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Apprentice Transmission Mechanic Entrance Exam

Purpose
The Apprentice Transmission Mechanic (ATM) 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 ATM 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 78 multiple choice and fill-in-the-blank questions on the test and the total allotted time to take test is 2 hours and 45 minutes (165 minutes).

Topics Covered in the Test
- Mathematics
  - Addition, subtraction, multiplication, division
  - Fractions and decimals
  - Ratios
  - Algebra
  - Trigonometry
  - Geometry
  - Logic
- Basic Electricity
  - Ohms Law
  - AC/DC power systems
- Instrumentation
  - Basic components
  - ANSI/ISA-95 Standard Symbology
- Mechanics
  - Ratios
  - General Mechanical Knowledge
  - Engines (Two-stroke, Four-stroke, Diesel)
- 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. 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, ear phones, personal calculators, cameras, or other electronic equipment will **NOT** be allowed in the testing area. Please secure these items **before** entering the testing location.

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 ATM 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.

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.

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
- 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

<table>
<thead>
<tr>
<th>Order of Operations</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEMDAS (Parenthesis, Exponents, Multiply or Divide, before you Add or Subtract)</td>
<td></td>
</tr>
</tbody>
</table>

## Basic Operations

- Addition
- Subtraction
- Multiplication
- Division
- Place values (tenths, hundredths, thousandths, etc.)
- Ratios
- Fractions
  - Simplest Terms
  - Addition
  - Subtraction
  - Multiplication
  - Division

## Pythagorean Theorem

\[ a^2 + b^2 = c^2 \]

\[
\begin{align*}
& a^2 + b^2 = c^2 \\
& (3)^2 + (4)^2 = (5)^2 \\
& 9 + 16 = 25
\end{align*}
\]
Trigonometry

\[
\text{Sine} = \frac{\text{Opposite}}{\text{Hypotenuse}}
\]

\[
\text{Cosine} = \frac{\text{Adjacent}}{\text{Hypotenuse}}
\]

\[
\text{Tangent} = \frac{\text{Opposite}}{\text{Adjacent}}
\]
### Area

<table>
<thead>
<tr>
<th>Shape</th>
<th>Area Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangle</td>
<td>( A = \text{Length} \times \text{Width} )</td>
</tr>
<tr>
<td>Triangle</td>
<td>( A = \frac{(\text{Base} \times \text{Height})}{2} )</td>
</tr>
<tr>
<td>Circle</td>
<td>( A = \pi \times \text{radius}^2 )</td>
</tr>
</tbody>
</table>

### Linear Algebra

- Used to determine position on a line: \( y = mx + b \)
- Output: \( \text{Output} = \left( \frac{\text{Input} - \text{Input min}}{\text{Input max} - \text{Input min}} \right) \times (\text{Output max} - \text{Output min}) + \text{Output min} \)

### Basic Electricity

#### Ohm’s Law

- \( V = I \times R \)
- \( I = \frac{V}{R} \)
- \( R = \frac{V}{I} \)

- \( V = \) voltage expressed in Volts
- \( I = \) current expressed in Amps
- \( R = \) resistance expressed in Ohm
Alternating Current (AC)

Direct Current (DC)
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.
- 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.

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

For example:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>First Letter(s)</th>
<th>Second Letter(s)</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI</td>
<td>T</td>
<td>I</td>
<td>Temperature Indicator (Temperature Gauge)</td>
</tr>
<tr>
<td>PI</td>
<td>P</td>
<td>I</td>
<td>Pressure Indicator (Pressure Gauge)</td>
</tr>
<tr>
<td>FQY</td>
<td>F, Q</td>
<td>Y</td>
<td>Flow Rate Total Computer (Total Flow Computer)</td>
</tr>
</tbody>
</table>

**Mechanics**

**Sample tool list used by Gas Transmission Mechanics:**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Drill</th>
<th>File</th>
<th>Vise</th>
<th>Pipe Wrench</th>
<th>Pressure Gauges</th>
<th>Multimeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screwdrivers</td>
<td>Drills</td>
<td></td>
<td></td>
<td>Drill Bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tape Measure</td>
<td></td>
<td>File</td>
<td></td>
<td>Saws</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque Wrench</td>
<td></td>
<td></td>
<td>Vise</td>
<td>Pipe Wrench</td>
<td>Pressure Gauges</td>
<td></td>
</tr>
<tr>
<td>Crescent Wrenches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multimeter</td>
</tr>
<tr>
<td>Wire Strippers</td>
<td></td>
<td></td>
<td></td>
<td>Wire Cutters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mallets/Hammers</td>
<td></td>
<td></td>
<td></td>
<td>Pipe Cutter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Physics

#### Gas Laws

- **Boyle’s Law**
  \[ P_1 \cdot V_1 = P_2 \cdot V_2 \]

- **Charles’s Law**
  \[ \frac{V_1}{V_2} = \frac{T_1}{T_2} \quad \text{or} \quad \frac{V_1}{V_2} = \frac{T_1}{T_2} \]

- **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?

\[ \text{ fraction } \quad \text{ decimal } \quad \text{ percent } \]

2. Find the length of “c” in the triangle below:

\[ a = 15 \quad c=? \quad c =\ ]
Use the triangle below for the next four questions.

3. What is the length of side “b” in the triangle below? Side $b = \underline{\hspace{1cm}}$

4. What is the measurement of angle $A$, to the nearest tenth? $\angle A = \underline{\hspace{1cm}}$

5. What is the measurement of angle $B$, to the nearest tenth? $\angle B = \underline{\hspace{1cm}}$

6. What is the measurement of angle $C$, to the nearest tenth? $\angle C = \underline{\hspace{1cm}}$
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. A pressure transducer with a range of 0 – 1000 psig is installed in a control system where it outputs 1 – 5 vdc. What voltage signal would you expect when the pressure transducer senses 675 psig?

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

**Electrical**

16. According to Ohm’s Law, what happens to current as resistance increases?

17. What electrical component allows current to flow in only one direction?
   a. Transformer
   b. Conductor
   c. Diode
18. Which of the below symbols represents a Hand Valve on a Piping and Instrumentation Diagram, according to the ANSI/ISA-95 standards?

- a
- b
- c

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

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

20. 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**

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

22. Which type of engine will produce more power, assuming RPMs and engine size are the same?
   a. Two-stroke motor  
   b. Four-stroke motor  
   c. Both produce the same amount of power

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

   ![Diagram of engine stroke]

   a. Intake Stroke  
   b. Compression Stroke  
   c. Power Stroke
Practice Problem Answer Key

1. 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. 3.70 vdc
15. 19.63
16. Decreases
17. C
18. B
19. C
20. B
21. C
22. A
23. C