

ECO 610  
Final Exam  
Fall 2017

Name: \_\_\_\_\_

Optional 4-digit number: \_\_\_\_\_

100 points total. Answer each question in the space provided.

1. (20 pts.) Read the attached article on the global cobalt market from the WSJ 11/30/17. Cobalt is mined by a number of companies in different places around the globe. Since the beginning of the year, cobalt prices have increased from around \$10/lb to \$30/lb. As you can see in the attached chart, cobalt prices had been in the \$10 to \$15 range for a number of years. Since you work for a major battery manufacturer supplying automobile manufacturers in North America, your bosses have asked you to explain what is going on. The CEO and most of the board members have MBA's, so they understand commodity market models. Now for the framework of your report:
  - a) What does long-run equilibrium look like in the global cobalt market? Is long-run equilibrium price closer to \$10 per pound or \$30 per pound? What does that suggest to you about minimum LRAC for producing cobalt? Draw diagrams for the market and for a typical cobalt mining company that are consistent with your description of long-run market equilibrium.
  - b) What does the future hold? Do you anticipate that prices will stay at \$30 per pound, or do you see them returning to a lower level? If so, what level? And how long do you think the adjustment process will take? Draw diagrams for the market and for a typical cobalt mining company consistent with your explanation of 2016 prices being \$10/lb, 2017 prices being \$30/lb, and 20?? prices being whatever you are predicting.

# Will a Shortage of Cobalt Kill Electric-Vehicle Makers?

Wedge between iron and nickel on the periodic table, cobalt has suddenly emerged as the electric-car killer.

The once-obscure metal, a critical part of batteries, has nearly tripled in price since last summer as concerns grow about whether there will be enough cobalt to meet demand.

The ingredients for a shortage are there: Output is concentrated in the politically unstable Democratic Republic of Congo and refining is dominated by China. Demand is set to soar as companies from Tesla to Volkswagen ramp up production of electric vehicles. With the price of cobalt

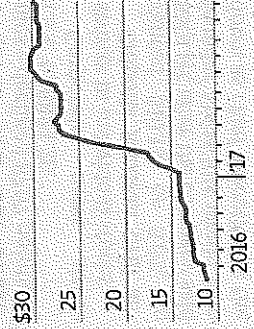
will worsen, is up 162% this year.

"I don't think automobile manufacturers are as concerned about price as availability," says George Heppel, a consultant at materials research firm CRU International who says the shortage could peak in 2021.

But the dreaded shortage of cobalt is a bit more complicated than industry projections would suggest. As anyone who remembers the fears around rare earth metals will agree, high prices have a way of boosting supply and reducing demand. With the cost of cobalt alone having risen to over \$800 for some leading electric mod-

## Pedal to the Metal

Price of cobalt US 99.8% a pound as tracked by CRU International



hitting \$30 a pound, investors have poured into shares of companies that mine or own rights to the metal. Canada's **Cobalt27 Capital**, which believes there is already a deficit in supply that

els—about as much as that of aluminum or plastic per vehicle—mother necessity is calling.

Like cobalt, rare earths aren't so rare. China's move to restrict exports in 2010 exacerbated the perceived shortage, sending the prices of some varieties up 10-fold. Companies such as **Moly-corp**, Rare Element Resources and **Quest Rare Mineral**, which all had some connection to reserves, saw their shares surge based on supposedly rosy prospects. Since then, all have lost nearly all of their value.

Already, Mr. Heppel explains, other users of the metal, for example in the

pigments industry, are searching for alternatives. Meanwhile, some batteries, such as a design by Tesla, use less of the metal. Lower performing batteries use none at all, and those batteries' capabilities may improve with technological tweaks.

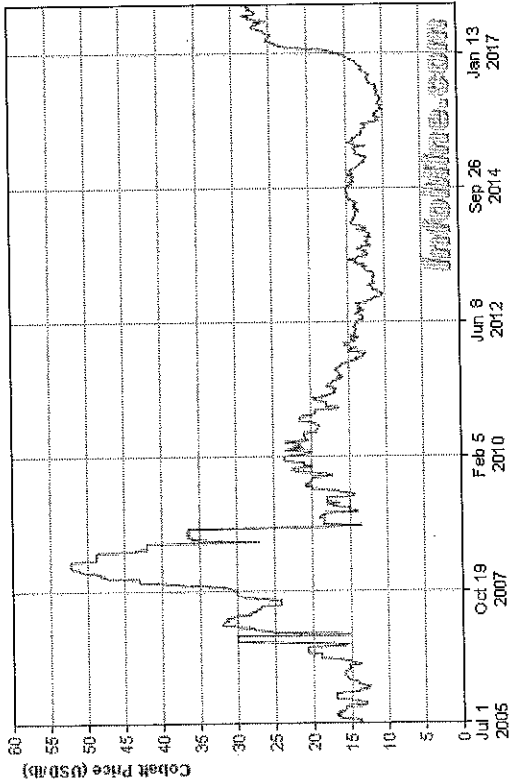
Supply will react, too. Companies that operate copper and nickel mines, where cobalt is co-produced, are targeting expansion, and there are some pure-play cobalt mines being planned that could start producing shortly after the projected shortage hits. For electric vehicles, this looks more like a speed bump than a cliff.

—Spencer Jakab

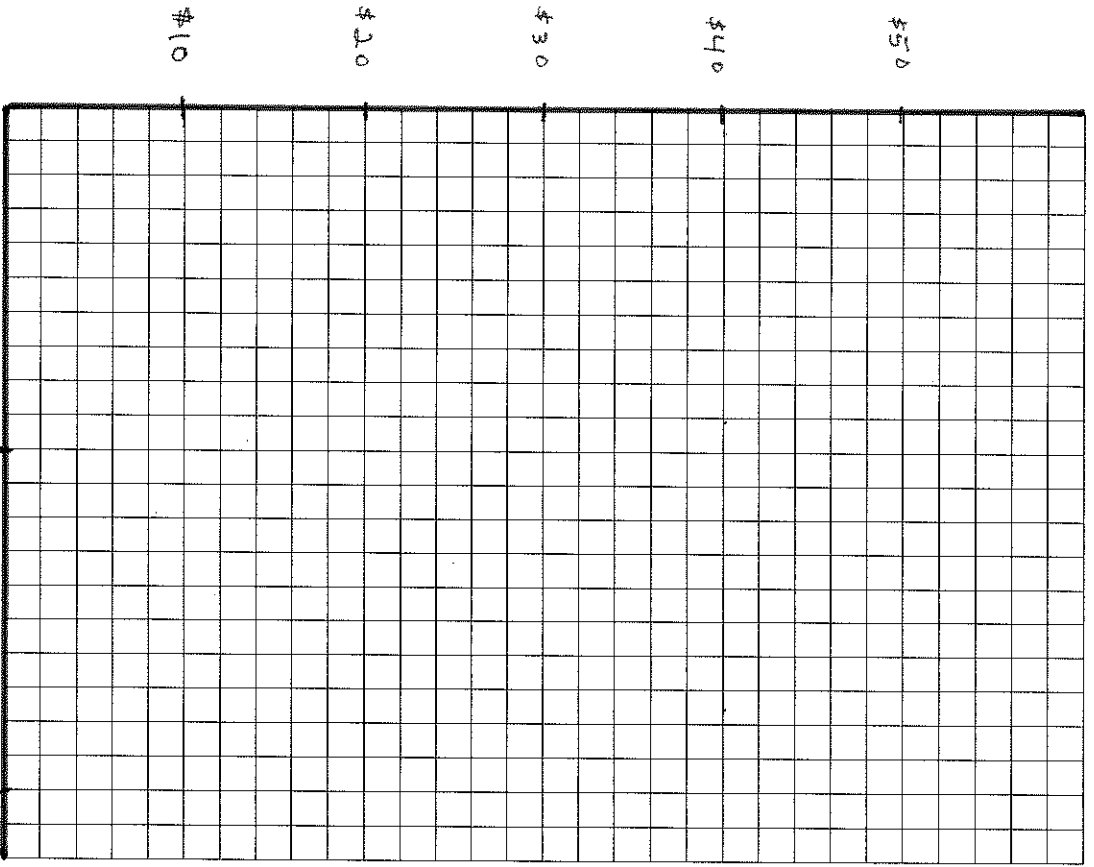
## Historical Cobalt Prices and Price Chart

Cobalt Price 29.71 USD/lb (65,500.00 USD/t) | 55,054.72 EUR/t | 29 Nov 2017 - 52 Week Low 13.61 USD/lb 52 Week High 3

Cobalt Price  
29.71 USD/lb  
29 Nov '17



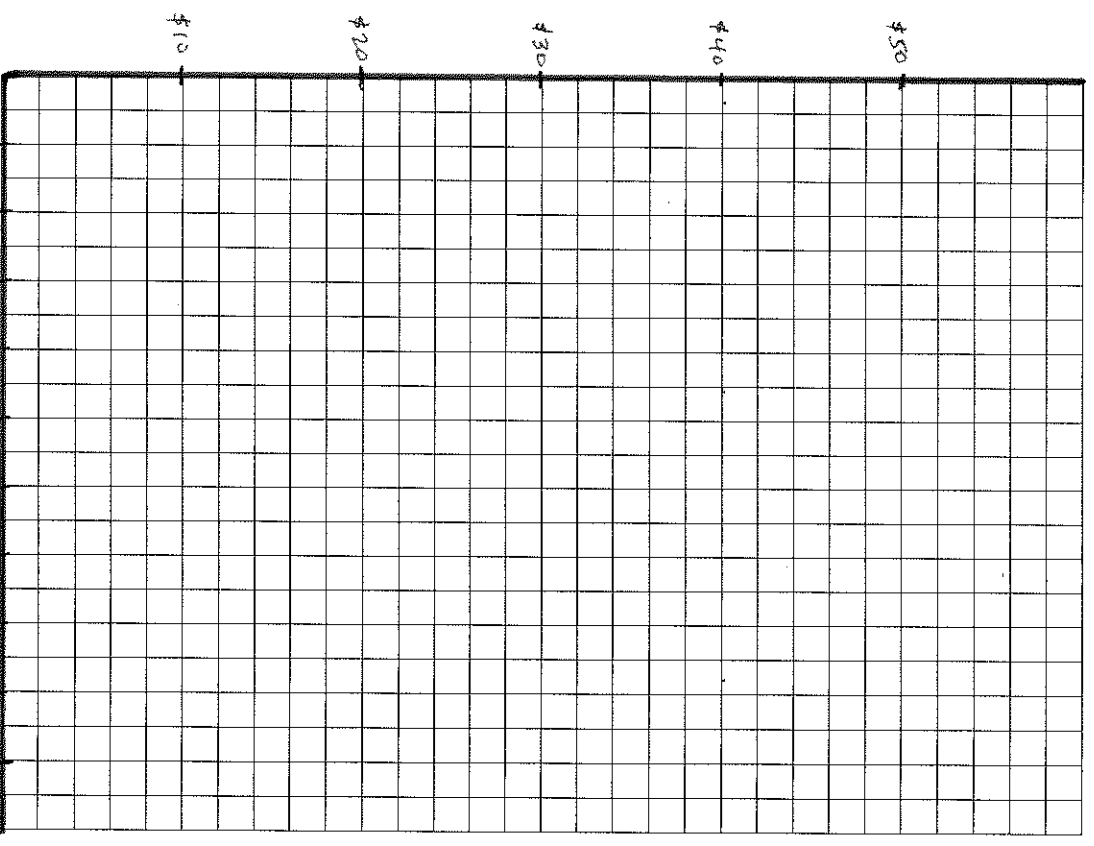
P (\$/pound)



World Cobalt Market

Q (metric tons)

P (\$/pound)

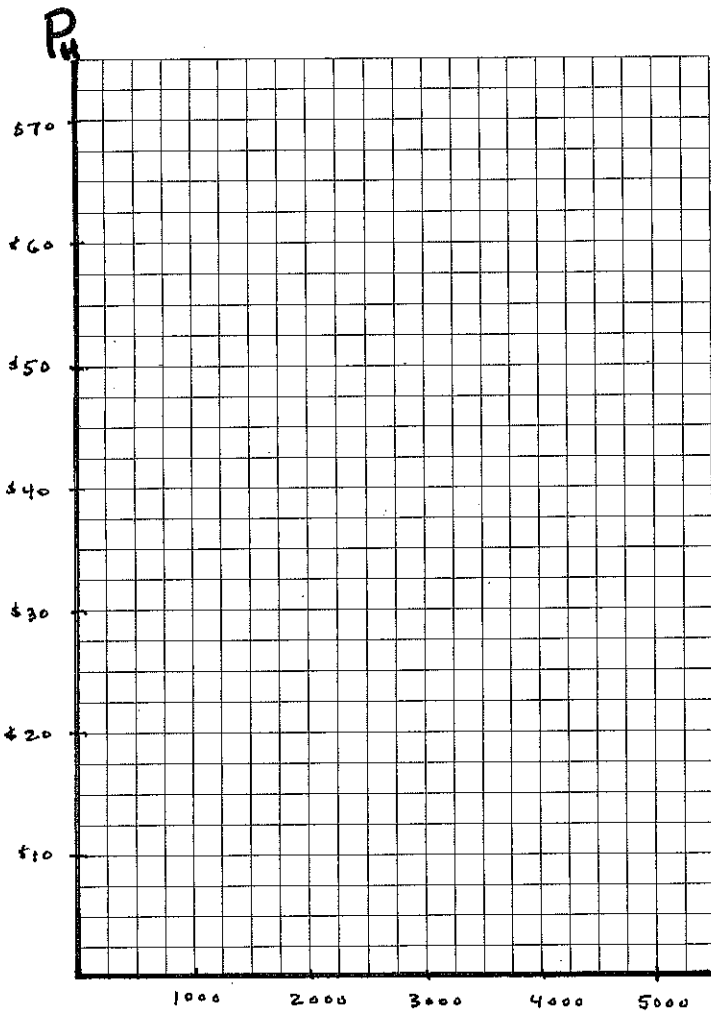


typical cobalt mining company

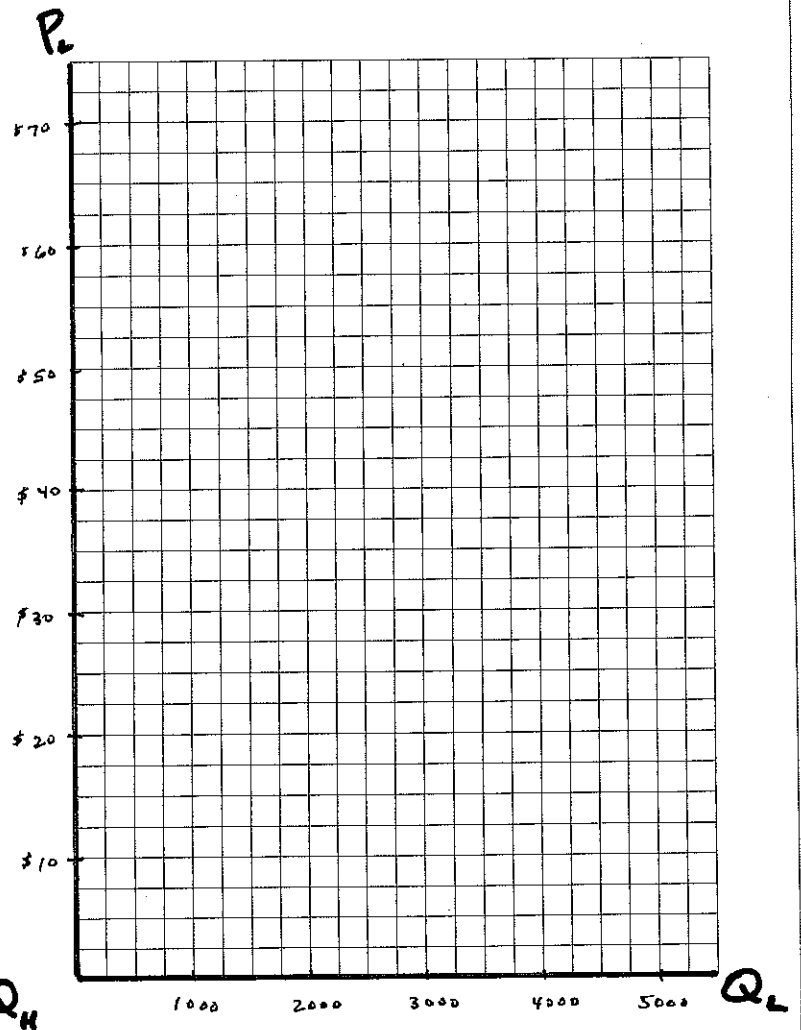
Q (metric tons)

2. (20 pts.) A major distilling company that is a market leader in producing and selling bourbon approaches you for help with their pricing strategy. There are two distinct segments to the market for their brands. Among high-end customers, monthly demand is given by  $Q_H = 5000 - 100P_H$ , where  $Q$  is the number of cases of 750 ml bottles and  $P$  is the price per 750 ml bottle. Among low-end customers, monthly demand is given by  $Q_L = 5000 - 250P_L$ . You really don't do anything substantially different in producing the high-end bourbon and the low-end bourbon other than letting one sit around in a warehouse for a longer time, and in fact sometimes when you have leftover high-end bourbon you just mix it in with the low-end bourbon. So for purposes of answering this question, take the marginal cost of producing a 750 ml bottle of either quality bourbon to be constant at \$10.

- Sketch the demand, marginal revenue, and marginal cost curves for each market segment. Indicate what price and output will maximize profit in each segment.
- The head of marketing approaches you and asks if you can give her a back-of-the envelope estimate of the own-price elasticity of demand for each type of bourbon. She knows that you have just completed your EMBA and know something about the inverse-elasticity pricing rule.



High-end bourbon



Low-end bourbon

3. (10 pts.) See the attached article from the WSJ 11/24/17. Take the information on sales by each of the major paint producers and calculate the industry HHI. Explain how you get your answer and show your work. There are a number of smaller producers not listed in the chart, but you can ignore them for purposes of answering this question.

WSJ 11/24/17

# Paint Industry Draws Excitement

The otherwise quotidian world of paint is turning into a feeding frenzy of merger activity. Money is to be made betting on the prime targets.

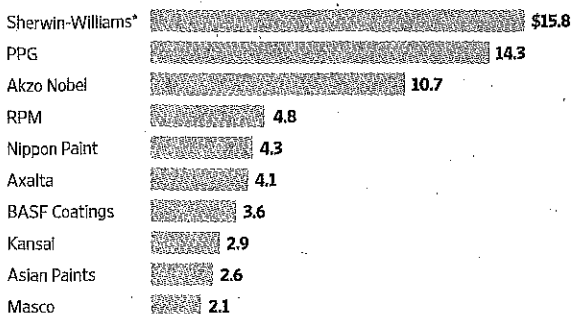
The latest news: Japan's **Nippon Paint** is interested in **Axalta Coating Systems**, pushing aside a bid by Dutch rival **Akzo Nobel**, which itself has been a target for industry leader **PPG Industries**. It is unclear what price Nippon has offered for Axalta, though it will need to be more than its current enterprise value of \$11.7 billion including debt.

Akzo's retreat before a smaller rival isn't as odd as it sounds. This year, the Dutch company refused to negotiate over three separate bids from Pittsburgh-based PPG, which vies with Cleveland-based **Sherwin-Williams** for the top spot in the global paints industry. Investors, noisily led by New York activist **Elliott Management**, wanted Akzo to negotiate.

Chairman Antony Burgmans blocked PPG by invoking arcane clauses of Dutch law, leaving him little credit with investors to draw on in

## Color Palette

Global coatings sales 2016, in billions



\*Pro-forma including Valspar.  
Sherwin-Williams's acquisition of Valspar completed in June 2017.  
Sources: Coatings World, Sherwin-Williams

THE WALL STREET JOURNAL.

support of a punchy takeover. The Axalta deal, billed as a "merger of equals," always looked like a poison pill to keep PPG away, but investors were happy to swallow it as long as Akzo could promise merger synergies without a hefty takeover premium. Nippon's all-cash offer has made that impossible.

Nippon Paint is making a huge bet. With an enterprise

value equivalent to \$10.6 billion, it is slightly smaller than Axalta. The offer looks serious, though. The Japanese company has no net debt and a clear ambition to be a global player.

Crucially, Nippon Paint's key shareholder implicitly stands behind its management. Almost two-fifths of the company's shares belong to **Wuthelam Holdings**, the

investment vehicle of Singaporean billionaire Goh Cheng Liang. Mr. Goh distributed Nippon paint for decades before his son, now director of the board, spearheaded a 2014 merger.

Akzo's inability to compete with Nippon Paint leaves it vulnerable. PPG has done its best to temper expectations of another round of bidding, but this could just be a negotiating ploy. The numbers should still work: The dollar has weakened against the euro this year, but PPG's share price has outperformed Akzo's, which is still 18% below the level of PPG's final bid. PPG's "put-up-or-shut-up" quiet period expires next month.

There is an outside chance **Sherwin-Williams** could also be interested in Akzo. In the spring it had its hands full with the acquisition of smaller rival Valspar, but this was completed in June.

In a consolidating market it makes sense to own the takeover targets. It is clearer than ever that these include Akzo Nobel as well as Axalta.

—Stephen Wilmot

4. (25 pts.) Ralph and Colleen play a game. Sometimes they both select their strategy at the same time; sometimes Ralph chooses his strategy first and Colleen chooses her strategy after she sees what Ralph has decided; and sometimes Colleen goes first and Ralph chooses second. The payoff matrix for this game is as follows, where Ralph's payoff is listed first and Colleen's payoff is listed second:

		Colleen		
		Left	Middle	Right
Ralph	Top	3, 1	2, 3	10, 2
	High	4, 5	3, 0	6, 4
	Low	2, 2	5, 4	12, 3
	Bottom	5, 6	4, 5	9, 7

- a) Suppose Ralph and Colleen choose their strategies simultaneously. How do you think the game will turn out? Use the solution concepts we developed in class and explain your answer in a step-by-step fashion.

- b) Now suppose that Ralph and Colleen decide to play the game sequentially, with one of them going first and the other one going second. The one who goes second chooses their strategy after seeing the strategy choice of the one who went first. They flip a coin to see who goes first, and Colleen wins. If you were Ralph, how much would you be willing to pay Colleen to let you go first? Draw the two game trees and explain how the game is likely to turn out in each case.

5. (10 pts.) Perform a Porter's Five Forces analysis of the market for pizza restaurants in West Liberty, KY.

6. (15 pts.) Some short-answer questions:

a) Why would a firm in a monopolistically competitive market like the restaurant industry remain in business if they are earning zero economic profit?

b) What popped the cork monopoly?

c) What are three sources of barriers to entry?

d) Pick one of the three categories of price discrimination and give an example of it.

e) Why do cartels tend to be unstable?