Joules to Dollars Midterm Exam 2018

Rules for the Exam: 1) The exam must be your own work. 2) You may use only your own notes and non-human resources from the internet to answer the questions. 3) **Show your calculations for all of your work and hand in your answers to these questions at the beginning of class on Tuesday, April 10th.** 4) Email your Excel spreadsheet from problem #5 (and any of the other problems) to both whitney.king@colby.edu and michael.donihue@colby.edu.

Honor Statement – your exam will not be graded if you do not complete this section
I agree to complete this exam *without help from anyone* through direct or indirect conversation in person, on the phone, via electronic communications (e.g., email, Twitter, etc.), and/or social media interactions (e.g., Facebook, blog posts, etc.). I understand that the consequences of violating this honor statement will constitute academic dishonesty with the possible consequences including failing this course.

_____ _____
(signature – handwritten or typed) (date)

1. Colby Power and Light produces steam at 417^{o}F and a pressure of 300 PSI in the boilers. After the steam passes through the electric turbine the steam is 280^{o}F and the pressure is 50 PSI.
    a. What is the maximum efficiency of generating electricity at Colby?

    b. Why is this a good deal for Colby?

2. Suppose the price elasticity of demand for electricity in Ohio is inelastic while the price elasticity of demand in Maine is relatively elastic. In which state will a 1% increase in electricity prices have a bigger effect on demand? Explain your answer carefully in words and with a supporting graph.

3. Converting Dollars to Joules. Consider the following data for a hypothetical college professor living in Central Maine:
    - In 2017 this professor paid a total of $1,627.93 for electricity at an average price of 16.57 cents per kWh
    - This same professor paid $1,837.59 for propane at an average price of $2.185 per gallon.

    a. How many **TOTAL** Joules of energy did this professor consume for his home in 2017?

    b. Which energy source delivered more useful heat or work? Explain.

    c. Before heat pumps became popular, simple electric heaters with 100% efficiency were common in new construction. Why are these older heating systems seldom used in Maine?

4. The New England Regional Greenhouse Gas Initiative (RGGI) trades carbon dioxide emission credits between the New England States. The current price of carbon emission is $4/ton of CO_2. Compared to an old oil burner, does the Efficiency Maine rebate of $3000 on pellet boilers make sense from a RGGI carbon dioxide abatement standpoint alone? Please justify your answer with appropriate calculations.

5. Heating your home. Create an Excel spreadsheet to help you answer the following parts to this question. Clearly label your answers to each part of this question. Annotate your spreadsheet with a brief explanation for your results.

    a. Using the technical information you gathered from our visit to Houles Plumbing, Heating and Cooling, current and projected fuel/electricity prices, and Efficiency Maine incentives, evaluate the mass of carbon dioxide produced, capital costs, operating costs, and the estimated payback of the system. Assume the total annual energy demand for your home is 150 mBTU/year and the currently installed system has an overall efficiency of 65%. Note that moving to a more efficient system will reduce your fuel costs and determine your payback period.

    b. State clearly your own objective function (e.g., minimize cost, maximize efficiency, reduced carbon emissions, etc.) and select a heating system for your 2500 ft^2 home that meets your goal.

    c. Determine the total amount of interest paid if you use a home equity line of credit to finance your purchase over 60 months at an annual interest rate of 2.5%.

    d. Suppose that the monthly payment in (c) is more than you can afford and you instead decide to finance your heating system using a credit card. You make the minimum monthly payment each month of 1% on the outstanding balance. The interest rate is 9% per year. How long will it take you to pay off your purchase? (Note that 1% of the outstanding balance is less than the total interest owed each month. For most credit cards, the unpaid interest is typically rolled over and added to the unpaid principal for the outstanding balance for the next month.

    e. Suppose you justify your decision to use your credit card for this purchase by the fact that you earn “points” on your credit card purchases in the amount of 1% of your expenditures and you plan to use these points to help finance a vacation to Florida. Was this a good reason to use the strategy in (d) to purchase your heating system? Justify your answer with an appropriate calculation of the interest rate cost and the value of points earned.