The following is a list of subjects for the SI CEM exam. The study guide will not lead you to answers to all of the questions, but it will certainly lead you to a very large number of correct answers. A person with the necessary experience who reviews the study guide should have a good chance of passing the exam.

The exam will be open book and will last four hours. All questions are 8 points each. The maximum exam score is 1040 points and passing score is 704. All candidates must answer Sections I and II: Energy Accounting and Economics, and Energy Audits and Instrumentation. The candidate should choose 9 of the remaining 13 sections. If more than 9 additional sections are marked, only the first 9 will be scored. After the first two mandatory sections, the thirteen sections remaining are as follows:

**I. ENERGY ACCOUNTING AND ECONOMICS**

- Life-cycle Cost Analysis
- Simple Payback Period
- Time Value of Money
- Present Worth
- Net Present Value
- Present Worth Method
- Internal Rate of Return
- Energy Accounting
- Point of Use Costs
- Discounted Cash Flows
- Energy Unit Conversions
- Interest Formulas and Tables
- Project Life
- Annual Worth Method
- Economic Performance Measures
- Minimum Annual Rate of Return
- Energy Use Index
- Efficiency Measures

**II. ENERGY AUDITS AND INSTRUMENTATION**

- Role of Audits
- Energy Management Measures
- Combustion Analysis
- Power Factor Correction
- Basic Thermodynamics
- Air Velocity Measurement
- Light Level Measurement
- Infrared Equipment
- Audit Equipment
- Load Factors
- Combustion Analyzers
- Electric Metering Equipment
- Temperature Measurement
- Pressure Measurement
- Humidity Measurement
- Data Loggers
III. **ELECTRICAL SYSTEMS**

- Demand and Energy
- Real Power
- Power Factor
- Power Factor Correction
- Rate Structure and Analysis
- Variable Speed Drives
- Voltage Imbalance
- Harmonics

- Load Factors
- Reactive Power
- Single- and Three-phase Systems
- Peak Demand Reduction
- Motors and Motor Drives
- Affinity Laws (Pump and Fan Laws)
- Power Quality
- IEEE Power Quality Standard 519

IV. **HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS**

- Heating Systems
- Air Conditioning Systems
- HVAC Equipment Types
- Cooling Towers
- Vapor Compression Cycle
- Affinity Laws
- Psychrometric Charts
- Heat Transfer
- Air- and Water-based Heat Flow
- Demand Control Ventilation
- Ventilation Heat Recovery

- Ventilating Systems
- Economizers
- Chillers
- Heaters
- Absorption Cycle
- Performance Ratings (COP, HSPF, EER, kW/ton, and more)
- Heating and Cooling Degree Days
- Air Distribution Systems (Reheat, Multizone, VAV)
- Energy Consumption Estimates
- ASHRAE Ventilation Standard 62.1
- ASHRAE Thermal Comfort Standard 55

V. **MOTOR AND DRIVE SYSTEMS**

- AC Induction Motors
- DC Motors
- Load Factor and Slip
- Motor Speed Control
- Fan and Pump Laws
- Motor Selection Criteria
- Motor Management Software

- AC Synchronous Motors
- High Efficiency Motors
- Power Factor and Efficiency
- Variable Frequency Drives
- Variable Flow Systems
- New vs Rewound Motors
- Power Factor Correction

VI. **INDUSTRIAL SYSTEMS**

- Waste Heat Recovery
- Industrial Energy Management
- Fuel Choices
- Steam Systems
- Heat Exchangers
- Turbines
- Affinity Laws
- Compressed Air Systems
- Air Compressor Controls

- Boilers and Thermal Systems
- Pipe Insulation
- Fuel Selection
- Steam Tables
- Steam Traps
- Pumps
- Compressors
- Air Compressors
- Compressed Air Leaks
VII. BUILDING ENVELOPE

Thermal Resistance
Heating and Cooling Degree Days
Insulation
Solar Heat Gain
Thermally Light Facilities
Conduction Heat Transfer
Air Heat Transfer

Heat Transfer Coefficients
Infiltration and Exfiltration
Vapor Barriers
Solar Shading
Thermally Heavy Facilities
Psychrometric Chart Calculations
Water Heat Transfer

VIII. COMBINED HEAT AND POWER SYSTEMS AND RENEWABLE ENERGY SYSTEMS

Power Cycles
Combined Cycles
Topping Cycles
Prime Movers
Load Calculations
Combined Heat and Power
Net Metering
Regulations

Fuel Selection
Operating Strategies
Bottoming Cycles
Distributed Generation
Efficiencies (Power, Thermal, and System)
Solar, Wind, Biomass, Hydropower and Other RE Systems
Solar Thermal and Solar Photovoltaic Systems
Renewable Energy Resources

IX. BUILDING AUTOMATION SYSTEMS

Energy Management Strategies
Distributed Control
Optimization Controls
Building Control Strategies
Expert Systems
Self-Tuning Control Loops
Communication Protocols

Interactive Control Strategies
Building Automation Systems
Artificial Intelligence
Energy Information Systems
Internet, Intranets and WWW
Web Based Systems
ASHRAE Standard 135

X. CONTROL SYSTEMS

Basic Controls
BACnet & LON
Open- and Closed-loop Controls
Power Line Carriers
Terminology
Signal Carriers
Electric Controls
PID Controls

Direct Digital Control
Central Control
Control Signals
Reset Controls
Communication Protocols
Pneumatic Controls
Basic Control Definitions
Cut-in, Cut-out, Differentials, and Dead Bands

XI. THERMAL ENERGY STORAGE SYSTEMS

Design Strategies
Storage Media
Thermal Calculations
Chilled Water Storage
Equipment Sizing
Full Storage Systems

Operating Strategies
Advantages and Limitations
Interaction with Utility Rate Tariffs
Ice Storage
Volume Requirements
Partial Storage Systems

XII. LIGHTING SYSTEMS

Light Sources
Lamp Life
Lighting Retrofits
Zonal Cavity Design Method

Efficiency and Efficacy
Strike and Restrike
Lux
Inverse Square Law
XIII. BOILER AND STEAM SYSTEMS

- Combustion Efficiency
- Air to Fuel Ratio
- Excess Air
- Combustion Control
- Steam Tables
- Boiler Economizers
- Steam Traps
- Steam Leaks
- Condensate Return
- Boiler Blowdown
- Waste Heat Recovery
- Flash Steam
- Scaling and Fouling
- Turbulators
- Condensing Boilers
- Heat Transfer

XIV. MAINTENANCE AND BUILDING COMMISSIONING

- Combustion Control
- Compressed Air Leaks
- Steam Leaks
- Steam Traps
- Insulation
- Outside Air Ventilation
- Group Relamping
- Scheduled Maintenance
- Preventive Maintenance
- Proactive Maintenance
- Boiler Scale
- Water Treatment
- Purpose of Commissioning
- Commissioning New Buildings
- Need for Commissioning
- Real Time and Continuous Commissioning
- Measurement & Verification
- Commissioning Agent
- Phases of Commissioning
- Facility Design Intent
- Commissioning Documentation
- Re-commissioning
- Benefits of Commissioning
- Monitoring-based Commissioning

XV. FINANCING, PERFORMANCE CONTRACTS, & MEASUREMENT AND VERIFICATION (M&V)

- Sources of Capital
- Project Finance Options
- Leasing
- Capital Lease
- Performance Contracts
- Energy Service Companies
- Shared Savings
- Utility Financing
- Risk Management
- Contract Adjustments
- Baseline Energy Use
- Post Retrofit Energy Use
- Goals of M&V
- M&V Baseline for Savings
- Utility Bill Comparison
- Calibrated Simulation Modeling
- Measurement & Verification Protocols
- ASHRAE Guideline 14
- EVO IPMVP
- IPMVP M&V Options
- Continuous Measurement
- Spot Measurement
EXAM REVIEW QUESTIONS

1. One of the most basic goals of an energy audit is to determine the cost of energy that a facility uses.
   (A) True      (B) False

2. What would be used to find the quantity of electric current in an electrical circuit?
   (A) Ohmmeter  (B) Ammeter
   (C) Wattmeter  (D) None of the above

3. If electricity costs $0.06 per kilowatt-hour and is used for electric heating with an efficiency of 100%,
   what is the equivalent price of natural gas per gigajoule if it can be burned with an efficiency of 80%?
   (A) $8.00/GJ   (B) $13.30/GJ
   (C) $15.10/GJ  (D) $21.20/GJ
   (E) $24.30/GJ

4. In operating a boiler with dual fuel capability, which is the lowest cost of fuel given the following?
   Natural gas $4.00/GJ    efficiency = 92%,
   Fuel oil $123/ton      efficiency = 88%  (42,000 kJ/kg)
   (A) Natural gas
   (B) Fuel oil

5. A 1000 square metre building consumes the following amounts of energy per year. What is the Energy
   Use Index in MJ per square metre per year?
   Natural Gas 500 GJ/year    Electricity 60,000 kWh/year
   (A) 716 MJ/m²/yr            (B) 883 MJ/m²/yr
   (C) 8150 MJ/m²/yr           (D) 17,500 MJ/m²/yr
   (E) 70,000 MJ/m²/yr

6. An energy saving device will save $25,000 per year for 8 years. How much can a company pay for this
   device if the interest rate (discount rate) is 15%?
   (A) $112,180   (B) $53,590
   (C) $76,451    (D) $178,420

7. An energy saving device costs $34,500 and will save $9,000 per year for its full life of 8 years. What is
   the approximate internal rate of return?
   (A) 10%    (B) 12%
   (C) 15%    (D) 20%
   (E) 25%

8. A new device costs $40,000 installed. The device will last 10 years at which time it will have to be
   replaced. How much will it have to save each year to obtain a 18% internal rate of return before taxes?
   (A) $4,600   (B) $6,450
   (C) $7,970    (D) $9,460

9. An audit for one facility showed that the cos φ is almost always 70% and that the demand is 1000 kW.
   What capacitor size is needed to correct cos φ to 90%?
   (A) 266 kvar    (B) 536 kvar
   (C) 1,000 kvar  (D) 618 kvar
   (E) 1,214 kvar

10. The amount of reactive power that must be supplied by capacitors to correct a cos φ of 84% to 95% in a
    300 kW motor at 75% load and 98% efficiency is:
    (A) 72.8 kvar    (B) 82.5 kvar
    (C) 92.4 kvar    (D) 90.0 kvar
    (E) 123.4 kvar

11. Power factor (Cos φ) correcting capacitors may be located:
    (A) At the inductive load
    (B) At load control centres
12. One disadvantage of metal halide lamps is a pronounced tendency to shift colours as the lamp ages.
   (A) True  (B) False

13. A lighting survey of a 400 square metre office building identified the following fixtures:
    30 - 4 tube fixtures @ 192 watts/fixture
    10 - 100 watt incandescent floodlights
    20 - 75 watt task lamps
What is the lighting density in W/m² of this facility?
   (A) 82.7  (B) 46.7
   (C) 36.4  (D) 20.7
   (E) 10.1

14. A building currently has the following lighting system:
    Present: 196 mercury vapour light fixtures
    Size: 250 watt/lamp, 285 watt/fixture, including ballast
You have chosen to replace the existing system with the following:
    Proposed: 140 high pressure sodium fixtures
    Size: 150 watt/lamp, 185 watt/fixture, including ballast
The facility operates 24 hours/day. Approximate the heating effect if the heating system efficiency is 80%, fuel costs $5.00/GJ and there are 200 heating days in a year.
   (A) $4,446/yr  (B) $2,490/yr
   (C) $6,900/yr  (D) $5,290/yr
   (E) $3,240/yr

15. You find that you can replace a 50 kW motor with a 5 kW motor by cutting the total air flow requirements. Calculate the total dollar savings, given the information below:
    Runtime: 8,760 hours/year
    Motor Efficiency: 90% (both motors)
    Electrical Rate: $9.00/kW-month & $0.05/kWh
    Fuel Cost Adjustment: $0.005/kWh
   (A) $29,490  (B) $20,400
   (C) $22,090  (D) $14,010
   (E) $6,460

16. In a facility audit you find one large air handling unit delivering 200 m³/min conditioned air. The air is delivered to two manufacturing areas. One has been discontinued, so you find you can close some dampers and cut air flow to 150 m³/min. What will be the size required for the new motor if the old one was 20 kW?
   (A) 45.12 kW  (B) 13.67 kW
   (C) 8.44 kW  (D) 5.82 kW
   (E) 2.0 kW

17. A 75 kW rotary screw air compressor (and motor) generates approximately how much heat as it compresses the air?
   Assume the air compressor only produces 10% of its input in the form of useful work with compressed air.
   (A) 1000 kJ/hr  (B) 10,000 kJ/hr
   (C) 100,000 kJ/hr  (D) 250,000 kJ/hr
   (E) 500,000 kJ/h

18. In calculating heat flows, metal generally provides little resistance to heat flow compared to insulation or even air films.
   (A) True  (B) False
19. Air at 20.6 °C dry bulb and 50% relative humidity flows at 3,185 L/s and is heated to 32.2°C dry bulb. How many kW is required in this heating process?
(A) 4.67 kW  
(B) 26.56 kW  
(C) 44.33 kW  
(D) 69.33 kW  
(E) 75 kW

20. Estimate the seasonal energy consumption for a building if its design heating load has been determined to be 105 kW for a design temperature difference of 30°C if the heating season has 1,800 degree days. The heating unit efficiency is 80%.
(A) 700.0 GJ/yr  
(B) 350.1 GJ/yr  
(C) 462.2 GJ/yr  
(D) 720.6 GJ/yr  
(E) 680.4 GJ/yr

21. An absorption chiller system with a COP of 0.8 is powered by hot water that enters at 90°C and leaves at 80°C at a rate of 2 L/s. The chilled water operates on a 5°C temperature difference and the condenser water on a 10°C temperature difference. Calculate the water flow.
(A) 0.8 L/s  
(B) 1.6 L/s  
(C) 3.2 L/s  
(D) 3.6 L/s  
(E) 2.4 L/s

22. A wall has a total thermal resistance of 2.64 m²°C/W. Determine the annual cost of the heat loss per square metre in a climate having 2,500 heating degree days. The heating unit efficiency is 70% and the fuel cost is $5.00/GJ.
(A) $0.41/m²  
(B) $0.33/m²  
(C) $0.58/m²  
(D) $0.20/m²  
(E) $0.06/m²

23. The k value for a particular piece of insulation changes with temperature.
(A) True  
(B) False

24. When a large insurance call center has an unmanned server room, it produces 340,000 kJ per hour of heat from equipment and lights. How many kW of air conditioning is needed just to remove this heat from the equipment and lights?
(A) 17.13 kW  
(B) 44.70 kW  
(C) 94.44 kW  
(D) 134.37 kW  
(E) 189.29 kW

25. 5000 L/s of air leaves an air handler at 10°C. It is delivered to a room at 18°C. How many kW of air conditioning capacity was lost in the ductwork?
(A) 48 kW  
(B) 20 kW  
(C) 36 kW  
(D) 60 kW  
(E) 3 kW

26. The refrigerant in a vapour compression air conditioner is always in the vapour state.
(A) True  
(B) False

27. Given the parameters below, estimate the percent outside air in this simple single zone heating system.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Air Temperature</td>
<td>5 °C</td>
</tr>
<tr>
<td>Return Air Temperature</td>
<td>22 °C</td>
</tr>
<tr>
<td>Mixed Air Temperature</td>
<td>18.3 °C</td>
</tr>
</tbody>
</table>

(A) 27.2 %  
(B) 21.8 %  
(C) 36.5 %  
(D) 5.0%   
(E) 86.5 %

28. A large commercial building will be retrofitted with a closed loop air heat pump system. Individual meters will measure costs at each department. Demand billing a small part of the total electrical cost. Would you recommend a TES?
(A) Yes  
(B) No
29. With a load levelling TES strategy, a building manager will:
   (A) Not operate the chiller during peak hours
   (B) Essentially base load the chiller (i.e., operate at a high load most of the time)
   (C) Operate only during the peaking times
   (D) Operate in the “off” season

30. What is the percentage fuel savings in a natural gas fired boiler if the installation of turbulators reduces the stack temperature from 250°C to 200°C? Assume the boiler is operating with 20% excess air.
   (A) 1.10 %  
   (B) 1.95 %  
   (C) 2.65%  
   (D) 3.65%

31. Which of the following methods could be used to detect failed steam traps?
   (A) Ultrasonic equipment to listen to the steam trap operation
   (B) Infrared camera to detect the change in temperature
   (C) Real time MMS using conductance probes
   (D) All the above

32. Given the same amount of excess air and the same flue gas temperature, which fuel provides the highest combustion efficiency?
   (A) Natural Gas  
   (B) No.2 Fuel Oil  
   (C) No.6 Fuel Oil  
   (D) Coal  
   (E) Propane

33. A boiler is rated at 300 kW (output) and 80% efficient. What is the input rating?
   (A) 325,000 J/s  
   (B) 375,000 J/s  
   (C) 10,000 J/s  
   (D) 1,050,000 J/s
   (E) 8,068,000 J/s

34. Which of the following is not a positive displacement air compressor?
   (A) Helical compressor  
   (B) Reciprocating compressor  
   (C) Sliding vane compressor  
   (D) Axial compressor  
   (E) none of the above

35. Which of the following heat exchanger types is most likely to allow cross contamination between heat exchange fluids?
   A) Shell & tube  
   B) Heat pipe  
   C) Heat wheel  
   D) Recuperator

36. How does steam injection into a gas turbine affect the operation?
   (A) Increases thermal efficiency  
   (B) Reduces NOx  
   (C) Increases NOx  
   (D) A and B  
   (E) A and C

37. How much will an air leak cost a facility annually in energy if it has a leak hole that is 6.35 mm in diameter and a pressure of 690 kPa and it goes unrepaired for three months? (based upon 7 cents per kWh)
   (A) $935.00  
   (B) $2390.00  
   (C) $1620.00  
   (D) $5390.00

38. What is the flow rate of 16°C water through a control valve with a flow coefficient of 0.01 and a pressure difference across the valve of 100 kPa?
39. The difference between the setting at which the controller operates to one position and the setting at which it changes to the other is known as the:
   (A) Throttling range  (B) Offset
   (C) Differential      (D) Control Point

40. Devices using 4-20 mA current loops are using digital data transmission.
   (A) True              (B) False
EXAM REVIEW SOLUTIONS

1. (A) True

2. (B)

3. (B) $(0.06/kWh) \times (277.8 \text{kWh/GJ}) = ($16.67/GJ)
   \[= ($X/GJ) \times (1/0.8)\]
   \[X = $13.30/GJ.\]

4. (B) For natural gas
   
   $(4.00/GJ)(1.0/0.92) = $4.35/GJ
   
   For fuel oil
   
   $(123/ton)(1 \text{ton}/1000 \text{ kg})(1 \text{ kg}/42,000 \text{ kJ})(1/0.8)
   
   $(1,000,000 \text{ kJ}/GJ) = $3.33/GJ
   
   Choose fuel oil

5. (A) Gas $(600 \text{ GJ/yr})(1000 \text{ MJ/GJ}) = 600,000 \text{ MJ/yr}$
   
   Elect $(60,000 \text{ kWh/yr})(3.6 \text{ MJ/kWh}) = 216,000 \text{ MJ/yr}$
   
   EUI = $(716,000 \text{ MJ/yr})/1000 \text{ m}^2 = 716 \text{ MJ/ m}^2 \text{ yr}$

6. (A) $P = A \times \text{[P/A, I, N]}
   
   $P = 25,000 \times \text{[P/A, 15%, 8]}
   
   $= 25,000 \times [4.4873] = $112,182 \text{ (round off)}
   
   or $112,175 \text{ (depending on tables)}$

7. (D) $P = A \times \text{[P/A, IRR, 8]}
   
   $34,500 = 9000 \times \text{[P/A, IRR, 8]}$

   From the Interest Tables – Look for P/A and 8 years

   For I = 20% table; P/A = 3.83 so IRR = 20%

8. (C) $P = A \times \text{[P/A, I, N]}
   
   40,000 = A \times \text{[P/A, 15%, 10]}
   
   $A = 40,000/[5.0188] = $7970$

9. (B) $kVAR = 1,000 \text{ kW} \times [\tan (\cos^{-1} 0.7) - \tan (\cos^{-1} 0.9)]
   
   $kVAR = 1,000 \text{ kW} \times [0.3172 \text{ (from table)}] = 536 \text{ kvar}$

10. (A) $kW = (300 \text{ kW}) \times 0.75/0.98 = 229.6 \text{ kW}$

    $kvar = 229.6 \text{ kW} \times [\tan (\cos^{-1} 0.84) - \tan(\cos^{-1} 0.95)] = 72.8 \text{ kvar}$

11. (D)

12. (A) True

13. (D) $W = [(30 \times 192) + (10 \times 10) + (20 \times 75)]
   
   = 8260 \text{ watts}
   
   $W/m^2 = 8260 \text{ W/400 m}^2 = 20.67 \text{ W/m}^2$

14. (E) $kW \text{ saved} = 196 \text{ fix x (0.285 kW/fix)}$

    $- 140 \text{ fix x (0.185 kW/fix)} = 30 \text{ kW}$

   Heating effect

   $(30 \text{ kW}) \times (24 \text{ h/day}) \times (1/0.8) \times (200 \text{ days/yr}) \times (3.6\text{MJ/kWh}) = 648,000 \text{ MJ/yr} = 648 \text{ GJ/yr}$

   Added cost = $(648 \text{ GJ/yr})($5/GJ) = $3,240/yr

15. (A) $kW \text{ saved} = (45) \times 1/0.9 = 50 \text{ kW}$

   $kWh \text{ saved} = 50 \text{ kW} \times 8,760 \text{ hours/yr}$

   $= 438,000 \text{ kWh}

   $\$ \text{ saved} = 50 \text{ kWh} \times \$9/\text{kWh/mo} \times 12 \text{ mo/yr}$

   $+ 438,000 \text{ kWh} \times \$0.085/\text{kWh}$

   $= 239,490/yr$

16. (C) $kWhn = 20 \times (150/200)^3 = 8.44 \text{ kW}$

17. (D) $kJ/h = (75 \text{ kW})(3600 \text{ kJ/h/kW})(0.9) = 243,000 \text{ kJ/h}$

18. (A) True

19. (C) $q = \text{LPS} \times 1.2 \times DT = (3185)(1.2)(32.2-20.6) = 44.3 \text{ kW}$

20. (E) $q = UA DT$

    $UA = 105 \text{ kW/30 C} = 3.5 \text{ kW/C}$

    Also,

    $Q = UA \times 24 \times DD$

    $= (3,500) \text{ W/C} \times 24 \text{ h/day} \times 1,800 \text{ C-day/yr} \times 1/0.8$

    $= 189,000 \text{ kWh/yr} = 680.4 \text{ GJ/yr}$
21. (C) \[ q = \text{LPS} \times 4.2 \times DT \]
\[ q_{in} = (2)(4.2)(90-80) = 84 \text{ kW} \]
\[ q_{out} = \text{COP} \times q_{in} = 0.8 \times q_{in} = 67.2 \text{ kW} \]
\[ 67.2 = (\text{LPS})(4.2)(5) \]
\[ \text{LPS}_{out} = 3.2 \text{ LPS} \]

22. (C) \[ Q = UA \times 24 \times DD \]
\[ = (1/2.64) \text{ W/m}^2\cdot\text{C} \times 24 \text{ h/day} \times 2,500 \text{ C-day/yr} \]
\[ \times 1/0.7 \times 0.0036 \text{ MJ/Wh} \times $0.005/\text{MJ} \]
\[ = $0.584/\text{m}^2\cdot\text{yr} \]

23. (A) True

24. (C) \[ \text{kW} = (340,000 \text{ kJ/h})/(3600 \text{ kJ/kWh}) \]
\[ = 94.44 \text{ kW} \]

25. (A) \[ q = \text{LPS} \times 1.2 \times DT \]
\[ = 5000 \times 1.2 \times 10 = 48,000 \text{ W} = 48 \text{ kW} \]

26. (B) False

27. (B) \[ \% = (\text{RAT} - \text{MAT})/(\text{RAT} - \text{OAT}) \]
\[ = (22 - 18.3)/(22 - 5) = 21.8\% \]

28. (B) No

29. (B)

30. (C) From combustion chart
\[ \text{Eff}_\text{OLD} = 80.5\% \quad \text{Eff}_\text{NEW} = 82.7\% \]
\[ \% \text{ savings} = (\text{Eff}_\text{NEW} - \text{Eff}_\text{OLD})/\text{Eff}_\text{NEW} \]
\[ = (82.7 - 80.5)/82.7 = 2.65\% \]

31. (D)

32. (D)

33. (B) \[ \text{Input} = 300 \text{ kW} \times (1/0.8) = 375 \text{ kW} = 375,000 \text{ J/s} \]

34. (D)

35. (C)

36. (D)

37. (C)

38. (A) \[ \text{L/s} = \text{Cv}\sqrt{PD} = 0.01\sqrt{100} = 0.1 \text{ L/s} \]

39. (C)

40. (B) False