Problem 1.   Consider the following table:

	Firm 1	Firm 2	Firm 3	Firm 4
Sales Revenue ($)	540,000	330,000	230,000	385,000
Cost of Intermediate Goods ($)	200,000	150,000	130,000	80,000
Wages, Interest, Rent Paid to Households ($)	300,000	180,000	135,000	90,000

- Firm 1 sells its products to households, buys intermediate goods from Firm 2.

- Firm 2 sells its products to Firm 1 and Firm 3, buys intermediate goods from Firm 3.

- Firm 3 sells its products to Firm 2 and Firm 4, buys intermediate goods from Firm 2.

- Firm 4 sells its products to households, buys intermediate goods from Firm 3.

Determine the following values:

(a) Value of final goods sold by firm 1

(b) Value of final goods sold by firm 2

(c) Value of final goods sold by firm 3

(d) Value of final goods sold by firm 4

(e) Nominal GDP as the sum of the market values of the all final goods

Answer 1.

(a) Firm 1 is selling to households, i.e. is selling a final product. So their revenue is all from final goods. Thus the answer is $540,000.

(b) Firm 2 is selling intermediate goods to Firm 1, so they are not selling any final goods.

(c) Firm 3 is selling intermediate goods to Firm 2 and Firm 3, so they are not selling any final goods.

(d) Firm 4 is selling to households, i.e. is selling a final product. So their revenue is all from final goods. Thus the answer is $385,000.

(e) Nominal GDP is therefore $540,000 + $385,000 = $925,000$.

Important!!!!!!11 The total revenue from the sale of (i.e. value of) final goods and services is equivalent to total expenditure on final goods and services. This is because revenue is generated when someone is spending money for those final goods. So we have an equivalence:

$$\text{NGDP} = \text{value of final goods and services} = \text{expenditure on final goods and services}.$$

Reminder. Pay close attention to dollar signs, commas, and decimal places. It will usually say how to format the answers, and it's very picky.

Problem 2.   Consider the same table:

	Firm 1	Firm 2	Firm 3	Firm 4
Sales Revenue ($)	540,000	330,000	230,000	385,000
Cost of Intermediate Goods ($)	200,000	150,000	130,000	80,000
Wages, Interest, Rent Paid to Households ($)	300,000	180,000	135,000	90,000

- Firm 1 sells its products to households, buys intermediate goods from Firm 2.

- Firm 2 sells its products to Firm 1 and Firm 3, buys intermediate goods from Firm 3.

- Firm 3 sells its products to Firm 2 and Firm 4, buys intermediate goods from Firm 2.

- Firm 4 sells its products to households, buys intermediate goods from Firm 3.

Determine the following values:

(a) Value added by Firm 1

(b) Value added by Firm 2

(c) Value added by Firm 3

(d) Value added by Firm 4

(e) Nominal GDP as the sum of the values added

Answer 2.

(a) Firm 1 buys $200,000 worth of intermediate goods, makes stuff with those intermediate goods, and sells that stuff for $540,000. So they have *added the value* of

$$\$540,000 - \$200,000 = \$340,000$$

to the intermediate goods that they started with.

(b) $330,000 - 150,000 = 180,000$

(c) $230,000 - 130,000 = 100,000$

(d) $385,000 - 80,000 = 305,000$

(e) Sum the values added for nominal GDP:

$$340,000 + 180,000 + 100,000 + 305,000 = 925,000.$$

So now we have shown that

$$\text{NGDP} = \text{value of final goods and services}$$
$$= \text{expenditure on final goods and services}$$
$$= \text{sum of values added.}$$

Problem 3. Consider the same table:

	Firm 1	Firm 2	Firm 3	Firm 4
Sales Revenue ($)	540,000	330,000	230,000	385,000
Cost of Intermediate Goods ($)	200,000	150,000	130,000	80,000
Wages, Interest, Rent Paid to Households ($)	300,000	180,000	135,000	90,000

- Firm 1 sells its products to households, buys intermediate goods from Firm 2.

- Firm 2 sells its products to Firm 1 and Firm 3, buys intermediate goods from Firm 3.

- Firm 3 sells its products to Firm 2 and Firm 4, buys intermediate goods from Firm 2.

- Firm 4 sells its products to households, buys intermediate goods from Firm 3.

Determine the following values:

(a) Income generated by firm 1

(b) Income generated by firm 2

(c) Income generated by firm 3

(d) Income generated by firm 4

(e) Nominal GDP as the total income generated

Answer 3. The (factor) income generated by a firm is the wages received by its employees; plus the interest paid to the bank; plus the rent paid to households; plus the firm's own profit.

$$Profit = Revenue - All\ Costs$$

$$\implies Income = (Revenue - All\ Costs) + (Wages,\ Interest,\ Rent\ Paid\ to\ Households)$$

$$= Revenue - Cost\ of\ Intermediate\ Goods$$

$$= Value\ Added.$$

So the income generated by the firm is exactly the same as their value added. Therefore the answers are the same as in problem 2.

(a) $540,000 - 200,000 = 340,000$

(b) $330,000 - 150,000 = 180,000.$

(c) $230,000 - 130,000 = 100,000$

(d) $385,000 - 80,000 = 305,000$

(e) Sum the incomes generated by each firm to find nominal GDP:

$$340,000 + 180,000 + 100,000 + 305,000 = 925,000.$$

Equivalent Statements of NGDP

Combining the three exercises, we have seen that

$$\begin{aligned}
\text{Nominal GDP} &= \text{sum of value of final goods and services} \\
&= \text{sum of expenditure on final goods and services} \\
&= \text{sum of values added} \\
&= \text{sum of factor income.}
\end{aligned}$$

We've touched the least on the expenditure aspect. This is because we'll be seeing a lot more of it later on. Make sure you know the difference between *factor* income and *household* income, 'cuz they ain't the same thing.

Problem 4.

Data for Islandia

Year	Haircuts P	Haircuts Q	Coconuts Produced and sold by firms in Current Year P	Coconuts Produced and sold by firms in Current Year Q	Coconuts Produced but not sold by firms in Current Year Q	Pineapples Produced and sold by firms in Current Year P	Pineapples Produced and sold by firms in Current Year Q	Leftover Pineapples from previous year's production by firms sold in Current Year	Baskets weaved by households for their own use in Current year P	Baskets weaved by households for their own use in Current year Q	Baskets weaved by households and sold to others in Current year P	Baskets weaved by households and sold to others in Current year Q	Pineapples imported from the neighboring island country in Current year P	Pineapples imported from the neighboring island country in Current year Q
2010	$10	102	$2.00	173	27	$ 1.00	100	20	$50.00	68	$50.00	75	$1.00	16
2011	$11	104	$2.00	203	1.75	$ 1.50	120	22	$55.00	70	$55.00	84	$1.50	16
2012	$11	106	$3.00	205	2	$ 1.75	140	26	$55.00	89	$55.00	91	$1.75	17
2013	$12	107	$3.10	210	0	$ 2.00	140	29	$56.00	90	$56.00	104	$2.00	19

Let 2011 be the base year. Calculate the following values:

(a) Islandia's nominal GDP in 2012

(b) Islandia's real GDP in 2013

(c) Islandia's GDP deflator in 2010

Answer 4.

(a) Sum the price times quantity for each qualifying good. To quality for inclusion in GDP, it must satisfy these criteria:

- a final good
- produced in this country
- produced in this year
- that was intended on being sold in the market.

$$[\$11 \times 106] + [\$3 \times (205 + 2)] + [\$1.75 \times 140] + [\$55 \times 91] = 7037.$$

(b) To find real GDP in 2013, multiply relevant 2013 quantities by base year (2011) prices:

$$[\$11 \times 107] + [\$2.00 \times 210] + [\$1.5 \times 140] + [\$55 \times 104] = 7527.$$

(c) The GDP deflator in 2010 requires both real and nominal GDP:

$$NGDP = [\$10 \times 102] + [\$2.00 \times (173 + 27)] + [\$1 \times 100] + [\$50 \times 75] = 5270,$$

$$RGDP = [\$11 \times 102] + [\$2.00 \times (173 + 27)] + [\$1.50 \times 100] + [\$55 \times 75] = 5797.$$

Therefore GDP Deflator $= \frac{5270}{5797} \times 100 \approx 90.91$.

Problem 5.   A used car dealer purchased my 1992 Ford Tempo for $1,000. He paid a worker $200 to wash it. He purchased four tires for a total of $400 to replace the existing tires on the car. He then sold the car for $4,000. All these economic activities took place in 2017. What was the used car dealer's value added in 2017?

Answer 5.   Value added is the revenue minus the cost of intermediate goods. In this case, buying the used car constitutes the cost of an intermediate good, as do the new tires. The cost of the car wash, however, constitutes a wage since he payed an employee to wash it. So the value added is

$$4,000 - (1,000 + 400) = 2,600.$$

This was the used car dealer's contribution to 2016 GDP.

Problem 6.   Here are Mrs. Baker's revenue and expenses for 2016:

- Revenue from sale of bread to customers: $65,000

- Cost of materials (such as sugar, yeast, baking soda, etc): $15,000

- Wages paid: $20,000

- Rent paid: $10,000

- Interest paid: 0

Find Mrs. Baker's contribution to 2016 GDP and find her profit in 2016.

Answer 6.   Contribution to GDP, as we showed earlier, is the value added:

$$65,000 - (15,000) = 50,000.$$

Her profit is revenue minus all costs:

$$65,000 - (15,000 + 20,000 + 10,000) = 20,000.$$

Problem 7.   Which of the following are included in 2015 GDP?

(a) We imported $10 million worth of Italian wine in 2015.

(b) We exported $20 million worth of tomatoes to Europe in 2015.

(c) You fixed your uncle's neighbor's brother's ex-wife's garage door for $75 in 2015.

(d) The computers that Dell Corporation produced in 2015 that it could not sell.

(e) GM sold some cars in 2015 that it had produced in 2014.

(f) Dad sold his old lawn mower in a garage sale in 2015.

(g) The cost of a freeway overpass built by the government in 2015.

(h) The salaries paid to teachers in public schools in 2015.

Answer 7.

(a) Nope. Not produced domestically.

(b) Yep. Produced domestically.

(c) Yeah. You were paid $75 for your service.

(d) Oui. Produced domestically and intended for market sale.

(e) Nein. Not produced in 2016.

(f) Nyet. Sale of used or secondhand goods are not counted towards GDP because nothing new was produced.

(g) Yahuh. Government produced goods and services are included at the cost of providing them.

(h) Affirmative. Since it's a public school, it is in essence a government service.

Problem 8. Ivan is a real estate investor. He flips homes—he buys undervalued homes and sells them at a higher price later to make a profit out of the price differential (these kind of people are called flippers). In May 2016 he bought a house built in 1997 for $1,000,000 and sold it two months later for $1,200,000. Not bad. The real estate agent got 6% of the sale price as her commission. As a result of these activities the 2016 GDP increased by how much?

Answer 8. Ivan does not purchase any new paint or make any other improvements to the house—otherwise we would have been told the cost of, say, paint, or a new kitchen sink—so we cannot talk about value added. In this case, the house is treated like an asset, and its appreciation in value is a **captal gain**, due entirely to changes in the housing market, and therefore does not count toward GDP.

So the only way this affects GDP is through the service the real estate agent provides. In particular, the value of the real estate agent's service is

$$1,200,000 \times 0.06 = 72,000.$$

Problem 9.   The U.S. government treats the goods produced by a firm in a year that are not sold in that year as increases in inventories and includes them in that year's GDP at market prices. In other words, the government assumes that the firm itself buys those goods for future resale. With that in mind, state whether the following are true or false.

(a) Any good produced in a year will be included in that year's GDP.

(b) Any good produced in a year will be included in that year's GDP, except those produced by households for household consumption.

(c) Any good produced and sold in a year will be included in that year's GDP.

(d) Any good produced and sold in a year will be included in that year's GDP, except those produced by firms that are not sold.

(e) Any good sold in a year will be included in that year's GDP.

(f) Any service sold in a year will be included in that year's GDP.

Answer 9.

(a) False. I cooked a frozen pizza last night—ate the entire thing myself because that's how I roll. Technically, I added value to that frozen pizza by cooking it—I produced a cooked pizza—but the value of that cooked pizza is not included in GDP because it's a household good—I had no intention of selling the pizza after cooking it because you better believe I'm eating the whole thing.

For a more sane example, consider someone who likes woodworking and builds a rocking chair for Granny. The chair is produced, but it's not intended for sale, and therefore is not included in GDP—it is a household good.

(b) True.

(c) True, including intermediate goods—but intermediate goods are *implicitly* included in the prices of their final goods, so we don't directly add them to GDP.

(d) False. If the good is produced and was intended to be sold, then any unsold inventories will be "bought" by the firm itself and thus counts towards that year's GDP.

(e) False. You can sell a good produced last year and it won't count towards this year's GDP.

(f) True. A service is produced when it is sold: think haircuts. There are no unsold services.

Problem 10.

Year	Good 1		Good 2	
	Price	Quantity	Price	Quantity
2008	$130	34	$5	45
2009	$120	4	$7	65
2010	140	5	8	55
2011	152	3	11	40
2012	150	5	14	35

(a) Calculate this country's nominal GDP in 2012.

(b) Calculate this country's real GDP in 2011.

(c) Calculate this country's GDP deflator in 2011.

Answer 10.

(a) To calculate NGDP, just take that year's prices times that year's quantities.

$$NGDP_{2012} = (\$150 \times 5) + (\$14 \times 35) = 1240.$$

(b) The purpose of real GDP is to reflect that year's *production*. To that end, we will use the base year's prices—essentially holding prices constant—so that any difference between base year GDP and 2011 GDP must reflect differences in production between those two years.

We are told that 2009 is the base year, so let's fix prices to 2009 prices and then calculate RGDP using 2011 quantities. We get

$$RGDP_{2011} = (\$120 \times 3) + (\$7 \times 40) = 640.$$

(c) To calculate the GDP deflator, we'll need both NGDP and RGDP. We just found RGDP of 640, so let's find nominal GDP.

$$NGDP_{2011} = (\$152 \times 3) + (\$11 \times 40) = 896$$

$$\implies \quad \text{GDP deflator} = \frac{NGDP}{RGDP} \times 100 = \frac{896}{640} \times 100 = 140.$$

Problem 11. If the nominal wage rate is $W = 5,000$ per worker and the price of the output is $P = 100$ per unit, the firm will want to employ ＿＿＿＿＿＿＿ workers (using the marginal productivity rule discussed in the class). With this many workers, it will be able to produce ＿＿＿＿＿＿＿ tons of output.

If the wage rate increases to $W = 6,000$ and the price level increases to $P = 150$, the firm will want to hire ＿＿＿＿＿＿＿ workers in which case it will produce ＿＿＿＿＿＿＿ tons of output.

Total Number of Workers Hired (Persons)	Total Amount of Output Produced (Tons)
0	0
1	80
2	150
3	210
4	260
5	300
6	330
7	350
8	360

Answer 11.   The real wage is $5000/100 = 50$. Hence the firm will hire up to the worker with $MPL = 50$, which happens to be the fourth worker. With four workers, 260 tons of output is produced.

After the wage change, $W/P = 40$, so the firm will hire up to the worker with $MPL = 40$, which happens to be the fifth worker. With five workers, 300 units will be produced.

Problem 12. Suppose that due to a technological advance, the productivity of labor increases so that the marginal product of each and every worker increases by 30 units. If the real wage remains constant at its current level. In that case, the firm will be willing to hire _____ workers to maximize its profit. If the firm employs this many workers, it will be able to produce _____ tons of the product.

Total Number of Workers Hired (Persons)	Total Amount of Output Produced (Tons)
0	0
1	80
2	150
3	210
4	260
5	300
6	330
7	350
8	360

Answer 12.   The firm still hires the worker with $MPL = 50$. Since everyone's MPL has gone up by 30, this means the person who used to have 20 MPL will now be hired because their new MPL is $20 + 30 = 50$. This happens to be the seventh worker. *Each worker produces 30 more than they did before.* Hence with seven workers, output will be $350 + 30 \times 7 = 560$ units.

Problem 13. If the price of a product decreases with the nominal wage unchanged, the firm producing that product will want to hire fewer workers. Which of the following is true?

(a) This will be represented as a movement along the demand-for-labor function.

(b) This will be represented as a leftward shift in the demand-for-labor function.

Answer 13. P changing with W constant means W/P changes. Since W/P is the variable on the vertical axis of the labor market graph, it means we are talking about a movement along the curve.

Problem 14.   Assume that there are 1,000 identical firms in the economy so that if one firm hires, for example, 3 workers, all the firms in the economy will hire 3,000 workers. In this economy the equilibrium real wage equals _____ units and the equilibrium level of employment equals _____ persons.

Total Number of Workers Hired (Persons)	Total Amount of Output Produced (Tons)	Number of Workers Willing and Able to Work	Real Wage
		0	10
0	0	1000	20
1	80	2000	30
2	150	3000	40
3	210	4000	50
4	260	5000	60
5	300	6000	70
6	330	7000	80
7	350	8000	90
8	360		

Answer 14.   At the real wage of 50, each firm hires four workers because the fourth worker has MPL of 50. Thus, in total, firms want to fill 4000 jobs. Also at the real wage of 50, 4000 workers want to work. Hence the equilibrium real wage is 50 with 4000 jobs. (The demand curve is derived by using $MPL = W/P$ for 1000 identical firms.)

   We can also use the tables to construct the labor market graph, which illustrates the same conclusion.
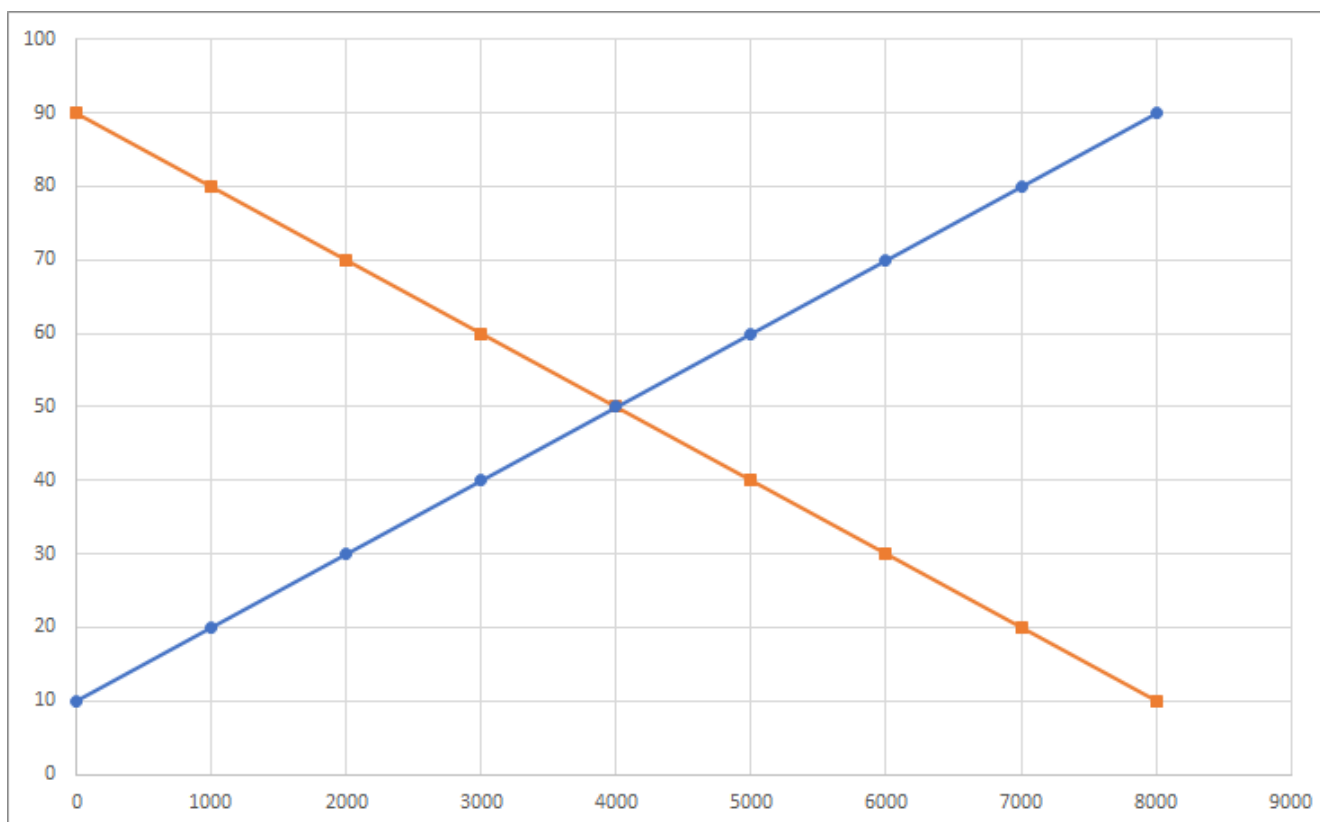
**Problem 15.** The potential GDP in this economy equals _____ units.

Total Number of Workers Hired (Persons)	Total Amount of Output Produced (Tons)	Number of Workers Willing and Able to Work	Real Wage
		0	10
0	0	1000	20
1	80	2000	30
2	150	3000	40
3	210	4000	50
4	260	5000	60
5	300	6000	70
6	330	7000	80
7	350	8000	90
8	360		

Answer 15. Potential GDP is the output produced when the labor market is in equilibrium. Each firm wants to hire four workers. According to the production function, four workers means each firm produces 260 units. There are a thousand firms doing the same thing, and hence total production amounts to

$$260 \times 1000 = 260,000 \text{ tons.}$$

Problem 16.   Suppose that over the course of several years, increases in the amount capital and improvements in technology cause demand for labor to increase by 4,000 persons. At the same time, increases in population and labor for force participation rate cause the supply of labor to increase by 2,000 persons. As a result of these events, the equilibrium real wage will equal _____ units the equilibrium employment will equal _____ units.

Answer 16. Shift demand to the right by 4000 and also shift supply to the right by 2000 to get the following labor market:
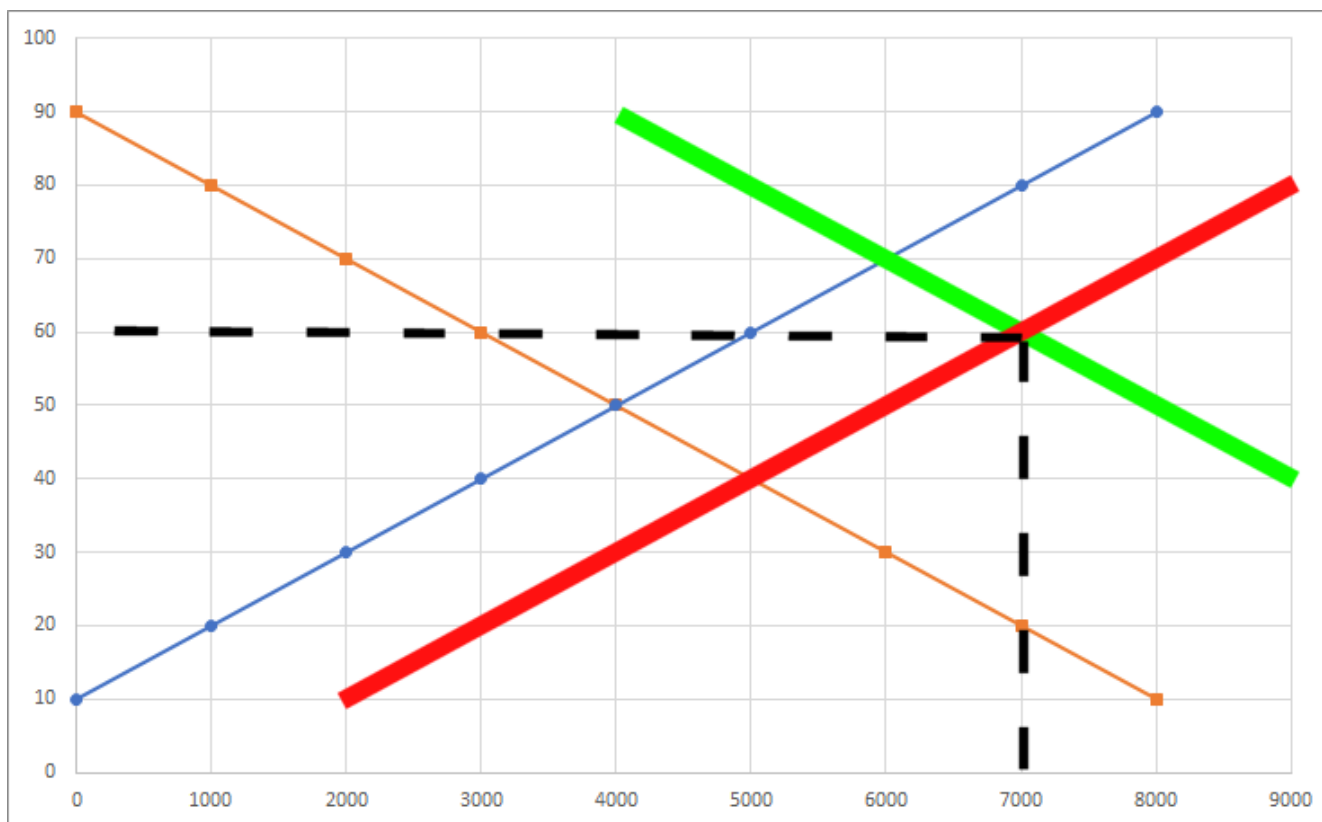
Here it can be seen that the new equilibrium real wage is 60 and equilibrium labor is 7000 workers.

Problem 17.   Consider the table below, where the base year is 1984:

Year	Good 1		Good 2		Good 3	
	P	Q	P	Q	P	Q
1984	$20.00	2	$30.00	5	$10.00	6
2006	$40.00	4	$60.00	7	$20.00	8
2018	$51.00	4	$72.00	7	$23.00	8

Calculate the following:

(a) Consumer price index in 1984

(b) Consumer price index in 2006

(c) Consumer price index in 2018

Answer 17. The point of CPI is to compare changes in the price level of *a bundle of goods that consumers might typically buy.* (Contrast this to the GDP deflator, which includes *everything* produced in the economy, including things not typically purchased e.g. helicopters.)

So to calculate CPI, we hold the *quantities* fixed at the base year quantities (a *fixed basket of goods*), but allow prices to change. Then we compare the cost of that fixed basket to its base year cost:

$$CPI_{year} = \frac{\text{cost of fixed basket in year}}{\text{cost of fixed basket in base year}} \times 100.$$

That means we'll assume a fixed basket of 2, 5, and 6. The base year cost of the basket is

$$CPI_{1984} = (\$20 \times 2) + (\$30 \times 5) + (\$10 \times 6) = \$250.$$

Now compare this to the other years' basket costs.

(a) $CPI_{1984} = \dfrac{(\$20 \times 2) + (\$30 \times 5) + (\$10 \times 6)}{(\$20 \times 2) + (\$30 \times 5) + (\$10 \times 6)} \times 100 = \dfrac{250}{250} \times 100 = 100$

(b) $CPI_{2006} = \dfrac{(\$40 \times 2) + (\$60 \times 5) + (\$20 \times 6)}{(\$20 \times 2) + (\$30 \times 5) + (\$10 \times 6)} \times 100 = \dfrac{500}{250} \times 100 = 200$

(c) $CPI_{2018} = \dfrac{(\$51 \times 2) + (\$72 \times 5) + (\$23 \times 6)}{(\$20 \times 2) + (\$30 \times 5) + (\$10 \times 6)} \times 100 = \dfrac{600}{250} \times 100 = 240$

Problem 18. *True or False?* If the amount of physical capital increases, demand for labor will increase if capital is substitute for labor.

Answer 18. *False.* If capital is a substitute for labor, then labor can be replaced with machines, and therefore there is less demand for workers.

Problem 19. *True or False?* If a labor-saving technological progress takes place, demand for labor will shift to the left.

Answer 19. *True.* Labor-saving technological progress means the same amount of stuff can be produced with fewer workers. Hence the demand for workers falls. This means the demand curve for labor shifts to the left.

Problem 20. *True or False?* An increase in the amount of complementary capital will cause a movement along the demand-for-labor function.

Answer 20. *False.* Complementary capital means the capital makes workers even more productive, i.e. their MPL increases. This means the entire labor demand curve will shift to the right as firms want to hire more workers now that they're more productive.