



Apprentice Transmission Mechanic (ATM) Entrance Exam

Preparation Guide

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Apprentice Transmission Mechanic Entrance Exam

Purpose

The Apprentice Transmission Mechanic Apprenticeship Entrance Exam is a computer-based knowledge test that is used in the selection process for hiring employees into the Apprentice Transmission Mechanic program.

About the Test

- The Apprentice Transmission Mechanic Entrance Exam allows you to demonstrate your knowledge, aptitude, and understanding of the fundamentals of basic mathematics, basic electricity, and mechanical concepts, as well as your preparedness for advanced technical training throughout your apprenticeship.
- There are **41** multiple choice and fill-in-the-blank questions on the test and the total allotted time to take test is **1** hours and **30** minutes (**90** minutes).

Topics Covered in the Test

- Mathematics
 - Addition, subtraction, multiplication, division
 - Fractions and decimals
 - Ratios
 - Algebra
 - Trigonometry
 - Geometry
 - Logic
- Instrumentation
 - Basic components
 - ANSI/ISA-95 Standard Symbology
- Mechanics
 - Ratios
 - General Mechanical Knowledge
- Tools
 - Basic knowledge of hand tools
- Physics and Chemistry
 - Pressure forces
- Process Control

During the Test

It is important that you follow the directions of the Test Administrator. If you have any questions about the testing session, be sure to ask before the testing begins.

Once you start the test, you may **NOT** leave the room, talk, smoke, eat, or drink (except for bottled water). Bathroom breaks are **not** allowed once you start the test. You should consider these factors before beginning the test.

All cellular devices, smart phones, smart watches, music players, earphones, personal calculators, cameras, or other electronic equipment will **NOT** be allowed in the testing area. Please secure these items **before** entering the testing location. Employees will need to complete LiveSafe prior to checking in and will secure their cell phones as they enter the testing room.

You will **NOT** be able to use your own calculator during testing. The Test Administrator will provide you with a non-programmable scientific calculator that you can use for the test.

The Test Administrator will provide the following materials:

- Calculator: **Texas Instruments TI-30Xa**
- Scratch Paper
- Pencils

Once the test has been submitted for scoring, the Test Administrator will collect all material.



Computer-Based Test Directions

The Apprentice Transmission Mechanic Entrance Exam is a computer-based test.

You will be seated at a computer testing station. The Test Administrator will assist with launching the test. You will be asked to enter your candidate ID and password; this information will be provided by the Test Administrator.

You only need minimal computer experience and typing skills. You will only use the keyboard for minimal entries (information to identify you and a password). You will answer all questions with a computer mouse.

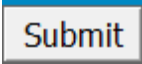
A test time will be visible throughout the exam in the top right corner. The time will start once you launch the exam. The test automatically closes when the time limit expires. If the test times out before you submit, the test will end, and any unanswered questions are scored as incorrect.

Block 1 of 1 Time remaining:: 02 : 15 : 00  

When you have selected your answer to a question, click the “Next Question” button in order to move to the next question. To return to a question, click the “Previous Question” button.

Answers can be changed any time during the test until the time runs out or when you click the “Submit” button. **Once you click “Submit”, you cannot change your answers.** Please do not select “Submit” until all questions have been answered. If you click “Submit” by mistake, you will receive a display warning box. Click “Cancel” if you want to continue working.

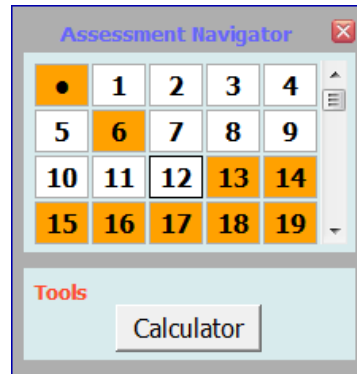



The “Assessment Navigator” will help identify questions that have been answered.

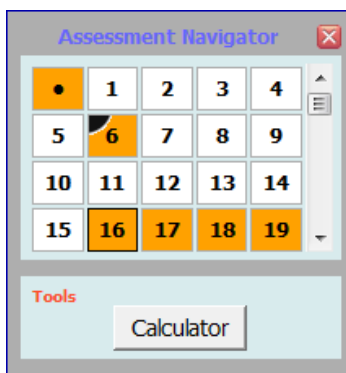
- Orange = unanswered question
- White = answered question

In the example below, questions 6 and 13-19 have not been answered, while 1-5 and 7-12 have been answered.

In addition, you can use the “Assessment Navigator” to jump to a particular question by clicking on the question number.



The “Flag” button , at the bottom of the window, allows you to mark a question for further review. When you click on the “Flag” button, this adds a black corner to the question number in the “Assessment Navigator”. In the example below, question 6 has been flagged. Click the “Flag” button again to un-flag the question.



Below is an example of what you can expect to see when taking the computer-based test.

The screenshot shows a test interface for PG&E Academy. At the top, it displays the date (Apr 16 2014), the user's name (Testers Name), the current block (Block 1 of 1), and the time remaining (02:15:00). The main content area shows a question: "83 of 95 Potentiometers have ___ terminals, while rheostats have ___ terminals." with three radio button options: "2, 3", "3, 2", and "4, 2". The "3, 2" option is selected. Below the question, there are navigation buttons: "< Previous Question", "Next Question >", "Assessment Navigator" (with a flag icon), and "Submit".

Annotations and callouts include:

- "Time Remaining" pointing to the time display.
- "Font Size increase/decrease and contrast icons" pointing to the icons next to the time display.
- "Question with responses" pointing to the question text.
- "The Assessment Navigator will help identify questions that have been answered" pointing to the Assessment Navigator window.
- "To move forward to the next questions or backwards" pointing to the "Previous Question" and "Next Question" buttons.
- "Flag icon, mark a question for further review" pointing to the flag icon in the Assessment Navigator button.
- "To send in the test, click Submit." pointing to the "Submit" button.

The Assessment Navigator window is a grid showing question numbers from 75 to 94. The number 81 is highlighted in orange, indicating it is the current question. Below the grid is a "Tools" section with a "Calculator" button.

Note: During the test if you experience any technical issues, raise your hand for assistance.

Resources

The Internet is an excellent resource for much of the information to prepare for this test. Many excellent mathematics, basic electricity, mechanics, and electronics books are available from libraries, bookstores, and on-line resources. A general reference book is invaluable as a supplement to other textbooks from classes or specific subjects, and as an instrument for general review in preparing for qualifying tests. However, it is not a substitute for formal education and training.

The following are suggested resources to review:

- *Electricity: Principles and Applications* by Richard Fowler
- *Instrumentation and Process Control* by Kirk, Weedon, and Kirk
- *Control Loop Foundation – Batch and Continuous Processes* by Blevins and Nixon
- *The Complete Rigger's Reference Handbook* by Mike Riggs, Third Edition
- ANSI/ISA-95 Instrumentation Standards

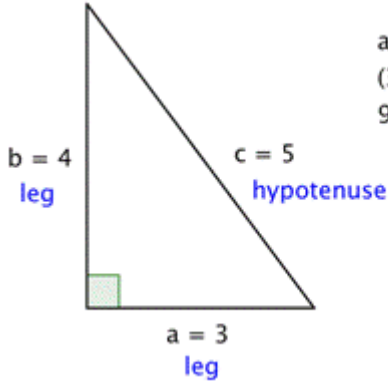
Additional resources for improving understanding of the concepts may be found at local libraries, online, and bookstores.

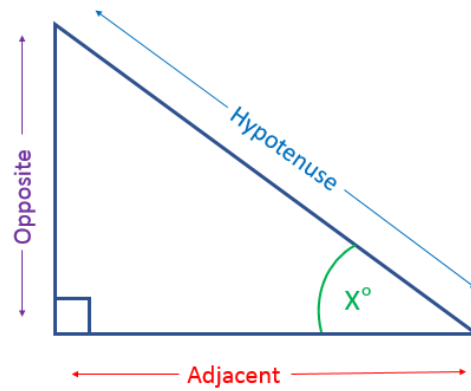
Make sure that you are physically and mentally alert when you are scheduled to take your test.

We hope you find this information helpful. Pacific Gas and Electric Company wishes you the best of luck in qualifying on your test.

Formulas and Symbols

The following formulas and symbols will be helpful when taking the test.

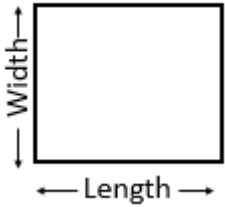
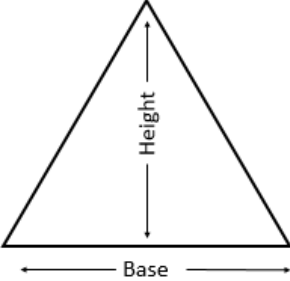
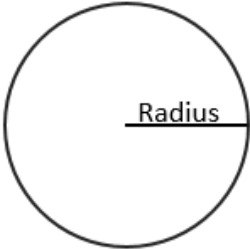
Mathematics	
Order of Operations	PEMDAS= Parenthesis, Exponents, Multiply or Divide, before you Add or Subtract
Basic Operations	Addition Subtraction Multiplication Division Place values (tenths, hundredths, thousandths, etc.) Ratios Fractions <ul style="list-style-type: none"> • Simplest Terms • Addition • Subtraction • Multiplication • Division
Pythagorean Theorem	$a^2 + b^2 = c^2$  $a^2 + b^2 = c^2$ $(3)^2 + (4)^2 = (5)^2$ $9 + 16 = 25$

Trigonometry

$$\textit{Sine} = \frac{\textit{Opposite}}{\textit{Hypotenuse}}$$

$$\textit{Cosine} = \frac{\textit{Adjacent}}{\textit{Hypotenuse}}$$

$$\textit{Tangent} = \frac{\textit{Opposite}}{\textit{Adjacent}}$$

Area	<p>Rectangle</p> 	<i>Area = Length x Width</i>
	<p>Triangle</p> 	<i>Area = $\frac{(Base \times Height)}{2}$</i>
	<p>Circle</p> 	<i>Area = $\pi \times radius^2$</i>
Linear Algebra	<p>Used to determine position on a line</p> $Output = \left(\frac{Input - Input\ min}{Input\ max - Input\ min} \right) \times (Output\ max - Output\ min) + Output\ min$	<i>$y = mx + b$</i>

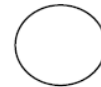
Instrumentation

Below are a selection of symbols according to the ANSI/ISA-95 Instrumentation Standards. This selection provides an idea of the types of symbols which you will use in the field and will be covered on the test. Please note that these do **NOT** cover **ALL** standard or PG&E specific symbols.

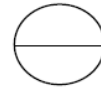
You can find additional symbols in the ANSI/ISA-95 Standards, and in the *Instrumentation and Process Control* textbook by Kirk, Weedon, and Kirk.

ANSI/
ISA-95
Standard
Symbols

Discrete Instrument,
field mounted



Discrete instrument,
accessible to operator



Visible on video Display

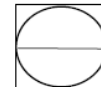
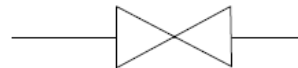


Figure 7-11. Excerpt from ISA-5.1 General Instrumentation or Symbol Function

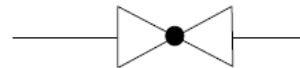
General Symbol



Ball Valve



Globe Valve



Damper

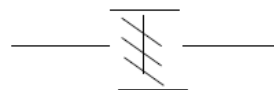


Figure 7-12. Excerpt from ISA-5.1 Valve Body and Damper Symbols

- Generic actuator, Spring-diaphragm
- Spring-diaphragm with positioner
- Linear piston actuator with positioner
- Rotary motor operated actuator
- Solenoid actuator for on-off valve

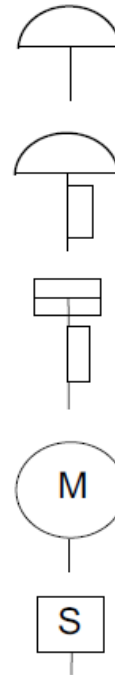
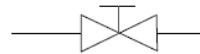


Figure 7-13. Excerpt from ISA-5.1 Actuator Symbols

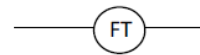
Restriction Orifice, With Flow Transmitter



Hand Valve



Inline Measurement



Measurement Element

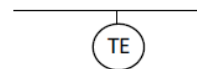


Figure 7-14. Excerpt from ISA-5.1 Symbols for Other Devices


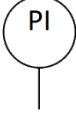

This table is intended to provide insight to how symbols are labeled on a diagram. While you are **NOT** expected to memorize this table for this test, you should have a general idea of what the letters may mean for instruments. Sample commonly used tags in the Natural Gas industry are noted in **BOLD** text, and highlighted in either Blue or Orange.

Instrument
Tag ID
Table

	First Letter		Second Letter		
	Measured or Initiating Variable	Modifier	Readout or Passive Function	Output Function	Modifier
A	Analysis		Alarm		
B	Burner Flame			Control	
C	Conductivity				
D	Density or Specific Gravity	Differential			
E	Voltage		Primary Element		
F	Flow Rate	Fraction/ Ratio			
G	Gaging (Dimensional)		Glass		
H	Hand/ Manually Ctrl				High
I	Current		Indicate		
J	Power	Scan			
K	Time			Control Station	
L	Level		Light (Pilot)		Low
M	Moisture				Middle or Intermediate
N					
O			Orifice (Restriction)		
P	Pressure		Point		
Q	Quantity or Event	Total, Integrate			
R	Radioactivity		Record or Print		
S	Speed or Frequency	Safety		Switch	
T	Temperature			Transmit	
U	Multivariable		Multi-function	Multi-function	Multi-function
V	Viscosity, Vibration			Valve, Damper, Louver	
W	Weight, Force		Well		

	First Letter		Second Letter		
	Measured or Initiating Variable	Modifier		Measured or Initiating Variable	Modifier
X					
Y	Event or State			Relay or Computer	
Z	Position			Drive, Actuate	

For example:




Symbol	First Letter(s)	Second Letter(s)	Instrument
	T	I	Temperature Indicator (Temperature Gauge)
	P	I	Pressure Indicator (Pressure Gauge)
	F, Q	Y	Flow Rate Total Computer (Total Flow Computer)

Mechanics

Sample tool list used by Gas Transmission Mechanics:

Screwdrivers	Drills	Drill Bits
Tape Measure	File	Saws
Torque Wrench	Vise	Pipe Wrench
Crescent Wrenches	Tubing Benders	Pressure Gauges
Wire Strippers	Wire Cutters	Multimeter
Mallets/Hammers	Pipe Cutter	

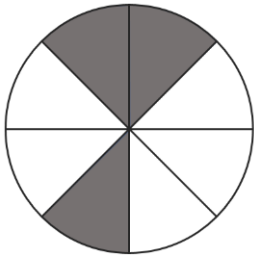
Physics

Gas Laws	Boyle's Law	$P_1 \cdot V_1 = P_2 \cdot V_2$	
	Charles's Law	$\frac{V_1}{V_2} = \frac{T_1}{T_2}$ or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	
	Ideal Gas Law	$P \cdot V = m \cdot R \cdot T$	
Force Equation			
	Force = Pressure x Area	Pressure = $\frac{\text{Force}}{\text{Area}}$	Area = $\frac{\text{Force}}{\text{Pressure}}$

Practice Problems

Math

1. What part of the object is shaded?

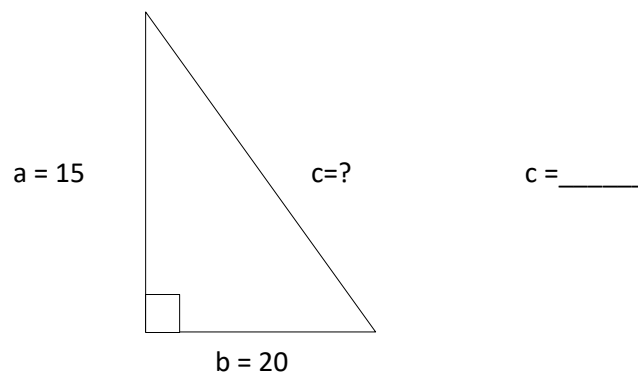


_____ fraction

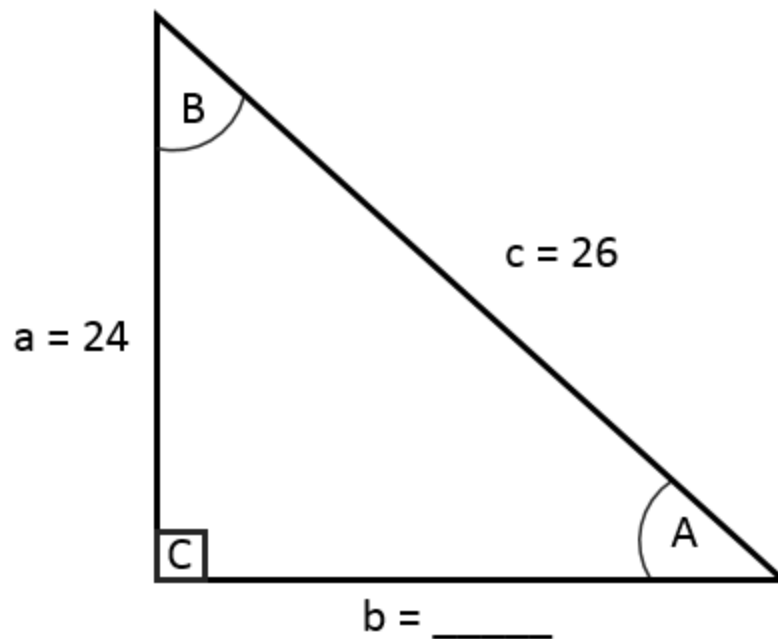
_____ decimal

_____ percent

2. Find the length of "c" in the triangle below:



Use the triangle below for the next four questions.



3. What is the length of side “b” in the triangle below? Side b = _____
4. What is the measurement of angle A, to the nearest tenth? $\angle A = \underline{\hspace{2cm}}$
5. What is the measurement of angle B, to the nearest tenth? $\angle B = \underline{\hspace{2cm}}$
6. What is the measurement of angle C, to the nearest tenth? $\angle C = \underline{\hspace{2cm}}$

7. Complete the pattern? 12, 16, 20, _____, 28
8. How many meters are there in 900mm?
9. Solve the following equation, rounding to the nearest hundredth:

$$2.25(3.14)(0.678)$$

10. What is 9% of 64.52, rounded to the nearest hundredth?

11. Solve the following equation:

$$-1 \times (-4)$$

12. Solve the following equation:

$$\frac{(-8 + 3)}{(7 + (-3))}$$

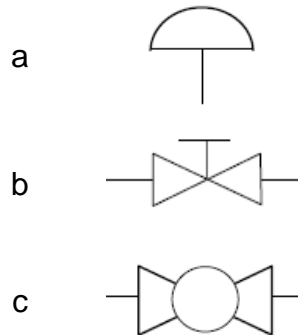
13. Subtract and express in simplest terms:

$$15\frac{2}{3} - 3\frac{1}{2}$$

14. Assuming $\pi = 3.14$, what is the area of a circle with a diameter of 5 feet, rounded to the nearest hundredth?

Instrumentation

15. Which of the below symbols represents a Hand Valve on a Piping and Instrumentation Diagram, according to the ANSI/ISA-95 standards?

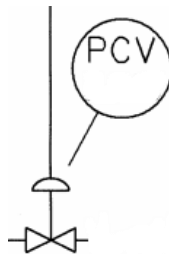


16. What instrument does the following symbol represent on a Piping and Instrumentation diagram?



- a. Motor
- b. Pressure Gauge
- c. Linear piston actuator with positioner

17. What instrument does the following symbol represent on a Piping and Instrumentation diagram?

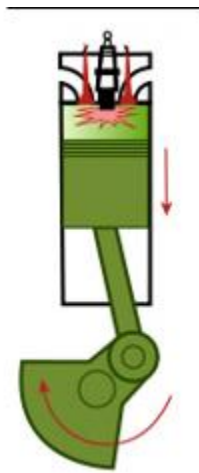


- a. Hand Control Valve
- b. Pressure Control Valve
- c. Pressure Indicating Transmitter

Mechanics

18. Which stroke of a typical four-stroke engine process occurs immediately after the spark plug ignites the fuel-air mixture?
- Intake
 - Compression
 - Power
 - Exhaust

19. Which four-stroke engine stroke is depicted by the picture below?



- Intake Stroke
- Compression Stroke
- Power Stroke

Practice Problem Answer Key

1. $\frac{3}{8}$, 0.375, 37.5%
2. 25
3. 10
4. 67.4°
5. 22.6°
6. 90.0°
7. 24
8. 0.9 m
9. 4.79
10. 5.81
11. 4
12. -1.25
13. $12\frac{1}{6}$
14. 19.63
15. B
16. C
17. B
18. C
19. C