

**EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING**
Revised for
ACCESS TO APPRENTICESHIPS

**COMMUNICATIONS SKILLS
DRAWING CONCLUSIONS**

**AN ACADEMIC SKILLS MANUAL
for
The Industrial Maintenance Mechanic Trades**

This trade group includes the following trades:
Boiler Maker,
Facilities Maintenance Mechanic & Technician, and
Industrial Maintenance Mechanic (Millwright)

*Workplace Support Services Branch
Ontario Ministry of Education and Training*

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In preparing these Academic Skills Manuals, we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

COMMUNICATIONS SKILLS

DRAWING CONCLUSIONS

*An academic skill required for the study of the
Industrial Maintenance Mechanic Trades*

INTRODUCTION

Drawing conclusions means making a decision through a process of reasoning. It involves finding facts, examining opinions, and determining causes and effects. From this background, the relevant information is selected and used to reason through to the best conclusion.

For example, your cutting shears won't get through a piece of metal that you need to cut. What conclusion can you draw that might lead to a solution to the problem?

First you look for the relevant information. You check the manual to find out what kind of shears should be used for this type of metal. You observe the strength of the shears and their condition, and the thickness of the metal. You reason that the dull edge on the blade is the cause of the problem. You come to the conclusion that you need to sharpen your shears. You have identified the problem and decided on a solution.

As you can see, this is a useful process when you need to make a decision on the job, such as determining the cause of a malfunctioning machine. When you think about the connection between what you observe and what you already know, you can come to a valid conclusion. You can use this conclusion to guide you in making workplace decisions.

You draw conclusions by comparing information obtained from different sources. Your information might come from texts and manuals, from listening to knowledgeable workers and teachers and from experience gained working on projects. Here is an example from an everyday situation.

Example: The ice on Lake Simcoe is thin, so you decide it won't be safe to snowmobile. Knowing the condition of the ice and the weight of a machine, you conclude there's a risk of an accident. The next day, when the newspaper reports a snowmobiler went through the ice, you realize you made the right conclusion.

In this skills manual, we examine the process of drawing conclusions by looking at the following:

- ◆ Selecting information for valid conclusions
- ◆ Drawing valid conclusions
- ◆ Recognizing conclusions

PART I **SELECTING INFORMATION FOR VALID CONCLUSIONS**

A **valid conclusion** is one that is reasonable and that is based on fact as much as possible. The facts you use to draw a conclusion will come from instructors, textbooks, knowledgeable workers and your careful observations. Use this information and your experience to think through to a reasonable answer or solution – in other words, to a valid conclusion.

Example: An *insulator*, or non-conductor, does **not** allow electric current to flow through it whereas current flows easily through a *conductor*. You discover current is flowing in a wire where it shouldn't be; you need to know why because this is a fire safety issue.

If there is no knowledgeable person available to ask, you will have to look at the wiring system for clues. Check any information you have on conductors and insulators. The information you read and your observations should help you draw a reasonable conclusion as to the cause of the problem.

If you can't find a simple cause and solution, shut off the power or the switch and wait for an electrician to come. Turning an electrical problem over to a trained technician is a reasonable conclusion in this situation.

Read Passage 1 below as an example of information that might explain the reason for the problem.

Passage 1 **Conductors**

A material that allows an electric current to pass through it easily is called a *conductor*. Although there is no perfect conductor of electricity, conductors can be divided into three classes: good, medium and poor.

Insulators (Non-Conductors)

If a material does not allow enough electric current to pass through it to be calculated, it is called an *insulator* or *non-conductor*. Although there is no such thing as a perfect insulator, insulators are used to prevent electricity from flowing where it is not desired.

Note: Moisture has the ability to change an insulator into a poor conductor; it has the ability to change a poor conductor into a medium conductor.

When you start reading this passage you might think that the problem is with an insulating material – maybe a wire has been nicked.

Then you see the reminder about moisture and recall the dampness in the basement. You conclude that moisture is a more likely source of the problem. Looking for moisture somewhere near the electrical system is the first thing you should do. If you don't find a source of moisture, you need to keep looking for other reasons for the problem, so you can reach a valid conclusion.

Understanding Relationships

Drawing a valid conclusion often depends on understanding the relationship between two things. To discover the connection between the cause of a problem and its effect, such as the situation above, you might follow these steps:

- You look for information and read that moisture has an effect on an insulator.
- You conclude that this effect could be a possible reason for the problem.
- You go back and look for moisture at the site
- If there is moisture, you can conclude that this is a possible cause.
- If there is no moisture, you need to keep looking.
- In either case, you reasonably conclude that this is a situation for an experienced electrician.

These steps are useful when you have a problem to solve.

In many cases, looking at the relationship between different parts of a system will lead you to a reason for the problem. If one thing is not working the way it is supposed to, it can lead to difficulties in many areas. Using the following steps to observe cause and effect relationships can often lead to a solution or even prevent a problem in the first place.

1. You observe the situation
2. You find information about what might cause this situation.
3. You compare your information to what you see.
4. You reach a conclusion about a likely cause.
5. You check to see if the conclusion seems reasonable.
6. You decide on an action based on your conclusion.
7. After carrying out this course of action, you recheck to see if it solved the problem.

Passage 2 describes factors that affect the performance of bearings. **Read Passage 2 and answer the questions that follow. Answers are at the end of this skill manual.**

Passage 2

Surface Finish of Journal and Bearing

The surface finish of both the journal (the part of the shaft, axle or spindle that turns in a bearing) and the bearing affects the amount of contact between the metal surfaces. Metals can be kept separated from each other with very thin oil if surface finishes are also very fine. This ensures satisfactory bearing performance.

A surface may feel smooth to the touch, but it will show peaks and valleys when magnified. These saw-toothed projections are smoothed out or worn down by a *run-in* (wear-in or break-in) period. After the run-in period, the surfaces will have a high degree of smoothness. The peaks will be reduced and flattened, sharp edges will be rounded, and surface variations between peaks and valleys will be reduced. With smoothed surfaces, a very thin oil film keeps the journal and bearing separated and the bearing can thus support heavy loads.

Questions:

1. You can conclude that satisfactory bearing performance will result from:
 - a) smoothness of surface finishes and proper run-in period.
 - b) very fine surface finish and very thin oil.
 - c) a surface smooth to the touch and a reduction of heavy loads.

2. You can conclude that a change in the thickness of oil could affect:
 - a) the amount of contact between metal parts.
 - b) the weight of the loads.
 - c) the saw-toothed projections.
 - d) all of the above.

3. A smoother finish and a thicker grade of oil should result in best operating efficiency.

T F

4. The proper run-in period will wear down the peaks and valleys of the journal and bearing surface.

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Passage 2 describes the importance of a proper run-in period on bearing performance. Having this information will ensure that you take the time to do a proper run-in. You can conclude from the passage that if you changed or omitted the run-in period, the result will not be satisfactory.

Each step in the process is important. You need to pay attention to details because a small change can make a big difference. Machine operation, the life of the parts, their ability to support weight, and the costs of down time depend on making sound decisions.

Note important details before you start a job. Read, ask questions, and use the information available to arrive at a practical conclusion as to how to carry out a job. Find out what factors will have an effect on the result. You may need to experiment and do some tests to check that you have drawn a logical conclusion.

PART II
DRAWING VALID CONCLUSIONS

Sometimes you know the result, but not the exact cause.

Example: When you read the newspaper report about the snowmobiler going through the ice on Lake Simcoe, you concluded that the ice was too thin for snowmobiling. This is probably true, but there could also be other factors involved.

You might have a good idea of what happened but you might be missing some of the reasons for the problem. For example, being unfamiliar with the lake and travelling over an area of strong currents could be factors in the snowmobile accident. Bad visibility might also have been a

factor. You can conclude that thin ice was the cause of the accident but you don't know why the snowmobiler ended up over the unsafe ice in the first place.

Getting all the Pieces

The same principle applies to paying attention to all the information concerning procedures you use at your workplace. If you make quick observations or if you skim through your manual, you might go ahead, assuming that you have all the pieces. But there is also the possibility that you have missed something. You can't draw a valid conclusion or find a solution to a problem if you overlook important, available information.

A valid conclusion relies on having, and examining, all of the information important to that situation.

Read Passage 3 below. Consider the conclusions you might draw with the information given. **Answer the questions that follow. Answers are at the end of this skill manual.**

Passage 3 Butt Welds

A butt weld is made in the joint between two pieces of metal which are in approximately the same plane. Weld in a sequence which will allow one area to cool before welding in the area next to it. This means welding in a 1, 3, 5, 7 type of sequence and then going back to weld in a 2, 4, 6, 8 sequence. When welding is done by skipping every other section (or intermittently) and then going back to weld the spaces in between, each weld cools. This intermittent, or *stitch welding*, results in less strain.

Before filling the spaces between intermittently placed beads, grind the beads along the surface on the panel. Then fill the space with metal. If you place weld metal and do not grind the surface of the beads, blowholes can be produced. When welding thin panels (0.79mm or less), stitch welding is essential to prevent burn-through.

Questions:

1. What might you conclude if you discover blowholes in a weld?
 - a) An area did not cool before welding in an area next to it.
 - b) A section cooled too quickly.
 - c) The beads along the surface of the panel were not ground.
 - d) All of the above.
2. Thin panels require intermittent welding when they are in approximately the same plane.

T F
3. Which of the following will result from using the correct sequence for a butt weld?
 - a) prevention of burn-through in thin panels
 - b) less strain
 - c) avoidance of the problems of blowholes
 - d) all of the above

4. A weld made in a 1, 2, 3, 4, 5 sequence would not affect the strength of the completed weld provided that each weld was allowed to cool before the next weld was made.

T F

Getting the whole picture

Factors which are not stated may also affect the results of a job. For example, suppose you followed the sequence outlined in Passage 3, and still produced a weak or poor weld. Is something else different? Is your equipment up to standard? Is the angle of weld or your technique not what it should be? Is there something you didn't understand?

When looking for the cause of a problem, you usually start with the obvious reasons. But sometimes you need to check out everything. Make sure you don't reach a conclusion based on only part of the information. You want all the available information before drawing a conclusion. Always get the whole picture first.

Example: Suppose you work in an area with gas engines and motors. After a few months you come down with flu symptoms - headaches, dizziness and nausea. The symptoms hang on and you see your doctor. Your doctor asks if there are any factors at work that might cause the symptoms but you say everything seems fine. You and the doctor decide this is just a nasty bug. You carry on at work but the flu symptoms don't go away.

A few weeks later you notice the following warning on a piece of machinery where you are working:

NOTE: Use only in a well-ventilated area. Fumes from this machine can accumulate in the body and cause flu-like symptoms.

You wonder if your flu-like symptoms are caused by lack of ventilation. You make sure the window is open and the fan is running from now on when you are working on that machine. You look for changes in your health over the next weeks. Soon your illness is gone.

Can you conclude that lack of ventilation caused the problem? From your observations, it seems likely. You can now act on this conclusion by making sure your work area is properly ventilated.

In this example, your first conclusion was that you had the flu. You based this on your past experiences. It felt like other flu that you have had. However, when the flu didn't get better, you realized that there may be another reason for your symptoms.

From the information about fumes, you learned about another factor that might be causing the problem. You acted on that information by providing better ventilation and your symptoms disappeared. You drew a new conclusion based on further information and observation.

Is it a valid conclusion?

If a first conclusion doesn't provide a practical solution, you have to keep looking. When you add new information, you should then be able to draw a different, and more valid, conclusion. In other words, new information can lead to a new conclusion when the first conclusion is not valid.

Making an estimate about a job is one form of drawing a conclusion. To come up with a reasonable estimate requires several steps

- ◆ You have to know what options are available.
- ◆ You have to find out the cost of each option.
- ◆ You have to compare the advantages and disadvantages of each option.
- ◆ Then you have to weigh the cost against the advantages and disadvantages. You will have to decide what the most important factors are in making this decision.
- ◆ Reaching a final estimate involves coming to a conclusion as to what the best option is for the cost.
- ◆ You can now present this estimate to the customer along with reasons for your choices.

To make sound decisions in the industrial maintenance trade, you study information in texts, manuals and diagrams so that you learn the material and can apply it. You observe different factors in the workplace for the same reason - so you can understand and evaluate what you see. What you read (theory) and what you do (practice) are essential to making good decisions. You read and learn when working with written material; you observe and learn when gaining hands-on experience.

Example: You experience a mild shock while drilling. You take a good look at your drill and notice that the cord is frayed. You know from your reading that frayed cords can cause shocks. After concluding that the frayed cord is the cause of the electrical shock, you unplug the drill carefully and set it aside until the cord is replaced.

Here is another situation which calls for reaching a conclusion. **Read Passage 4 and answer the questions which follow. Answers are at the end of this skills manual.**

Passage 4 Pressurization

The mechanical welding bond between two pieces of sheet metal is directly related to the amount of force exerted on the sheet metal by the welding tips.

The tips squeeze the sheet metal together while an electrical current flows from the tips through the base metal. This causes the metal to melt and fuse together. Weld spatter (internal and external) results from low pressure on the tip or excessive electrical current flow. A high tip pressure causes a small spot weld and a reduced mechanical bond of the weld. What happens is the high tip pressure forces the tip into the softened area; this causes thinning and weakening of the weld.

Questions:

1. What conclusion can you come to if you have excessive electrical current?

2. You could conclude that a reduced mechanical bond of the weld is directly related to high tip pressure.
T F
3. Which of the following could cause a problem with the mechanical welding bond?
 - a) The tips squeeze the sheet metal together.
 - b) The electrical current which flows from the tips.
 - c) Either high or low tip pressure.

In this passage, you learn about factors in resistance spot welding which can result in a weak weld. Low pressure in the tip and excessive electrical current flow cause weld spatter. High tip pressure causes a reduced mechanical bond. When you understand the relationships between such factors, you can draw conclusions that will get you the reasonable results. You can also look for reasons when a weld is not up to trade standards.

Look ahead

When you read technical information such as the passage above on resistance spot welding, you obtain facts on which you can make **predictions**. To make a prediction, you must read the instructions and then think ahead to what the outcome of following those steps might be.

You can predict that your outcome will be successful if you follow the provided instructions, use the right equipment and give yourself enough time for the job. You can also predict that you will not get the right result if you do not follow the directions exactly or if you work without the required knowledge and skills.

Note: Because of other factors – unknown to you or overlooked – this may not result in a valid conclusion. If you do not arrive at the correct conclusion, you will have to continue researching until you discover it.

Look behind

You can turn the process of drawing conclusions around by **looking backwards**. If you have discovered a problem, you'll need to go back to find a cause. You may have to go through the instructions sentence-by-sentence. After reading the information again, check your technique and tools, and then observe what is actually happening on the job. This will help you to identify the cause of the problem. Then you can draw a conclusion that will let you figure out how to avoid the problem next time.

Process of elimination

The examples in this unit ask you to use a process of reasoning for several reasons. You might want to:

- decide what is the best way to proceed,
- choose a material,
- find an answer to a question, or
- find a solution to problem.

To come to a reasonable conclusion in these cases, you might use a process of eliminating possibilities. You make a preliminary selection between possible choices as a way of getting started.

- First, you try to eliminate the least likely or the weakest possibilities first.
- Next you look carefully at the more likely possibilities, based on your reading and experience.
- Then you pick what looks like the best choice.
- If you get more information or if your choice doesn't seem to be working out, you start the process over.
- You might have to look for more options to consider.

As you begin to see the relationship between various factors, you can begin to draw conclusions that work for your situation.

Example: You know that a change in altitude means a change in atmospheric pressure. If you are working at a different altitude than sea level, you conclude that a pressure gauge will not give you an accurate reading unless it is adjusted. Drawing this conclusion will lead you to check your equipment before you use it and to make the proper adjustments.

Is this valid?

When you observe what happens in the workplace, you use what you see to draw conclusions about what works and what doesn't. At some point, you have to decide if your conclusions are valid.

Often when you draw a conclusion, you need more testing or examples to be sure it is valid. If an outcome happens once during project, you can't be sure it will always happen that way. More examples are required before you can use that outcome to make predictions. You will know the conclusion is valid if the same thing happens every time you follow that procedure.

Example: You may produce a defective weld because you used the wrong filler material. However, in another situation, a defective weld may be the result of voltage that is too low.

Noticing causes and results, while you are learning and while you are working, adds to your awareness of what is a valid conclusion for a given situation. With experience, you will come to instinctively figure out what is the best way to proceed.

You may have overlooked other factors which affect the outcome of the finished work. If you notice that you have missed something on a project, make sure to take it into account the next time. Each factor will have an effect on the finished product. As you learn how each factor affects the process, you will work hard to develop the skills needed to reach a satisfactory conclusion.

Sometimes you need to reach a conclusion quickly, perhaps about what product to choose. You don't have time to check all the possible results of using the different products. You can ask

other workers what they would choose. You can also rely on manufacturers' literature. The information will often tell you what to expect. If the company is reliable, you can count on them to test their product and to guarantee them.

A conclusion may be valid in one situation given the information you have available. It may *not* apply in another situation. Learn to judge each new situation before you draw a conclusion. Look at the relationship between cause and effect. Keep track of what happens in different situations so you have a range of possibilities from which to choose. Consider all the possibilities and keep your mind open when making conclusions.

There are skills you can develop to help in making valid conclusions:

- 1) Observe and keep records of what happens in different situations on the job.
- 2) Talk to skilled workers to add to your store of knowledge.
- 3) Watch and listen as you work.
- 4) Test your ability to judge a situation.
- 5) Start to see patterns that can help you make reliable prediction.

As you become more experienced, you will find it easier to reach valid conclusions and make logical decisions.

PART III ***RECOGNIZING CONCLUSIONS***

You might be reading a text or manual and you want to decide if the information is presented in a way that you can use to draw a conclusion. Experienced workers might talk about different situations and you aren't sure what conclusion to draw from the conversation. There are guides that help you recognize when a conclusion is being made.

The language of conclusion

Some words and phrases provide clues that a conclusion is being drawn. When you examine information, notice when any of these words are used. They will give you a signal that the writer is drawing a conclusion.

The words *therefore*, *must have (must be)* and *would have to be* often indicate that a conclusion is being drawn:

Example: You look at a porous weld with little holes in it. You can see rust on the base metal. You tell someone, "If the base metal is rusted, it causes a poor weld. I can see rust on the base metal, so that *must be* the cause of the poor weld."

Example: In another case, you might say something like: "The weld defect can't be caused by a problem with the base metal because I checked it before starting; however, it *may be* caused by the arc length being too long."

The words *if, so that, due to, because of, or since* often indicate that a cause and effect statement will follow. They point out the causes that lead to a result. The conclusion follows.

Examples:

If the spark plug is not taken out before removing the engine, it could fire accidentally or break when you disassemble parts.

Since every engine make and model is built to certain dimensions and specifications, you must follow the right service manual.

Due to clean air regulations, some solvents are no longer used.

Because of the wide variety of tools available, procedures for misfires differ.

Words such as *will then, consequently, as a result, must, thus or therefore* often indicate a result. Once you know the cause and result of a situation, you can sometimes use the information to reach a conclusion.

Examples:

Too much difference in handle adjustment will *result in* uneven bending by the brake.

The conclusion to be drawn is that you shouldn't adjust the handle too much.

Some metals are very brittle; *therefore*, they may break when bent to make sharp corners.

You conclude that brittle metals shouldn't be used when making sharp corners.

If a tool uses more air pressure, *it will then cause* the air compressor to wear out faster.

If you want your compressor to last, you conclude that you shouldn't use too much air pressure if possible.

CONCLUSION

To draw valid conclusions, you must first make accurate observations. Then you compare what you see to what the information you have from textbooks and manuals. You might ask a more experienced worker for their opinion of the situation. All this information is used to reason through to a logical conclusion.

After reaching a conclusion, you need to check if it seems valid in other situations. This process will gradually build up a wealth of experience that you can use to make future decisions. You will be able to quickly decide what course of action to take in various situations. This will also be useful in making a reasonable estimate.

Understanding the relationship between cause and effect is a necessary step in reaching a valid conclusion. Skill in drawing conclusions will give you the ability to judge a situation accurately. You will also develop the habit of making sound decisions as you learn. This will help you develop into an efficient and effective maintenance mechanic.

Summary

1. **Use a variety of resources to draw conclusions.** These include experience, observations, advice from experts and all relevant technical reading information
2. **Read technical material carefully** to find information about causes, results and solutions; you can then use the information in the workplace.
3. **Carefully observe** what is happening in the workplace.
4. **Understand the relationship between things** to be able to judge cause and effect.
5. **Understand that a change in a procedure, material or tool often affect something else.** Notice how these changes affect the result.
6. **Consider whether you have all the information** needed to reach a valid conclusion. Are there factors affecting the outcome that you do not understand or don't know about?
7. **Eliminate weak possibilities** to focus on the strongest and the most likely.
8. **Observe language used in drawing conclusions** such as *therefore, thus, would have to be, must be* which set up the situation and then reach a conclusion.

Answer page

Part II Passage 3, Butt Welds

1. What might you conclude if you discover blowholes in a weld?
c) the beads along the surface of the panel were not ground.
2. Thin panels require intermittent welding.

T Passage 3 tells you that butt welds (intermittent or stitch welding) are used in the joint between two pieces of metal which are in approximately the same plane. The last sentence tells you that intermittent welding is essential to prevent burn-through in panels of 0.79mm or less – in other words, thin panels.

3. Which of the following will result from using the correct sequence for a butt weld?
d) all of the above.

4. A weld made in a 1, 2, 3, 4, 5 sequence would not affect the strength of the completed weld provided that each weld was allowed to cool before the next weld was made.

T This is a logical conclusion. The passage states that each weld must cool before you weld the one next to it so there is *less strain*. However, if you waited for each weld to cool and ground each bead before continuing, you would increase the amount of time required to do this job.

Passage 4 Pressurization

1. 1. What conclusion can you come to if you have excessive electrical current?

Passage 4 states that either internal or external weld spatter results from excessive electrical current. So, you can conclude that internal or external spatter is a likely result if you have excessive electrical current.

2. You could conclude that a reduced mechanical bond of the weld is directly related to high tip pressure.

T Passage 4 states the direct relationship between the two: high tip pressure causes a “small spot weld and therefore a reduced mechanical bond.”

3. Which of the following could cause a problem with the mechanical welding bond?

c) Either high or low tip pressure. The passage describes the type of problem to look for if tip pressure is either too high or too low. To correct the problem, you need to know how to adjust the pressure so that is the right for each welding situation.