



# Techsplorers™

Engineers of Tomorrow™

## BSA Engineering Merit Badge Report Guide

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### Merit Badge Procedure

1. **Obtain Blue Card signed by your Scout Leader.**  
Do not bring it to class. You will mail it to Mr. Dalton later.
2. **Bring the Electronics Merit Badge Workbook and the Techsplorers Report Guide to class.**  
Take good notes during class; you'll need them to prepare the report.
3. **Perform additional activities at home, if necessary.**  
All badge requirements must be satisfied. Contact Mr. Dalton if you have questions about the requirements.
4. **Write up a report.**  
See the guidelines below for details and helpful hints.
5. **Email the report to Mr. Dalton for review (rdalton@techsplorers.com).**  
Once the report is approved, Mr. Dalton will schedule a phone call with you.
6. **Conference call with Mr. Dalton.**  
Parents, grandparents, or others are welcome to join the call. An adult must be on the call with you.
7. **Mail your Blue Card with a self-addressed stamped envelope to:**  
Techsplorers  
14460 Falls of Neuse Rd.  
Suite 149-141  
Raleigh, NC 27614

Mr. Dalton will sign and return the card to you. You're ready for Honor Court.  
Congratulations on obtaining your badge!

## Report Tips

1. You may write your answers in the BSA Workbook, but we recommend writing them in a separate document, as the Workbook may not contain enough space for complete answers. A typed report is preferable (easier to send, read, and edit), but paper and postage is also acceptable.
2. Mr. Dalton will review your first draft but you might need to add more information in order to fully satisfy a requirement. Make sure you complete all of the required sections. The reason most first drafts are not accepted is because a section is forgotten.
3. Hand drawn sketches and diagrams are perfectly okay.
4. The report should be in your own words. Copying text from the internet or any other form of plagiarism will not be tolerated.
5. You are free to choose any of the items from the BSA's list of requirements. You don't have to do the ones recommended in the Workbook Guide below.
6. Remember it is okay to contact Mr. Dalton if you have questions about your badge report ([rdalton@techsplorers.com](mailto:rdalton@techsplorers.com)).

## Workbook Guide

1. **Select a manufactured item in your home (such as a toy or an appliance) and, under adult supervision and with the approval of your counselor, investigate how and why it works as it does. Find out what sort of engineering activities were needed to create it. Discuss with your counselor what you learned and how you got the information.**

During class, an internal combustion engine from a lawn mower was completely disassembled and reassembled. The function of each major component was discussed along with the scientific and engineering theory behind how each component works and how it was designed and manufactured.

Write a couple paragraphs describing how the engine works and pick 3 important parts of the engine and explain what they do. Below is a list of topics covered in class to get you started.

- A. Basic mechanics tools & techniques
  - Ratchets
  - Open and closed-ended wrenches
  - Rounding bolts or stripping threads
- B. Intake/Compression/Power/Exhaust strokes
- C. Carburetor
  - Throttle
  - Butterfly valve
  - Choke or primer button
  - Float
  - Jets
  - Fuel/air ratio
  - Air filter
- D. Flywheel
  - Flywheel key
  - Magnet and counter weight
  - Balancing
- E. Magneto
  - Spark timing
  - Electrical induction
- F. Muffler
  - Baffles
  - Sound cancellation
  - Silencer method
- G. Head Area
  - Head gasket
  - Valves
  - Piston crown
- H. Crankcase Area
  - Lubrication
  - Camshaft
  - Tappets
  - Piston and connecting rod
- I. Superchargers and turbochargers
- J. Octane rating
- K. 2-stroke engine operation

2. **Select an engineering achievement that has had a major impact on society. Using resources such as the Internet (with your parent's permission), books, and magazines, find out about the engineers who made this engineering feat possible, the special obstacles they had to overcome, and how this achievement has influenced the world today. Tell your counselor what you learned.**

Write few paragraphs. Make sure each underlined topic is discussed in the write-up.

3. **Explain the work of six types of engineers. Pick two of the six and explain how their work is related.**

Write a couple sentences about each of your 6 chosen engineering disciplines explaining what they do (Mechanical, Electrical, Nuclear, Chemical, Computer Science, etc). Then, pick at least two types of engineers and discuss a type of product they would collaborate to design. Explain HOW and WHY they would need to work together and why one type of engineer could not design the product on their own.

4. **Visit with an engineer (who may be your counselor or parent) and do the following:**

- a. **Discuss the work this engineer does and the tools the engineer uses.**
- b. **Discuss with the engineer a current project and the engineer's particular role in it.**
- c. **Find out how the engineer's work is done and how results are achieved.**
- d. **Ask to see the reports that the engineer writes concerning the project.**
- e. **Discuss with your counselor what you learned about engineering from this visit.**

You may choose to interview a friend, family member, or counselor who is an engineer OR you can set up a phone call with Mr. Dalton and he can work with you to complete this requirement.

5. **Do ONE of the following:**

**(Remember you don't have to choose 5b, you can do the other requirement if you wish)**

- b. **Make an original design for a piece of patrol equipment. Use the systems engineering approach to help you decide how it should work and look. Draw plans for it. Show the plans to your counselor, explain why you designed it the way you did, and explain how you would make it.**

Write 1 to 2 paragraphs explaining what Systems Engineering is and how it differs from other types of engineering.

You can choose any type of patrol equipment that you like. The example we often work on together in class when demonstrating Systems Engineering methods is developing a new type of tent that will stay cooler during the summer months. You can stick with that idea and develop it further for this section of your report or come up with something else.

Remember to first start like a Systems Engineer and define the high-level requirements for your new warm-weather tent. Then take the role of a Design Engineer and make the specific drawings showing your design in detail. You should also have a written section to go with the drawings explaining exactly how your invention is made.

**6. Do TWO of the following:**

**(Remember you don't have to choose 6b and 6e, can do the other requirements if you wish)**

- b. Using electricity. Make a list of 10 electrical appliances in your home. Find out approximately how much electricity each uses in one month. Learn how to find out the amount and cost of electricity used in your home during periods of light and heavy use. List five ways to conserve electricity.**

In class, you were taught how to calculate Kwh energy usage from electrical specifications provided on the back label plate of home appliances and how to use this information to determine cost of operating.

Create a table listing 10 or more appliances like the one below. For each appliance, find its label plate and write down the wattage rating (the number with a "W" next to it) in the table. If you can't find or reach the label, you can use the internet to look up an average wattage for that type of appliance. Then, estimate the number of hours the appliance is used each day and use the formulas below to calculate the amount of energy used by that appliance each month and its monthly cost. Electricity costs may vary depending on your power company, but it's generally about 13.5¢ per kWh.

$$\text{Energy per Month (kWh)} = \frac{\text{Power} \times \text{Hours per Day} \times 30 \text{ Days}}{1000 \text{ kW/W}}$$

$$\text{Cost per Month} = \text{Energy} \times \$0.135$$

Appliance	Power (Watts)	Hours Used per Day	Energy Used per Month (kWh)	Cost per Month (\$)
Ex: Hair dryer	1200	0.2	7.2	0.97

Study your home electricity bill and see how well the estimates match up with actual monthly usage.

Figure out what time of day each of the major appliances in your home are used and for how long to calculate the amount and cost of electricity during light and heavy use. This link is helpful: <https://www.wholesalesolar.com/solar-information/how-to-save-energy/power-table>.

Don't forget to also list 5 ways to conserve energy.

- e. Converting energy. Do an experiment to show how mechanical, heat, chemical, solar, and/or electrical energy may be converted from one or more types of energy to another. Explain your results. Describe to your counselor what energy is and how energy is converted and used in your surroundings.**

Write a paragraph or two explaining how the engine converts chemical energy into mechanical energy. Then write a paragraph or two explaining how the magneto converts mechanical energy into electrical energy.

Optional: Can you make a little magneto at home and test it? Write about your results.

**7. Explain what it means to be a registered Professional Engineer (PE). Name the types of engineering work for which registration is most important?**

Write a paragraph or two explaining what you learned about Professional Engineers in class, what types of engineering work require PE certification, and what steps are necessary to obtain the PE certification.

**8. Study the Engineer's Code of Ethics. Explain how it is like the Scout Oath and Scout Law.**

<http://www.nspe.org/resources/ethics/code-ethics>

The code of ethics for the National Society of Professional Engineers was discussed, including situations like the space shuttle Challenger disaster and the role that Morton Thiokol engineers played in not reporting the potential cause. Other ethical situations that arise in industry were discussed with the class.

Write 1 to 2 paragraphs describing how the NSPE Code of Ethics and the Scout Oath and Law are similar to each other. Do you think it is important that young people learn this and spend time thinking about it? Are you going to encounter ethical situations before you become an engineer?

**9. Find out about three career opportunities in engineering. Pick one and research the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.**

During item 3 discussions we also talk about what careers opportunities are associated with each type of engineering discipline. Write few paragraphs explaining the education, training, and experience requirements of your selected engineering discipline.

Do not just guess at the education requirements. Make sure that you take the time to learn about different types of degrees offered by universities and technical colleges. Why do you want to be that type of engineer? What do you think is cool about it? What part would you enjoy the best?