EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

COMMUNICATIONS SKILLS
INTERPRETATION OF DIAGRAMS

AN ACADEMIC SKILLS MANUAL
for
The Construction Trades: Mechanical Systems

This trade group includes the following trades:
Electrician. Network Cabling, Painter& Decorator,
Plumber, Steamfitter, Sprinkler &Fire Protection, and
Refrigeration/Air Conditioning

Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities

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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
INTERPRETATION OF DIAGRAMS

An academic skill required for the study of the Construction Trades: Mechanical Systems

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.

The information in a diagram might illustrate a new concept, explain how a piece of equipment works, show the correct order of the steps of a procedure or give the requirements and measurements for the job you are about to start. You need to interpret the information in a diagram correctly to understand the concept, equipment or procedure shown. Clearly, *interpretation of diagrams* is an essential skill for your technical reading toolbox.

Accuracy is essential in your trades. Diagrams can provide 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 end 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 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 complex ideas in a small space. They serve many purposes: they illustrate concepts, show relationships, compare information and illustrate how something works, how to do something, or where something is.

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. You need to learn what symbols represent in your reading or on the job.

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 **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 **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 drawings.

Example: Ohm's law states that the ratio of the voltage to the current is equal to the resistance of the circuit. Therefore, V/I=R.

The purpose of the sentence above is to pass along specific information about an aspect of your trade – *electronics.* Your ability to interpret the information depends on understanding the meaning of V, I, and R. 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:

V = symbol for voltage, measured in volts (V).
I = symbol for current, measured in Amperes (A).
R = symbol for Resistance, measured in ohms (Ω).

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**).

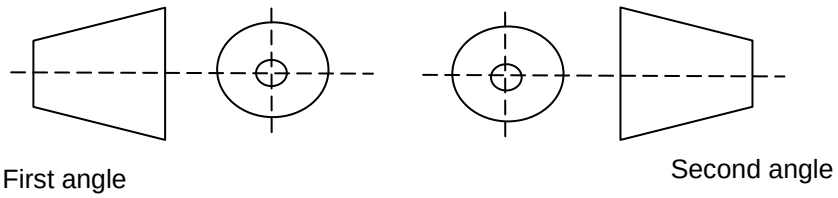


Figure 1: ISO symbols for the first- and third- angle projections

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 correctly interpret the symbols and use that information to solve questions.

Example: Solve for V, where R=100Ω and I=2A.

You know the meanings of V, Ω and A, from the earlier example, so you know where to fill in the quantities in the equation, V/I=R, in order to solve it.

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 mechanical 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:

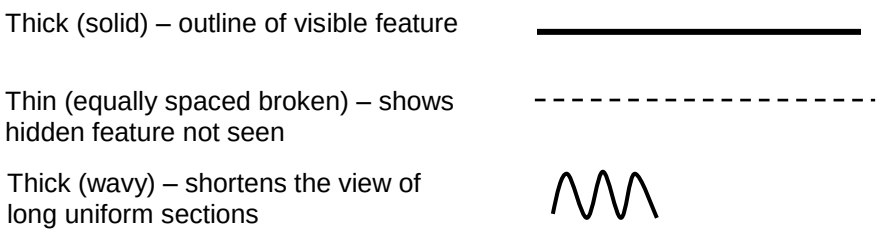


FIGURE 2: Examples of lines in technical drawings

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. Look at the diagram of an automatic bleed-down circuit.

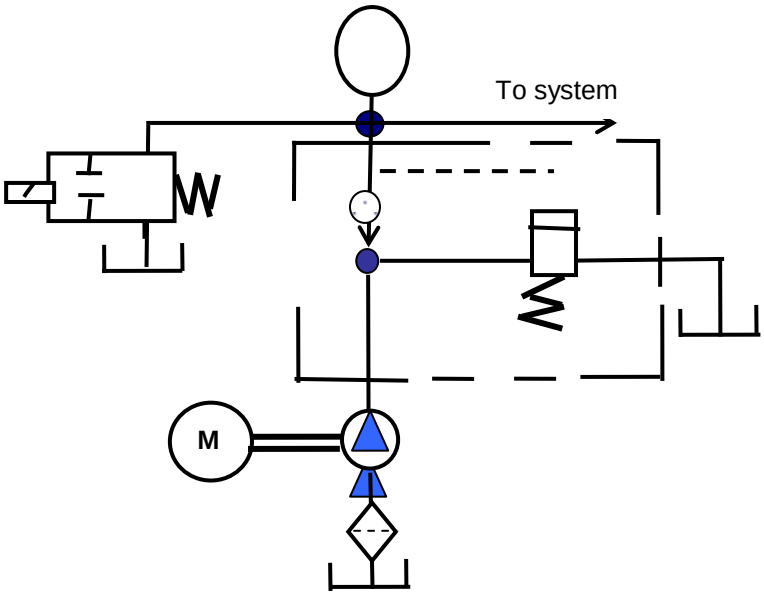


FIGURE 3: Automatic Bleed-Down

As you can see, working diagrams don't always look like what they represent. In Figure 3, 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 a diagram, you know that the diagram includes a motor.

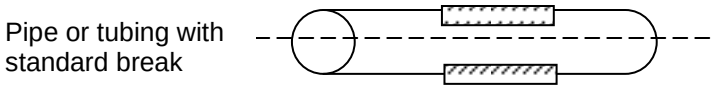
Each symbol you can interpret increases your ability to understand and use information presented in diagrams. Lines in drawings provide exact information about an object or a process. Figure 3 uses lines and symbols to show a series of relationships. It is a stripped down, but concise, visual language. 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 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.



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:** The two-value capacitor motor, as shown in Figure 2-10, combines the advantage of high starting torque and high running torque due to the way in which the windings are wired into the circuit.

Read everything
Knowing the purpose of a graphic helps you interpret what is being conveyed. 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 the information. 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. *Use all the information provided by labels and written descriptions within the diagram to get the complete picture.*

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 Centrifugal pump.
Figure 2 Cutaway showing impeller design of centrifugal pump.
Figure 3 Simplified cross section of an impeller and surrounding volute. Centrifugal force flings water into the volute chambers.

Using Text and Diagram Together

Using the diagram and text together in Passage 1 gives you a more complete picture than each would on their own.

Passage 1
Reciprocating Pumps

Reciprocating pumps lift water by moving a piston back and forth in a cylinder. Figure 4 illustrates the basic operation of a double-acting reciprocating pump.

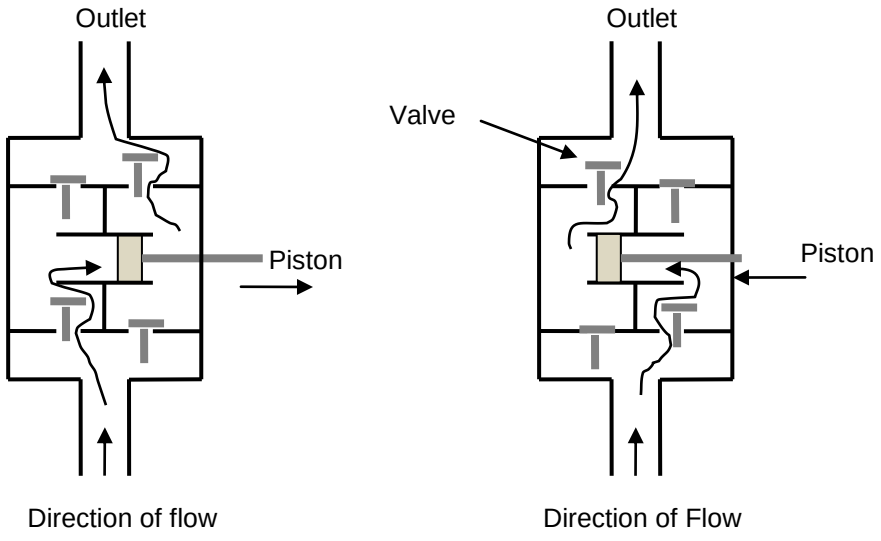


FIGURE 4: A double piston and four check valves permit a reciprocating pump to supply a steady flow of fluid.

There are many advantages of reciprocating pumps. They have the ability to pump water containing sand, they adapt easily to low-capacity water supplies, they can operate with a variety of head pressures, they can be hand operated and can be installed in very small diameter wells. Disadvantages include a pulsating discharge, high maintenance costs, and the possibility of system damage if the pump is permitted to operate against closed valves.

The diagram above gives you a pretty good picture of what happens as water passes through a reciprocating pump. It has a clear purpose: it is labelled so you can identify various parts. It is simplified: you get enough information to see an operation, but not so much that it distracts you from understanding the key details. And note the information added by the use of symbols: the direction of movement of water (arrows) and the piston (arrows).

The diagram aids your understanding of a reciprocating pump. You can "see":

- the piston, and the direction in which they are travelling (arrows)
- the outlet,
- the direction of flow (arrows),
- the valves.

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

The example above shows how graphics and text relate to each other to provide required information. When you have read and understood both the graphic and the text, you should be able to:

1. Explain what *a reciprocating pump* is.
2. Explain how water is supplied by a reciprocating pump.
3. List several advantages and disadvantages of reciprocating pumps.

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.

Passage 2 describes the function, uses and installation of a castle nut and cotter pin. By showing correct and incorrect procedures, the diagram helps you to avoid problem.

Passage 2
The Castle Nut

Castle nuts are used on bolts that have a drilled hole through the threaded end (see Figure 5). A cotter pin is used to prevent the nut from turning and should always be installed properly as shown in Figures 5A and 5B.

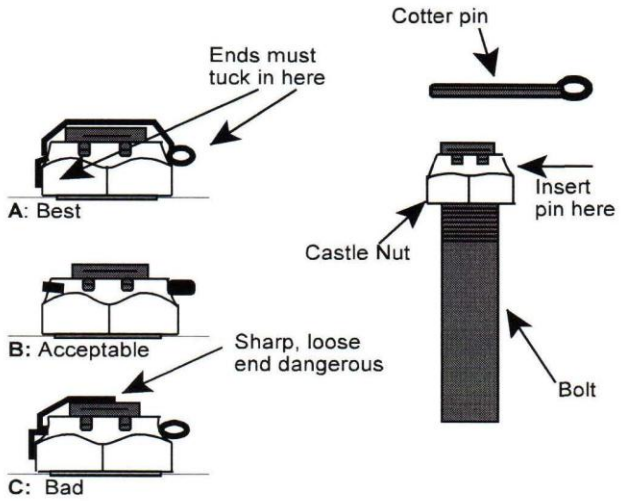


FIGURE 5: Correct Installation Of Cotter Pins

Figures 5A and 5B are acceptable installation methods of the cotter pin, while 5C is incorrect. The pin is placed through the castle nut and bolt hole to prevent the nut from coming off the bolt. Method 5A is the most difficult to produce, but it will eliminate a sharp end.

The text and diagram above give you a good idea of the correct installation of cotter pins in castle nuts. It is simplified: you get enough information to see the process but not so much that it distracts you from understanding the key details. The text directs us to specific points or aspects of a drawing.

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.

PART IV
INFORMATION IN TEXT AND DIAGRAMS WHICH MATCH

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. Try to describe to yourself in words what the diagram represents. If you don't recognize certain symbols, look them up.

Read **Passage 3** below and identify places on the diagram that correspond to the main text. The text explains what is happening; the diagram converts this into something visual.

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.

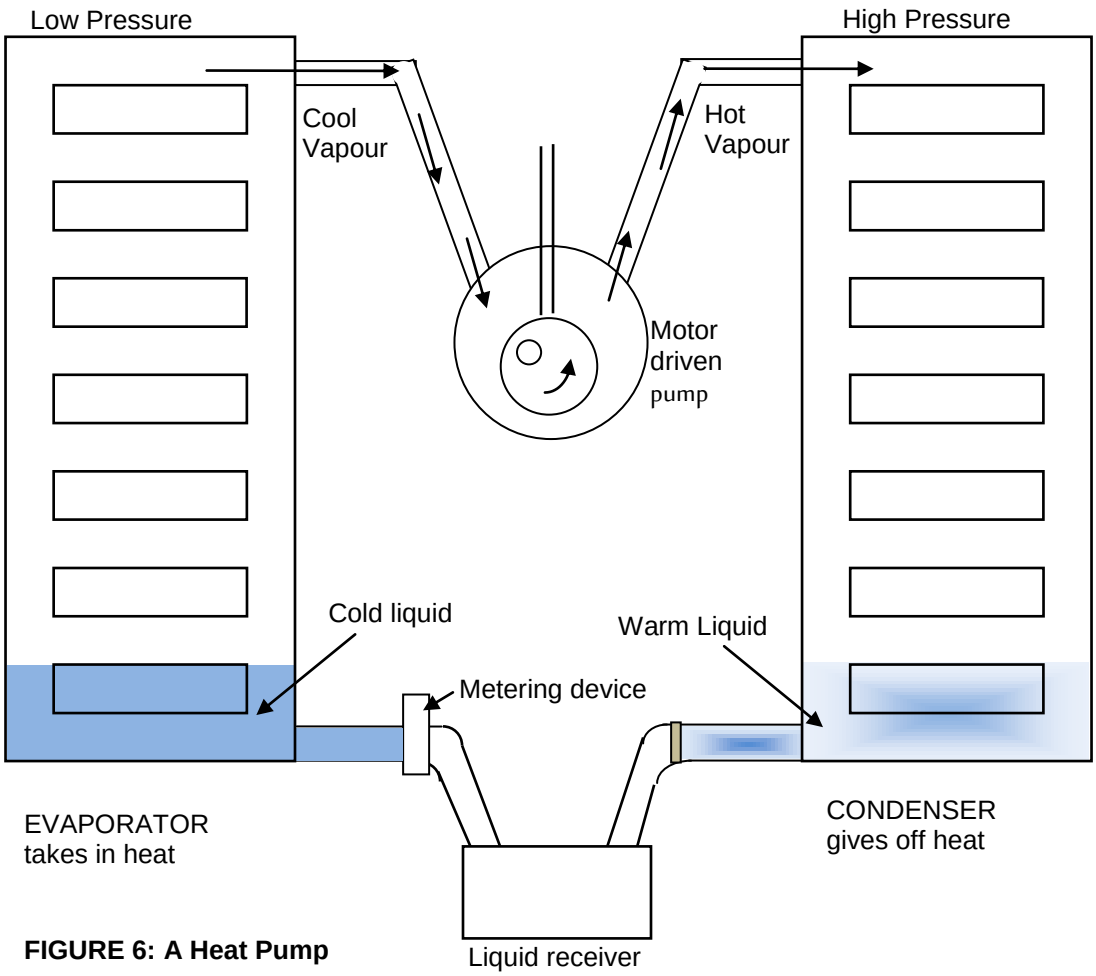


FIGURE 6: A Heat Pump

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 house heater (that is to warm air inside the house), you would:

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

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.

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.

Use all the information in text and diagrams to enlarge your trade knowledge. To make sure you understand what you are looking at, try to describe to yourself in words what the diagram represents. If you can't describe what you see, read the text again or ask for help. If you don't recognize certain symbols in the diagram, look them up.

Technical diagrams and symbols transfer information. Provided you read carefully and interpret correctly, graphics can do 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 Passage 3 and Figure 6, Heat Pump

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

   The text states that, "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 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

   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 as a house heater (that is, to warm air inside the house), you would
   b) put condenser in the house so it can warm air inside the house.

   The text states that: 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 clearly states below: gives off heat.