EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

COMMUNICATIONS SKILLS
INTERPRETATION OF DIAGRAMS

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

Revised 2011

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
INTERPRETATION OF DIAGRAMS

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

INTRODUCTION

You've probably heard this expression: "A picture is worth a thousand words." It means that something you can see would take a thousand words to explain. The purpose of graphic material (diagrams, charts, pictures) is to make information about your trade easy to see. The correct ***interpretation of diagrams*** is necessary in order for you to benefit from the information they contain.

Information in a diagram might illustrate a new concept, show the correct order of the steps of a procedure or give you the requirements and measurements for a particular job or assignment. Clearly, *interpretation of diagrams* is an essential skill for your technical reading toolbox.

Interpreting diagrams is an essential skill used to interpret displays on computerized scanning equipment and to locate operational information. You will study technical drawings to locate data; interpret symbols and "shorthand" notations to troubleshoot problems; and to identify fire extinguisher and WHMIS hazard class symbols. A schematic diagram will show you how electrical, hydraulic, oil circulation and pneumatic systems operate. Blueprints, flow charts and illustrations show what tasks must be completed, and if any changes or modifications are required.

Accuracy is essential in the industrial maintenance trades. Diagrams can provide you with details about areas that you can't see or touch. When you don't have access to hidden structures, you rely on diagrams to provide the background information needed to work precisely and safely.

Other graphics such as charts and tables list details such as measurements in a way that makes it easy to find the correct component needed for a specific situation. Pictures can give you an idea of the result, or they can show differences in related items.

Interpreting graphics correctly is an important skill to develop as you master the knowledge and techniques of your trade. In this skill sheet, we will look at:

- Standard symbols and diagrams.
- Symbols and diagrams as visual language.
- Diagram and text that interpret information.
- Information in text and diagrams that match.

PART I
STANDARD SYMBOLS AND DIAGRAMS

Graphics
The term ***graphics*** refers to the various types of technical drawings and charts used in your trade. Graphics are a means of communicating information. They serve many purposes: they illustrate concepts, show relationships, compare information and illustrate how something works, how to do something, or where something is. Graphics can show you the location of features in a building or piece of equipment – this is especially useful in showing where hidden features are situated.

Symbols
As you learn your trade, you will be introduced to many symbols. Symbols are a shortened form of language. An object, part, process, relationship or number can be converted into a symbol. Many symbols are international. When you come across a symbol in your reading or on the job, you need to learn what term the symbol stands for and you also need to know what that term means.

Example: These three international symbols demonstrate this:

× multiplication symbol	Multiplication is indicated by the symbol **x**. The **x** symbol immediately identifies a process. It also tells you what to do.
CO_2 carbon dioxide symbol	The relationship between a carbon molecule and an oxygen molecule can be stated symbolically. The symbol $\mathbf{CO_2}$ stands for or represents carbon dioxide. The **C** stands for a carbon molecule; the **O** stands for an oxygen molecule; the $_2$ tells you there are two oxygen molecules. Glance back over this explanation on $\mathbf{CO_2}$. "A symbol is worth a thousand words".
M number symbol for million	Many numerical amounts are represented by symbols. **M** is the first letter of the Greek word mega (great) and it is used to represent the number million.

While many symbols, such as the ones shown above, are international, some countries and some agencies have their own symbols. The International Standards Organization (ISO), the Canadian Standards Association (CSA) and the American National Standards Institute (ANSI) are different accredited groups that use their own symbols. The following extract from a table of hydraulic and pneumatic symbols tells you that *ISO* has published these symbols.

Example:

Table 1: Basic Hydraulic and Pneumatic Symbols

ISO Symbols	Definitions
▼	Hydraulic Flow
△	Pneumatic flow
↗	Indication of variability

Symbols in text
Symbols are routinely used in technical writing as well as in graphics.

> **Example:** Most anti-friction bearings require a shaft surface finish of up to 0.30 μ m **AA** (12 μ in.). Too rough a surface finish may result in loss of interference fit, excessive shaft wear, and fretting of the bearing seat.

The purpose of the paragraph below is to provide specific information about an aspect of your trade - *shaft surface finish.* Your ability to follow directions depends on your ability to understand the meaning symbols such as μ m, **AA** and μ in. If symbols used in the text or diagrams are unclear, you need to look them up.

We have listed the meanings of these symbols below:

> μ m = symbol for micrometers. A micrometer is one millionth of a metre (0.000 001 metres)
> μ in. = symbol for micro inches. A micro-inch is one millionth of an inch (0.000 001 inch)
> **AA** = refers to arithmetical average height of surface roughness

As you learn your trade, you will encounter many symbols – some will be familiar and others will be new. It is your job to learn what they mean to add to your understanding of the concepts, principles, and "language" of your trade.

Which way is up?
Symbols help explain information.

> **Example:** Objects shown at right angles can be viewed from different positions. The symbols in Figure 1 indicate the angle at which you view an object. They show whether you are viewing from left to right (**first-angle**) or from right to left (**third-angle**).

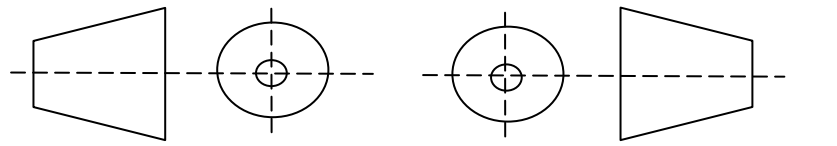


FIGURE 1: ISO Symbols For The First- And Third- Angle

Symbols are shorthand for something. You need to know how to unlock the meaning presented by a symbol in a text or drawing. Each symbol transfers information to you efficiently, but you need to know precisely what it stands for. The difference between 30^{o} and 30" is significant.

Purpose
Your purpose in learning symbols is to learn to read and speak the language of your trade. You need to interpret both written material *and* any graphic material found in the text to understand and use the information presented.

PART II
SYMBOLS AND DIAGRAMS AS VISUAL LANGUAGE

Once you learn the meanings of trade symbols, you can recognize their meaning when you come across them in later sentences. This is the next sentence in the paragraph about shaft surface finish in the earlier example.

> Babbitt and bronze sleeve bearings require a finish of up to 0.81 μ m AA (32 μ in.).

You already know the meaning of μ m, **AA** and μ in, so you can figure out what the sentence means.

Lines mean something

Lines used in technical drawings convey meaning. Lines can be *thick* or *thin*; broken, with equal spacing; broken with long/short spacing and so on. As with symbols, *standards apply to these lines and define their meaning* in the industrial maintenance trades. Different lines mean different things and the information they convey must be exact.

Canadian Standards define line thicknesses as *thick* or *thin*: *thick* is at least twice the thickness of *thin*. It is essential that you recognize what each line stands for in a chart or diagram. Figure 2 contains some samples to illustrate this:

Thick (solid) – outline of visible feature

Thin (equally spaced broken) – shows hidden feature not seen

Thick (wavy) – shortens the view of long uniform sections

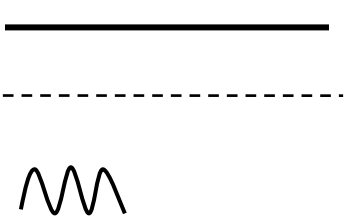


FIGURE 2: Examples Of Lines In Technical Drawings

What does this mean?

A diagram that contains lines and shapes is abstract in that it represents something real but it doesn't look like the real thing.

> **Example:** Working diagrams usually don't look like what they represent. In the diagram of an automatic bleed-down circuit below, the circle with **M** in the middle stands for motor. This certainly doesn't look like a motor but, when you know M represents a motor and you see it in the diagram, you know the diagram includes a motor.

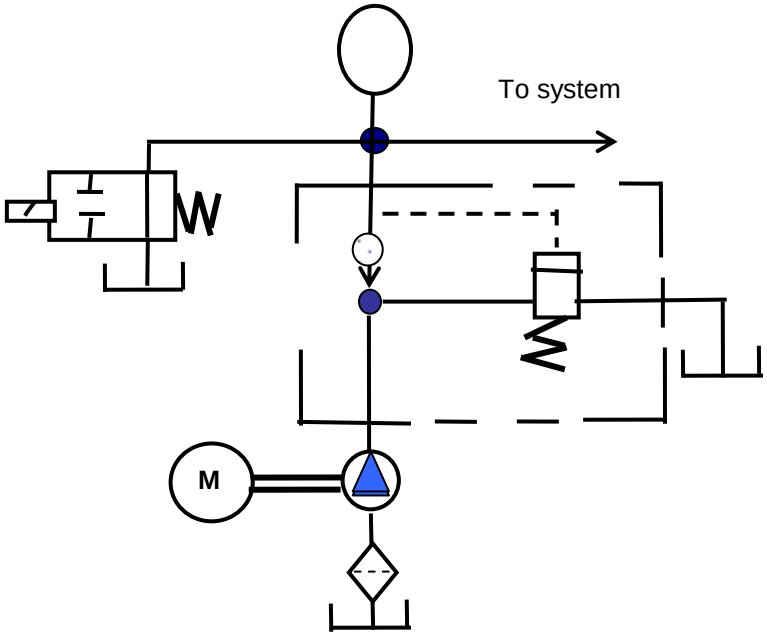


FIGURE 3: Automatic Bleed-Down Circuit

Each symbol you can interpret increases your ability to understand and use information presented in diagrams. Lines in drawings provide exact information about an object or a process. Figure 3 uses lines and symbols to show a series of relationships. It is a stripped down, but concise, visual language. Each part of this diagram conveys information about the placement of the following in an automatic bleed-down circuit:

- flow lines
- springs
- motor

Road maps

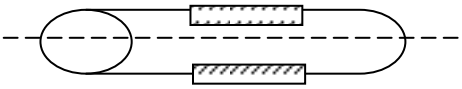
Compare Figure 3 to a road map. A road map gives you an overview of a whole system: compass directions, routes, distances, names of places. From it, you can calculate distance and travelling time, determine stopping points, plan routes. A figure with each of its symbols is like a map to use as a guide to essential trade information.

PART III
DIAGRAMS AND TEXT INTERPRET INFORMATION

Diagrams

Diagrams relate to something real. They show you how to do something, what something looks like, or the things that you can't see such as the flow of liquids or electrons. In some cases, the diagram looks like the real thing (such as the drawing of a tool); in other cases, it represents but does not look like the real thing such as this drawing of a standard break in pipe or tubing

Pipe Or Tubing



Figures
When you are reading, you might be directed to a graphic, which is usually labelled as a Figure with a number. The reference to the graphic may be in parentheses like this (Figure 2-10). Or, the text may tell what the graphic will show you.

> **Example:** A pilot operated relief valve with the vent port blocked off, and the valve acting as a straight relief is shown in Figure 16.

Read everything
Knowing the purpose of a graphic helps you interpret what is being conveyed to you. It's important to get all the information available from a graphic. The information is there to help you develop a clear understanding of the principles and concepts required by your trade.

Labels and headings
Headings, titles and labels add to the information available in diagrams and help you interpret what the information is telling you. *Use all the information provided in the labels and written descriptions within the diagram along with the graphics to get the complete picture.*

Be sure to read all titles and headings. The labels or descriptions in a diagram identify what you are looking at; they may contain directions or point you to an important aspect of the diagram.

To interpret a diagram, start by reading the label. A label offers important information. It may

- identify the diagram,
- describe how to follow the information on the diagram,
- refer you to the text for clarification,
- highlight important points.

Diagram labels provide a focus for the information presented. Here are some samples of labels attached to diagrams. Each label gives more information than the one before it and each label relates to the graphic *and* text.

> **Figure 1** Parts of gear and gear teeth,
> **Figure 2** Using a gear gauge, and
> **Figure 3** Hydraulic effect and backlash of meshing gears.

Using Text and Diagram Together
Figure 4 provides key information about applying cutting fluids. The text and diagram are important and useful on their own, but together, they give a more complete picture.

Passage 1
Application of Cutting Fluids

The method of applying cutting fluid has a pronounced effect on both the life of a cutting tool and the machining operation. Cutting fluid needs to be supplied in a generous stream under low pressure so both the work and the cutting tool are covered well. It needs to be directed to where the chip is forming in order to reduce and control the heat created during the cutting action and to prolong tool life.

In *slab milling*, cutting fluid should be directed to both sides of the cutter by fan-shaped nozzles about three-fourths the width of the cutter (Fig. 4)

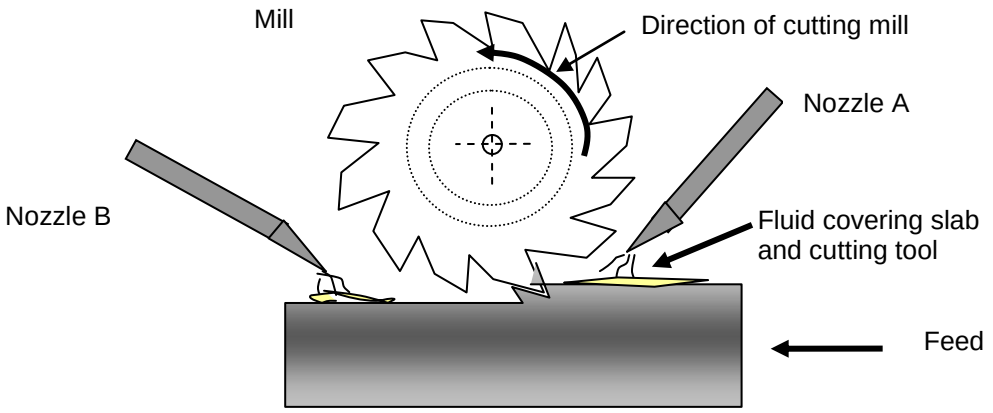


FIGURE 4: Cutting Fluid Being Supplied To Both Sides Of The Cutter In Slab Milling

The diagram above gives you a good idea of slab milling. The diagram has a clear purpose: it is labeled so that you can identify various parts. It is simplified: you get enough information to see the process but not so much that it distracts you from understanding the key details. Also note the information added with symbols: the centre of the mill (circle with crossed lines), and the direction of movement of mill and feed (arrows).

The diagram aids your understanding of one aspect of slab milling. You can "see" cutting fluid supplied:

- in large amounts so that the cutting tool is well covered;
- to the area where the chip is being formed;
- from both sides of cutter; and
- through the fan-shaped nozzles.

The text provides explanations and directions not found in the diagram. The diagram shows where and how something happens. The diagram and the text differ; yet, ***they work together*** to provide a clear written and visual picture of the procedure.

When you have read and understood both the graphic and the text, you should be able to:

1. List two purposes of a cutting fluid.
2. Show where the cutting fluid should be applied.
3. Explain why the cutting tool and work should be covered.

How not to . . .

Technical drawings often show you how to do something. The text describes the actions to be done and explains the reasons for doing them, while the drawings show how to perform those actions. Examining both text and drawings helps you accurately follow directions and avoid problems.

In the next example, the text describes how to clamp to a drill-press table in a correct and then an incorrect way. The diagrams illustrate both ways.

Passage 2
Drill Press Table

The work piece must be held securely for any drill-press operation. The clamps, bolts, and packing blocks must be located properly and the work clamped securely enough to prevent movement, but not tight enough to spring or distort the work. The correct clamping procedure is illustrated in Fig. 5A. Note that the step or packing block is slightly higher than the work and the bolt is located close to the work piece so that the main pressure is applied to the work.

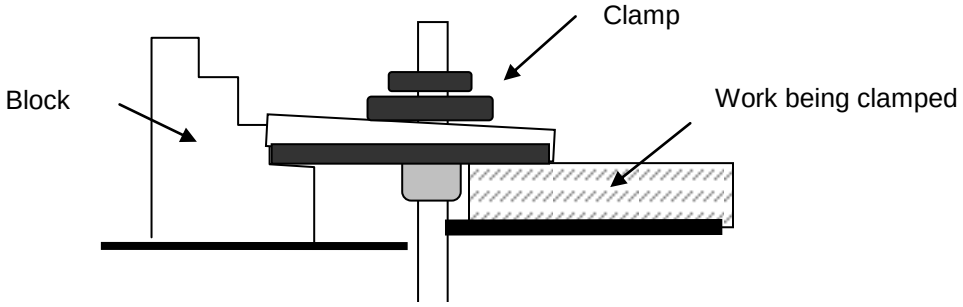


FIGURE 5A: **Correct Clamping Procedure**. Block is higher than piece being clamped

Figure 5B illustrates an incorrect clamping procedure in which most of the pressure is applied to the step or packing block. Incorrect clamping occurs whenever the step or packing block is lower than the part being clamped, or when the bolt is closer to the block than to the work.

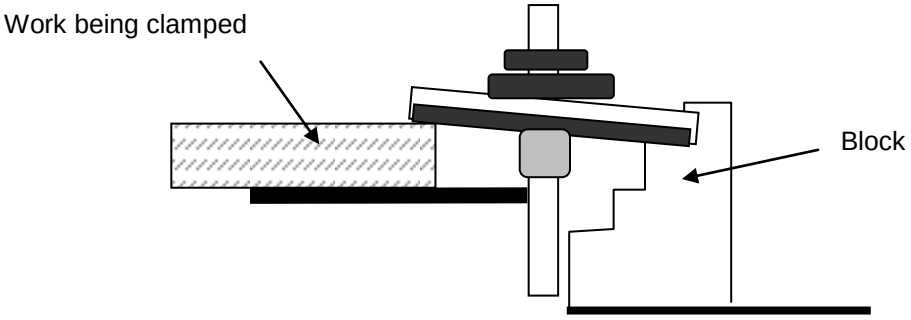


FIGURE 5B: **Incorrect Clamping Procedure**. Block is lower than piece being clamped

Read it all

When we look at diagrams, charts or tables, we need to refer back to *the guidance of the text*. The text tells us when to refer to the diagram and directs us to specific aspects of a drawing; it may repeat or emphasize important points.

The text in Passage 2 directs you to Figure 5A in the third sentence. Next, the text directs your attention to a point on the diagram:

> Note that the step or packing block is slightly higher than the work and the bolt is located close to the work piece.

Make sure you find the corresponding spot on the diagram. It is illustrated so that you can see it and understand it. You need to be sure that you are seeing exactly what you are supposed to see. The rest of the sentence gives you a reason for the placement described:

> . . . so that the main pressure is applied to the work.

Figure 5B shows you incorrect clamping. After comparing correct and incorrect methods, you should be able to apply these directions. Further, the visual information should help you remember how to do this and why it's important to do it right.

Test yourself
Assess how well you are interpreting diagrams. If we removed the references to the figures in the text in Passage 2 (e.g. Figure 5A, Figure 5B), could you do the following:

1. Match the text and diagrams correctly.
2. Identify which method of clamping is correct and which is incorrect.
3. Explain why the two methods differ? If it is not clear, read and then reread. Match diagram to text and text to diagram as you go. Find relevant spots on the diagram the way you would pick out points on a map.
4. Compare the two diagrams while referring to the text.
5. Piece together possible consequences of incorrect clamping from information contained in the text and diagrams.

If you can answer yes to the questions above, you have correctly interpreted the information.

INFORMATION IN TEXT AND DIAGRAMS

Stop and read the diagram
A diagram relates to something real, whether it is an electrical circuit or a blueprint symbol. You need to be able to convert the information into language and later into actions. The first step is to understand what is being depicted by the diagram.

Read Passage 3 below and identify places or points on the diagram that correspond to the main text. The text explains what is happening; the diagram converts this into something visual. Use both to answer the questions which follow.

> **Passage 3**
> **The Heat Pump**
>
> A system used in refrigeration, air conditioning, and geo-thermal heating is shown in its essentials in Figure 6. The freezer compartment of an electric refrigerator (for household use) is an example of an

evaporator. The chambers are double-walled and contain a liquid that evaporates very readily.

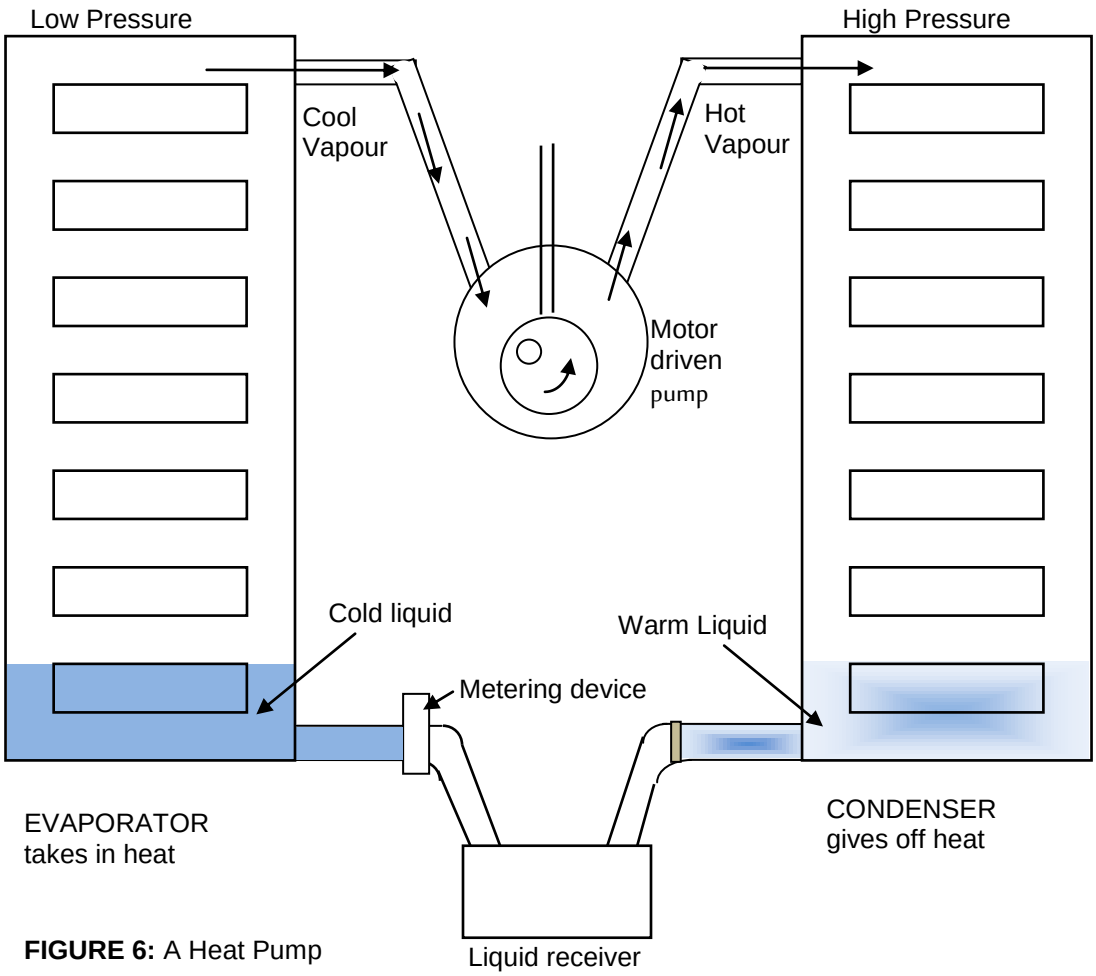


FIGURE 6: A Heat Pump

This works much like the cooling that takes place when liquids such as gasoline, cleaning solvents or water evaporate from your hands. The faster the liquid evaporates, the cooler the effect; in other words, heat is removed at a quicker rate.

When the insides of a refrigerator warm a little, a thermostat activates an electric motor that runs a pump. The pump moves vapour away from the liquid in the evaporator. As a result more liquid is allowed to evaporate. As the liquid evaporates, it draws heat from the metal evaporator and from everything nearby. The vapour which goes through the pump is warmed by compression. The now hot vapour, under pressure, is cooled in the condenser to the point where it changes to liquid. It now gives off the heat that it absorbed in the evaporator when it became vapour. The air in the room cools the condenser; that is, it draws heat from the condenser.

Answer the questions below using information from both the text and diagram. Answers are at the end of the skills manual.

1. The vapour will be at its warmest:

   a) just **before** going through the pump.
   b) just **after** going through the pump.
   c) There is no difference.

2. Which sequence of information is correct, **A** or **B**?

A. a) electric motor starts
   b) vapour is pumped away from liquid in evaporator
   c) more liquid evaporates
   d) heat is withdrawn from evaporator

B. a) electric motor starts
   b) liquid goes through pump
   c) and is warmed by compression
   d) under pressure it is cooled in condenser

3. To make the device work as a building heater (that is to warm air inside a building), you would:

   a) put evaporator in the house so it can warm air inside a building.
   b) put condenser in the house so it can warm air inside a building.

CONCLUSION

The text that accompanies a diagram is directly related to it. They are partners. Usually the main text explains in words the information you see in a diagram. It also directs you at the appropriate time to study the diagram. It tells you what you should look for in the diagram.

When you use the information from both text and graphics, you develop a clearer understanding of a principle, a procedure or a type of equipment. Use text and diagrams together to enrich your learning. They can clearly show you a complex idea in a small space.

When the text describes steps in a process and the diagram illustrates it, you can follow the information flow. Your eyes can move in all directions. You can *see* the information from different points in the process. You can interpret what is happening at different stages.

Technical diagrams and symbols transfer information. Provided you read carefully and interpret correctly, graphics can do any of the following in little space and at a glance:

- ♦ show relationships.
- ♦ make abstract ideas easier to understand.
- ♦ show you something invisible or hidden
- ♦ focus on and emphasize important aspects on information.

Summary

1. **Symbols are a form of shorthand.** Understand what these symbols represent to understand the language of your trade. Note any differences between countries.

2. **Lines convey information**. Lines and symbols can show relationships, objects and processes.

3. **Diagrams (graphics) use a visual approach** to make technical information meaningful.

4. **Diagrams are clearly labeled** to identify parts and their relationships.

5. **The text and diagram are directly related to each other and work as partners**. Always use them together.

6. **Always read the description that accompanies each diagram**. They tell you what you are looking at and what to look for.

7. **Diagrams and symbols relate to something you need to know**. Interpret and connect them to achieve understanding.

Answer page

***PART IV,* Heat Pump and Diagram**

1. The vapour will be at its warmest
   b) just **after** going through the pump

   The text states, "The vapour which goes through the pump is warmed by compression. The now hot vapour, under pressure, gets cooled in the condenser to the point. . ."The vapour is described as being **hot** as it is warmed by compression – not before compression.

   The diagram makes this clearer: the vapour (top left) is **cool**. After going through the pump, it is **hot**.

2. Which information is correct, **A** or **B**?

   a) electric motor starts
   b) vapour is pumped away from liquid in evaporator
   c) more liquid evaporates
   d) heat is withdrawn from evaporator

   The text provides this in the same sequence. The diagram shows the changing states of liquid to vapour and shows with arrows the flow of vapour. No liquid goes through the pump.

3. To make the device work to heat a building, you would:

   b) put condenser in the house so it can warm air inside the house.

   The text states, "The now hot vapour, under pressure, gets cooled in the condenser to the point where it changes again to liquid. It now **gives off the heat that it absorbed in the evaporator.** The air of the room cools the condenser; **that is, it draws heat from the condenser".**

   The diagram shows this very simply. The word "***condenser"***, clearly labels the drawing of a condenser and states below "*gives off heat".*