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2018 Building Science Theory Exam Learning Objectives

(All new additions since the 2017 Learning Objectives have been Italicized)

Indoor and Outdoor Environment:

1. Describe the impact of the characteristics of the Canadian climate on building design (temperature, relative humidity, solar radiation, wind, precipitation)
2. Explain what is meant by urban heat island effect
3. Define degree-days and explain the impact of degree-days on heating and cooling loads
4. Calculate total degree-days given average monthly temperatures
5. Describe the underlying mechanisms of the various thermal comfort factors (temperature, RH, air movement, radiation, activity level,
   clothing) and how they impact human's perception of their environment
6. Predict how changes in thermal comfort factors affect the zone of comfort as defined by ASHRAE Standard 55
7. *Explain what heat transfer mechanisms are impacted by Humidex and Wind Chill Factor and under what conditions these typically occur*

Moisture and Moisture Movement:

8. Describe the significance of D'Alton's Law and the Ideal Gas Law and how they would be applied
9. Calculate the density and humidity ratio of moist air in different conditions.
10. Use the psychrometric chart to determine different properties of air (RH, moisture content, enthalpy, sensible and latent heat, dry bulb, wet bulb, specific volume and density)
11. Demonstrate heating, cooling and evaporative processes using the psychrometric chart
12. Explain the three main water transport mechanisms in buildings (vapour diffusion, surface diffusion, capillary flow)
13. Explain the difference between permeance and permeability
14. Explain why material permeances vary based on dry, wet and inverted cup tests
15. Explain the difference between air and vapour barriers
16. Calculate moisture diffusion, composite permeances, and vapour pressure drops across materials to determine interstitial relative humidity
17. Describe how efflorescence and subflorescence occur
18. Describe dimensional changes due to changes in moisture content
19. Illustrate different strategies for managing moisture in buildings
20. Describe the functions of rainscreen walls and how they are different from face-sealed walls
21. Describe the conditions required for a leak to occur through a building component

Wood Masonry and Controlling Moisture Below Grade:

22. Describe the difference between adsorbed and free water
23. Compare shrinkage and expansion of different cuts of wood
24. Explain how freeze-thaw impacts masonry and describe what spalling is
25. Show how annual below-grade temperatures vary with annual air temperatures
26. Describe best practice below grade design in residential and commercial applications
27. Explain how capillary heat transfer occurs

Heat Transfer:

28. Explain the difference between energy and power
29. List different units for energy and power and show how to convert between them
30. Explain what drives the three main heat transfer mechanisms: conduction, convection and radiation
31. Contrast why different materials exhibit different conductances and conductivities
32. Determine the fractions of absorption, reflection and transmission of radiation from different materials
33. Calculate emissivity across air spaces
34. Describe the difference between long and short wave radiation
35. Calculate the absorption and emission of radiation
36. Explain the importance of Kirchoff's identity
37. Determine equilibrium temperature of an object given incident radiation and material properties
38. Calculate transfer of radiation between two parallel surfaces
39. Identify areas of convective heat loss in buildings and how to prevent them.
40. Use the tables to estimate heat transfer coefficients due to radiation and convection
41. Illustrate how all heat transfer mechanisms are balanced on a particular object
42. Describe why the thermal resistance properties of insulation materials differ
43. Describe when 1D, 2D and 3D heat flow analysis are appropriate
44. Calculate composite thermal resistance
45. Use Fourier's Law to calculate one-dimensional heat flow rate and total heat flow
46. Determine surface conductance factors for various surface orientations and emissivities
47. Estimate building interior surface temperatures
48. Determine steady state temperature profiles for various envelope sections including walls and roofs.
49. Using temperature and vapour pressure profiles, determine condensation risks for various envelope sections
50. Using various building materials, show how interstitial condensation can be controlled
51. *Estimate below grade heat losses*
52. *Estimate the heating and cooling loads due to transmission heat losses and gains through the envelope*
53. *Using climate normals and costs of energy and system efficiencies, estimate the cost of providing heating and cooling given various building envelope options*

Frost-Heave and Adfreezing:

54. Explain the three conditions required for frost heave to occur
55. Explain how heat flows through the soil and varies seasonally
56. Using an understanding of coupled heat and moisture movement, explain how frost heave and ice segregation occurs
57. Explain what determines the direction of frost heave
58. Explain the difference between basal heave and frost heave by the mechanism of adfreezing
59. Explain the various ways in which frost heave and adfreezing can be controlled for various structures including retaining walls, below grade parking garages and pier foundations

Air Movement and Air Leakage in Buildings:

60. Describe the importance of air leakage and the potential effects on durability and energy use
61. Using Bernoulli's fundamental flow equation, calculate the flow through building openings in response to pressure differences
62. Describe how flow differs between sharp-edged and smooth-edge orifices
63. List the three basic ways in which pressure differences are created in and around buildings
64. Describe how wind varies with terrain and elevation
65. Using airport observations, estimate average and peak wind speeds at various elevations and location using terrain exponents
66. Describe how wind pressure coefficients around buildings vary in time and space and with wind direction
67. Using site-determined wind speeds, calculate the pressure differences potentially induced by wind

68. Describe how a blower door test works and why it would be conducted
69. *With the assistance of blower door data, determine the flow coefficient and flow exponent for the generalized flow equation*
70. Calculate pressure differences due to stack action for both low and high rise buildings
71. Describe how the neutral pressure surface varies depending upon the location of leakage openings
72. Describe how stack action affects the flow of air in buildings when the building is being heated and when the building is being cooled
73. Describe how mechanical systems affect air pressure differences within buildings
74. Calculate the combined effects of wind, stack, and mechanical ventilation on air leakage
75. Describe the importance of building tight and ventilating right
76. Estimate the fresh air requirements for various occupancies
77. Describe how uncontrolled air leakage can lead to energy losses, interstitial condensation, and rain penetration
78. Describe the various ways in which air barriers may be made continuous
79. Describe the strength and the weaknesses of interior, exterior and interstitial air barriers
80. Describe how these various air barriers can be constructed and maintained
81. Calculate the energy costs of uncontrolled air leakage and how these costs can be reduced through air-tightness measures and the provision of controlled ventilation

Solar Radiation and Buildings:

82. Describe why sun angles and intensity vary with latitude, orientation, time of year and time of day
83. Calculate window solar heat gains on a daily and monthly basis using shading coefficients/solar heat gain factors and solar heat gain coefficients
84. Describe how window coatings can be used to control solar heat gain
85. Describe how multiple glazings, frame types and glass coatings can be used to reduce transmission heat losses
86. Calculate daily and monthly net heat gains or losses for various windows and orientations
87. Investigate solar effects on opaque elements
88. Calculate the sol-air temperature for various building surfaces
89. Discuss solar design principles including shading devices

Roof Design Principles:

90. Explain why conventional roofs may experience concealed condensation issues
91. Distinguish between low-slope and steeper pitched roofs and the various materials typically used in their construction
92. Discuss the large temperature differences that roof materials may experience, both seasonally and diurnally, and describe how these large temperature differences can be accommodated in conventional roofing system design
93. Discuss the need for venting of conventional roofs and how this venting can be established and maintained
94. Describe how protected membrane roofs offer the opportunity to address temperatures changes and concealed condensation problems.
95. Describe how a double roof can be constructed when historic buildings are thermally retrofitted
96. Compare different roof assemblies for thermal and moisture performance

Principles for Controlling the Rain Penetration of Walls:

97. Identify and describe how rain enters wall systems
98. Describe how wind pressures influence rain penetration and how pressure-driven films enter the wall
99. Describe the various rain penetration control strategies and methods
100. Describe the two fundamental moisture control strategies for wall systems including the face seal and rainscreen approach
101. Describe how a pressure-moderated rainscreen works
102. Describe how a drained EIFS system works
103. Recognize the difference between a window wall and a curtain wall
104. Explain how rainscreen principles can be applied to various wall elements including windows and precast joints

Case Studies that Illustrate the Application of Building Science Principles:

105. Identify challenges to retrofitting residential and commercial buildings
106. Identify situations that lead to decay in wood and how wood decay can best be controlled in both existing and new buildings
107. Identify the difference between subflorescence and efflorescence, the reasons for masonry decay and how masonry decay can best be controlled in existing and new buildings
108. Identify causes of interior condensation and how condensation can best be controlled in existing and new buildings
109. Identify ways in which moisture and moisture movement can be controlled in special indoor environments including swimming pools, hospitals and museums
110. Identify how wind driven rain can best be controlled and how effective air barriers can be constructed and verified