

## PACIFIC GAS AND ELECTRIC COMPANY

PGE



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July 18, 1984

Local Union No. 1245  
 International Brotherhood of  
 Electrical Workers, AFL-CIO  
 P. O. Box 4790  
 Walnut Creek, California 94596

Attention: Mr. Jack McNally, Business Manager

Gentlemen:

A two-week operating training program, "Power Plant Physics, Chemistry and Introduction to Electrical Schematics," has been developed for presentation at the Central Training Facility in Oakland. The program is designed for Auxiliary Operators and Assistant Power Plant Operators in the 12- to 18-month wage step. The material is derived from the Operator Training Manual, Volume I, and is covered in a non-mathematical, higher operator-oriented, generic manner relating all concepts to the power plant. The course is one which is currently required.

Company proposes to amend the Steam Generation Department Operator Training Program to provide that all Auxiliary Operators and Assistant Power Plant Operators who enter the classification on or after September 1, 1982, be required to successfully complete the school.

- Attached are:
1. Proposed addition to the Steam Generation Department Operator Training Program.
  2. Outline and schedule for the proposed new two-week program.
  3. Course quizzes and examinations.

If you are in accord with the foregoing and attachments and agree thereto, please so indicate in the space provided below and return one executed copy of this letter to the Company.

Yours very truly,

PACIFIC GAS AND ELECTRIC COMPANY

By *John D. Broughton*  
 Manager of Industrial Relations

The Union is in accord with the foregoing and the attachments and it agrees thereto as of the date hereof.

LOCAL UNION NO. 1245, INTERNATIONAL  
 BROTHERHOOD OF ELECTRICAL WORKERS, AFL-CIO

By *Jack McNally*  
 Business Manager

Feb 13, 1984

STEAM GENERATION  
OPERATOR TRAINING PROGRAM

III.

D. Two-week Power Plant Physics, Chemistry and Introduction to Electrical Schematics

All Auxiliary Operators and Assistant Power Plant Operators who enter the classification on or after September 1, 1982, shall be required to successfully complete the two-week Power Plant Physics, Chemistry and Introduction to Electrical Schematics course.

1. Auxiliary Operators and Assistant Power Plant Operators will normally be scheduled to attend the Power Plant Physics, Chemistry and Introduction to Electrical Schematics course at approximately the 15-month step of their program.
2. An Operator who fails the Power Plant Physics, Chemistry and Introduction to Electrical Schematics course shall have three opportunities in a three-month period to successfully pass the test established for the Power Plant Physics, Chemistry and Introduction to Electrical Schematics course. Such three-month period will commence upon completion of the course for which the test was failed.
3. Successful completion of the Power Plant Physics, Chemistry and Introduction to Electrical Schematics course shall be a requirement for the 18-month PWI. An employee's PWI will not be withheld if Company is unable to schedule the employee to the school in a timely manner.
4. An Operator who fails to pass the Power Plant Physics, Chemistry and Introduction to Electrical Schematics course within the specified time shall be removed from the classification and demoted to Helper in a Steam Maintenance Department in the region. As a Helper, the employee shall either fill a vacancy if one exists or displace the junior employee in the classification provided such junior employee does not have more service.
5. The requirement to attend the Power Plant Physics, Chemistry and Introduction to Electrical Schematics course is waived for Diablo Canyon Power Plant Operators.

# **POWER PLANT PHYSICS, CHEMISTRY, AND INTRODUCTION TO ELECTRICAL SCHEMATICS**

## **1.0 INTRODUCTION**

**Purpose of the training program and requirements for classroom participation.**

## **2.0 POWER PLANT PHYSICS**

### **2.1 Combustion Process**

**2.1.1 Natural gas and oil fuels**

**2.1.2 Boiler safeguards**

**2.1.3 Fission process**

**2.1.4 Geothermal process**

**2.1.5 Gas turbine cycle**

### **2.2 Heat Transfer**

**2.2.1 Conduction**

**2.2.2 Convection**

**2.2.3 Radiation**

**2.2.4 Heat transfer, boiler overall**

### **2.3 Properties of Water and Steam**

**2.3.1 Water and steam properties defined**

**2.3.2 The basic thermal cycle (water to steam)**

**2.3.3 Steam tables**

**2.3.4 Pressure/specific volume diagram**

**2.3.5 T--temperature, S--entropy diagram**

**2.3.6 Mollier diagram**

**2.3.7 Heat balance (typical reheat unit)**

- 2.4 Fluid Flow
  - 2.4.1 Continuity equation
  - 2.4.2 General energy equation
  - 2.4.3 Piping, material, and joints
  - 2.4.4 Valves
- 2.5 Basic Instrumentation
  - 2.5.1 Pressure measurement
  - 2.5.2 Temperature measurement
  - 2.5.3 Liquid level measurement
  - 2.5.4 Flow measurement
  - 2.5.5 Transducers
- 2.6 Fluid Machinery (Heat to Mechanical Energy Conversion)
  - 2.6.1 Turbines
  - 2.6.2 Pumps
  - 2.6.3 Fans
- 2.7 Basic Electrical (Mechanical to Electrical Energy Conversion)
  - 2.7.1 Introduction; electrical terms and basic principles
  - 2.7.2 Ohm's law, power defined
  - 2.7.3 Magnetism, application to generation
  - 2.7.4 Basic ac generation
  - 2.7.5 Generator loading, power factor
  - 2.7.6 Reactive capability
  - 2.7.7 Transformers (power and instrumentation)
- 3.0 POWER PLANT CHEMISTRY
  - 3.1 Introduction to P. P. Chemistry, Purpose
  - 3.2 Principles of Chemistry (Glossary)

- 3.2.1 Elements and compounds (tables)
  - 3.2.2 Acid/base solutions, ph
  - 3.2.3 Conductivity and analysis
- 3.3 Makeup Water Systems
  - 3.3.1 Domestic water
  - 3.3.2 Makeup water, high quality
  - 3.3.3 Evaporators, filters
  - 3.3.4 Demineralizers
  - 3.3.5 Reverse osmosis units
- 3.4 Condensate and Feedwater
  - 3.4.1 Deaeration, chemical treatment
  - 3.4.2 Analysis
- 3.5 Boiler Water
  - 3.5.1 Chemical treatment
  - 3.5.2 Chemical charging and blowing
- 3.6 Circulating Water
  - 3.6.1 Once through system
  - 3.6.2 Recirculating cooling water systems (cooling towers, bearing cooling water)
- 4.0 BOILER CHEMICAL CLEANING
  - 4.1 Methods and Frequency
  - 4.2 Typical Chemical Cleaning Process
    - 4.2.1 Preparation of the boiler
    - 4.2.2 Chemically cleaning process
    - 4.2.3 Safety precautions
  - 4.3 Air Preheater Washing
    - 4.3.1 Purpose and general procedures

## **5.0 EFFLUENT CONTROL**

### **5.1 Effluent Sources in Our Plants**

#### **5.1.1 Sumps**

#### **5.1.2 Oily water separators**

#### **5.1.3 Yard drains**

#### **5.1.4 Oil spills (contingency plan)**

## **6.0 HAZARDOUS WASTE MANAGEMENT**

**Presentation by a Power Plant Chemist**

## **7.0 ELECTRIC SCHEMATIC DIAGRAMS**

### **7.1 Introduction, Review of Single Line Diagrams**

### **7.2 Purpose of the Schematic Diagram**

#### **7.2.1 Guide rules applying to schematics**

#### **7.2.2 Symbols**

#### **7.2.3 Device tables for schematic analysis**

#### **7.2.4 Relays**

#### **7.2.5 Schematic print symbols**

### **7.3 Development of a Schematic Diagram**

#### **7.3.1 Basic electrical connection (motor to bus)**

#### **7.3.2 Development of starting, stopping (manual), indication and protective schemes**

#### **7.3.3 Ac control circuit (auto operation)**

#### **7.3.4 Control circuit functions**

#### **7.3.5 Overload protection**

#### **7.3.6 Auxiliary relay (reset coil)**

### **7.4 Ac Control Circuit Operation**

#### **7.4.1 Sequence of events**

- 7.5 Motor Operation:  
Condition: Motor is Running (Device Status)
  - 7.5.1 Stopping the motor
  - 7.5.2 Overload shutdown
  - 7.5.3 Operation of the reset scheme
- 7.6 Circuit Status Indication
  - 7.6.1 Review of schematic, introduction to indicating system
  - 7.6.2 Addition of indicating circuitry, sequence of indicating events
- 7.7 Automatic Starting Feature
  - 7.7.1 Introduction and development of this feature
- 7.8 Direct Current Control Circuitry
  - 7.8.1 Analyzing the dc control circuit
  - 7.8.2 Operational sequence of this scheme

# POWER PLANT PHYSICS, CHEMISTRY, ELECTRICAL SCHEMATICS CLASS SCHEDULE

WEEK 1

|      | MONDAY   | TUESDAY  | WEDNESDAY  | THURSDAY  | FRIDAY   |
|------|--|--|--|---|--|
| 0800 | Introduction   | Nuclear<br>Geothermal,<br>Gas Turbine,                     | Properties of<br>Water & Steam<br>(Cont'd)                           | Fluid Flow<br>Continuity EQ                                       | Instruments<br>pressures<br>temperature<br>level<br>flow                 |
| 0830 | <u>Physics</u><br>Combustion<br>Process and<br>Heat Transfer | Plant Cycles   | Steam Tables<br>T-S Basic<br>Superheat Cycle                         | General Energy<br>EQ  |  |
| 0945 |  |  |  |   |  |
| 1000 | BREAK  | BREAK  | BREAK  | BREAK   | BREAK  |
|      | Boiler<br>Hazards  | Properties<br>of<br>Water & Steam                          | T-S Reheat<br>Cycle<br>Mollier Diagram                               | Piping<br>Joints<br>Expansion                                     | Analyze Heat<br>Balance at<br>Min. & Full Load<br>330 MW 750 MW<br>Units |
| 1100 | Combustion<br>Demonstration                                  |  | Heat Balance<br>in Reheat Unit                                       | Valves  |  |
| 1145 |  | (Up To<br>Steam Tables)                                    |  |   | QUIZ   |
| 1200 | QUIZ   | QUIZ   | QUIZ   | QUIZ  |  |
| 1230 | LUNCH  | LUNCH  | LUNCH  | LUNCH   | LUNCH  |
|      | ←  | ← ELECTRICAL SCHEMATICS →                                  |  |   | →  |
|      | Introduction<br>Symbols<br>Devices<br>Tables                 | Start Development<br>of Schematic<br>Print                 | Control<br>Circuit<br>Power Source<br><br>Function of<br>Cont. Circ. | Develop A-C<br>Cont. Circ.<br><br>OL Protection<br>Feature, Added | Aux. Relay<br>OL Reset<br>(Double Coil<br>Relays)<br>Review              |
| 1415 |  |  |  |   | QUIZ   |
| 1430 | QUIZ   | QUIZ   | QUIZ   | QUIZ  |  |
| 1445 | BREAK  | BREAK  | BREAK  | BREAK   | BREAK  |
|      | ←  | ← CHEMISTRY →  |  |   | →  |
|      | Purpose<br>Principles<br>pH                                  | Conductivity<br>Domestic Water<br>Softeners<br>Evaporators | Precoat Filters<br>Demineralizers                                    | Reverse Osmosis<br><br>Condensate &<br>Feedwater                  | Boiler Water   |
| 1615 |  |  |  |   |  |
| 1630 | QUIZ   | QUIZ   | QUIZ   | QUIZ  | QUIZ   |



# POWER PLANT PHYSICS, CHEMISTRY, ELECTRICAL SCHEMATICS CLASS SCHEDULE

## WEEK 2

|      | MONDAY  | TUESDAY   | WEDNESDAY  | THURSDAY   | FRIDAY                             |
|------|---|---|--|--|------------------------------------|
| 0800 | <u>FLUID MACH.</u><br>Turbines<br>Turbine Blading                               | <u>FLUID MACH.</u><br>Pumps<br>1. Positive Displace.<br>2. Rotary<br>3. Jet<br>4. Centrifugal     | <u>BASIC ELECTRIC</u><br>Generation<br>Review Elect. Principles<br>Review of Magnetism | <u>BASIC ELECTRIC</u><br>Generation<br>Rev. Requirements for Paralleling.<br>Paralleling<br>Turbine Torque | Review of 2 Weeks Training Session |
| 0830 |   |   |  |  |                                    |
| 0945 |   |   |  |  |                                    |
| 1000 | BREAK   | BREAK   | BREAK  | BREAK  | BREAK                              |
| 1100 | Turbine Thrust<br>Turb. Driven Aux.<br><br>Condenser<br><br>Review Heat Balance | 5. Mixed Flow<br>6. Fans<br><br>Review <u>Fluid Mach</u><br>Question and Answer                   | Principles of Elect. Gen. Up To Parelleling  | pf, vars<br>React. Cap Curve<br><br>TRANSFORMERS<br>Power Potential Current                                | FINAL EXAM                         |
| 1145 |   |   |  |  |                                    |
| 1200 | QUIZ  | QUIZ  | QUIZ   | QUIZ   |                                    |
| 1230 | LUNCH   | LUNCH   | LUNCH  | LUNCH  | LUNCH                              |
| 1415 | ←<br>A-C Cōnt. Circ. Operation<br>Motor Operation<br><br>G.O.O. Motor Starts    | ← <b>ELECTRICAL SCHEMATICS</b> →<br>Motor Operation<br>OL Shutdown and Reset<br>Indicating Lights | Automatic Starting Feature<br><br>D.C. Control Circuit                                 | →<br>Large Motor Starting<br>Circuitry<br>St/By Starting   | REVIEW<br>CLEARANCE<br>PROCEDURES  |
| 1430 | QUIZ  | QUIZ  | QUIZ   | QUIZ   |                                    |
| 1445 | BREAK   | BREAK   | BREAK  | BREAK  |                                    |
| 1615 | ←<br>Geothermal Abatement Program   | ← <b>CHEMISTRY</b> →<br>Hazardous Waste Management  | Circ. Water Cooling Towers<br>Bay Cool. Wtr. Effluent Control                          | →<br>Boiler Chemical Cleaning  | Review<br><br>Final Exam           |
| 1630 | QUIZ  | QUIZ  | QUIZ   | QUIZ   |                                    |

PHYSICS

Quiz P-1

1. How does the fission process produce heat?
  
2. a. What is the source of geothermal steam? Explain.  
b. What is normal pressure and temperature?
  
3. The steam removed from the turbine to the heaters is called\_\_\_\_\_
  - a. Steam Heat
  - b. reducing steam
  - c. extraction steam
  - d. superheat steam
  
4. A Gas Turbine uses external air to drive the unit up to synchronous speed. T      F
  
5. The boiler feed pump takes suction from the hotwell and pumps through heaters to the boiler. T      F
  
6. How is the fission process controlled in a PWR? ( Give at least three methods )

Quiz P-1  
(Continued)

For Questions 7-10

Use the list of components to draw a simple one line diagram of each plant listed. Use arrows to show flow direction and label each component.

7. Geothermal Cycle:

Steam Inlet, Cooling Tower, Condenser, Circ Pumps(2), Generator, Basin, Hotwell, Turbine.

8. Gas Turbine:

Generator, Drive Turbine, Compressor, Power Turbine, Air Inlet, Fuel Inlet, Combustion Chamber.

Quiz P-1  
(Continued)

9. Primary Loop of a PWR:

Reactor, Reactor Coolant Pump, Steam Generator, Pressurizer.

10. Fossil Fuel Reheat, Regenerative Cycle:

Turbine, Boiler, Reheat, Condenser, Extraction, Condensate Pump,  
Heater, Boiler Feed Pump, Hotwell.

Quiz P-2

1. Define pressure.
2. List three commonly used units of pressure measurement and when each is generally used.
3. List four types of energy encountered in power plant operation.
4. The Continuity Equation states, "at any point in a pipe system, the flow rate is the same as long as no \_\_\_\_\_ is \_\_\_\_\_ or \_\_\_\_\_."
5. The General Energy Equation states, "the total energy contained in a fluid at any point in the system must be equal to the total energy contained at any other point in the system provided there has been no \_\_\_\_\_, or \_\_\_\_\_."
6. What is enthalpy? What are the units of enthalpy?

Quiz P-2

(Continued)

7. What happens to the specific volume of water as it is heated?
8. What happens to the specific volume of steam as it is cooled?
9. What happens to saturation temperature as pressure increases?
10. According to the Continuity Equation and General Energy Equation, what happens to velocity and pressure as flow area in a pipe system increases?
11. Refer to the steam table.
  - a. How many BTU's must be added to one pound of a saturated liquid at 200 psia to convert it to one pound of saturated vapor? \_\_\_\_\_
  - b. What is the saturation temperature of steam at 1,300 psia? \_\_\_\_\_
  - c. If a boiler is operating at 2,000 psia and 1,000 F, how many degrees superheat is being attained? \_\_\_\_\_
12. Which contains more total energy, one pound of water at 212 F or one pound of steam at 212 F? How much more? ( Refer to Steam Table )

(Continued)

- 3 -



Quiz P-2

(Continued)

19. A transducer is used to convert a \_\_\_\_\_.

- a. Low air signal to high air signal.
- b. Low electric signal to high electrical signal.
- c. Any type of signal to another type of signal.
- d. Converts an AC signal to a DC signal.

20. Define BTU.

## 2. SATURATION: PRESSURES

| Abs Press. |        | Specific Volume |        | Enthalpy |          |        | Entropy |          |        | Internal Energy |          |        | Abs Press. |
|------------|--------|-----------------|--------|----------|----------|--------|---------|----------|--------|-----------------|----------|--------|------------|
| Lb         | Temp   | Sat.            | Sat.   | Sat.     | Evap     | Sat.   | Sat.    | Evap     | Sat.   | Sat.            | Evap     | Sat.   | Lb         |
| Sq In.     | F      | Liquid          | Vapor  | Liquid   | $h_{fg}$ | Vapor  | Liquid  | $s_{fg}$ | Vapor  | Liquid          | $u_{fg}$ | Vapor  | Sq In.     |
| P          | t      | $v_f$           | $v_g$  | $h_f$    |          | $h_g$  | $s_f$   | $s_{fg}$ | $s_g$  | $u_f$           | $u_{fg}$ | $u_g$  | P          |
| 1.0        | 101.74 | 0.01614         | 333.8  | 69.70    | 1036.3   | 1106.0 | 0.1326  | 1.8456   | 1.9782 | 69.70           | 974.6    | 1044.3 | 1.0        |
| 2.0        | 126.08 | 0.01623         | 173.73 | 93.99    | 1022.2   | 1116.2 | 0.1749  | 1.7451   | 1.9200 | 93.98           | 957.9    | 1051.9 | 2.0        |
| 3.0        | 141.48 | 0.01630         | 118.71 | 109.37   | 1013.2   | 1122.6 | 0.2008  | 1.6855   | 1.8863 | 109.36          | 947.3    | 1056.7 | 3.0        |
| 4.0        | 152.97 | 0.01636         | 90.63  | 120.86   | 1006.4   | 1127.3 | 0.2198  | 1.6427   | 1.8625 | 120.85          | 939.3    | 1060.2 | 4.0        |
| 5.0        | 162.24 | 0.01640         | 73.52  | 130.13   | 1001.0   | 1131.1 | 0.2347  | 1.6094   | 1.8441 | 130.12          | 933.0    | 1063.1 | 5.0        |
| 6.0        | 170.06 | 0.01645         | 61.98  | 137.96   | 996.2    | 1134.2 | 0.2472  | 1.5820   | 1.8292 | 137.94          | 927.5    | 1065.4 | 6.0        |
| 7.0        | 176.85 | 0.01649         | 53.64  | 144.76   | 992.1    | 1136.9 | 0.2581  | 1.5586   | 1.8167 | 144.74          | 922.7    | 1067.4 | 7.0        |
| 8.0        | 182.86 | 0.01653         | 47.34  | 150.79   | 988.5    | 1139.3 | 0.2674  | 1.5383   | 1.8057 | 150.77          | 918.4    | 1069.2 | 8.0        |
| 9.0        | 188.28 | 0.01658         | 42.40  | 156.22   | 985.2    | 1141.4 | 0.2759  | 1.5203   | 1.7962 | 156.19          | 914.6    | 1070.8 | 9.0        |
| 10         | 193.21 | 0.01659         | 38.42  | 161.17   | 982.1    | 1143.3 | 0.2835  | 1.5041   | 1.7876 | 161.14          | 911.1    | 1072.2 | 10         |
| 14.696     | 212.00 | 0.01672         | 26.80  | 180.07   | 970.3    | 1150.4 | 0.3120  | 1.4446   | 1.7566 | 180.02          | 897.5    | 1077.5 | 14.696     |
| 15         | 213.03 | 0.01672         | 26.29  | 181.11   | 969.7    | 1150.8 | 0.3135  | 1.4415   | 1.7549 | 181.06          | 896.7    | 1077.8 | 15         |
| 20         | 227.96 | 0.01683         | 20.089 | 196.16   | 960.1    | 1156.3 | 0.3356  | 1.3962   | 1.7319 | 196.10          | 885.8    | 1081.9 | 20         |
| 30         | 250.33 | 0.01701         | 13.746 | 218.82   | 945.3    | 1164.1 | 0.3680  | 1.3313   | 1.6993 | 218.73          | 869.1    | 1087.8 | 30         |
| 40         | 267.25 | 0.01715         | 10.498 | 236.03   | 933.7    | 1169.7 | 0.3919  | 1.2844   | 1.6763 | 235.90          | 856.1    | 1092.0 | 40         |
| 50         | 281.01 | 0.01727         | 8.515  | 250.09   | 924.0    | 1174.1 | 0.4110  | 1.2474   | 1.6585 | 249.93          | 845.4    | 1095.3 | 50         |
| 60         | 292.71 | 0.01738         | 7.175  | 262.09   | 915.5    | 1177.6 | 0.4270  | 1.2168   | 1.6438 | 261.90          | 836.0    | 1097.9 | 60         |
| 70         | 302.92 | 0.01748         | 6.206  | 272.61   | 907.9    | 1180.6 | 0.4409  | 1.1906   | 1.6315 | 272.38          | 827.8    | 1100.2 | 70         |
| 80         | 312.03 | 0.01757         | 5.472  | 282.02   | 901.1    | 1183.1 | 0.4531  | 1.1676   | 1.6207 | 281.76          | 820.3    | 1102.1 | 80         |
| 90         | 320.27 | 0.01766         | 4.896  | 290.56   | 894.7    | 1185.3 | 0.4641  | 1.1471   | 1.6112 | 290.27          | 813.4    | 1103.7 | 90         |
| 100        | 327.81 | 0.01774         | 4.432  | 298.40   | 888.8    | 1187.2 | 0.4740  | 1.1286   | 1.6026 | 298.08          | 807.1    | 1105.2 | 100        |
| 120        | 341.25 | 0.01789         | 3.726  | 312.44   | 877.9    | 1190.4 | 0.4916  | 1.0962   | 1.5878 | 312.05          | 795.6    | 1107.6 | 120        |
| 140        | 353.02 | 0.01802         | 3.220  | 324.82   | 868.2    | 1193.0 | 0.5069  | 1.0682   | 1.5751 | 324.35          | 785.2    | 1109.6 | 140        |
| 160        | 363.53 | 0.01815         | 2.834  | 335.93   | 859.2    | 1195.1 | 0.5204  | 1.0436   | 1.5640 | 335.39          | 775.8    | 1111.2 | 160        |
| 180        | 373.06 | 0.01827         | 2.532  | 346.03   | 850.8    | 1196.9 | 0.5325  | 1.0217   | 1.5542 | 345.42          | 767.1    | 1112.5 | 180        |
| 200        | 381.79 | 0.01839         | 2.288  | 355.36   | 843.0    | 1198.4 | 0.5435  | 1.0018   | 1.5453 | 354.68          | 759.0    | 1113.7 | 200        |
| 250        | 400.95 | 0.01865         | 1.8438 | 376.00   | 825.1    | 1201.1 | 0.5675  | 0.9588   | 1.5263 | 375.14          | 740.7    | 1115.8 | 250        |
| 300        | 417.33 | 0.01890         | 1.5433 | 393.84   | 809.0    | 1202.8 | 0.5879  | 0.9225   | 1.5104 | 392.79          | 724.3    | 1117.1 | 300        |
| 350        | 431.72 | 0.01913         | 1.3260 | 409.69   | 794.2    | 1203.9 | 0.6056  | 0.8910   | 1.4966 | 408.45          | 709.6    | 1118.0 | 350        |
| 400        | 444.59 | 0.0193          | 1.1613 | 424.0    | 780.5    | 1204.5 | 0.6214  | 0.8630   | 1.4844 | 422.6           | 695.9    | 1118.5 | 400        |
| 450        | 456.28 | 0.0195          | 1.0320 | 437.2    | 767.4    | 1204.6 | 0.6356  | 0.8378   | 1.4734 | 435.5           | 683.2    | 1118.7 | 450        |
| 500        | 467.01 | 0.0197          | 0.9278 | 449.4    | 755.0    | 1204.4 | 0.6487  | 0.8147   | 1.4634 | 447.6           | 671.0    | 1118.6 | 500        |
| 550        | 476.93 | 0.0199          | 0.8422 | 460.8    | 743.1    | 1203.9 | 0.6608  | 0.7934   | 1.4542 | 458.8           | 659.4    | 1118.2 | 550        |
| 600        | 486.21 | 0.0201          | 0.7698 | 471.6    | 731.6    | 1203.2 | 0.6720  | 0.7734   | 1.4454 | 469.4           | 648.3    | 1117.7 | 600        |
| 700        | 503.10 | 0.0205          | 0.6554 | 491.5    | 709.7    | 1201.2 | 0.6925  | 0.7371   | 1.4296 | 488.8           | 627.5    | 1116.3 | 700        |
| 800        | 518.23 | 0.0209          | 0.5687 | 509.7    | 688.9    | 1198.6 | 0.7108  | 0.7045   | 1.4153 | 506.6           | 607.8    | 1114.4 | 800        |
| 900        | 531.98 | 0.0212          | 0.5006 | 526.6    | 668.8    | 1195.4 | 0.7275  | 0.6741   | 1.4020 | 523.1           | 589.0    | 1112.1 | 900        |
| 1000       | 544.61 | 0.0216          | 0.4456 | 542.4    | 649.4    | 1191.8 | 0.7430  | 0.6467   | 1.3897 | 538.4           | 571.0    | 1109.4 | 1000       |
| 1100       | 556.31 | 0.0220          | 0.4001 | 557.4    | 630.4    | 1187.8 | 0.7575  | 0.6205   | 1.3780 | 552.9           | 553.5    | 1106.4 | 1100       |
| 1200       | 567.22 | 0.0223          | 0.3619 | 571.7    | 611.7    | 1183.4 | 0.7711  | 0.5956   | 1.3667 | 566.7           | 538.3    | 1103.0 | 1200       |
| 1300       | 577.46 | 0.0227          | 0.3293 | 585.4    | 593.2    | 1178.6 | 0.7840  | 0.5719   | 1.3559 | 580.0           | 519.4    | 1099.4 | 1300       |
| 1400       | 587.10 | 0.0231          | 0.3012 | 598.7    | 574.7    | 1173.4 | 0.7963  | 0.5491   | 1.3454 | 592.7           | 502.7    | 1095.4 | 1400       |
| 1500       | 596.23 | 0.0235          | 0.2765 | 611.6    | 556.3    | 1167.9 | 0.8082  | 0.5269   | 1.3351 | 605.1           | 486.1    | 1091.2 | 1500       |
| 2000       | 635.82 | 0.0257          | 0.1878 | 671.7    | 463.4    | 1135.1 | 0.8619  | 0.4230   | 1.2849 | 662.2           | 403.4    | 1065.6 | 2000       |
| 2500       | 668.13 | 0.0287          | 0.1307 | 730.6    | 360.5    | 1091.1 | 0.9126  | 0.3197   | 1.2322 | 717.3           | 313.3    | 1030.6 | 2500       |
| 3000       | 695.36 | 0.0316          | 0.0858 | 802.5    | 217.8    | 1020.3 | 0.9731  | 0.1885   | 1.1615 | 783.4           | 169.3    | 972.7  | 3000       |
| 3206.2     | 705.40 | 0.0503          | 0.0503 | 902.7    | 0        | 902.7  | 1.0580  | 0        | 1.0580 | 872.9           | 0        | 872.9  | 3206.2     |

NAME \_\_\_\_\_  
DATE \_\_\_\_\_

**POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS**

**Quiz P-3**

( 30 points each )

1. What are the three principle combustible constituents of fuel?

- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_

2. What are the three principle elements of combustion air?

- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_

3. Why do we use only fuel oil that has low sulfur content?

- a. \_\_\_\_\_  
\_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. a. In which direction do the blades on an induced draft fan curve?

\_\_\_\_\_

b. Why? (give at least two reasons)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. The forced draft fan takes suction after the economizer and discharges to the stack.

T F

6. The air preheater cold end average temperature must be controlled to a certain point as a protection against-----

a) flue gases too hot

c) fan protection

b) flue gas recirculation

d) corrosion

7. What is the proper operator action to correct an abnormal air/fuel ratio resulting in incomplete combustion?

a. \_\_\_\_\_  
\_\_\_\_\_

b. \_\_\_\_\_  
\_\_\_\_\_

c. \_\_\_\_\_  
\_\_\_\_\_

8. What should be the immediate operator action in the event of total loss of fire in a boiler ?

a. \_\_\_\_\_

b. \_\_\_\_\_

9. Where is the radiant zone of the boiler ?

10. The major product of combustion is:

a) NO<sub>x</sub>

c) H<sub>2</sub>SO<sub>4</sub>

b) CO

d) CO<sub>2</sub>

### Quiz P-4

1. The number of stages designed into the turbine depends on \_\_\_\_\_.
  - a. number of extraction points
  - b. steam pressure
  - c. type of turbine
  - d. all of these
2. Typically, the first few stages in a high pressure turbine have reaction blading. T F
3. In most turbines the steam flow is parallel to the axis of the shaft. T F
4. The pressure drop across the moving blades reduces the axial thrust in a reaction turbine. T F
5. It is possible to cause excessive rotor thrust by clearing a feedwater heater. T F
6. Thrust bearings are made to accept loading in either direction. T F
7. Either a fluid or vapor may be the motive force to operate a jet pump. T F
8. The discharge of a jet pump is a mixture of the motive fluid and the fluid being pumped. T F
9. Briefly describe how vacuum is created in a condenser while the unit is in service.

Quiz P-4

(Continued)

10. What is a fluid machine?

NAME \_\_\_\_\_  
DATE \_\_\_\_\_

POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS

Physics Review Quiz

(For lessons P-1 through P-4)

True/False

1. PGandE uses only fuel oil that is low in sulfur content because it is less expensive. \_\_\_\_\_
2. In the event a boiler upset results in excess combustibles, the operator should increase air flow to restore excess  $O_2$  as fast as possible. \_\_\_\_\_
3. When an atom of fuel fissions, it splits into two smaller particles having less total mass than the atom of fuel. \_\_\_\_\_
4. Water and steam in contact in a pressure vessel have the same temperature. \_\_\_\_\_
5. Heat flow to or from a fluid that does not result in a change of temperature is known as sensible heat. \_\_\_\_\_
6. In a closed pipe system, if the cross-sectional area decreases, the velocity of the fluid increases. \_\_\_\_\_
7. In a closed pipe system, a decrease in velocity of fluid flow results in an increase in pressure. \_\_\_\_\_
8. An increase in temperature will increase viscosity. \_\_\_\_\_

PHYSICS REVIEW QUIZ

(Continued)

9. Turbine rotor thrust may be excessive if stage differential pressures are exceeded. T F
10. When reading a "U-tube" manometer, the inches of pressure is obtained by reading the indication on the high leg. T F

Multiple Choice

1. The number of stages designed into the turbine depends on \_\_\_\_
- a. Steam pressure
  - b. extraction points
  - c. type or use of turbine
  - d. all of these
2. Head meters utilize \_\_\_\_ as the primary element.
- a. Venturi tube
  - b. Thin plate orifice
  - c. Flow nozzle
  - d. Any of the above
3. A gas turbine uses an external air source to drive up to \_\_\_\_ speed.
- a. Synchronous
  - b. Cool down
  - c. Ignition
  - d. Windmill
4. To correct an abnormal air/fuel ratio resulting in incomplete combustion you should \_\_\_\_.
- a. Decrease air slowly.
  - b. Increase air and decrease gas together
  - c. Alternately increase air slowly and decrease fuel slowly.
  - d. Increase gas slowly.



Physics Review Quiz

(Continued)

5. Potential energy is energy due to a body's \_\_\_\_.
- a. Heat
  - b. Motion
  - c. Position
  - d. Friction.
6. The turbine design which produces the greatest thrust is \_\_\_\_.
- a. Impulse Turbine
  - b. Tandem Compound
  - c. Reaction Turbine
  - d. Cross Compound
7. 50 psig is approximately equal to \_\_\_\_.
- a. 65 psia
  - b. 7" H<sub>2</sub>O
  - c. 25" Hg
  - d. 14.7 psia
8. Superheater tube metal temperature is higher than boiler tube temperature because: \_\_\_\_.
- a. Flue gas temperature is higher.
  - b. Air/flue gas flow is greater.
  - c. Steam has poorer heat transfer ability than water.
  - d. Superheater tubes are thicker than boiler tubes.
9. Match the following types of gauges with their usual application:
- a. Hg filled single leg manometer      \_\_\_\_ positive pressure
  - b. Bourdon tube      \_\_\_\_ low positive pressure
  - c. H<sub>2</sub>O filled "U-tube" manometer      \_\_\_\_ negative pressure

Physics Review Quiz

(Continued)

10. When shutting down a set of air ejector primary jets, the first valve to close is \_\_\_\_\_ .
- |                       |                    |
|-----------------------|--------------------|
| a. Steam supply valve | c. Discharge valve |
| b. Air removal valve  | d. Drip line valve |

Essay Questions

1. What should be the immediate operator action in the event of total loss of fire in the boiler?

- a. \_\_\_\_\_
- b. \_\_\_\_\_

2. Refer to the Steam Table in your handout and answer the following:

- a. How many Btu's must be added to one pound of a saturated liquid at 500 psia to convert it to one pound of saturated vapor?

\_\_\_\_\_

- b. What is the saturation temperature of water at 2,000 psia?

\_\_\_\_\_

- c. If a boiler is operating at 1,300 psia and 900°F, how many degrees superheat is being attained?

\_\_\_\_\_

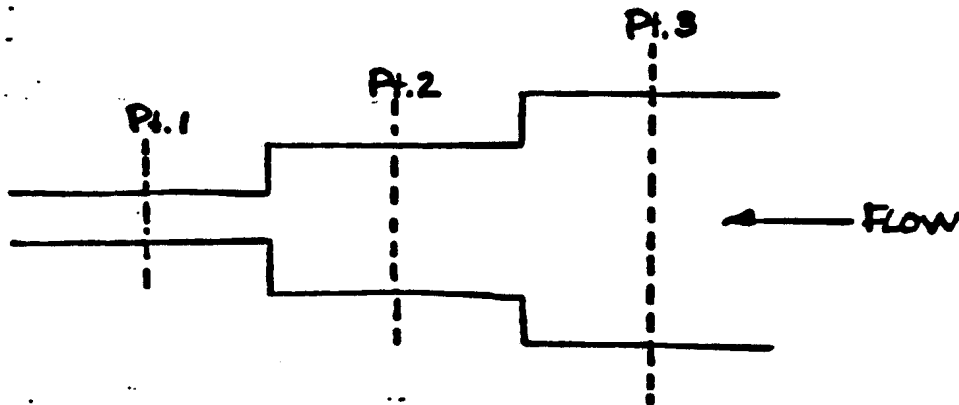
- d. What would be the change in specific volume when condensing one pound of saturated steam at 212°F to a saturated liquid at 101.74°F?

\_\_\_\_\_

Physics Review Quiz

(Continued)

3.



Consider the closed pipe system above:

- a. What is the difference in flow rate between Point 1 and Point 3?

---

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- b. Name the principle and give a brief statement that applies to the flow relationship.

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- c. When the flow area decreases from Point 3 to Point 2, what happens to pressure?

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Physics Review Quiz

(Continued)

d. What is the principle that applies to this relationship?

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4. What are the three elements necessary for combustion?

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5. What causes "flashing" when venting a vessel filled with water at or below saturation temperature?

---

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## 2. SATURATION: PRESSURES

| Abs Press.<br>lb<br>Sq In.<br>p | Temp<br>F<br>t | Specific Volume                  |                                 | Enthalpy                         |                         |                                 | Entropy                          |                         |                                 | Internal Energy                  |                         |                                 | Abs Press.<br>lb<br>Sq In.<br>p |
|---------------------------------|----------------|----------------------------------|---------------------------------|----------------------------------|-------------------------|---------------------------------|----------------------------------|-------------------------|---------------------------------|----------------------------------|-------------------------|---------------------------------|---------------------------------|
|                                 |                | Sat.<br>Liquid<br>v <sub>f</sub> | Sat.<br>Vapor<br>v <sub>g</sub> | Sat.<br>Liquid<br>h <sub>f</sub> | Evap<br>h <sub>fg</sub> | Sat.<br>Vapor<br>h <sub>g</sub> | Sat.<br>Liquid<br>s <sub>f</sub> | Evap<br>s <sub>fg</sub> | Sat.<br>Vapor<br>s <sub>g</sub> | Sat.<br>Liquid<br>u <sub>f</sub> | Evap<br>u <sub>fg</sub> | Sat.<br>Vapor<br>u <sub>g</sub> |                                 |
| 1.0                             | 101.74         | 0.01614                          | 333.6                           | 69.70                            | 1036.3                  | 1106.0                          | 0.1326                           | 1.8456                  | 1.9782                          | 69.70                            | 974.6                   | 1044.3                          | 1.0                             |
| 2.0                             | 126.08         | 0.01623                          | 173.73                          | 93.99                            | 1022.2                  | 1116.2                          | 0.1749                           | 1.7451                  | 1.9200                          | 93.98                            | 957.9                   | 1051.9                          | 2.0                             |
| 3.0                             | 141.48         | 0.01630                          | 118.71                          | 109.37                           | 1013.2                  | 1122.6                          | 0.2008                           | 1.6855                  | 1.8863                          | 109.36                           | 947.3                   | 1056.7                          | 3.0                             |
| 4.0                             | 152.97         | 0.01636                          | 90.63                           | 120.86                           | 1006.4                  | 1127.3                          | 0.2198                           | 1.6427                  | 1.8625                          | 120.85                           | 939.3                   | 1060.2                          | 4.0                             |
| 5.0                             | 162.24         | 0.01640                          | 73.52                           | 130.13                           | 1001.0                  | 1131.1                          | 0.2347                           | 1.6094                  | 1.8441                          | 130.12                           | 933.0                   | 1063.1                          | 5.0                             |
| 6.0                             | 170.06         | 0.01645                          | 61.98                           | 137.96                           | 996.2                   | 1134.2                          | 0.2472                           | 1.5820                  | 1.8292                          | 137.94                           | 927.5                   | 1065.4                          | 6.0                             |
| 7.0                             | 176.85         | 0.01649                          | 53.64                           | 144.76                           | 992.1                   | 1136.9                          | 0.2581                           | 1.5586                  | 1.8167                          | 144.74                           | 922.7                   | 1067.4                          | 7.0                             |
| 8.0                             | 182.66         | 0.01653                          | 47.34                           | 150.79                           | 988.5                   | 1139.3                          | 0.2674                           | 1.5383                  | 1.8057                          | 150.77                           | 918.4                   | 1069.2                          | 8.0                             |
| 9.0                             | 188.28         | 0.01656                          | 42.40                           | 156.22                           | 985.2                   | 1141.4                          | 0.2759                           | 1.5203                  | 1.7962                          | 156.19                           | 914.6                   | 1070.8                          | 9.0                             |
| 10                              | 193.21         | 0.01659                          | 38.42                           | 161.17                           | 982.1                   | 1143.3                          | 0.2835                           | 1.5041                  | 1.7876                          | 161.14                           | 911.1                   | 1072.2                          | 10                              |
| 14.696                          | 212.00         | 0.01672                          | 26.80                           | 180.07                           | 970.3                   | 1150.4                          | 0.3120                           | 1.4446                  | 1.7566                          | 180.02                           | 897.5                   | 1077.5                          | 14.696                          |
| 15                              | 213.03         | 0.01672                          | 26.29                           | 181.11                           | 969.7                   | 1150.8                          | 0.3135                           | 1.4415                  | 1.7549                          | 181.06                           | 896.7                   | 1077.8                          | 15                              |
| 20                              | 227.96         | 0.01683                          | 20.089                          | 196.16                           | 960.1                   | 1156.3                          | 0.3356                           | 1.3962                  | 1.7319                          | 196.10                           | 885.8                   | 1081.9                          | 20                              |
| 30                              | 250.33         | 0.01701                          | 13.746                          | 218.82                           | 945.3                   | 1164.1                          | 0.3680                           | 1.3313                  | 1.6993                          | 218.73                           | 869.1                   | 1087.8                          | 30                              |
| 40                              | 267.25         | 0.01715                          | 10.498                          | 236.03                           | 933.7                   | 1169.7                          | 0.3919                           | 1.2844                  | 1.6763                          | 235.90                           | 856.1                   | 1092.0                          | 40                              |
| 50                              | 281.01         | 0.01727                          | 8.515                           | 250.09                           | 924.0                   | 1174.1                          | 0.4110                           | 1.2474                  | 1.6585                          | 249.93                           | 845.4                   | 1095.3                          | 50                              |
| 60                              | 292.71         | 0.01738                          | 7.175                           | 262.09                           | 915.5                   | 1177.6                          | 0.4270                           | 1.2168                  | 1.6439                          | 261.90                           | 836.0                   | 1097.9                          | 60                              |
| 70                              | 302.92         | 0.01748                          | 6.206                           | 272.61                           | 907.9                   | 1180.6                          | 0.4409                           | 1.1906                  | 1.6315                          | 272.38                           | 827.8                   | 1100.2                          | 70                              |
| 80                              | 312.03         | 0.01757                          | 5.472                           | 282.02                           | 901.1                   | 1183.1                          | 0.4531                           | 1.1676                  | 1.6207                          | 281.76                           | 820.3                   | 1102.1                          | 80                              |
| 90                              | 320.27         | 0.01766                          | 4.896                           | 290.56                           | 894.7                   | 1185.3                          | 0.4641                           | 1.1471                  | 1.6112                          | 290.27                           | 813.4                   | 1103.7                          | 90                              |
| 100                             | 327.81         | 0.01774                          | 4.432                           | 298.40                           | 888.8                   | 1187.2                          | 0.4740                           | 1.1286                  | 1.6026                          | 298.08                           | 807.1                   | 1105.2                          | 100                             |
| 120                             | 341.25         | 0.01789                          | 3.728                           | 312.44                           | 877.9                   | 1190.4                          | 0.4916                           | 1.0962                  | 1.5878                          | 312.05                           | 795.6                   | 1107.6                          | 120                             |
| 140                             | 353.02         | 0.01802                          | 3.220                           | 324.82                           | 868.2                   | 1193.0                          | 0.5069                           | 1.0682                  | 1.5751                          | 324.35                           | 785.2                   | 1109.6                          | 140                             |
| 160                             | 363.53         | 0.01815                          | 2.834                           | 335.93                           | 859.2                   | 1195.1                          | 0.5204                           | 1.0436                  | 1.5640                          | 335.39                           | 775.8                   | 1111.2                          | 160                             |
| 180                             | 373.06         | 0.01827                          | 2.532                           | 346.03                           | 850.8                   | 1196.9                          | 0.5325                           | 1.0217                  | 1.5542                          | 345.42                           | 767.1                   | 1112.5                          | 180                             |
| 200                             | 381.79         | 0.01839                          | 2.288                           | 355.36                           | 843.0                   | 1198.4                          | 0.5435                           | 1.0018                  | 1.5453                          | 354.68                           | 759.0                   | 1113.7                          | 200                             |
| 250                             | 400.95         | 0.01865                          | 1.8438                          | 376.00                           | 825.1                   | 1201.1                          | 0.5675                           | 0.9588                  | 1.5263                          | 375.14                           | 740.7                   | 1115.8                          | 250                             |
| 300                             | 417.33         | 0.01890                          | 1.5433                          | 393.84                           | 809.0                   | 1202.8                          | 0.5879                           | 0.9225                  | 1.5104                          | 392.79                           | 724.3                   | 1117.1                          | 300                             |
| 350                             | 431.72         | 0.01913                          | 1.3260                          | 409.69                           | 794.2                   | 1203.9                          | 0.6056                           | 0.8910                  | 1.4966                          | 408.45                           | 709.6                   | 1118.0                          | 350                             |
| 400                             | 444.59         | 0.0193                           | 1.1613                          | 424.0                            | 780.5                   | 1204.5                          | 0.6214                           | 0.8630                  | 1.4844                          | 422.6                            | 695.9                   | 1118.5                          | 400                             |
| 450                             | 456.28         | 0.0195                           | 1.0320                          | 437.2                            | 767.4                   | 1204.6                          | 0.6356                           | 0.8378                  | 1.4734                          | 435.5                            | 683.2                   | 1118.7                          | 450                             |
| 500                             | 467.01         | 0.0197                           | 0.9278                          | 449.4                            | 755.0                   | 1204.4                          | 0.6487                           | 0.8147                  | 1.4634                          | 447.6                            | 671.0                   | 1118.6                          | 500                             |
| 550                             | 476.93         | 0.0199                           | 0.8422                          | 460.8                            | 743.1                   | 1203.9                          | 0.6608                           | 0.7934                  | 1.4542                          | 458.8                            | 659.4                   | 1118.2                          | 550                             |
| 600                             | 486.21         | 0.0201                           | 0.7698                          | 471.6                            | 731.6                   | 1203.2                          | 0.6720                           | 0.7734                  | 1.4454                          | 469.4                            | 648.3                   | 1117.7                          | 600                             |
| 700                             | 503.10         | 0.0205                           | 0.6554                          | 491.5                            | 709.7                   | 1201.2                          | 0.6925                           | 0.7371                  | 1.4296                          | 488.8                            | 627.5                   | 1116.3                          | 700                             |
| 800                             | 518.23         | 0.0209                           | 0.5687                          | 509.7                            | 688.9                   | 1198.6                          | 0.7108                           | 0.7045                  | 1.4153                          | 506.6                            | 607.8                   | 1114.4                          | 800                             |
| 900                             | 531.98         | 0.0212                           | 0.5006                          | 526.6                            | 668.8                   | 1195.4                          | 0.7275                           | 0.6741                  | 1.4020                          | 523.1                            | 589.0                   | 1112.1                          | 900                             |
| 1000                            | 544.61         | 0.0216                           | 0.4456                          | 542.4                            | 649.4                   | 1191.8                          | 0.7430                           | 0.6467                  | 1.3897                          | 538.4                            | 571.0                   | 1109.4                          | 1000                            |
| 1100                            | 556.31         | 0.0220                           | 0.4001                          | 557.4                            | 630.4                   | 1187.8                          | 0.7575                           | 0.6205                  | 1.3780                          | 552.9                            | 553.5                   | 1106.4                          | 1100                            |
| 1200                            | 567.22         | 0.0223                           | 0.3619                          | 571.7                            | 611.7                   | 1183.4                          | 0.7711                           | 0.5956                  | 1.3667                          | 566.7                            | 536.3                   | 1103.0                          | 1200                            |
| 1300                            | 577.46         | 0.0227                           | 0.3293                          | 585.4                            | 593.2                   | 1178.6                          | 0.7840                           | 0.5719                  | 1.3559                          | 580.0                            | 519.4                   | 1099.4                          | 1300                            |
| 1400                            | 587.10         | 0.0231                           | 0.3012                          | 598.7                            | 574.7                   | 1173.4                          | 0.7963                           | 0.5491                  | 1.3454                          | 592.7                            | 502.7                   | 1095.4                          | 1400                            |
| 1500                            | 596.23         | 0.0235                           | 0.2765                          | 611.6                            | 556.3                   | 1167.9                          | 0.8082                           | 0.5269                  | 1.3351                          | 605.1                            | 486.1                   | 1091.2                          | 1500                            |
| 2000                            | 633.82         | 0.0257                           | 0.1878                          | 671.7                            | 463.4                   | 1135.1                          | 0.8619                           | 0.4230                  | 1.2849                          | 662.2                            | 403.4                   | 1065.6                          | 2000                            |
| 2500                            | 668.13         | 0.0287                           | 0.1307                          | 730.6                            | 360.5                   | 1091.1                          | 0.9126                           | 0.3197                  | 1.2322                          | 717.3                            | 313.3                   | 1030.6                          | 2500                            |
| 3000                            | 695.36         | 0.0346                           | 0.0858                          | 802.5                            | 217.8                   | 1020.3                          | 0.9731                           | 0.1885                  | 1.1615                          | 783.4                            | 189.3                   | 972.7                           | 3000                            |
| 3206.2                          | 705.40         | 0.0503                           | 0.0503                          | 902.7                            | 0                       | 902.7                           | 1.0580                           | 0                       | 1.0580                          | 872.9                            | 0                       | 872.9                           | 3206.2                          |

Quiz P-5

1. Discharge pressure of a reciprocating pump is determined by the discharge piping. T F
2. The discharge valve on a positive displacement pump is closed on pump starting to avoid excessive flow. T F
3. What consideration must be given when selecting material for use in a piping system? List four.
4. What type of valve will normally be used in a high pressure system where a motor operator is desired?
5. When may a check valve be used as a clearance point?
6. List three types of expansion joints commonly used in power plants.
7. The functions of the centrifugal pump flow passages, volute section & nozzle are to convert the potential energy of the liquid to pressure. T F
7. Boiler feed pumps have multiple stages to increase output pressure T F

(Continued)

- 2 -

Quiz P-5

(Continued)

14. Why is it desirable to maintain feedwater heater levels in their proper range?
15. A butterfly valve is used to allow flow in one direction only. T F
16. An extraction trip will close the extraction trip valves. T F
17. What happens to final superheat temperature after the highest pressure feedwater heater is removed from service?
18. Normally, which valve is closed first when securing a feedwater heater?
19. How might a tube leak in the # 1 heater of a feedwater system be detected?  
List at least four indications.
20. Why is it desirable to have a Bailey feedwater valve lock in position upon loss of control air?



Quiz P-6

T or F

1. The force that causes electron flow in a conductor is known as potential difference and is measured in units called volts. \_\_\_\_\_
2. When a potential difference exists, electron flow will be from positive to negative. \_\_\_\_\_
3. Ohm's Law states that " The electric current in a conductor equals the volts applied to the conductor divided by the resistance of the conductor. " \_\_\_\_\_
4. A force of one volt causing one ampere to flow through a conductor is equal to one watt. \_\_\_\_\_
5. A basic law of magnetism is that "Opposite poles repel each other and like poles attract each other." \_\_\_\_\_
6. Magnetism is the process of electrically charging a neutral body by contact, conduction, or induction. \_\_\_\_\_
7. The stronger the magnetic field and the faster the motion of the conductor, the greater will be the voltage induced in the conductor. \_\_\_\_\_
8. Since the polarity of a generator field must remain unchanged, alternating current is supplied to the field winding. \_\_\_\_\_

Quiz P-6

9. Using the formula  $N = \frac{120f}{p}$ , a four pole generator will run at 1800 rpm to produce 60 cycles. \_\_\_\_\_
10. An A.C. generator has its windings placed in the rotor and they are spaced 180 degrees apart, thus giving three phases. \_\_\_\_\_
11. a) How is a potential transformer electrically connected in a circuit ?
- b) A current transformer ?
12. Prior to paralleling a generator to the system, the generator stator volts are matched to system volts but there is no amperage indicated on the stator amp meter. Why ?
13. What are some factors that will affect generator output even if turbine steam flow does not change ? Give at least 3 factors.

Circle correct word----

14. When paralleling a generator to the system, the breaker should be closed just before/after the synchroscope reaches the 12 o'clock position.
15. When paralleling a generator to the system, the synchroscope pointer should be turning slowly in the slow/fast direction.

Quiz P-6

16. The generator stator field rotates at the same speed as the rotor field and the force it exerts acts in the same/opposite direction as the rotor rotation.
17. If the stator current is lagging behind the voltage as the rotor revolves the generator power factor is said to be leading/lagging .
18. Generator operation in lagging power factor of less than 0.85 causes the temperature of the rotor/stator conductor to be a more limiting factor than current flow.

Essay-----

19. What determines, in a transformer , which is the primary coil and which is the secondary coil ?
20. Describe how mechanical energy in the turbine is converted to electrical energy in the generator.

Quiz P-7

1. What is the unit of measurement for "Heat Rate"?
2. List two benefits for having a reheat cycle.
3. List two benefits for having units operate at higher steam pressures.

4. Refer to Figure 1.

On the T-S diagram, which point or line identifies the following phases in a superheat cycle:

- |   |       |
|---|-------|
| a. Saturated water at boiler pressure.              | _____ |
| b. Superheating of steam.                           | _____ |
| c. Condensing of steam.                             | _____ |
| d. Steam expansion through the turbine.             | _____ |
| e. Water entering the boiler at feed pump pressure. | _____ |

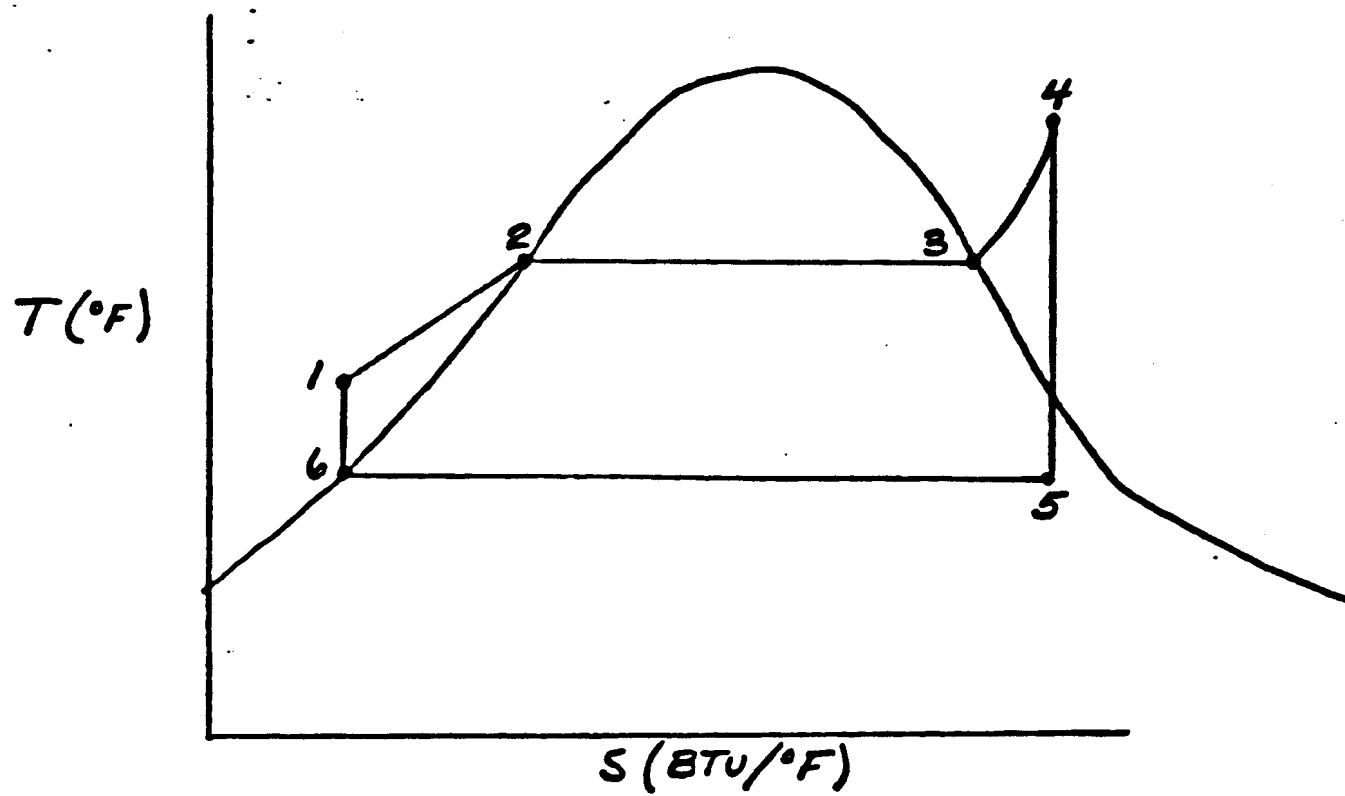


FIGURE 1

POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS

Final Examination

PHYSICS:

True/False  
(3 points each)

1. Excess air in too great a proportion will cause inefficiency, but will reduce  $\text{NO}_x$  emissions. \_\_\_\_\_
2. Incomplete combustion indicated by the combustibles recording pen calls for immediate trip of the boiler fuel. \_\_\_\_\_
3. Boiler tube metal temperature is lower than superheater tube metal temperature because water has better heat transfer properties than steam. \_\_\_\_\_
4. Soot accumulation on convection pass surfaces increases fan loading, but has little or no effect on heat transfer rate. \_\_\_\_\_
5. The change from a saturated liquid to a saturated vapor is accompanied by a large change in specific volume and a small change in temperature. \_\_\_\_\_
6. The degree of superheat refers to the temperature the steam is raised above its saturation point. \_\_\_\_\_
7. If the flow area in a pipe system decreases, the velocity increases, and pressure decreases. \_\_\_\_\_

Final Examination

(Continued)

True False  
(3 points each)

8. In a pipe system, flow is always from a low pressure area to a higher pressure area. \_\_\_\_\_
9. A liquid in<sup>a</sup> glass thermometer utilizes the principle of differential expansion. \_\_\_\_\_
10. A vacuum reads pressure between<sup>0 psia</sup> absolute and atmospheric pressure. \_\_\_\_\_
11. Steam passing through a nozzle undergoes a pressure drop, velocity increase, and a corresponding increase in specific volume. \_\_\_\_\_
12. Mixed flow pumps are used when large flow rates at high discharge pressure is required. \_\_\_\_\_
13. In an ac generator the voltage alternately changes from positive to negative, but current flows in only one direction. \_\_\_\_\_
14. When a voltage is induced by a magnetic field, the stronger the field and the faster the motion, the greater the induced voltage will be. \_\_\_\_\_
15. The boiler feed pump takes suction from the hotwell and pumps through heaters to the boiler. \_\_\_\_\_

Final Examination  
(Continued)

Multiple Choice:  
(3 points each)

1. The difference between normal, safe combustion and an explosion is \_\_\_\_\_.
  - a. Unit load
  - b. Sulfur content of fuel
  - c. Rate of heat release
  - d. Fuel temperature
  
2. An indication of incomplete combustion in a furnace is \_\_\_\_\_.
  - a. A drop in steam temperature and fuel flow increase with no change in steam flow
  - b. A visible, white plume from the stack
  - c. A slow, steady decrease in drum level
  - d. A sudden rise in superheat temperature
  
3. The boiler furnace area is designed to be large enough to permit \_\_\_\_\_.
  - a. Free passage of combustion gases
  - b. Accommodating large waterwall surface area
  - c. Using the open register light-off procedure
  - d. Time for the complete combustion of the fuel



Final Examination

(Continued)

Multiple Choice:

(3 points each)

4. When heat is transferred in a waterwall tube, the greatest temperature drop occurs \_\_\_\_ .
- a. Through the tube wall
  - b. Through the steam film
  - c. Through the water film
  - d. Through the gas film
5. The precise temperature at which water boils for a given pressure is known as \_\_\_\_ .
- a. Superheat temperature
  - b. Latent heat of evaporation
  - c. Sensible heat
  - d. Saturation temperature
6. The enthalpy of a saturated vapor at 450 psia is \_\_\_\_
- a. 1,118.7
  - b. 1,178.6
  - c. 1,204.6
  - d. 212

Final Examination  
(Continued)

Multiple Choice:  
(3 points each)

7. Under what condition would boiler feedwater flow be higher than steam flow to the unit and auxiliaries? \_\_\_\_.
- a. Boiler tube leak
  - b. During soot blowing
  - c. Boiler blowdown for chemical control
  - d. Any of the above
8. What would be an indication of a dirty condenser? \_\_\_\_.
- a. Differential pressure across the condenser will decrease and water velocity will increase.
  - b. Differential pressure across the condenser will increase and water velocity will increase.
  - c. Differential pressure across the condenser will decrease and water velocity will decrease.
  - d. Differential pressure across the condenser will increase and water velocity will decrease.
9. A head meter utilizes the fluid principle of \_\_\_\_.
- a. Differential pressure
  - b. Differential temperature
  - c. Viscosity
  - d. Specific gravity differential

Final Examination

(Continued)

Multiple Choice:

(3 points each)

10. If a unit thrust bearing temperature alarm accompanied by a Squeeler Ring Temperature Alarm occurs, \_\_\_\_.
- a. Notify the System Dispatcher and lower load.
  - b. Code the Shift Foreman.
  - c. Trip the unit immediately.
  - d. Submit a Form 23 for instrumentation check.
11. A thermocouple works on the principle that when the fused junction of two dissimilar metal wires is heated, \_\_\_\_.
- a. An electric voltage is produced.
  - b. There will be differential expansion indicated.
  - c. The bourdon tube will be deflected.
  - d. The pressure is converted to temperature.
12. The Forced Draft Fan must supply the combustion air requirements at sufficient static pressure to \_\_\_\_.
- a. Permit throttling air registers.
  - b. Keep the stack clear.
  - c. Overcome the resistance of boiler components.
  - d. Maintain reheat temperature control.

Final Examination

(Continued)

Multiple Choice:

(<sub>3</sub> points each)

13. If the voltage and current produced in a single-phase ac generator are plotted, the result will be \_\_\_\_.
- a. A straight line
  - b. A sine wave
  - c. A 45° angle
  - d. The same as a dc generator
14. Operating a generator with a leading pf < 0.95 is limited by \_\_\_\_.
- a. Rotor conductor heating
  - b. System speed
  - c. End-iron heating
  - d. Stator conductor temperature
15. The steam removed from the turbine to the heaters is called \_\_\_\_.
- |                   |                     |
|-------------------|---------------------|
| a. Steam Heat     | c. extraction steam |
| b. reducing steam | d. superheat steam  |

Final Examination

(Continued)

Essay: <sup>5</sup>~~4~~ points each)

1. Consider one pound of water in a pressure vessel at 1,300 psia. (Refer to Steam Table.)

a. What is the saturation temperature?

---

b. What is the latent heat of evaporation?

---

c. What does the latent heat of evaporation represent?

---

d. What is the change in specific volume corresponding to the change in state from liquid to vapor?

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Final Examination

(Continued)

2. Describe how mechanical energy of a turbine is converted to electrical energy by a generator.

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## 2. SATURATION: PRESSURES


| Abs Press.<br>lb<br>Sq In.<br>P | Temp<br>F<br>t | Specific Volume                  |                                 | Enthalpy                         |                         |                                 | Entropy                          |                         |                                 | Internal Energy                  |                         |                                 | Abs Press.<br>lb<br>Sq In.<br>P |
|---------------------------------|----------------|----------------------------------|---------------------------------|----------------------------------|-------------------------|---------------------------------|----------------------------------|-------------------------|---------------------------------|----------------------------------|-------------------------|---------------------------------|---------------------------------|
|                                 |                | Sat.<br>Liquid<br>v <sub>f</sub> | Sat.<br>Vapor<br>v <sub>g</sub> | Sat.<br>Liquid<br>h <sub>f</sub> | Evap<br>h <sub>fg</sub> | Sat.<br>Vapor<br>h <sub>g</sub> | Sat.<br>Liquid<br>s <sub>f</sub> | Evap<br>s <sub>fg</sub> | Sat.<br>Vapor<br>s <sub>g</sub> | Sat.<br>Liquid<br>u <sub>f</sub> | Evap<br>u <sub>fg</sub> | Sat.<br>Vapor<br>u <sub>g</sub> |                                 |
| 1.0                             | 101.74         | 0.01614                          | 333.6                           | 69.70                            | 1036.3                  | 1106.0                          | 0.1326                           | 1.8456                  | 1.9782                          | 69.70                            | 974.6                   | 1044.3                          | 1.0                             |
| 2.0                             | 126.08         | 0.01623                          | 173.73                          | 93.99                            | 1022.2                  | 1116.2                          | 0.1749                           | 1.7451                  | 1.9200                          | 93.98                            | 957.9                   | 1051.9                          | 2.0                             |
| 3.0                             | 141.48         | 0.01630                          | 118.71                          | 109.37                           | 1013.2                  | 1122.6                          | 0.2008                           | 1.6855                  | 1.8863                          | 109.36                           | 947.3                   | 1056.7                          | 3.0                             |
| 4.0                             | 152.97         | 0.01636                          | 90.63                           | 120.86                           | 1006.4                  | 1127.3                          | 0.2198                           | 1.6427                  | 1.8625                          | 120.85                           | 939.3                   | 1060.2                          | 4.0                             |
| 5.0                             | 162.24         | 0.01640                          | 73.52                           | 130.13                           | 1001.0                  | 1131.1                          | 0.2347                           | 1.6094                  | 1.8441                          | 130.12                           | 933.0                   | 1063.1                          | 5.0                             |
| 6.0                             | 170.06         | 0.01645                          | 61.98                           | 137.96                           | 996.2                   | 1134.2                          | 0.2472                           | 1.5820                  | 1.8292                          | 137.94                           | 927.5                   | 1065.4                          | 6.0                             |
| 7.0                             | 176.85         | 0.01649                          | 53.64                           | 144.76                           | 992.1                   | 1136.9                          | 0.2581                           | 1.5586                  | 1.8167                          | 144.74                           | 922.7                   | 1067.4                          | 7.0                             |
| 8.0                             | 182.66         | 0.01653                          | 47.34                           | 150.79                           | 988.5                   | 1139.3                          | 0.2674                           | 1.5383                  | 1.8057                          | 150.77                           | 918.4                   | 1069.2                          | 8.0                             |
| 9.0                             | 188.28         | 0.01656                          | 42.40                           | 156.22                           | 985.2                   | 1141.4                          | 0.2759                           | 1.5203                  | 1.7962                          | 156.19                           | 914.6                   | 1070.8                          | 9.0                             |
| 10                              | 193.21         | 0.01659                          | 38.42                           | 161.17                           | 982.1                   | 1143.3                          | 0.2835                           | 1.5041                  | 1.7876                          | 161.14                           | 911.1                   | 1072.2                          | 10                              |
| 14.696                          | 212.00         | 0.01672                          | 26.80                           | 180.07                           | 970.3                   | 1150.4                          | 0.3120                           | 1.4446                  | 1.7566                          | 180.02                           | 897.5                   | 1077.5                          | 14.696                          |
| 15                              | 213.03         | 0.01672                          | 26.29                           | 181.11                           | 969.7                   | 1150.8                          | 0.3135                           | 1.4415                  | 1.7549                          | 181.06                           | 896.7                   | 1077.8                          | 15                              |
| 20                              | 227.96         | 0.01683                          | 20.089                          | 196.16                           | 960.1                   | 1156.3                          | 0.3356                           | 1.3962                  | 1.7319                          | 196.10                           | 885.8                   | 1081.9                          | 20                              |
| 30                              | 250.33         | 0.01701                          | 13.746                          | 218.82                           | 945.3                   | 1164.1                          | 0.3680                           | 1.3313                  | 1.6993                          | 218.73                           | 869.1                   | 1087.8                          | 30                              |
| 40                              | 267.25         | 0.01715                          | 10.498                          | 236.03                           | 933.7                   | 1169.7                          | 0.3919                           | 1.2844                  | 1.6763                          | 235.90                           | 858.1                   | 1092.0                          | 40                              |
| 50                              | 281.01         | 0.01727                          | 8.515                           | 250.09                           | 924.0                   | 1174.1                          | 0.4110                           | 1.2474                  | 1.6585                          | 249.93                           | 845.4                   | 1095.3                          | 50                              |
| 60                              | 292.71         | 0.01736                          | 7.175                           | 262.09                           | 915.3                   | 1177.6                          | 0.4270                           | 1.2168                  | 1.6438                          | 261.90                           | 836.0                   | 1097.9                          | 60                              |
| 70                              | 302.92         | 0.01748                          | 6.206                           | 272.61                           | 907.9                   | 1180.6                          | 0.4409                           | 1.1906                  | 1.6315                          | 272.38                           | 827.8                   | 1100.2                          | 70                              |
| 80                              | 312.03         | 0.01757                          | 5.472                           | 282.02                           | 901.1                   | 1183.1                          | 0.4531                           | 1.1676                  | 1.6207                          | 281.76                           | 820.3                   | 1102.1                          | 80                              |
| 90                              | 320.27         | 0.01766                          | 4.896                           | 290.56                           | 894.7                   | 1185.3                          | 0.4641                           | 1.1471                  | 1.6112                          | 290.27                           | 813.4                   | 1103.7                          | 90                              |
| 100                             | 327.81         | 0.01774                          | 4.432                           | 298.40                           | 888.8                   | 1187.2                          | 0.4740                           | 1.1286                  | 1.6026                          | 298.08                           | 807.1                   | 1105.2                          | 100                             |
| 120                             | 341.25         | 0.01789                          | 3.728                           | 312.44                           | 877.9                   | 1190.4                          | 0.4916                           | 1.0962                  | 1.5878                          | 312.05                           | 795.6                   | 1107.6                          | 120                             |
| 140                             | 353.02         | 0.01802                          | 3.220                           | 324.82                           | 868.2                   | 1193.0                          | 0.5069                           | 1.0682                  | 1.5751                          | 324.35                           | 785.2                   | 1109.6                          | 140                             |
| 160                             | 363.53         | 0.01815                          | 2.834                           | 335.93                           | 859.2                   | 1195.1                          | 0.5204                           | 1.0436                  | 1.5640                          | 335.39                           | 775.8                   | 1111.2                          | 160                             |
| 180                             | 373.06         | 0.01827                          | 2.532                           | 346.03                           | 850.8                   | 1196.9                          | 0.5325                           | 1.0217                  | 1.5542                          | 345.42                           | 767.1                   | 1112.5                          | 180                             |
| 200                             | 381.79         | 0.01839                          | 2.288                           | 355.36                           | 843.0                   | 1198.4                          | 0.5435                           | 1.0018                  | 1.5453                          | 354.68                           | 759.0                   | 1113.7                          | 200                             |
| 250                             | 400.95         | 0.01865                          | 1.8438                          | 376.00                           | 825.1                   | 1201.1                          | 0.5675                           | 0.9588                  | 1.5263                          | 375.14                           | 740.7                   | 1115.8                          | 250                             |
| 300                             | 417.33         | 0.01890                          | 1.5433                          | 393.84                           | 809.0                   | 1202.8                          | 0.5879                           | 0.9225                  | 1.5104                          | 392.79                           | 724.3                   | 1117.1                          | 300                             |
| 350                             | 431.72         | 0.01913                          | 1.3260                          | 409.69                           | 794.2                   | 1203.9                          | 0.6056                           | 0.8910                  | 1.4966                          | 408.45                           | 709.6                   | 1118.0                          | 350                             |
| 400                             | 444.59         | 0.0193                           | 1.1613                          | 424.0                            | 780.5                   | 1204.5                          | 0.6214                           | 0.8630                  | 1.4844                          | 422.6                            | 695.9                   | 1118.5                          | 400                             |
| 450                             | 456.28         | 0.0195                           | 1.0320                          | 437.2                            | 767.4                   | 1204.6                          | 0.6356                           | 0.8378                  | 1.4734                          | 435.5                            | 683.2                   | 1118.7                          | 450                             |
| 500                             | 467.01         | 0.0197                           | 0.9278                          | 449.4                            | 755.0                   | 1204.4                          | 0.6487                           | 0.8147                  | 1.4634                          | 447.6                            | 671.0                   | 1118.6                          | 500                             |
| 550                             | 476.93         | 0.0199                           | 0.8422                          | 460.8                            | 743.1                   | 1203.9                          | 0.6608                           | 0.7934                  | 1.4542                          | 458.8                            | 659.4                   | 1118.2                          | 550                             |
| 600                             | 486.21         | 0.0201                           | 0.7698                          | 471.6                            | 731.6                   | 1203.2                          | 0.6720                           | 0.7734                  | 1.4454                          | 469.4                            | 648.3                   | 1117.7                          | 600                             |
| 700                             | 503.10         | 0.0205                           | 0.6354                          | 491.5                            | 709.7                   | 1201.2                          | 0.6925                           | 0.7371                  | 1.4296                          | 488.8                            | 627.5                   | 1116.3                          | 700                             |
| 800                             | 518.23         | 0.0209                           | 0.5687                          | 509.7                            | 688.9                   | 1198.6                          | 0.7108                           | 0.7045                  | 1.4153                          | 506.6                            | 607.8                   | 1114.4                          | 800                             |
| 900                             | 531.98         | 0.0212                           | 0.5006                          | 526.6                            | 668.8                   | 1195.4                          | 0.7273                           | 0.6741                  | 1.4020                          | 523.1                            | 589.0                   | 1112.1                          | 900                             |
| 1000                            | 544.61         | 0.0216                           | 0.4436                          | 542.4                            | 649.4                   | 1191.8                          | 0.7430                           | 0.6467                  | 1.3897                          | 538.4                            | 571.0                   | 1109.4                          | 1000                            |
| 1100                            | 556.31         | 0.0220                           | 0.4001                          | 557.4                            | 630.4                   | 1187.8                          | 0.7575                           | 0.6205                  | 1.3780                          | 552.9                            | 553.5                   | 1106.4                          | 1100                            |
| 1200                            | 567.22         | 0.0223                           | 0.3619                          | 571.7                            | 611.7                   | 1183.4                          | 0.7711                           | 0.5956                  | 1.3667                          | 566.7                            | 536.3                   | 1103.0                          | 1200                            |
| 1300                            | 577.46         | 0.0227                           | 0.3293                          | 585.4                            | 593.2                   | 1178.6                          | 0.7840                           | 0.5719                  | 1.3559                          | 580.0                            | 519.4                   | 1099.4                          | 1300                            |
| 1400                            | 587.10         | 0.0231                           | 0.3012                          | 598.7                            | 574.7                   | 1173.4                          | 0.7963                           | 0.5491                  | 1.3454                          | 592.7                            | 502.7                   | 1095.4                          | 1400                            |
| 1500                            | 596.23         | 0.0235                           | 0.2765                          | 611.6                            | 556.3                   | 1167.9                          | 0.8082                           | 0.5269                  | 1.3351                          | 605.1                            | 486.1                   | 1091.2                          | 1500                            |
| 2000                            | 633.82         | 0.0257                           | 0.1878                          | 671.7                            | 463.4                   | 1135.1                          | 0.8619                           | 0.4230                  | 1.2849                          | 662.2                            | 403.4                   | 1065.6                          | 2000                            |
| 2500                            | 668.13         | 0.0287                           | 0.1307                          | 730.6                            | 360.5                   | 1091.1                          | 0.9126                           | 0.3197                  | 1.2322                          | 717.3                            | 313.3                   | 1030.6                          | 2500                            |
| 3000                            | 695.36         | 0.0316                           | 0.0958                          | 802.5                            | 217.8                   | 1020.3                          | 0.9731                           | 0.1885                  | 1.1615                          | 783.4                            | 189.3                   | 972.7                           | 3000                            |
| 3206.2                          | 705.40         | 0.0503                           | 0.0503                          | 902.7                            | 0                       | 902.7                           | 1.0580                           | 0                       | 1.0580                          | 872.9                            | 0                       | 872.9                           | 3206.2                          |

ELECTRICAL  
SCHEMATICS




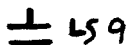


Quiz E-1

1. All relay contacts are shown in the position they take when their associated relay is \_\_\_\_\_.
2. In the number 52 - 31 - 63, encountered on a schematic print:
  - a) 52 means \_\_\_\_\_
  - B) 31 means \_\_\_\_\_
  - c) 63 means \_\_\_\_\_

3. 42/0  42/R: This symbol encountered on a schematic print refers to: \_\_\_\_\_

- a) Two relays, 42/0 and 42/R
- b) A double coil, electrically operated, mechanically latched relay.
- c) Auto reset relay.
- d) Double coil overcurrent relay.

4. \_\_\_\_\_ is the symbol for a contact normally closed when LS-9 has no level applied.    a)     b)     d)     e) 

5. Match the number to the device.

- |          |  |
|----------|--|
| 42 _____ | 1. A-C Circuit Breaker                       |
| 52 _____ | 2. A-C thermal relay                         |
| 49 _____ | 3. Alarm relay                               |
| 74 _____ | 4. Running circuit breaker ( Line, starter ) |
| 27 _____ | 5. A-C undervoltage relay                    |

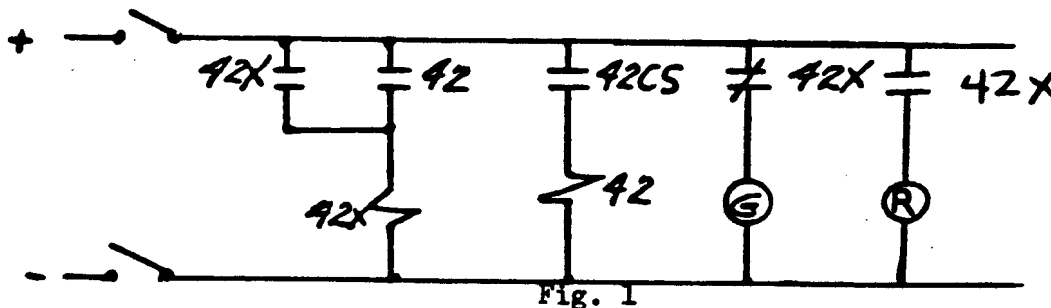
Quiz E-1

(Continued)

6. A schematic print shows every wiring connection for the circuit            T     F
7. What is the difference between a single line diagram and a schematic print?
8. What is the purpose of a device table?
9. All symbols are the same on all prints.    T     F
10. What is the difference between a single coil relay and a double coil  
mechanically latched relay?

### Quiz E-2

1.  $\text{⚡}$  81 indicates a device, and as drawn is considered de-energized. T F
2.  $\text{⚡}$  81 is a contact operated by device  $\text{⚡}$  81. T F
3.  $\text{⚡}$  81 is a contact closed when  $\text{⚡}$  81 is energized. T F
4. The contact  $\text{⚡}$  27 is closed when device 27 is de-energized. T F
5.  $\text{⚡}$  PS-3 is a contact closed when pressure switch No. 3 has low pressure applied to it. T F
6. The symbol  $\text{⚡}$  LS-7 on an electrical schematic denotes a contact closed with zero level on Level Switch No. 7. T F



7. With the DC switch closed and the 42CS open, will the green light be lighted? ( Refer to Fig. 1 )
8. What is the sequence of events to energize the red light. (Refer to Fig. 1)

Quiz E-2

(Continued )

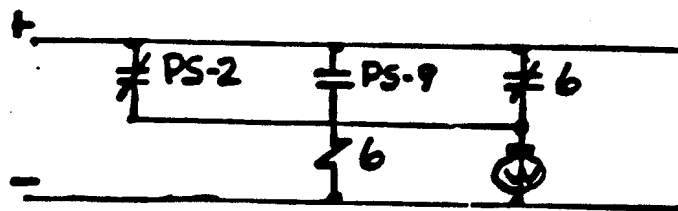


Fig. 2

For questions 9-12 refer to Fig. 2

- |   |   |   |
|---|---|---|
| 9. PS-2 contact will close on some pressure to energize device No. 6 and the white light. | T | F |
| 10. PS-9 will close on no pressure to energize Device No. 6                               | T | F |
| 11. The white light will be lighted with no pressure on PS-9.                             | T | F |
| 12. The white light will be on with no pressure on PS-2.                                  | T | F |

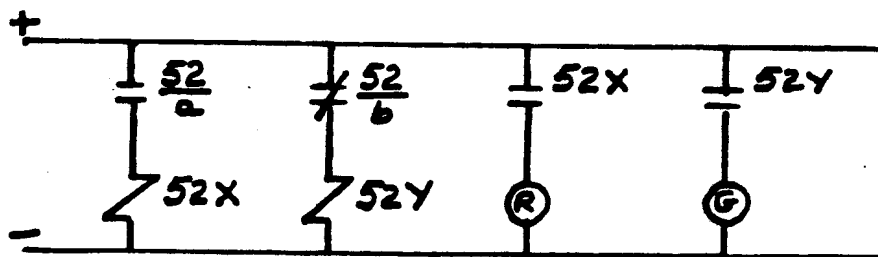
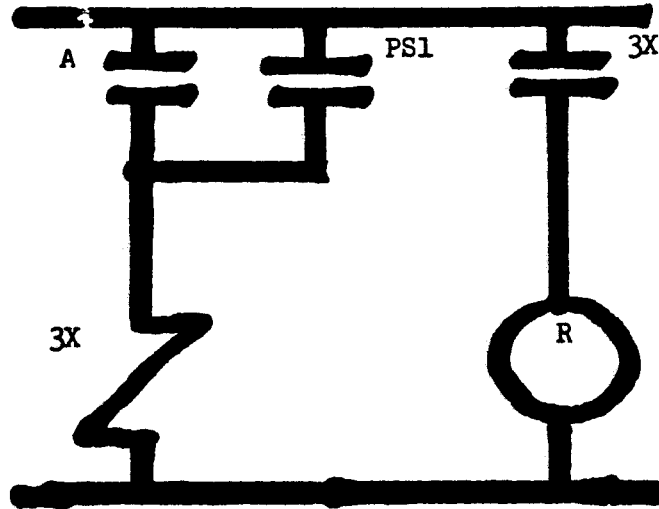


Fig. 3

For questions 13 and 14 refer to Fig. 3

- |   |   |   |
|---|---|---|
| 13. With the 52X device energized the red light will be on.       | T | F |
| 14. The green light will be out when the 52Y device is energized. | T | F |

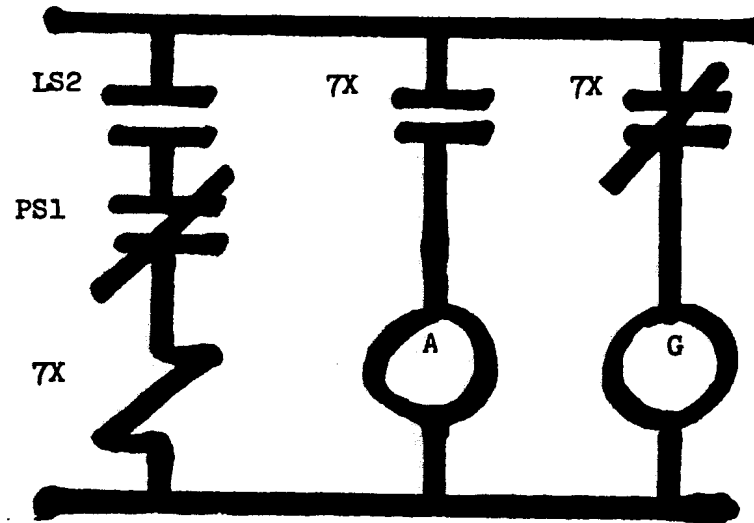
Quiz E-2  
(Continued)



15. Give the sequence of events after you close the "A" contact.
16. If there is some pressure on PS1 and you close the "A" contact, what will happen ?

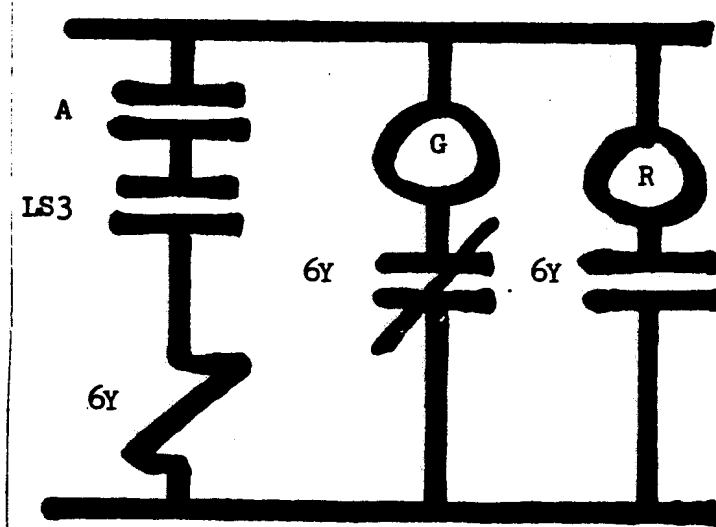
Quiz E-2

(Continued)



17. What does it take to energize the 7X relay coil ?
18. What will the lights do when 7X is energized ?

Quiz E-2  
(Continued)



19. What does it take to energize the 6Y relay coil ?

20. When will the green light be on ?

Quiz E-3

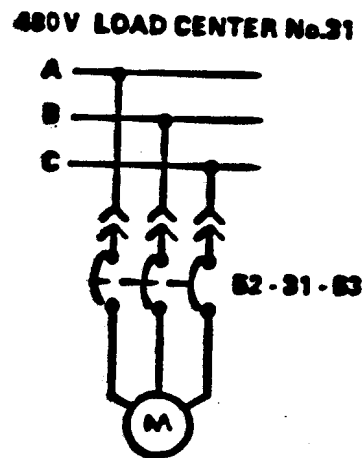


Fig. 1

For questions 1-3 refer to Fig. 1

1. The dotted lines connecting the three phases of the ACB indicate that the phases rack out. T      F
2. ACB 52-31-63 is in cubicle No. \_\_\_\_\_, located in load center \_\_\_\_\_.
3. With this setup the only means of starting and stopping the motor is by \_\_\_\_\_.

For questions 4-20 refer to Fig. 2

4. A safety feature is provided by making the control circuit transformer connections on the \_\_\_\_\_ of the ACB. The control circuit is \_\_\_\_\_ when the ACB is open.
5. The control circuit is protected against \_\_\_\_\_ by a \_\_\_\_\_ in the circuit.



Quiz E-3  
(Continued)

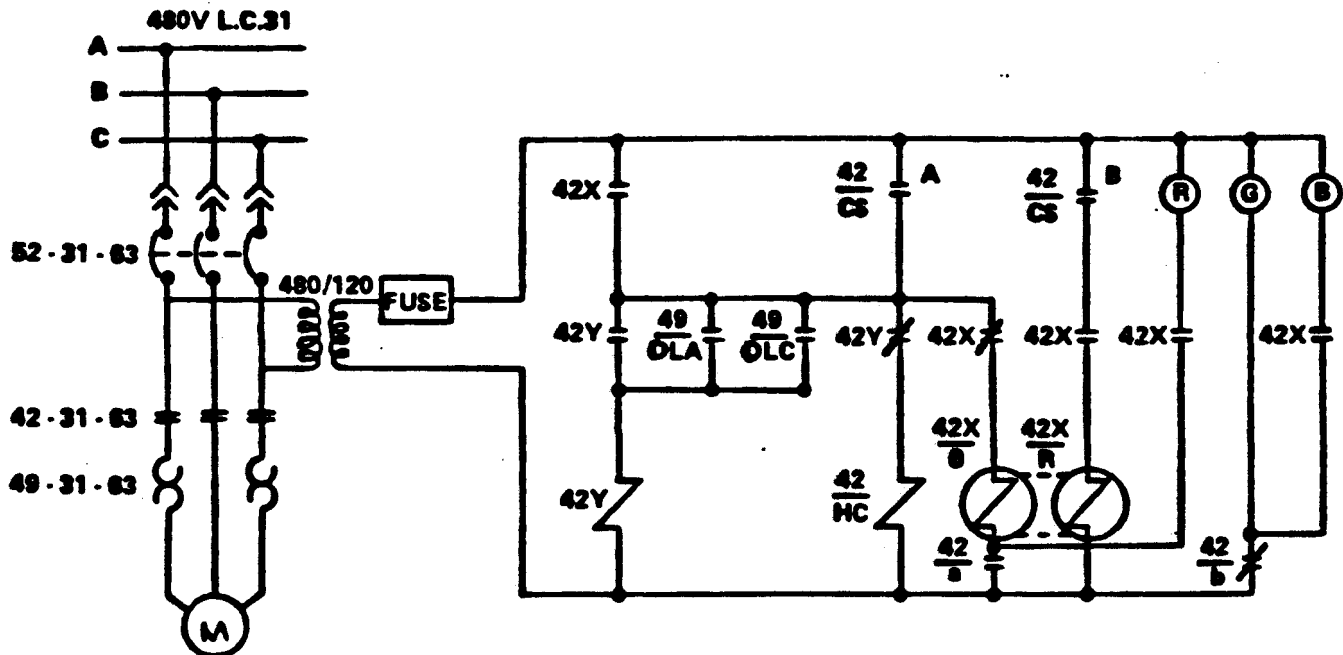


Fig. 2

6. What is required to provide a proper working clearance on the control circuit in the schematic?
  
7. On a motor start, 42 x/o relay is energized until \_\_\_\_\_.
  - a. 42y relay operates
  - b. the 42 CS/A contact is opened
  - c. the normally closed contact 42X opens
  - d. the 42/a contact opens.
  
8. If the fuse in the control circuit blows, ACB 52 opens. T    F
  
9. 42 X/O cannot be energized unless the 42/HC has been energized. T    F

Quiz E-3

(Continued)

10.  $42X/0$  in the operate position seals in  $42/HC$ . T F
11. With the motor stopped normally, closing the "B" contact will energize the  $42X/R$  relay coil. T F
12. An overload (overcurrent) condition exists, OLA contact is closed.  
(Circle correct answer)
- a.  $\frac{1}{T}$   $42Y$  seals in.
- b.  $\frac{1}{T}$   $42/CS$  trips to off position.
- c.  $\frac{1}{Z}$   $42/HC$  is energized.
- d.  $\frac{1}{X}$   $42X$  contact opens.
13. If the motor is running and the breaker is opened and then reclosed, the  $42X/0$  coil will be energized. T F
14. The motor will stop when CS  $42-31-63$  is released. T F
15. Should an overload occur contact  $49/OLA$  or  $49/OLC$  closes to seal in relay  $42Y$ . T F
16. On an overload contact  $\frac{1}{X}$   $42Y$  opens,  $42/HC$  is de-energized and the contacts  $42-31-63$  open to stop the motor. T F
17. Contact  $\frac{1}{X}$   $42Y$  will open when  $\frac{1}{T}$   $42CS$  is closed. T F

Quiz E-3

(Continued)

18. The motor will restart when the thermal device cools and OL contacts open.

T F

19. Normally, relay 42Y is de-energized and its contact ~~42Y~~ 42Y is open in the starting circuit.

T F

20. What light(s) will be lighted following an overcurrent relay?

For questions 21-25 refer to Figs. 2 & 3.

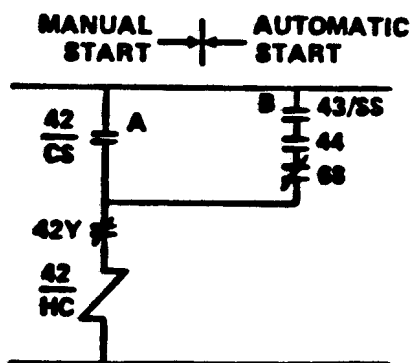


Fig. 3

Note: Fig. 3 depicts a parallel circuit by-passing 42/CS, normal starting switch.

Devices:

68 Thermal protective relay in another circuit.

44 Contact operated by the stand-by starting relay in another circuit operated by a primary sensing device. (Pressure, level, etc.)

43 Pump selector switch

Quiz E-3




(Continued)


21. The  $\overline{68}$  contact is closed, the 68 coil is energized. T F
22. The  $\frac{1}{44}$  will be closed at some predetermined level or pressure in the system. T F
23. The motor may be started manually at any time regardless of the auto setup. T F
24. As drawn, closing the  $\frac{1}{44}$  contact will start the motor. T F
25. What conditions are necessary for an automatic start of the motor?

### Schematics Review Quiz

(For lessons E-1 through E-3)

1. Following is a list of devices. Opposite each place the letter next to the most appropriate description.

- |  |  |
|--|--|
| a.  | _____ AC thermal device.                       |
| b.  | _____ Contact closed when 52 is closed         |
| c. 42  | _____ Normally closed contact.                 |
| d. $\neq 52\frac{1}{2}$  | _____ Contact open when 42Y is energized.      |
| e. $\neq 42Y$  | _____ Double coil relay, mechanically latched. |
| f.  | _____ Contactor, running breaker.              |

2.  PS-3 is a contact closed when \_\_\_\_\_.

- a. There is some pressure on PS-3.
- b. There is zero pressure on PS-3.

3. All relay contacts are shown in the position they assume when the associated relay is \_\_\_\_\_.

4. AC control circuit transformer taps are located on the \_\_\_\_\_ side of the motor ACB.

5. The underlined numbers shown on a schematic drawing refer to \_\_\_\_\_.

For questions 6 through 12 refer to Fig. S-13 ( Handout ).

6. When energized, the 42X/0 relay will cause the motor to start, then, when 42X/0 is de-energized the motor will stop.

T F

Schematics Review Quiz

(Continued)

7. The 52 device must be closed manually to provide AC potential on the control circuit. T F
8. With the motor running, if the fuse in the control circuit blows, the 42X relay returns to the RESET position. T F
9. After closing the ACB 52-31-63, the 42/CS is operated to close its "A" contact. The 42/HC will then be energized, provided the 42Y coil is energized. T F
10. The 42X/O relay coil provides a seal-in contact for the 42/HC coil. T F
11. The contact 42Y  $\frac{1}{\overline{\text{A}}}$  functions to \_\_\_\_\_.
12. List the sequence of events when contact "A" is closed.

Schematics Review Quiz

(Continued)

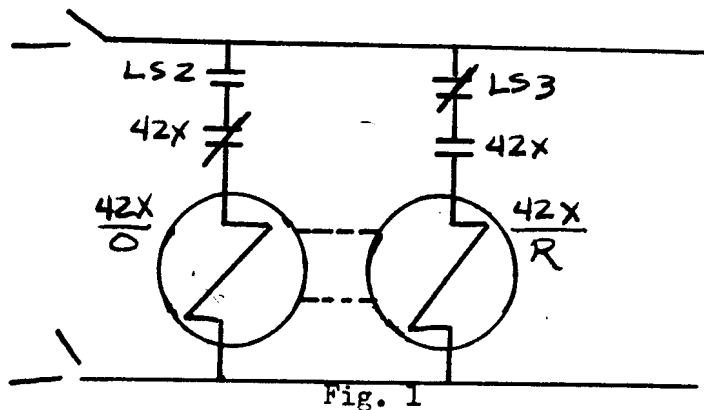


Fig. 1

For questions 13 through 16 refer to Fig. 1 above.

13. When will device 42X be operated? Explain.

14. When will device 42X be reset? Explain.

15. How long do the coils of device 42X remain energized?

16. Given some level on LS-2 and no level on LS-3, explain what happens.

Schematics Review Quiz

(Continued)

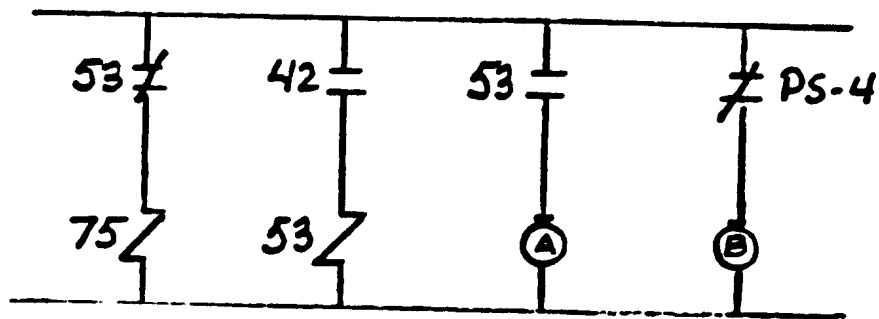
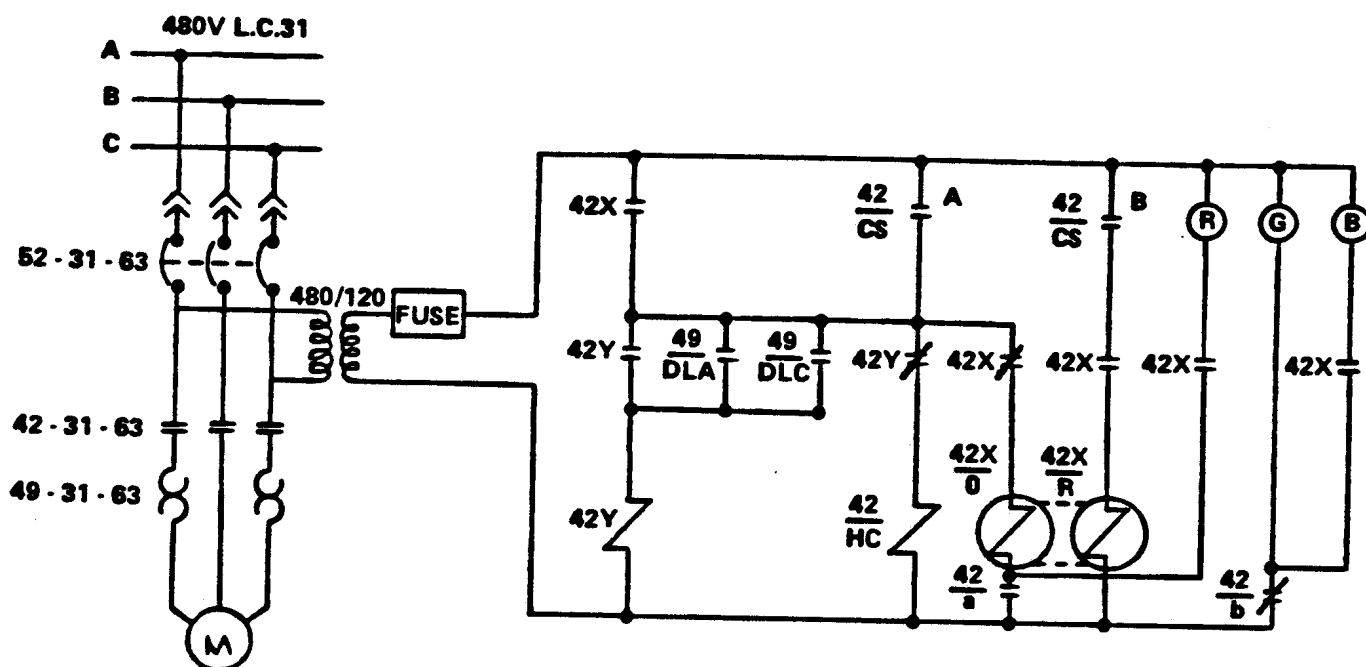


Fig. 2

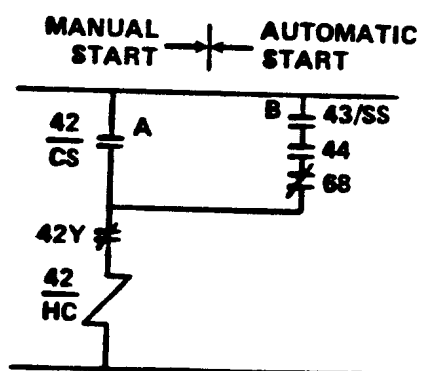
For questions 17 through 20 refer to Fig. 2 above.

17. When the coil of device 53 is energized, the coil of device 75 is energized. T F
18. The amber light will be on when the coil of device 75 is de-energized. T F
19. No pressure on Switch No. 4 will cause the blue light to burn. T F
20. If the control power is opened, all device contacts on the schematic will be open. T F





S-13



S-14

56

QUIZ E-4

Refer to the schematic attached.

1. In this control scheme, contacts in the A.C. circuit close to energize a coil in the D.C. circuit that holds the 42 device in its operated position.  
T F
2. To start this motor, the CS/A contact is closed to energize the 42X/O coil. It has contacts in the A.C. circuit which open to de-energize a relay and allow the linestarter contacts to close.  
T F
3. If the thermal overload device operates, which coil is energized? \_\_\_\_\_
  - a. 27-1
  - b. 42X/R
  - c. 74-43
  - d. 42-43/HC
4. If the motor is running and D.C. power is lost, what will happen?
  - a. The motor will stop running.
  - b. The blue light will come on.
  - c. The white light will go out.
  - d. The motor will keep running
  - e. None of the above.
5. Relay 74-43 has three contacts associated with it. What is their function?
  - a.
  - b.
  - c.
6. With the 42X/O latched up, which contact closes to bring in the blue light?
7. Closing the D. C. switch will bring in the white light.  
T F

Quiz E-4

( Continued )

8. If the fuse blows in the A.C. circuit while the motor is running, what will the lights show?

$\frac{W}{\text{on/off}}$

$\frac{B}{\text{on/off}}$

$\frac{R}{\text{on/off}}$

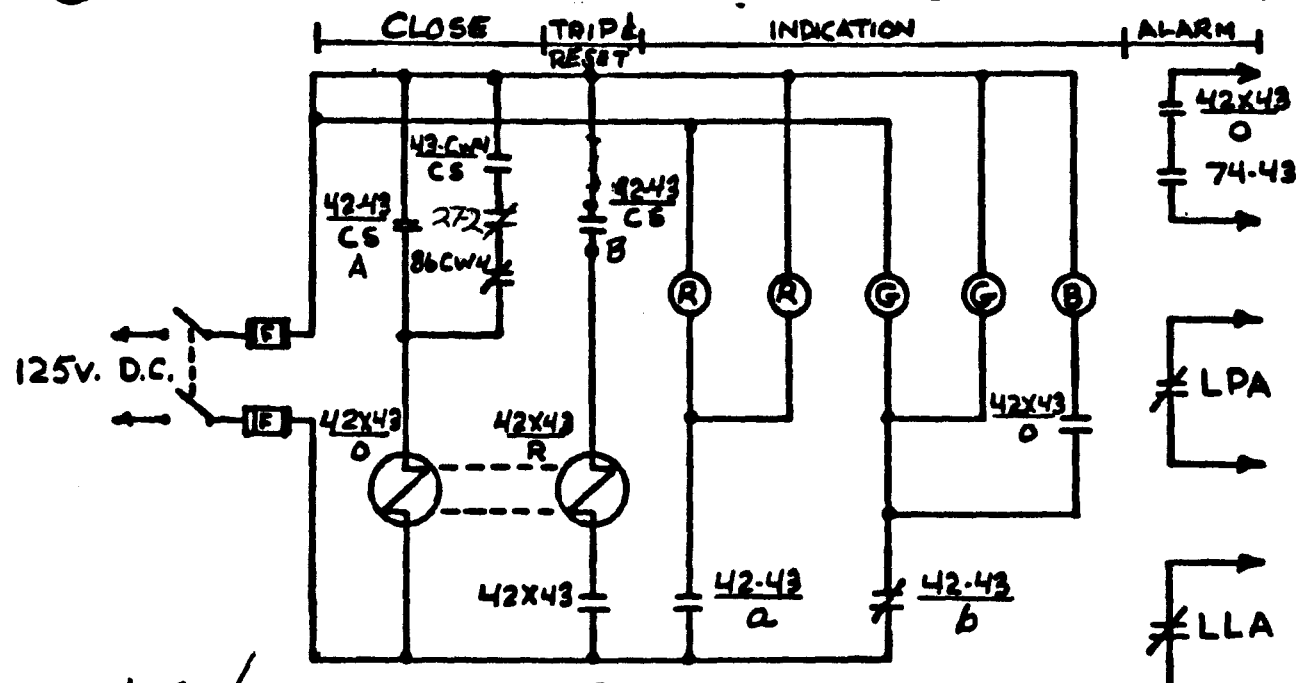
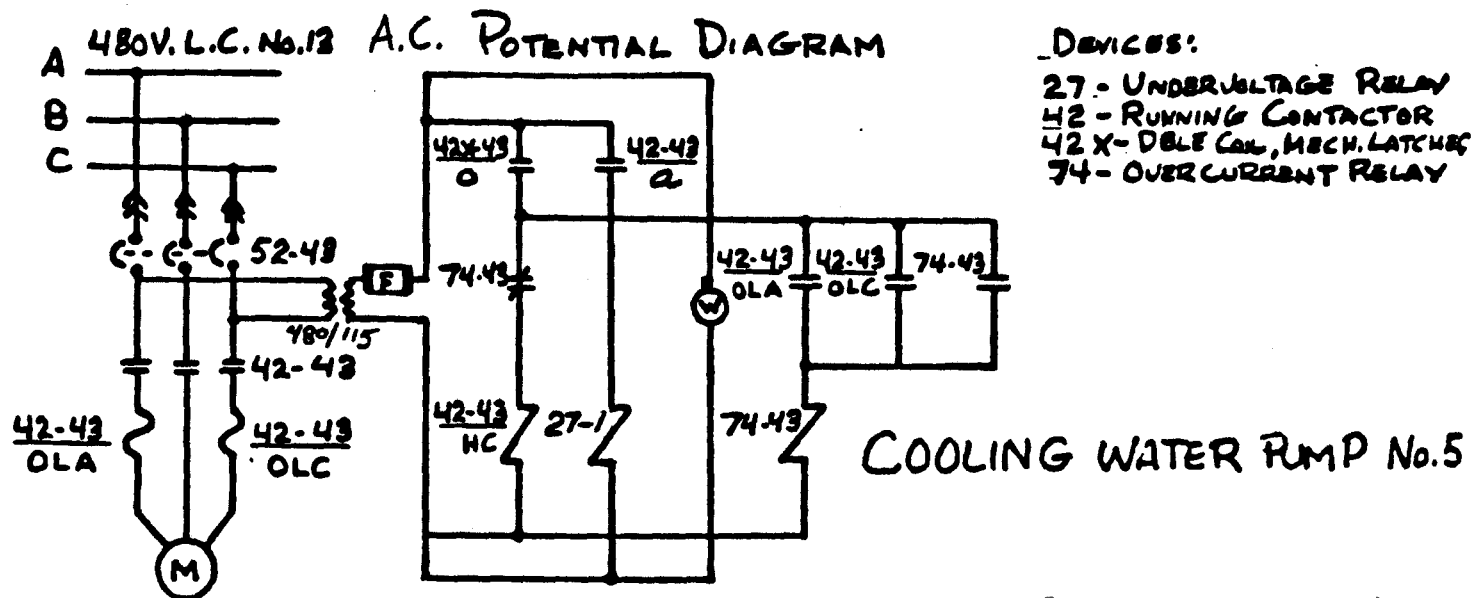
$\frac{G}{\text{on/off}}$

9. List the sequence of events to stop this motor normally.

10. List the sequence of events if 42-43 OLA operates.

Power Plant Physics, Chemistry & Electrical Schematics

Test E-4



Electrical Schematics  
E-5

20 points

1. This control circuit is:

- a) A.C. only
- b) D.C. only
- c) Both A.C. and D.C.

2.



has three contacts associated with it. What is their function?

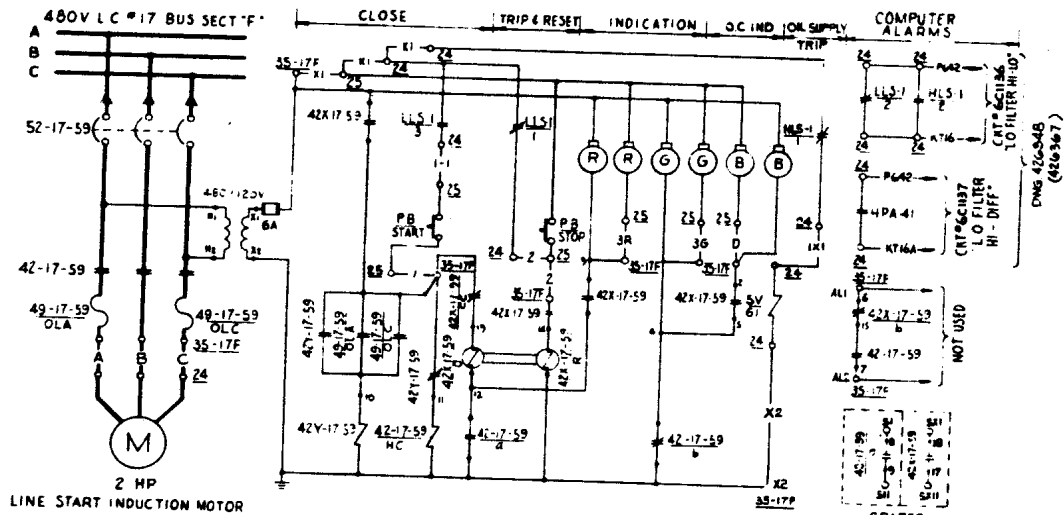
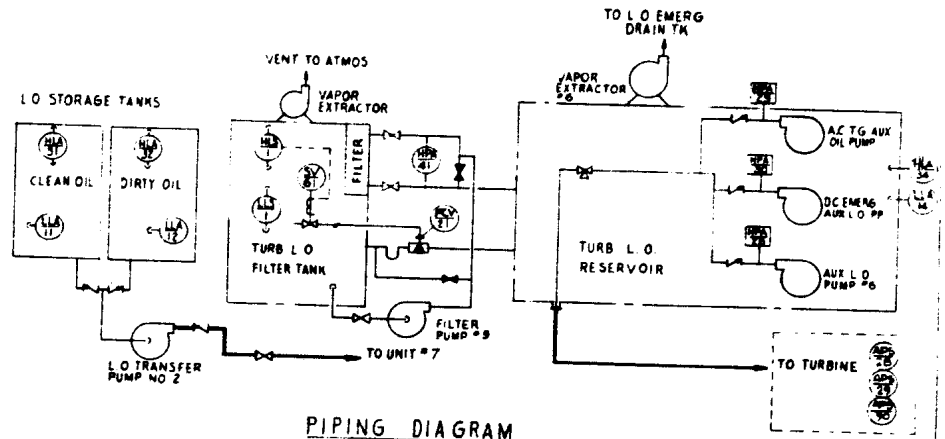
- a)  $\frac{LIS1}{1}$
- b)  $\frac{LIS1}{2}$
- c)  $\frac{LIS1}{3}$

3. What is the purpose of SV ?

4. Why doesn't the blue light come on when the operating coil closes  
42X-17-59 ?

5. List the sequence of events to stop this motor normally? (include lights)

# Test E- 5



THREE LINE DIAG.

AC CONTROL SCHEMATIC

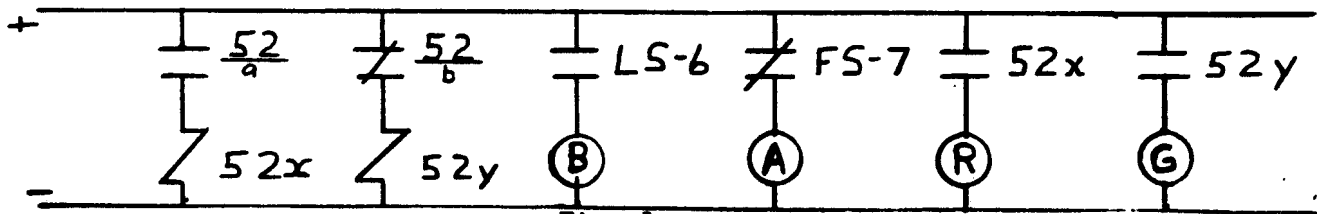
LUBE OIL FILTER PP#9-UNIT#6-CKT#17-59P  
 L O FILTER PP # 10 - UNIT # 7 - CKT # 19 - 59P SIMILAR

## SCHEMATICS

### Final Examination

4 Points  
each

1. Our plant motors may be either AC or DC controlled. T F
2. All relay contacts on a schematic print are shown in the position they take when their associated relay is energized. T F
3. In a double coil mechanically latched relay, the operating coil remains energized until the reset coil functions. T F
4. The contacts on a single coil relay will lock when the coil is de-energized. T F
5. A 49 device is used to protect a motor from undervoltage. T F



Refer to Fig. 1 for questions 6-10

6. When the control circuit is energized, the green light will be lighted if the breaker is closed. T F
7. When circuit breaker 52 is open, the red light will be on. T F

8. With no level on Level Switch LS-6, the blue light will be off. T F
9. With some flow on Flow Switch FS-7, the amber light will be on. T F
10. If the circuit breaker 52 is open, the 52X device is de-energized. T F

11. Match description with appropriate figure.

Electrically operated, mechanically latched double coil relay. \_\_\_\_\_

Contact closed when device 42Y is de-energized. \_\_\_\_\_

Contact closed when 42 contactor breaker is open. \_\_\_\_\_

Contact closed when 42X/O relay is in the operated position. \_\_\_\_\_

- a.  $\overline{42x}$     b.  $\textcircled{42}$     c.  $\neq 42y$     d.  $\neq 42/b$

For questions 12-18 refer to Schematic S-13/S-14 (Handout)

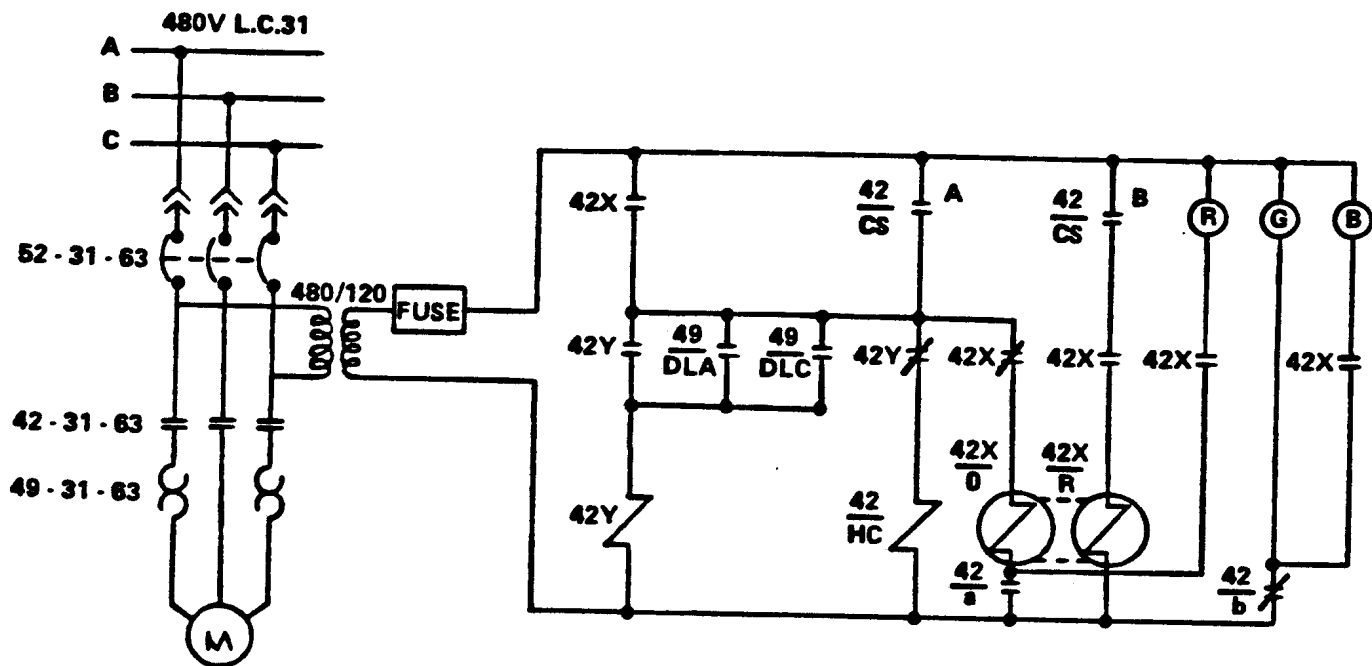
12. When 42 CS is operated to close the "A" contact and released \_\_\_\_.
- a. The 42 X/O relay is released to the reset position.
- b. The 42/HC remains energized through a seal in contact.
- c. 42X/R coil is energized.
13. An overload (overcurrent) condition exists, OLA contact is closed.
- (Circle correct answer)
1.  $\overline{42y}$  seals in.
2.  $\overline{42/CS}$  trips to off position.
3.  $\text{42/HC}$  is energized.
4.  $\neq 42X$  contact opens.



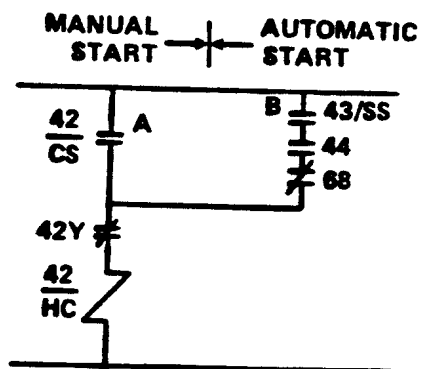
14. On a motor start, 42 X/O relay is energized until \_\_\_\_.
- a. 42Y relay operates
  - b. the 42 CS/A contact is opened
  - c. the normally closed contact 42X opens
  - d. the 42/a contact opens
15. The normal means of unlatching the 42X/O coil following OL relay is to \_\_\_\_
- a. Open 42/CS "A" contact.
  - b. Wait until the 42Y relay is de-energized.
  - c. Operate the 42/CS to close the "B" contact.
  - d. Open 52-31-63 at the breaker cuticle
16. What prevents the motor from restarting when the thermal device 49 cools and is normal?
17. Following an OL relay of the motor in this schematic the \_\_\_\_
- a. red light will be lighted
  - b. blue light will be on
  - c. green and blue lights are on
  - d. red and green lights are on
18. The following is necessary for an automatic start of this motor.
- a. some predetermined pressure on 44 primary device
  - b. this pump selected for stand-by starting
  - c. all of these conditions necessary
  - d. thermal device 68 de-energized

For questions 19-22 use the compressor schematic (Handout)

19. This control circuit is:
- a. AC
  - b. DC
  - c. Both AC and DC
20. What protection related to the lubrication system of the compressor is built into this control circuit?
21. With the control switch in the run position: List the sequence of events that will start this compressor. (10 points)
22. With the control switch in the standby position: List the sequence of events that will start this compressor on standby. (10 points)



S-13



S-14

36

TABLE OF DEVICES

| DEVICE NO | FUNCTION                    | RATING  | MFR | TYPE | CAT. OR REF. DWG. | REMARKS                        |
|-----------|-----------------------------|---------|-----|------|-------------------|--------------------------------|
| 42-3,4    | MAG STARTER                 |         |     |      |                   |                                |
| 42-7-2D   | " "                         |         |     |      |                   |                                |
| 42X-3,4,5 | AUX. RELAY STARTER          | 120 VAC | W   | SG   | STY. 1008539      |                                |
| 49-3,4,5  | THERMAL OVERLOAD            |         |     |      |                   |                                |
| 52-7-2D   | BREAKER, 480V MCC           |         |     |      |                   |                                |
|           |                             |         |     |      |                   |                                |
|           |                             |         |     |      |                   |                                |
| PS-X      | PRESSURE SWITCH &           |         |     |      |                   | Closes at 65 psi and           |
|           | PRESSURE SW. AUX. REL.      | 120 VAC | W   | MG-6 | STY. 11638        | opens at 100 psi               |
| PS-7X     | PRESS. SW. (STAND-BY START) |         |     |      |                   | Closes at 60 psi and           |
|           | " " AUX. RELAY              | 120 VAC | W   | MG-6 | STY. 1168         | opens at 70 psi                |
| PSL-5     | LOCAL PRESS. SAFETY SW.)    |         |     |      |                   | opens on high press. - 105 psi |
| LOS       | LOW OIL SW                  |         |     |      |                   |                                |
|           |                             |         |     |      |                   |                                |
|           |                             |         |     |      |                   |                                |
|           |                             |         |     |      |                   |                                |
|           |                             |         |     |      |                   |                                |



CHEMISTRY

NAME \_\_\_\_\_

DATE \_\_\_\_\_

**POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS**

**C-1**  
**Quiz ~~302~~**

1. What are the purposes of power plant chemistry? (Give at least four.)

- a. \_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_
- c. \_\_\_\_\_
- d. \_\_\_\_\_
- e. \_\_\_\_\_
- f. \_\_\_\_\_  
\_\_\_\_\_
- g. \_\_\_\_\_  
\_\_\_\_\_

2. What are physical properties of a substance? What are chemical properties?

- a. \_\_\_\_\_  
\_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_

C-1  
Quiz

(Continued)

3. What is the difference between an acid solution and a base solution?
4. Indicate whether the following pH values are acidic, alkaline, or neutral..
- |            |       |              |       |
|------------|-------|--------------|-------|
| a. pH = 0  | _____ | d. pH = 4.6  | _____ |
| b. pH = 7  | _____ | e. pH = 11.5 | _____ |
| c. pH = 14 | _____ | f. pH = 9.2  | _____ |
5. Circle the compounds:
- Ca, N<sub>2</sub>H<sub>4</sub>, SiO<sub>2</sub>, Fe, H, SO<sub>3</sub>, Na<sub>2</sub>SO<sub>3</sub>, CrO<sub>4</sub>, N, C, CaCO<sub>3</sub>,
6. What is conductivity? What are the units?
7. What is "ppm"?
8. What is the difference between a qualitative and a quantitative analysis?
9. What is meant by "end point" in a titration test?
10. What is meant by the solubility of gases & solids in water and how is it effected by pressure & temperature?



Quiz C-2

1. Briefly describe the reverse osmosis process.
2. Explain the basic idea for cracking scale on an evaporator.
3. What is the purpose of water softeners?
4. What are the consequences of operating an evaporator with high shell or brine conductivity?
5. What is the most efficient way to operate an evaporator? ( Include source of steam and routing of vapor )
6. What is the purpose of a precoat filter?
7. What chemical is generally used in the regeneration process of an anion resin bed?

Quiz C-2

(Continued)

8. Given a separate bed-type demineralizer system in which the flow is through the cation exchanger and then through the anion exchanger. In which bed would  $\text{Ca}^+$  and  $\text{Na}^+$  Ions be removed from the raw water?
9. What two chemical tests are most frequently conducted to determine when regeneration of a demineralizer is necessary?
10. Fill in the blank.
  - A. Never Subject resins to temperature greater than \_\_\_\_°F since the resins will become soft, stick together, and reduce the surface area available for ion exchange.
  - B. Never permit \_\_\_\_\_ to be introduced into demineralizer resin beds because it will coat the resins and prevent ion exchange.

NAME \_\_\_\_\_

DATE \_\_\_\_\_

**POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS**

**C-3**  
**Quiz**

(10 points each)

1. What are three major reasons chemical control of boiler water should be given prime consideration?

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

2. How is corrosion of nondrainable, pendant-type superheaters prevented when the boiler is secured?

\_\_\_\_\_  
\_\_\_\_\_

3. Boiler scale is formed when impurities enter the boiler via the feedwater system. How may these impurities enter the feedwater system?

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

C-3

Quiz  
(Continued)

4. What action should be taken on a unit that utilizes spray water at-  
temperature for reheat/superheat temperature control in the event  
excessive contamination is introduced into the feedwater system?
- a. \_\_\_\_\_  
\_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_
- c. \_\_\_\_\_  
\_\_\_\_\_
5. When performing a hydrostatic test on a boiler or when filling a boiler  
for chemical cleaning, what procedure must be followed to insure boiler  
water chemicals are not introduced into the superheater?
- a. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
6. a. What are the harmful effects of silica carryover?  
b. How is silica and its effects controlled?
- a. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

c-3  
Quiz  
(Continued)

7. For what reasons would a boiler blowdown be recommended for chemical control?
  - a.
  - b.
  - c.
8. What are two purposes of condensate and feedwater chemical control?
9. Why is ammonia used for pH control only in the feedwater and condensate systems which have all steel heater construction?
10. Supercritical plants have no tolerance for dissolved solids in the boiler. How are dissolved solids in these plants minimized?
  - a.
  - b.

NAME \_\_\_\_\_

DATE \_\_\_\_\_

**POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS**

*C-4*  
Quiz

(20 points each)

1. What is the purpose of chlorine injection in a once through circulating water system?

---

---

2. Why should demusseling be conducted on a routine, regular basis?

---

---

3. What method of chemical control is employed to minimize decay or rotting of the wood used in cooling towers?

---

4. What chemicals are used in the Bearing Cooling Water System and why?

a. \_\_\_\_\_  
\_\_\_\_\_

b. \_\_\_\_\_  
\_\_\_\_\_

5. What chemical is injected into the condenser outlet at some plants and why?

NAME \_\_\_\_\_

DATE \_\_\_\_\_

**POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS**

*C-5*  
Quiz

(20 points each)

1. List four prerequisites for boiler chemical cleaning.

- a. \_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_
- c. \_\_\_\_\_
- d. \_\_\_\_\_  
\_\_\_\_\_
- e. \_\_\_\_\_
- f. \_\_\_\_\_
- g. \_\_\_\_\_
- h. \_\_\_\_\_

2. Why is nitrogen gas used when draining a boiler during acid cleaning?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

C-5

Quiz

(Continued)

3. When water washing the air preheaters, will the pH of the initial wash water drain be acidic or basic? Why?

---

---

---

---

---

4. What is the basic pattern to be followed when blowing soot on a boiler?

---

---

5. What is the purpose of each of the following boiler chemicals used in chemical cleaning?

a. Hydrochloric Acid -----

---

---

b. Alkaline Boilout Chemical-----

---

---

c. Ammonia Bromate-----

---

---



Quiz C-6

1. List three operational activities that are related to Effluent Control.
  
  
  
  
  
  
  
  
  
  
2. a. What is "Effluent"?  
  
  
  
  
  
  
  
  
  
  
b. List 3 typical sources.
  
  
  
  
  
  
  
  
  
  
3. Why is air injected into the retention pond pump suction?
  
  
  
  
  
  
  
  
  
  
4. Oil is removed from the water surface of the Oil-Water separator by \_\_\_\_\_
  - a. Air blast
  - b. Skimmer
  - c. vacuum
  - d. pump
  
  
  
  
  
  
  
  
  
  
5. What is an oil spill contingency plan?

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

POWER PLANT PHYSICS, CHEMISTRY  
AND ELECTRICAL SCHEMATICS - QUIZ C-2

(20 points each)

1. What resource gives information about handling, storage and exposure of chemicals used in the work place?

Answer: \_\_\_\_\_

2. Small acid spills can be carefully washed down with water?

Answer:            True            False            (Circle one)

3. What is the definition of hazardous waste?

Answer: \_\_\_\_\_  
\_\_\_\_\_

4. All empty fiber or steel drums can be disposed of in dumpster after being triple rinsed?

Answer:            True            False            (Circle one)

5. Which Federal Agency has been assigned the authority to regulate the handling of hazardous waste?

Answer: \_\_\_\_\_

Name \_\_\_\_\_

Date \_\_\_\_\_

POWER PLANT PHYSICS, CHEMISTRY  
AND ELECTRICAL SCHEMATICS--QUIZ ~~8~~ <sup>C-8</sup>

(20 points each)

1. Why must  $H_2S$  be abated at the Geysers Power Plant? (3 reasons)
  
  
  
  
  
  
  
  
  
  
2. What are the three most prominent abatement chemicals?
  
  
  
  
  
  
  
  
  
  
3. Does the Stretford system remove  $H_2S$  from condensate or non-condensable gases?
  
  
  
  
  
  
  
  
  
  
4. Does the clarifying system remove solids from the circulating cooling water or the blowdown stream?
  
  
  
  
  
  
  
  
  
  
5. Why is the Geysers steam so unique? (2 reasons)

**POWER PLANT PHYSICS,  
CHEMISTRY, AND ELECTRICAL SCHEMATICS**

**Final Examination**

**CHEMISTRY:**

**True/False  
(4 points each)**

1. An acid solution contains an excess of hydrogen ions. \_\_\_\_\_
2. Conductivity, a measure of the electrical conductance of ions in water, is expressed in micro mhos. \_\_\_\_\_
3. In a separate bed type demineralizer,  $\text{Ca}^+$  and  $\text{Na}^+$  ions will be removed in the anion exchanger \_\_\_\_\_
4. Ammonia should be used for pH control only in feedwater and condensate systems which have all steel heater construction \_\_\_\_\_
5. As pressure increases, the solubility of gases in water increases; as temperature increases, the solubility of gases in water decreases. \_\_\_\_\_
6. The Stretford abatement system removes  $\text{H}_2\text{S}$  from the condensate \_\_\_\_\_
7. Hydrogen gas is used when draining a boiler during acid cleaning because nitrogen is liberated by the acid cleaning process. \_\_\_\_\_
8. In the event a severe condenser tube leak occurs, it is not necessary to reduce boiler load below the point requiring spray water attemperation if the  $\text{NaCl}$  concentration in the boiler can be controlled by blowdown \_\_\_\_\_
9. Sulphur dioxide is injected into the condenser outlet at some plants to control algae growth. \_\_\_\_\_
10. Demusseling is a process in which circulating water is heated and passed through the intake tunnels to kill organisms by thermal shock. \_\_\_\_\_

Final Examination

(Continued)

Multiple Choice  
(4 points each)

1. Never subject demineralizer resins to temperature greater than \_\_\_\_\_°F since the resins will become soft, stick together, and reduce the surface area available for ion exchange.  

|        |        |
|--------|--------|
| a. 75  | c. 150 |
| b. 100 | d. 105 |
2. A \_\_\_\_\_ is used to remove suspended solids from the raw water before introducing it to a demineralizer.  

|                         |               |
|-------------------------|---------------|
| a. Reverse osmosis unit | c. Resin bed  |
| b. Precoat filter       | d. Flash tank |
3. \_\_\_\_\_ is injected in a once-through circulating water system to prevent the formation of algae and slime or organism attack on the condenser tube metal.  

|                   |                     |
|-------------------|---------------------|
| a. Sulfur dioxide | c. Sodium hydroxide |
| b. Ammonia        | d. Chlorine         |
4. To prevent carry-over of dissolved solids from the drum into the superheater during hydrostatic testing or boiler chemical cleaning, \_\_\_\_\_.  

|   |
|---|
| a. backfill the superheater into the drum.    |
| b. Fill slowly from the bottom of the boiler. |
| c. use make-up quality water                  |
| d. leave the drum vents open                  |
5. Control of condenser tube leaks is important to prevent excess amounts of \_\_\_\_\_ from entering the boiler.  

|                  |                     |
|------------------|---------------------|
| a. $\text{Cl}^-$ | c. $\text{Mg}^+$    |
| b. $\text{Ca}^+$ | d. all of the above |
6. Substances which have uniform composition and structure, and that may be broken down into two or more simpler substances by chemical reaction are called \_\_\_\_\_.  

|              |             |
|--------------|-------------|
| a. elements  | c. mixtures |
| b. compounds | d. atoms    |
7. By charging \_\_\_\_\_ into the boiler water, the predominant contaminants -- calcium and magnesium -- react to form a soft precipitate that can be removed by boiler blowdown.  

|                     |                       |
|---------------------|-----------------------|
| a. sodium hydroxide | c. sodium sulfite     |
| b. ammonia          | d. disodium phosphate |

**Final Examination**

(Continued)

**Multiple Choice**  
**(4 points each)**

8. Which state government agency has the authority to regulate hazardous waste in California? \_\_\_\_\_
- a. Department of Transportation
  - b. Cal OSHA
  - c. Department of Health Services
  - d. State energy Commission
9. Indicate whether the following pH values are acidic, alkaline, or neutral.
- |            |       |              |       |
|------------|-------|--------------|-------|
| a. pH = 0  | _____ | d. pH = 4.6  | _____ |
| b. pH = 7  | _____ | e. pH = 11.5 | _____ |
| c. pH = 14 | _____ | f. pH = 9.2  | _____ |
10. Oil is removed from the water surface of the Oil-Water separator by \_\_\_\_\_
- a. Air blast
  - b. Skimmer
  - c. vacuum
  - d. pump

**Final Examination**

**(Continued)**

**Essay  
(4 points each)**

1.   a. What are the harmful effects of silica carry over?  
      b. How is silica controlled?  
  
      a.  
  
      b.
2. Explain the basic idea for cracking scale on an evaporator.
3. Briefly describe the reverse osmosis process.
4. How is corrosion of nondrainable, pendant-type superheaters prevented when the boiler is secured?
5. What are the consequences of operating an evaporator with high shell or brine conductivity?