CMGT 235 – Electrical and Mechanical Systems

Department of Construction Management ❀ California State University, Chico

Exam #1 – 1 point each answer except where indicated

Name: Answers

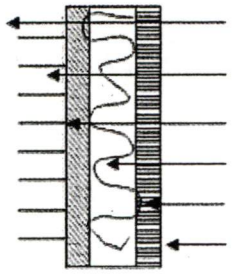
5 pts 1. If you have a six-inch thick, R – 19 fiberglass insulation batt that measures 2 ft x 8 ft and one side of the batt is 20°F and the other side is 70°F, what is the total heat loss through the batt?

$U = \frac{1}{R} = \frac{1}{19} = 0.053$

$Q = U \times A \times \Delta T = 0.053 \times 16 ft^2 \times 50°F$

$= 42.4$ Btuh

5pts 2. Calculate the total R-value of the wall.



outside air surface (winter)	0.17
4" brick	0.80
R- 1.32 sheathing	1.32
R- 11 insulation	11.00
1/2"gypson	0.45
inside air surface	0.68

$R_{Total} = 14.42$

5 pts 3. If the wall in problem ~~3~~ 2 is 40 ft long and 9 ft. high what is the heat loss through the wall for an indoor winter design temperature of 70°F and an outside temperature of 23°F?

$U = \frac{1}{14.42} = 0.07$

$Q = U \times A \times \Delta T$

$= 0.07 \times 360 ft^2 \times 47°F$

$= 1184$ Btuh

$V = 0.0693$

or 1173 Btu

5 pts 4. Determine the total heat loss due to infiltration for a house that is 1678 ft^2, 9 ft high with an infiltration rate of 0.38 ACH and 13 CFM due to a fireplace for an indoor winter design temperature of 70°F and an outside temperature of 23°F.

$$CFM = \frac{0.38\ ACH \times (1678\ ft^2 \times 9\ ft)}{60\ min/hr} + 13\ CFM = 109\ CFM$$

$$Q_{infil} = 109\ cfm \times 1.08 \times 47°F$$

$$= 5{,}533\ Btu/h$$

5 pts 5. A 60-gal hot water tank is installed in a residential garage where the temperature is 37°F. The tank has been off for several days. How many kW of electricity will be needed to raise the water temperature to 120°F?

$$Q = 60\ gal \times 8.35\ \frac{lb}{gal} \times 1\ \frac{Btu}{lb°F} \times (120°F - 37°F)$$

$$= 41{,}583\ Btu$$

$$Electricity = 41{,}583\ BTU \times \frac{1\ KW}{3413\ BTU} = 12.2\ KW$$

5 pts 6. If a duct is 18-inches by 2 feet and the average measured air velocity is 130 feet per minute, what is the resulting flow rate?

$$= 1.5\ ft \times 2\ ft \times 130\ \frac{ft}{min}$$

$$= 390\ CFM$$

5 pts 7. How much heat (Btu) is produced by a 150-W light bulb that is on for 10-hours?

$$P = 150W \times 10\,hrs = 1500\,W = 1.5\,KW$$

$$Q = 1.5\,KW \times 3414\,\frac{Btu}{KW} = 5121\ BTU$$

5 pts 8. If the lighting load for a 25,000 SF building is estimated at 0.8 W/SF, what will be the resulting heat generated by lighting in units of MBtu for one full year of lights on 24 hour per day?

$$P = 25{,}000\,SF \times 0.8\,W/_{SF} = 20{,}000\,W = 20\,KW$$

$$= 20\,KW \times 365\,\frac{day}{yr} \times 24\,\frac{hr}{day} = 175{,}200\,KW/yr$$

$$Q = 175{,}200\,\frac{KW}{yr} \times 3{,}414\,\frac{Btu}{KW} = 598\,\frac{MBTU}{yr}$$

5 pts If the electric power being used by the building is provided by a coal fired plant and the plant produces 2.4 lb of CO_2 per kWh. How much CO_2 will be liberated to the atmosphere due directly to the lighting operation in the building?

$$CO_2 = 2.4\,\frac{lb}{KW} \times 175{,}200\,\frac{KW}{yr} = 420{,}480\ lb/yr$$

5 pts 9. A 100 ft^2 concrete wall 8 in thick is at a temperature of 65°F. If after prolonged exposure to sunlight the concrete wall is storing 66,000 Btu, what is the temperature of the concrete wall?

$$Q = M \times C \times \Delta T$$

$$V_c = 100\,ft^2 \times \frac{8}{12}\,ft = 67\,ft^3$$

$$W_c = 67\,ft^3 \times 144\,lb/_{ft^3} = 9648\,lb$$

$$Q = 9648\,lb \times 0.21\,\frac{Btu}{lb\,°F} \times (T - 65°F)$$

$$T - 65°F = \frac{66{,}000\,Btu}{9648\,lb \times 0.21} = 33°$$

$$T = 65°F + 33°$$

$$= 98°F$$

1 pt 10. One Therm is equal to 100,000 Btu.

1 pt 11. ASHRAE Standard 52.2 helps you to select an air filter.

1 pt 12. ASHRAE Standard 62.1 presents recommendations pertaining to ventilation, or the amount of outdoor air introduced into a given area.

3 pts 13. ASHRAE Standard 55 links temp and humidity together to provide a measure of thermal comfort.

2 pts 14. How many tons of air conditioner are needed to produce 54,000 BTUH?

$$= \frac{54{,}000 \text{ Btuh}}{12{,}000} = 4.5 \text{ tons}$$

2 pts 15. What two main factors affect our sense of thermal comfort?
1. Temperature
2. Relative Humidity

6 pts 16. Using the Psychrometric chart find the characteristics of an air/water vapor mixture and complete the following table:

Characteristic	Case 1	Case 2
Dry-bulb temperature	**75**°F	**95**°F
Relative Humidity	**50%**	53 %
Wet-bulb temperature	63 °F	**80**°F
Humidity	65 grains/lb	132 grains/lb
Vapor Pressure	0.45 In Hg	0.87 In Hg
Dew point	55 °F	75 °F
Enthalpy	28 BTU/lb	44 BTU/lb
Specific volume	13.7 ft^3/lb	14.4 ft^3/lb

2 pts 17. If you have a wet bulb temperature of 65 degrees and 30 BTU/lb Enthalpy what is the dry bulb temperature?

NO ANS. Both are on the Same Line

2 pts 18. Find the Relative Humidity of an air/water vapor mixture at 70°F dry bulb and 50°F wet bulb.

20%

5 pts 19. How much heat is required to vaporize five gallons of water?

$$Q = 970 \frac{\text{Btu}}{\text{lb}} \times 5 \text{ gal} \times 8.34 \frac{\text{lb}}{\text{gal}} = 40{,}449 \text{ BTU}$$

5 pts 20. A room measures 9' x 12' x 8', and 1.5 ACH are expected. Find the outdoor air CFM for the room.

$$CFM = \frac{ACH \times V}{60} = \frac{1.5 \times (9 \times 12 \times 8)}{60} = 21.6 \text{ CFM}$$

6 pts 21. Estimate infiltration and ventilation air quantities for a 10,000 sq. ft. school classroom building built in 1954. The conditioned space is 12 feet high, and the total population is 320 students and teachers.

Infiltration CFM.
1.5 ACH in winter

$$CFM = \frac{ACH \times V}{60} = \frac{1.5 \times (10{,}000 \times 12)}{60} = 3000 \text{ CFM}$$

1.0 ACH in summer

$$CFM = \frac{1.0 \times (10{,}000 \times 12)}{60} = 2000 \text{ CFM}$$

Ventilation CFM. Estimate 15 CFM per person.

$$CFM = 15 \frac{CFM}{person} \times 320 = 4800 \text{ CFM}$$

5 pts 22. Find the heat loss through a 200 sq. ft window if its U value is 1.1, the indoor temperature is 70°F and the outdoor temperature is 10°F.

$$Q = U \times A \times \Delta T$$

$$= 1.1 \times 200 \text{ ft}^2 \times (70°F - 10°F)$$

$$= 13{,}200 \text{ BTUH}$$

5 pts 23. A building has an expected infiltration rate of 400 CFM. Find the BTUH heat loss when the indoor temperature is 70°F and the outdoor temperature is -10°F.

$$Q = 1.08 \times CFM \times \Delta T$$
$$= 1.08 \times 400 \times (70°F - -10°F)$$
$$= 34,560 \text{ BTUH}$$

4 pts 24. An exterior wall is made up of 8" of stone (R= 0.08 per inch), 3" of foamed-in-place polyurethane, and 0.75" Plywood, and 5/8" gypsum board. Determine the total R-value and U-Factor for the wall. Use the lookup table provided in class. Assume winter.

Component	R-Value
Wall – Outside Air Film	0.17
8" stone	0.64
3" foamed-in-place polyurethane	18.75
¾" plywood	0.93
5/8" gypsum board	0.56
Inside Air Film	0.68
Total Wall Assembly R-Value	21.73
U-Factor	0.046