

## A TONIC FOR A RUN-DOWN CHEMISTRY SYSTEM

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If you have ever thought your students were becoming disinterested in chemistry or if you have realized that many of them were not doing all the work they were capable of doing, then I have a tonic for them, one that will stir up enthusiasm and develop a wide-awake class.

This scheme revolutionized the chemistry class in the Newton Community High School, changing it from an ordinary class to one that fairly bristled with excitement. The quality and quantity of work done was such that I thought perhaps other teachers might like to know of the plan in case they had a run-down chemistry system.

This project appealed to every type of mind, "the tin cup, the quart, and the gallon," and to those who could draw, those who could write, those who were interested in advertising, etc. The greatest problem facing the classroom teacher is the taking care of individual differences. Unless the assignment appeals to every pupil in the class, it is in that degree a failure. The students oftentimes are not interested, and thus fail the course. It is not because they are lacking in ability but because we do not know them as individuals. We know our subject matter, but not our subjects—the pupils. It has long been an established fact that students differ in mental acumen or I. Q., all the way from dull to near geniuses, but they differ even more widely emotionally, temperamentally, and in special abilities, special aptitudes, and peculiar interests. Our assignments, then, must be so elastic that they will take care of these individual differences.

Following is an assignment on Carbon which I think takes care of these individual differences. This assignment was mimeographed and a copy given each student. In this way there was no excuse for anyone not knowing what the lesson was. The assignment is shown here just as it was given to the students. It was designed to appeal to the inferior as well as to the medium and superior student, and it provided ample opportunity for almost everyone to do excellent work if he wished.

## CARBON

March 25—April 8, 1929.

## 60 POINTS

Text book—Brownlee, Fuller, Hancock, Sohon, Whitsit.

Chapter XXIII "Carbon" p. 308-322.

Chapter XXIV "Oxide of Carbon" p. 322-336.

Chapter XXV "Gaseous and Liquid Fuels" p. 336-353.

Chapter XXXVIII "Carbon Compounds" p. 525-560.

*Study the above and write answers in ink to the following questions.*

## A. Due March 28.

1. How does bituminous coal differ from anthracite in appearance and in chemical composition?
2. Why does soft coal make such a smoky fire?
3. Why is anthracite coal preferred for household use?
4. Explain why fence posts are sometimes charred at the end before being placed in the ground.
5. What properties of lampblack make it suitable for printer's ink and for paint?
6. What happens when a solution of brown sugar is filtered through boneblack?
7. What kind of carbon is used in batteries?
8. State briefly how you could distinguish between pulverized charcoal and manganese dioxide.
9. What three conditions are necessary for ordinary burning?
10. Why does water put out a fire?
11. Why is a candle extinguished by blowing?
12. In working with compressed air it is found that combustible materials burn more readily than usual. Explain.

*Reference:* Brownlee, p. 320-321.

## B. Due April 1.

1. Why is hydrochloric acid preferred to sulfuric acid in preparing carbon dioxide from calcium carbonate?
2. Why does soda water effervesce when taken from the tank?
3. Describe three important uses of carbon dioxide, and state the properties on which each use depends.
4. How could you prove that there is carbon in alcohol?
5. By what process may carbon monoxide be obtained from carbon dioxide? Account for the explosions that sometime occur in coal stoves shortly after coal is added. State how these explosions may be avoided.
6. How would you determine whether a gas were hydrogen or carbon monoxide?
7. Why is it that such a large percentage of the cases of asphyxiation from water gas result fatally.
8. How many grams of sulfuric acid reacting with an excess of sodium carbonate are required to produce 200 grams of carbon dioxide?
9. It has been calculated that an average man exhales 464.5 liters (standard conditions) of carbon dioxide in a day. Calculate many grams of starch a plant could make from this.
10. Write the formula for (a) baking soda; (b) cream of tartar. write the equation for the reaction that takes place when these two substances are used in a baking powder. What causes the dough to rise?

*Reference:* Brownlee, p. 333-335.

## C. Due April 5.

1. What is a hydrocarbon?
2. Why is carbon tetrachloride preferable to gasoline for home use in the removal of grease spots from clothing.
3. Define alcoholic fermentation; acetic fermentation.
4. What is an alcohol?
5. Give formula for three common alcohols.
6. What is denatured alcohol? Why is alcohol denatured?
7. What group of elements is characteristic of aldehydes?
8. What relation does formaldehyde bear to wood alcohol?
9. What important chemical changes take place when sweet cider changes to vinegar?
10. How is soap made?
11. What reaction takes place when soap is added to water containing magnesium sulfate? Why?
12. Why do not soap suds form readily when soap is added to salt water?
13. Why is not boiling water used to prepare starch from corn?
14. How is dextrine obtained from starch?
15. Would you expect to find dextrine in the crust or in the center of a loaf of bread?
16. What substance is used to remove coloring matter from crude sugar?
17. Why is vinegar used in making sugar candy that is to be pulled?
18. What is barley sugar? What is caramel?

*Reference:* Brownlee, p. 559-560-561.

## For Reference Material

- a. Every Day Chemistry—Alfred Vivian—pages 244-280.  
Chapter XXIX "Compounds of Carbon and Hydrogen."  
Chapter XXX "Alcohols."  
Chapter XXXI "Organic Acids."  
Chapter XXXII "Fats, Oils, and Soaps."
- b. High School Chemistry—George H. Bruce.  
Chapter XXIV "Fuels" p. 299-325.  
Chapter XL "Alcohols, Aldehydes, etc." p. 503-515.  
Chapter XLI "Other Carbon Compounds" p. 515-524.
- c. Modern Baking Powder—Juanita Darrah.
- d. Article by Dr. S. R. Powers.
- e. Encyclopedia.
- f. Pamphlet, "Commercial Glucose and its Uses," George W. Ralph.
- g. Pamphlets about Magic Crystal.
- h. "Commercial Glucose as a Food," Victor C. Vaughn, M. D.
- i. "The Story of a Grain of Corn," Dr. W. P. Cutter.
- j. Public Welfare Service Bulletins.
- k. "The Laboratory," Vol. II No. 1.
- l. "Current Science," Vol. V. Jan. 14-18, 1929.
- m. Journals of Chemical Education.
- n. Pamphlet, "The Strength of Sweetness," Woods Hutchinson, M. D. This article may also be found in March number of Ladies Home Journal, 1929.

The above reference material may be found on the reference shelf in the chemistry room.

Pass examination covering material assigned in Brownlee. Must have a grade of 70. Examination will be Monday, April 5, 1929.

## 25 POINTS

Due April 3.

1. *Make a scrap book.* Newspaper clippings, cartoons, magazine articles, latest developments with carbon, etc. Any phase of carbon or its compounds.  
Not less than 10 pages. Additional points will be given for clever color schemes, good printing, clever arrangement of material.  
10 points for 1st place.  
7 points for 2nd place.  
5 points for 3rd place.  
Note! Scrap books will be entered in a contest put on by "Chemistry Leaflet" State College, Pa. First prize \$50, second prize \$25, 10 prizes of \$2 each.
2. *Articles—700 to 1000 words.* Due April 2.
  - a. "Commercial Glucose and its Uses."  
"A much misunderstood and maligned product. Necessary to certain Food Staples, and a good substitute for more expensive ingredients." George W. Ralfe.
  - b. *Life of Sir Humphrey Davy.* Due April 3.
  - d. *Interdependence of Living Things.* Due March 29.  
"The Cause of a Controversy." March 29.
  - e. Chapter I. *Modern Baking Powder* by Juanita Darrah.  
*Modern Baking Powder.* March 29.
  - f. "The Residues from Baking Powder. April 3. Chapter IX.
  - g. "The Magic Crystal." Leaflets on reference shelf.
  - h. "Commercial Glucose as a Food." Victor C. Vaughan, M. D.
  - i. "The Story of a Grain of Corn," by Dr. W. P. Cutter.
  - j. "All Made from King Corn." Leaflets on reference shelf.
  - k. "From Pasture to Pantry." Leaflets on reference shelf.
  - l. "The Discover of Gas." Page 3 to middle of page 7. Public Welfare Service Bulletin No. 1; 7th edition, 1927. Due April 4.
3. *Make a poster illustrating some phase of Carbon or its compounds.*
4. *Make a Carbon Tree or a Carbon Wheel with products of Carbon or Compounds hanging on branches of tree or suspended on spokes of wheel.* Due April 4.
5. *Make a chart showing substances that contain (a) tartaric acid (b) citric acid (c) acetic acid (d) lactic acids (e) tannic acids.*
6. "Synthetic Perfumes. Creative Chemistry.

## 25 POINTS

Laboratory experiments as previously assigned count 25 points.

## "CONTRACTS"

## 10 POINTS

1. 5 slogans which emphasize importance of Carbon or its Compounds.  
Articles 700 to 1000 words
  - a. The Davy Safety Lamp. Ref. "The Laboratory," Vol. II, No. 1.
  - b. Practical Uses of Oxalic Acid.
  - c. Soap Making.
  - d. Candle Making.



- e. "Testing Gasoline for Sulphur." Current Science, Vol. V. Jan. 14-18, 1929.
- f. "How Grain Alcohol Is Made." List the liquors containing alcohol and the percentage of it in each.
- g. The difference between grain alcohol and wood alcohol. List uses of each.
- h. The Use of Acetylene Gas for Illuminating Purposes.
- i. The Uses of Formaldehyde.
- j. Medicinal Uses of Carbon Compounds.
- k. Food Preservatives that are Carbon Compounds.
- l. Hydrogenation of Oils.
- m. Cleansing Powders ( $\text{Na C}_{13} \text{H}_{25} \text{O}_2$ ).
- n. The importance of Carbohydrates.
- o. The Deadly Carbon-Monoxide.
- p. The Valuable Diamond, an Allotropic Form of Carbon.
- q. Effervescent beverages depend upon Carbon.
- r. The  $\text{C O}_2$  fire extinguisher.
- s. Foamite.
- t. Petroleum and its Products.
- u. Gasoline and Kerosene.
- v. How Coal is Made. Public Welfare Service. Page 10.
- w. Cellulose—an important Carbon Compound.
- x. Tannic Acid and its Uses.
- y. "The Strength of Sweetness." Woods Hutchinson, M. D. March number of Ladies Home Journal.
- z. How a Pencil is Made.

Laboratory Experiments for Work with Carbon, March 25–April 5.

- Experiment 50. Properties of Carbon.  
 Experiment 51. Preparation and Properties of Carbon Dioxide  
 Experiment 52. Chemical Fire Extinguisher.  
 Experiment 54. Baking Powders.  
 Experiment 78. Fermentation.  
 Experiment 80. Soap Making (10 additional points will be given for best cake of soap submitted from both classes  
 Note! If toilet soap it will be judged for shape, color scent wrapping. If laundry soap, it will be judged on its merits and must be accompanied by list of reasons why it should excel.)  
 Experiment 81. Starch.  
 Experiment 83. Carbohydrates.

Must perform 5 experiments. The ones with a star before them are required to gain the 25 points toward an A.

Extra points will be given for the testing of liquor or hootch (as it is popularly known). The instructor will furnish individual instructions for the test. The liquor will be tested for:

- a. percentage of alcohol
- b. artificial coloring
- c. wood or grain alcohol

Extra points will be given for analyzing vanilla, lemon extract, and patent medicines for alcohol content.

In order to receive a grade of

- A you must have 200 points
- B you must have 175 points
- C you must have 150 points
- D you must have 100 points

Note!!! Anyone who does not receive 100 points receives 0. To receive an A one must have the 60 points (for required fundamental work), at least one of the 25 points and must perform laboratory experiments which count 25 points.

## "ADVERTISEMENT"

## 10 POINTS

Write an advertisement for one of the following products:

- |                                      |                                                    |
|--------------------------------------|----------------------------------------------------|
| 1. Diamonds                          | 39. Gasoline                                       |
| 2. Oleomargarine                     | 40. Kerosene                                       |
| 3. Peanuts                           | 41. Naphtha                                        |
| 4. Olive oil                         | 42. Wood alcohol                                   |
| 5. Soap                              | 43. Denatured alcohol                              |
| 6. Cleansing powders                 | 44. Alcoholic beverages                            |
| 7. Oil of wintergreen                | 45. Effervescent beverages                         |
| 8. Glucose                           | 46. Cosmetics that contain glycerine               |
| 9. Cane Sugar                        | 47. Glycerine                                      |
| 10. Charcoal                         | 48. Hand lotions                                   |
| 11. Lighting homes with gas          | 49. Ink                                            |
| 12. Acetylene gas                    | 50. Malt sugar                                     |
| 13. Gas stoves, fixtures, etc.       | 51. Starch—laundry                                 |
| 14. Honey                            | 52. Tapioca                                        |
| 15. Library paste                    | 53. Guncotton                                      |
| 16. Sago                             | 54. Celluloid                                      |
| 17. Lactose                          | 55. Corn starch                                    |
| 18. Molasses                         | 56. Dextrine                                       |
| 19. Vinegar                          | 57. Substances containing cellulose—rainment, etc. |
| 20. Jellies                          | 58. Chocolates                                     |
| 21. Mucilage                         | 59. Face powders                                   |
| 22. Gum drops                        | 60. Carbona                                        |
| 23. Gum arabic                       | 61. Energine                                       |
| 24. Salicylic acid                   | 62. Pyrene fire extinguishers                      |
| 25. Medicines using carbon compounds | 63. Rubber cement                                  |
| 26. Candles                          | 64. Rayon                                          |
| 27. Beef tallow                      | 65. Grapes                                         |
| 28. Butter                           | 66. Raisins                                        |
| 29. Cotton seed oil                  | 67. Caramels                                       |
| 30. Oxalic acid                      | 68. Paper                                          |
| 31. Cream of tartar                  | 69. Corn syrup                                     |
| 32. Baking powder                    | 70. All kinds of soap                              |
| 33. Oranges                          | 71. Pencils                                        |
| 34. Lemons                           | 72. Perfumes                                       |
| 35. Gooseberries                     | 73. Rayon hosiery                                  |
| 36. Currants                         | 74. Motor oil                                      |
| 37. Vaseline                         |                                                    |
| 38. Petroleum                        |                                                    |

The regular class discussions and laboratory work was carried out as before. During the course of study a trip was made to the Lincoln Refinery, Robinson, Illinois, so the students could see how gasoline, kerosene, naphtha, paraffin, vaseline, etc., were made from oil. The different parts of the project lent outside interest to the regular class work. Points were awarded as the outside material was handed in, and a chart was kept of it. It came in with such rapidity that it was possible to have a complete change for the bulletin board every day for two weeks. The bulletin board proved so attractive that other students flocked to the room and stated a desire for next year to come so they could take part in so interesting a course. Even other teachers marveled at the interest dis-

played by the class. Enough material was turned in to fill at least four or five good sized notebooks.

The students were learning about the properties, uses and compounds of carbon while they were doing something they liked to do. The advertisements, slogans, chart, carbon cycles, posters, scrap books, carbon trees, and carbon wheels, and articles on carbon were exceedingly clever. Here are a few of the slogans:

"Where there's life there's carbon."

"Protect your buildings by using Foamite."

"Out of sweetness came forth strength."

"Carbon is the base of life."

"Use acetylene gas for lighting your farm house."

"Carbon is a great health builder."

There were three carbon trees brought in. The outline of a tree had been drawn on cardboard, and the following articles which contain carbon or organic carbon compounds were hanging on the branches.

Tiny pictures of grapes, Dutch cleanser, lamps, perfumes, corn syrup, diamond rings, hand lotion, peanuts, rayon hosiery, bon-ami, lemons, tapioca, ink, chipso, soap, candles, oranges, energine, carbona, raisins, cocoa, chocolate, cream of tartar, peanut butter, oleomargarine, diamond bracelets, face powder, and cold cream.

Each member of the class was asked to bring either a carbon product or a carbon compound. Then the class wrapped a wheel in rayon and hung the following articles on it: ink, glycerin rose water, naphthalene, graphite, glucose, gasoline, candle, carbolic acid, cocoa, oxalic acid, sweet chocolate, Baer's chocolate, shot gun shell, bullets, eraser, peat, gum drop, anthracite coal, bituminous coal, lead pencil, soap, powder, face cream, rayon, coke, charcoal, cotton, paper, piece of inner tubing, synthetic perfume, jello glycerine, cotton seed oil, olive oil, cane sugar, baking powder, motor oil, kerosene, Ethyl gasoline, alco-rub, lamp black vinegar, face powder, citric acid crystals, also the following corn products: Argo Gloss Starch, Cerelose (corn sugar), Globe Pearl Starch, Corn Syrup (3 star unmixed), Argo Corn Starch, Buffalo Corn Gluten Feed, Karo (Red Label), Mazola.

Numerous articles were written. Every student worked out at least one of the 25 point assignments and some did as many as four of them.

The scrap books were unusually clever. A committee of three was chosen from the class to judge the three best scrap books. A blue ribbon was given for first place, red for second, and yellow for third, besides the additional points awarded as was stated in the assignment. The best ones were selected and were entered in a contest sponsored by the "Chemistry Leaflet," State College, Pa. One girl portrayed the life of a "Kewpie." She showed that nearly everything it did had something to do with carbon. All of the facts about the relation of the life of a "Kewpie" to carbon were given in poetry that she composed.

There were 109 advertisements handed in. All of these were accompanied by illustrations. Some of the students made sketches to advertise a carbon product or compound, while others cut out pictures from magazines and used them as illustrations.

Another committee was selected from the class to judge the soap that was made. There was some excellent soap made by the class. They made all different shapes, everything from round to modernistic. There were many different colored soaps, too. Most of them, however, were pink. Nearly every girl brought her favorite perfume bottle to the laboratory and made a sweet smelling toilet soap. Then each designed wrappers for his soap. Some were quite clever. One girl called her "Nuskin." She said her mother told her that she would need "New-skin" if she used it. Another was called "Palmoda." Besides designing the unusual looking wrapper that he did, he also wrote an advertisement for it. His advertisement contained a personal testimony from the most popular girl in high school.

Here is the testimony:

Miss Dorothy Lee, prominent in society in Newton and Ste. Marie, says, "Palmoda—that soft cleansing power makes me the envy of other girls in my social set. I guard my beautiful complexion with it, for it has always been the one soap which was not harsh to my skin."

One boy made some "Flea Soap," and another made laundry soap. The soap was much better than I had anticipated. Soap was made by all three processes, "cold, semi-boiled and boiled." The students used cocoanut oil, tallow, lard, and cottonseed oil.

At the end of two weeks' study on Carbon the following examination was given. Mimeographed copies were given each student.



April 5, 1929.

Name.....

Put a circle around T if the statement is true; put a circle around F if the statement is false.

1. T F Carbon is one of the most active elements.
  2. T F It forms numberless compounds with hydrogen.
  3. T F Every living thing, plant or animal contains carbon in its tissues in the form of organic compounds.
  4. T F In the combined form carbon is found as coal, graphite, and diamond.
  6. T F Lampblack is a compound of carbon and hydrogen.
  7. T F The Safety Lamp was discovered by Edward Goodrich Acheson.
  9. T F Anthracite coal produces so much soot when burned that it is not as desirable as bituminous.
  10. T F Lead pencils, crucibles, lubricants, are made from boneblack.
  11. T F Wood charcoal is used in decolorizing sugar and oils.
  12. T F Coke manufactures illuminating gas.
  13. T F Choke damp is another name for  $\text{CH}_4$ .
  14. T F Carbon dioxide is a colorless gas with a sharp taste and penetrating odor.
  15. T F  $\text{CO}_2$  can be liquified by pressure at ordinary temperatures.
  16. T F CO is a harmless gas.
  17. T F CO burns with a characteristic orange flame.
  18. T F A small percentage of CO in the air causes headache.
  19. T F Water containing dissolved bicarbonates is called water of temporary hardness.
  20. T F Permanent hard water can be softened by boiling.
- Complete the following statements:
21.  $\text{H}_2$ ,  $\text{CO}_2$ , Ca (OH) $_2$ .
  22. Carbon monoxide is formed by:
    - 1.
    - 2.
    - 3.
  23. Carbon dioxide is used. a. in charging beverages.  
b..... c.....
  24. Name 10 substances that contain some form of carbon.
 

1.....	2.....	3.....
4.....	5.....	6.....
7.....	8.....	9.....
10.....		
  25. The raising of bread depends on the expansion of bubbles of CO by heat. Write the equation for preparation of CO in bread.
  26. Name 4 fuels containing carbon. 1..... 2..... 3..... 4.....
  27. Write formula for 1. Ethyl alcohol.....  
2. Wood alcohol..... 3. Grain alcohol.....  
4. Methane.....  
5. Cream of tartar.....
  28. Calcium carbonate occurs in the form of 1.....  
2..... 3.....
  29. Why is denatured alcohol poisonous?
  30. How is formaldehyde prepared?
  31. Name 2 uses of formaldehyde. 1.....  
2.....
  32. Vinegar contains ..... acid.
  33. What is a practical use of oxalic acid?.....
  34. The name for cane or beet sugar is.....  
for fruit sugar is.....  
for grape sugar is.....

35. Citric acid is found in 1..... 2..... 3..... 4.....
36. To test for glucose we.....
37. Write formula for preparation of soap.
38. The term soap is applied in general to any..... of a .....
39. "Soft soap" is generally a mixture of the fatty acid.s and.....
40. Common "hard soap" is a mixture of fatty acids and.....
41. The formula for starch is.....
42. Dextrin is prepared by.....
43. ....is the most common aldehyde.
44. Why is vinegar used in making sugar candy that is to be pulled?
45. What is caramel?
46. What is hydrocarbon?
47. Name 3 important substances obtained from corn.  
1..... 2..... 3.....
48. Name 3 substances obtained by destructive distillation of soft coal.  
1..... 2..... 3.....
49. Name 5 substances obtained from petroleum.  
1..... 2..... 3..... 4..... 5.....
50. List 5 criticisms of the Nitrogen and Carbon projects. Criticisms may be either constructive or destructive. Tell how it could be improved or your reactions to it, etc. I want your honest opinion, it will not affect your score, just tell me exactly what you think of this type of a lesson plan.

During the third quarter I worked out an assignment on "Nitrogen" which was the same general type as this one on Carbon. The requirements for grades, however, were different.

At the end of two weeks the following report was made:

26 out of 29 students made A  
2 out of 29 students made B  
1 out of 29 students made C

There were no D's and no F's.

In working out this project on Carbon, I changed the requirements for grades. At the end of two weeks the following report was made:

20 out of 29 students made A  
5 out of 29 students made B  
2 out of 29 students made C  
2 out of 29 students made D

There were no F's.

These two reports certainly prove that this type of lesson plan inspires students to work.

The highest record made was 255, this being 55 points more than was required for an A. Out of 29 students 23 passed the examination on Carbon. The highest grade was 93.

There were more A's than most pedagogical books insist one should have, and there were no failures. I could not follow the normal marking curve because of the white heat interest manifested by the students. Each student seemed fired with enthusiasm and worked harder than "A" students had formerly.

Some might think that the students spent more than a fair share of their time on chemistry, but such was not the case. They did not neglect their other work. Out of the 29 students 26 voted that they had learned how to make better use of their time.

This type of assignment has many advantages:

1. It appeals to every type of student.
2. Ample opportunity is offered for anyone to receive a satisfactory grade, if he is willing to work.
3. The independent outside work increases the students reliance on his own efforts.
4. It creates a desire to do research work.
5. The properties and uses of elements are more easily remembered since they are associated with everyday life.
6. The association of elements or chemical compounds with everyday life makes them far more interesting.
7. Stressing the practical value of elements and chemical compounds in our everyday life is a boon to chemistry.
8. When you finish the study of a chemical substance in this manner the student really knows something about chemistry.
9. It appeals to the students because it is like a contest.
10. It teaches students the art of advertising.
11. It teaches students to be critics, as committees are chosen to judge the work handed in.
12. In making scrap books, posters, and advertisements, the students learn the importance of neatness and clever color schemes.

The point I must emphasize is that this kind of a project is merely a tonic. If you wish to improve the tone of your class and pep it up, then give them a dose of this. Beware of an over-dose!