.

