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Solution's Manual

Arnold, Economics, 14e; Chapter 2: Production Possibilities Frontier

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Chapter 2: Production Possibilities Frontier

Answers to Chapter Questions and Problems

1. Describe how each of the following would affect the U.S. PPF: (a) a war that takes place on U.S. soil, (b) the discovery of a new oil field, (c) a decrease in the unemployment rate, and (d) a law that requires individuals to enter lines of work for which they are not suited.

(a) A war would remove individuals, capital, and potentially other resources from the productive process; therefore, ceteris paribus, the PPF would shift inward.

(b) The discovery of a new oil field would represent an addition to the country's resources; therefore, the PPF would shift outward.

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(c) A decrease in the unemployment rate would be represented by movement from a point below the PPF to another point closer to or on the frontier, such as from point F to point D, in Exhibit 6.

(d) Such a law would decrease the productive efficiency of labor, thereby moving the economy from a point on or inside the frontier to another point further inside the frontier.

2. Explain how the following can be represented in a PPF framework: (a) the finiteness of resources implicit in the scarcity condition, (b) choice, (c) opportunity cost, (d) productive efficiency, and (e) unemployed resources.

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Scarcity is illustrated by the existence of the frontier: if there were unlimited resource availability, there would be no limit on output. Choice is illustrated by the variety of possible combinations along the frontier: there is not a single optimum or efficient combination of the two goods. Opportunity cost is represented by the slope of the frontier or can be viewed as how much we give up of one good to get one more unit of another good. Productive efficiency is represented by points on the frontier. Unemployed resources are represented by points below the frontier.

3. What condition must hold for the PPF to be bowed outward (concave downward)? To be a straight line?

In order for a nation's PPF to be bowed outward, resources must be somewhat specialized, so that the law of increasing opportunity costs holds. With specialized resources, additional units of a good can only be produced at increasing opportunity costs. In order for a nation's PPF to be a straight line, there must be complete interchangeability of resources, with no specialization, so that the law of increasing opportunity costs does not apply.

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4. Look back at Exhibit 4 and notice that the slope between points A and B is relatively flatter than it is between points C and D. What does the slope of a curve between two points have to do with the opportunity cost of producing additional units of a good?

The slope of the PPF represents the marginal opportunity cost of producing additional units of the good on the horizontal axis. A relatively flat slope between points A and B indicates that relatively little of Good X (5 units) must be given up to produce 10 more houses. A relatively steeper slope between points C and D indicates that relatively more of

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Good X (20 units) must be given up to produce 10 more houses. Therefore, as more houses are produced, the slope of the PPF becomes steeper and the marginal opportunity cost of producing houses increases.

5. Give an example to illustrate each of the following: (a) constant opportunity costs and (b) increasing opportunity costs.

Answers will vary. Constant opportunity costs occur when increasing output of a good does not cause society to give up more and more resources in order to produce that good. Although, at some point increasing opportunity costs will occur, over some level of output constant opportunity costs could prevail. For example, if a college has a $20 million budget and each class costs $25,000 to offer, then the school can offer 800 classes during the year. If the college received a $500,000 grant, it could offer another 20 classes if its costs did not increase, perhaps because there were unemployed professors ready and willing to work at the going wage rate. Increasing opportunity costs occur when society has to give up more and more of one resource in order to obtain another resource. If the college received a second $500,000 grant, it might not be able to offer another 20 classes, if there were no unemployed professors ready and willing to work at the going wage rate. In order to hire more teachers, the college would have to hire individuals who had a higher opportunity cost.

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6. Why are most PPFs for goods bowed outward (concave downward)?

Most production possibilities frontiers are concave downward because the law of increasing opportunity costs holds. This law says that as society devotes more resources to the production of a given good, the opportunity cost of producing that good will increase.

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The reason for this is that the most efficient resources will be used to initially produce that good. Only as those resources are used up will society employ less productive resources. Farmers will plant wheat in Kansas before they plant wheat in Alaska or Nevada.

7. Within a PPF framework, explain each of the following: (a) a disagreement between a person who favors more domestic welfare spending and one who favors more national defense spending, (b) an increase in the population, and (c) a technological change that makes resources less specialized.

(a) The first question deals with choices among possible output combinations along a frontier representing total government spending. For illustrative purposes, substitute for "Good X" with "domestic welfare spending" and "Houses" with "national defense spending" in Exhibit 4. The person favoring more welfare spending would prefer point C, while the person favoring more defense spending would prefer point D.

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(b) An increase in population, ceteris paribus, will shift the PPF outward, as in Exhibit 7(a).

(c) A technological change that makes resources less specialized will lessen the opportunity cost of switching production from one good to another. The production possibility frontier will become less bowed outward (straighter relative to the origin).

8. Explain how to derive a PPF. For instance, how is the extreme point on the vertical axis identified? How is the extreme point on the horizontal axis identified?

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The extreme point on the vertical axis is identified by figuring out how much of the good on that axis can be produced using all of the economy's available resources. The extreme point on the horizontal axis is identified by figuring out how much of the good on the horizontal axis can be produced using all of the economy's available resources. Once the extreme point on the vertical axis (for example) has been identified, other points can be identified by asking how much of that good must be given up in order to increase production of the good on the horizontal axis by some discrete amount. The production possibilities frontier can be derived by identifying all the points that show the combinations of both goods that can be produced in the economy.

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9. If the slope of the PPF is the same between any two points, what does this relationship imply about costs? Explain your answer.

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A PPF slope that is the same between any two points implies that the opportunity cost of producing the two goods represented on the axes is constant.

10. Suppose a nation's PPF shifts inward as its population grows. What happens, on average, to the material standard of living of the people? Explain your answer.

The material standard of living would tend to decrease. The economy, as a whole, would have fewer goods and services to go around and would be distributing them to more people. Consequently, each person would get less and less.

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11. Can a technological advancement in sector X of the economy affect the number of people who work in sector Y of the economy? Explain your answer.

Yes. A technological advancement in sector X makes it possible to produce X with fewer people, freeing those people to produce other things (Y, for example).

12. Use the PPF framework to explain something in your everyday life that was not mentioned in the chapter.

Answers will vary, but should illustrate some of the following: choice, opportunity costs, productive inefficiency, scarcity, productive efficiency, unemployed resources, and growth.

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13. What exactly allows individuals to consume more if they specialize and trade than if they don't?

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The fact that each person specializes in producing what he or she can produce at lower cost is what "releases" resources to produce more goods, which then leads to greater consumption.

Answers to the Problems in the Working with Numbers and Graphs Section

1. Illustrate constant opportunity costs in a table similar to the one in Exhibit 1(a). Next, draw a PPF that is based on the data in the table.

Answers will vary, but the PPF will be a straight line similar to the one in Exhibit 1(b).

2. Illustrate increasing opportunity costs (for one good) in a table similar to the one in Exhibit 2(a). Next, draw a PPF based on the data in the table.

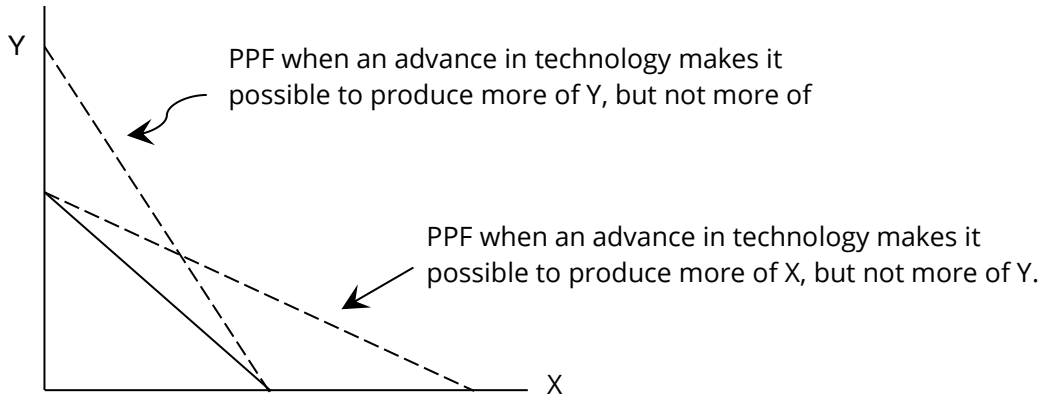
Answers will vary, but the PPF will be bowed outward similar to the one in Exhibit 2(b).

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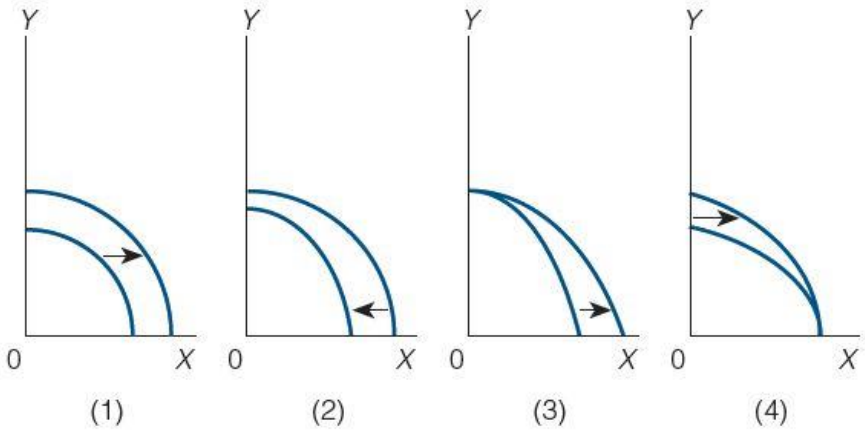
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3. Draw a PPF that represents the production possibilities for goods X and Y if there are constant opportunity costs. Next, represent an advance in technology that makes it possible to produce more of X, but not more of Y. Finally, represent an advance in technology that makes it possible to produce more of Y, but not more of X.



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4. In the following figure, which graph depicts a technological breakthrough in the production of good X only?



Graph (3). The technological breakthrough allows more of good X to be produced, so the extreme point of the PPF on the horizontal axis shifts outward.

5. In the preceding figure, which graph depicts a change in the PPF that is a likely

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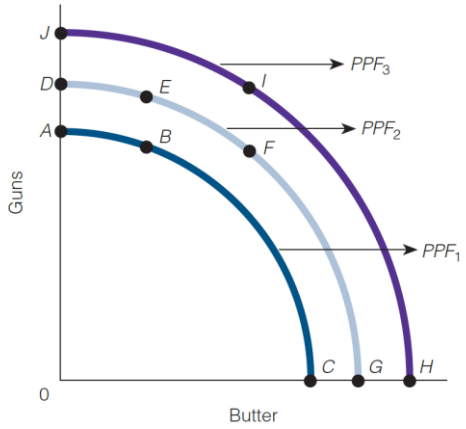
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consequence of war?

Graph (2). A likely consequence of war is decreased production of all goods leading to an inward shift of the PPF.

6. If PPF_2 in the graph that follows is the relevant PPF, then which points are unattainable? Explain your answer.



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J, I and H are unattainable. They are farther from the origin than PPF_2, which represents maximum possible output.

7. If PPF_1 in the preceding figure is the relevant PPF, then which point(s) represent productive efficiency? Explain your answer.

Points A, B, and C represent efficiency because they are located on the frontier itself. By definition, a point on the frontier requires us to use all our existing resources and technology to their most efficient level.

8. Tina can produce any of the following combinations of goods X and Y: (a) 100X and 0Y, (b) 50X and 25Y, and (c) 0X and 50Y. David can produce any of the following combinations of X and Y: (a) 50X and 0Y, (b) 25X and 40Y, and (c) 0X and 80Y. Who has a comparative advantage in the production of good X? Of good Y? Explain your answer.

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Tina gives up 50X to produce 25Y (100 – 50 and 0 – 25). David gives up 25X to produce 40Y (50 – 25 and 0 – 40). Tina's opportunity cost is 2X = 1Y (1X = 1/2Y), and David's is 5/8X = 1Y (1X = 8/5Y). David can give up 50X and get 80Y, while Tina gets only 25Y for 50X. So, David has the lower opportunity cost for good Y and Tina for good X.

9. Using the data in Problem 8, prove that both Tina and David can be made better off through specialization and trade.

Suppose Tina produces 50X and 25Y and David produces 25X and 40Y. Together, they produce 75X and 65Y. Now, suppose Tina produces 100X and 0Y and David produces 0X and 80Y. Together, they produce 100X and 80Y. Tina could now consume (for example) 60X and 35Y, and David could consume 40X and 45Y, making both better off.

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10. Suppose there is a PPF with two goods, X and Y. Suppose the economy is located at a point on the PPF. Does this point represent some of both goods or only one good and not the other?

The point may include some of both goods or it may contain only one good and not the other. Points that contain only one good and not the other may be found where the PPF intersects the horizontal and vertical axes. Points that contain some of both goods occur at all other points along the PPF.

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11. The economy is producing 100X and 200Y, but it could produce 200X and 300Y with the given resources and technology. Does it follow that when the economy is producing 100X and 200Y that it is productive inefficient and that when it is producing 200X and 300Y it is productive efficient? Explain your answer.

The economy is productive inefficient when it is producing 100X and 200Y because it is capable of producing a larger amount of both goods with the same resources and technology. However, we do not know whether the economy is capable of producing even more of both goods with the same resources and technology when it is producing 200X and 300Y. If it can produce more of both goods in that case, then it is productive inefficient. If it can produce more of one good only by reducing production of the other good, then it is productive efficient in that case.

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12. A person can produce the following combinations of goods *A* and *B*: 20A and 0B, 15A and 5B, 10A and 10B, 5A and 15B, and 0A and 20B. What is the opportunity cost of producing 1B? 1A?

The marginal opportunity cost is constant in this case, and the PPF is a straight line. The opportunity cost of an additional unit of B is 1A. The opportunity cost of an additional unit of A is 1B.

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Instructor Manual

Arnold, Economics, ISBN; Chapter 2: Production Possibilities Frontier Framework

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Purpose and Perspective of the Chapter

The purpose of this chapter is to introduce the basics of the PPF, comparative advantage, and trade. The PPF provides a framework for examining production and demonstrating several economic concepts. Using the PPF framework can show that individuals can make themselves better off by specializing in production according to their comparative advantages, and then trading for other goods.

Cengage Supplements

The following product-level supplements provide additional information that may help you in preparing your course. They are available in the Instructor Resource Center.

- Test Bank
- PowerPoint Slides

Chapter Objectives

The following objectives are addressed in this chapter:

02.01 Describe how the production possibilities frontier explains production.

02.02 Describe opportunity cost in the context of the production possibilities frontier.

02.03 Describe the factors that cause the production possibilities frontier to shift.

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02.04 Describe absolute advantage in the context of trade.

02.05 Explain how comparative advantage determines trade.

02.06 Explain how the terms of trade can lead to gains.

Complete List of Chapter Activities and Assessments

For additional guidance refer to the Teaching Online Guide.

Chapter Objective	PPT slide	Activity/Assessment	Duration
02.01	11	PPF Activity	5 minutes
02.01	13	Knowledge Check 1a	1 minute
02.02	14	Knowledge Check 1b	1 minute
02.03	15	Knowledge Check 1c	1 minute
02.05	22	Knowledge Check 2a	1 minute
02.05	23	Knowledge Check 2b	1 minute
02.06	24	Knowledge Check 2c	1 minute

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Key Terms

Comparative Advantage: The situation in which someone can produce a good at lower opportunity cost than someone else can.

Law of Increasing Opportunity Costs: As more of a good is produced, the opportunity costs of producing that good increase.

Production Possibilities Frontier (PPF): The possible combinations of two goods that can be produced during a certain span of time under the conditions of a given state of technology and fully employed resources.

Productive Efficient: The condition in which the maximum output is produced with the given resources and technology.

Productive Inefficient: The condition in which less than the maximum output is produced with the given resources and technology. Productive inefficiency implies that more of one good can be produced without any less of another being produced.

Technology: The body of skills and knowledge involved in the use of resources in production. An advance in technology commonly increases the ability to produce more output with a fixed amount of resources or the ability to produce the same output with fewer resources.

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What's New in This Chapter

The following elements are improvements in this chapter from the previous edition:

- New Exhibit 8 Added
- New Economics 24/7 Feature: The Covid-19 Pandemic and the PPF

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Chapter Outline

I. The Production Possibilities Frontier (02.01, 02.02, 02.03, PPT Slides 4-12)

a. Production Possibilities Frontier

The production possibilities frontier is a framework in which to examine production; it represents the combination of two goods that can be produced in a certain period of time, under the conditions of a given state of technology and fully employed resources.

b. Straight-Line PPF

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The PPF is a straight line; this is because the opportunity cost of books and shirts (Exhibit 1) is constant.

c. Bowed-Outward PPF

The PPF is a bowed-outward (concave-downward); this is because the opportunity cost of cell phones and coffee makers (Exhibit 2) is increasing opportunity costs.

d. Law of Increasing Opportunity Costs

The law of increasing opportunity costs holds for most goods because people have varying abilities. Exhibit 4 shows the increasing opportunity costs of building houses and as more houses are built, people with increasing opportunity costs must give up increasingly more of Good X.

e. Economic Concepts

The PPF framework is useful for illustrating and working with economic concepts as scarcity: the finiteness of resources is graphically portrayed by the PPF curve itself. Choice is where to operate on/in the PPF; opportunity cost is the trade-off of moving from one point on the PPF to another; efficiency is on the PPF while inefficiency is inside the PPF where there are unemployed resources. Economic growth occurs when the PPF curves shifts outward.

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f. Efficiency versus Inefficiency

Productive efficiency is represented by the points on the PPF while productive inefficiency is represented by any points below the PPF.

g. PPF Activity

Using Exhibit 6, ask the students to think about the USA and where to USA is on/below the PPF. Answer: Military is about 5% of GDP (See **www.bea.gov** and find current GDP numbers and take Government amount divided by total GDP) so very close to the point of Butter.

h. Technology

Technology is the resources to do more and be more. Example: **https://youtu.be/surlvCY6bpI** is from Microsoft commercial showing an advance in technology.

II. Specialization and Trade Can Move Us Beyond Our PPF (02.04, 02.05, 02.06, PPT Slides 16-21)

a. Simple PPF Model

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This section uses a two-person model to show the advantages of specialization and trade. Start with showing the individual PPFs for each person.

b. Step 1: Opportunity Cost

Elizabeth's opportunity cost is 20 Bread = 20 Apples so 1 Bread = 1 Apples or 1 Apple = 1 Bread.

Brian's opportunity cost is 10 Bread = 30 Apples so 1 Bread = 3 Apples or 1 Apples = 1/3 Bread.

c. Step 2: Comparative Advantage

Elizabeth's comparative advantage is Bread as she gives up less at 1 Apple and Brian gives up more at 3 Apples.

Brian's comparative advantage is Apples as he gives up less at 1/3 Bread and Elizabeth gives up more at 1 Bread.

d. Step 3: Specialize

Specialize in the comparative advantage so Elizabeth is Bread and Brian is Apples. Elizabeth specializes in 20 Bread and 0 Apples while Brian specializes in 30 Apples and 0 Bread.\

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e. Step 4: Trade

The terms of trade are the two-person agreement with the terms of the trade being Elizabeth trades 8 Bread and Brian trades 12 Apples so that Elizabeth has 12 Bread and 12 Apples and Brian has 8 Bread and 18 Apples so they both increased their consumption by specializing and trading.

Discussion Questions

You can assign these questions several ways: in a discussion forum in your LMS; as whole-class discussions in person; or as a partner or group activity in class.

1. Discussion: The Bowed-Outward PPF (02.01) Duration 10 minutes.
    a. Discuss how the law of increasing opportunity costs impacts the shape of the PPF. Use a specific example to help demonstrate your understanding of this relationship.
        i. Answers will vary. Example: Due to the varying abilities of resources to produce a given product, as more of that product is produced the opportunity cost of producing each successive unit tends to increase. This leads to the bowed outward shape of the PPF. For example, if cars are on the horizontal axis and lamps are on the vertical axis of

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the PPF, as the economy produces more cars it will begin to run out of resources that are very well-suited to make cars, and thus the opportunity cost in terms of lamps will increase, creating a bowed-outward PPF.

2. Discussion: Economic Concepts in a Production Possibilities Framework (02.01) Duration 10 minutes.
    a. Discuss the difference between a movement along a production possibilities frontier (PPF) and a shift of the PPF. Give a specific example of each to help support your answer.
        i. Answers will vary. Example: Suppose that a PPF is drawn with airplanes on the vertical axis and ice cream on the horizontal axis. A movement along the PPF would indicate society's decision to reallocate resources so that it can produce a different combination of airplanes and ice cream than it had previously. A shift of the PPF would indicate that there has been a change in the quantity of resources available and/or a change in the level of technology. For example, suppose that an improvement in technology allows for the production of more ice cream and more airplanes, this would result in a rightward shift of the PPF.

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Additional Resources

Cengage Video Resources

- MindTap Videos:
    - Video Lecture: Production Possibilities Frontier
    - Video Lecture: PPF and 7 Economic Concepts
    - Video Lecture: Specialization and Trade
    - Economics In 5 Minutes: Determining Comparative Advantage
    - Economics In 5 Minutes: How to Derive a Production Possibilities Frontier
    - Economics in 5 Minutes: Productive Efficiency and Inefficiency
    - Equation Basics
    - Equivalency of Fractions, Decimals, and Percentages
    - Graphing Basics
    - Graphing Linear Equations
    - Slope of a Curve
    - Slope of a Line
    - Video Problem Walk-Through 2.1: Deriving a PPF
    - Video Problem Walk-Through 2.2: A Bowed-Outward PPF
    - Video Problem Walk-Through 2.3: Determining Comparative Advantage

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- Video Problem Walk Through 2.4: Economic Concepts in a PPF framework
- Video Problem Walk Through 2.5: High Unemployment and the PPF

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Appendix

Generic Rubrics

Providing students with a rubric helps them understand expectations and components of assignments. A Rubric helps students become more aware of their learning process and progress, and they improve students' work through timely and detailed feedback.

Standard Discussion Rubric

Criteria	Meets Requirements	Needs Improvement	Incomplete
Participation	Submits or participates in discussion by the posted deadlines. Follows all assignment. instructions for initial post and responses. 5 points	Does not participate or submit discussion by the posted deadlines. Does not follow instructions for initial post and responses. 3 points	Does not participate in discussion. 0 points
Contribution Quality	Comments stay on task. Comments add value to discussion topic. Comments motivate other students to respond. 20 points	Comments may not stay on task. Comments may not add value to discussion topic. Comments may not motivate other students to respond. 10 points	Does not participate in discussion. 0 points
Etiquette	Maintains appropriate language. Offers criticism in a constructive manner. Provides both positive and negative feedback. 5 points	Does not always maintain appropriate language. Offers criticism in an offensive manner. Provides only negative feedback. 3 points	Does not participate in discussion. 0 points

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