WELCOME!

I hope this course marks the beginning of the end of your ARE experience!

I finished my last exam about nine months ago, and began sharing what I remembered from my exams and preparation. A lot of people have reached out to me since then, but the two most common questions I get are whether I provide tutoring and where I found so many practice questions. This course is my response to both questions.

I used the same online resources everyone else has, but the best study questions were the ones I asked myself. The questions I asked in order to force myself to really understand a concept I knew I did not know.

As for tutoring, I used to say no, for a lot of reasons, but things change. If you need a little extra help with planning your studies, holding yourself accountable or figuring out a few formulas send me a message and let's talk. I think this course will help with a lot of those things, however. I don't believe I am any more skilled or knowledgeable in any of this stuff than you are. I promise that during this course you will come across questions and information which you know far better than I do. I did well on the ARE because I can study efficiently and understand tests well. So the most valuable skills that I can share is how to focus your studies and how to think critically about these subjects. How to find the right information and how to ask yourself the tough questions that cut through all the filler and identify what's really important.

I hope you find this course helpful in your exam prep. I'm confident that if you focus on these assignment you will earn yourself more than a few extra correct answers on exam day.

Thank you for signing up, do well on your exams and keep in touch!

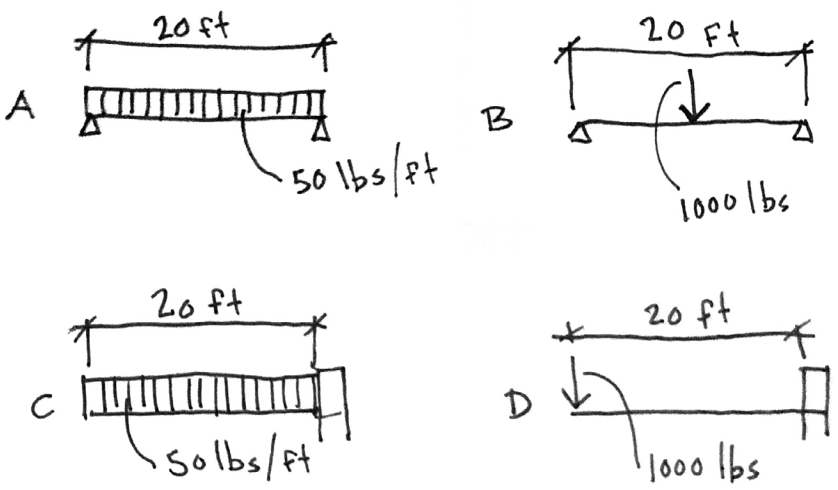
Regards,
Ben

STRUCTURES
ASSIGNMENT 1

Each of these beams is a W12x30. Consider the bending force acting on each beam:

- Which one is subjected to the most?
- Which one is subjected to the least?
- What structural property/formula should you reference?
- How much does each beam weigh?
- Does the size of the beam matter when considering bending moments?

Before you answer, which beam do you think you'd feel the most safe standing on?



A - Uniformly distributed load supported on both ends
B - Point load at center supported on both ends
C - Uniformly distributed load on a cantilever
D - Point load at end of cantilever

REFERENCES

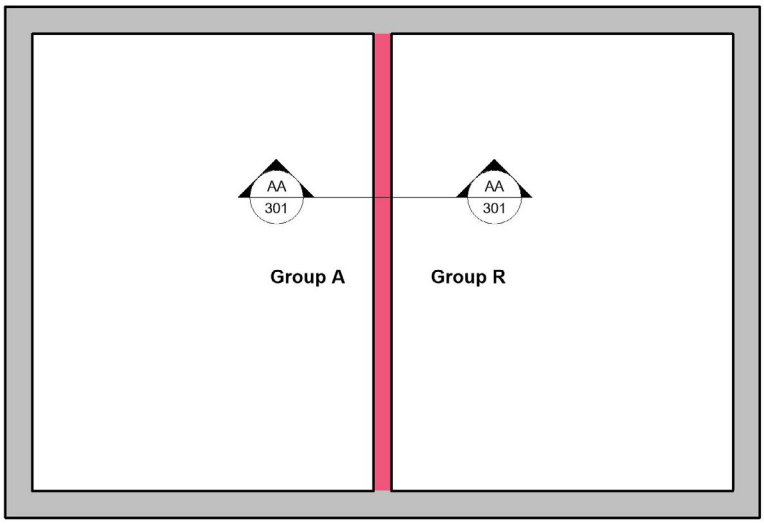
W-Flange Sizes
Structural Formulas - Architectural Graphic Standards pg 1026 - or - Structural Formulas Link
YouTube: Hyperfine - ARE Moment Formulas
YouTube: Civil Engineering Academy - Finding the Max Bending Moment in Beams
YouTube: Dartmouth X - Types of Beams - Cantilever and Simply Supported
YouTube: Dartmouth X - What is a Beam?

YOUR NOTES

CODE & CONSTRUCTION
ASSIGNMENT 2

- What is the required separation (hours) between Group A and Group R occupancies? Assume the building is equipped with sprinklers.
- Sketch a wall section of a metal stud wall with the required rating.
- Repeat this for Groups I-3 and M with no sprinklers and a minimum STC of 50.

Don't worry about the top and bottom connections of the wall, just think about the layers of material you need.



not my best floor plan ever

REFERENCES

2012 IBC - Chapter 5 - Section 508
UL Wall Selector
Architectural Graphic Standards pg 529

508.4 Separated occupancies.
Buildings or portions of buildings that comply with the provisions of this section shall be considered as separated occupancies.

TABLE 508.4
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)

OCCUPANCY	A, E		I-1[a], I-3, I-4		I-2		R[a]		F-2, S-2[b], U		B, F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1[a], I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R[a]	—	—	—	—	—	—	N	N	1[c]	2[c]	1	2	NP	NP	3	NP	2	NP	2	NP
F-2, S-2[b], U	—	—	—	—	—	—	—	—	N	N	1	2	NP	NP	3	4	2	3	2	NP
B, F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N	NP	NP	2	3	1	2	1	NP
H-1	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP	NP	NP

YOUR NOTES

MECHANICAL
ASSIGNMENT 13

The diagram on the right is a Centralized Variable Air Volume system.

Before looking up the components:

» Is B producing heat or coolth?

» Why do you think that?

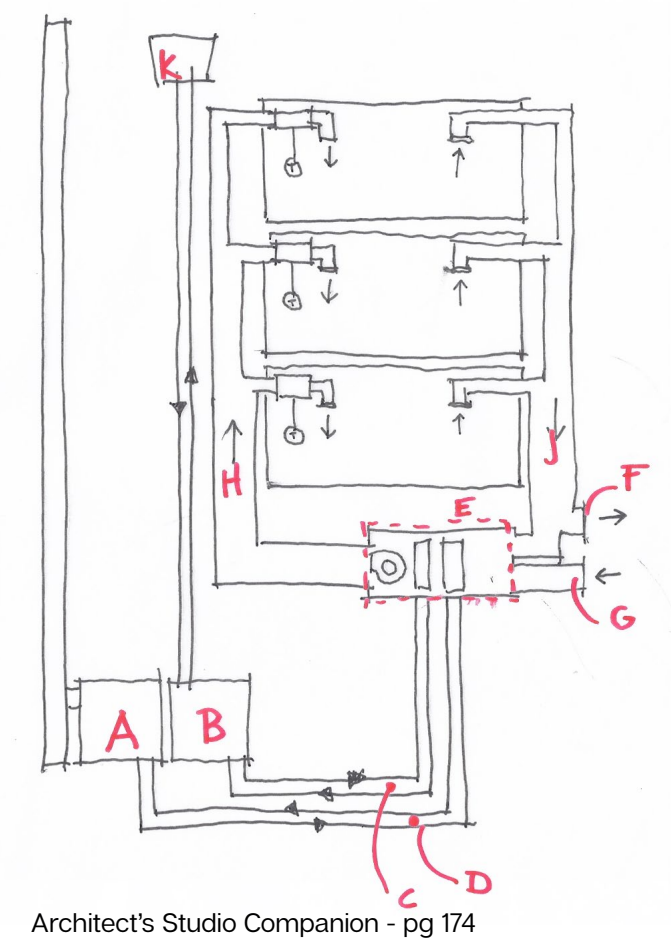
» Based on that answer, what do you think is in line C?

Ok, now you can look at some references

» Label all the lettered components

» Name some common project types that would use this system

» What are three advantages of this system?



Architect's Studio Companion - pg 174

REFERENCES:

Architect's Studio Companion (166, 168, 174)
Ching Building Construction Illustrated (11.17)
YouTube: The Engineering Mindset
Dept. of Energy Sustainability Guide Ch 5 PDF

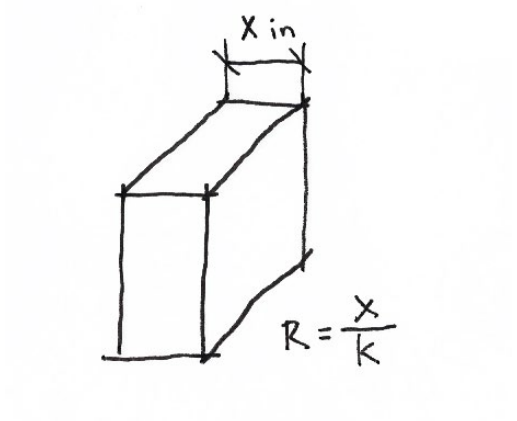
YOUR NOTES

MECHANICAL
ASSIGNMENT 36

K-Value is an important material property you may encounter on the exam. It is often what we actually mean to use when discussing U-Factor.

- Define K-Value
- How does this differ from U-Factor?
- What is the relationship between K-Value and R-Value?
- Does increasing the thickness of a material increase it's K-Value?
- Complete the chart at right
- What is the U-Factor for this assembly?

MATERIAL	K	THICKNESS	R
BRICK	5	3-5/8"	
AIR	1	1"	1
CMU	7	7-5/8"	
ROCK WOOL INSULATION	.3		11.7
GYP BOARD	.8	5/8"	



REFERENCES

Insulation.org: K-Value, U-Value, R-Value, C-Value
Designingbuildings.co.uk: K-Value and Thermal Conductivity
Mech. & Electrical Equipment for Buildings (Ch 7 - Heat Flow, Section on Thermal Properties, pg 183 in 11th Ed.

YOUR NOTES

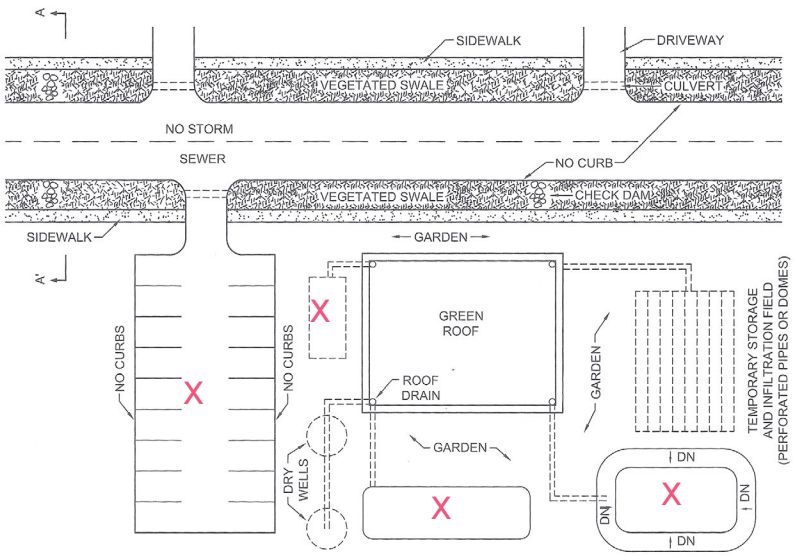
ENVIRONMENT
ASSIGNMENT 46

You'll likely see a few questions on stormwater management and site planning.

» What are 5 goals of current stormwater management planning?

» Fill in the site plan on the right with possible stormwater management strategies at the correct locations.

» Sketch what you think Section AA might look like.



PLUMBING, ELECTRICITY & ACOUSTICS Fig. 14.5o

REFERENCES:

Plumbing, Electricity & Acoustics: Chapter 4 pg 141-155
John Meyer Consulting: Cross County Shopping Center Renovation and Expansion*
Lake Superior Streams: Grassed Swales
Laramie County Conservation District: Ponds

* check out the index on the left for links to all kinds of site and civil drawings.

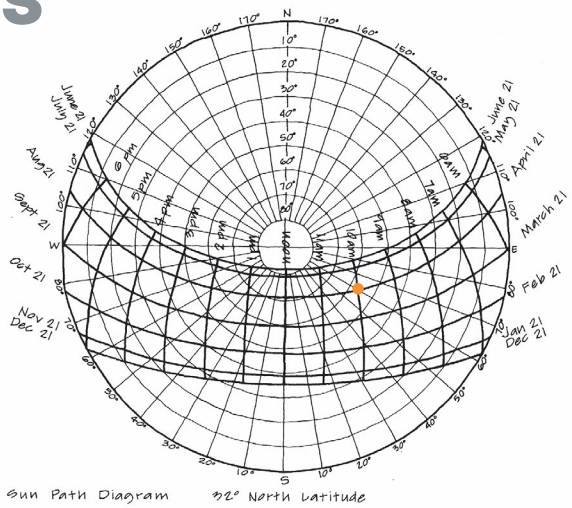
YOUR NOTES

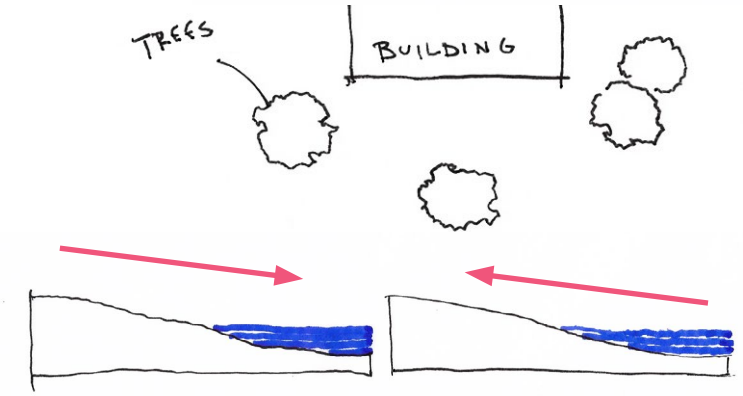
ENVIRONMENTAL CONDITIONS

ASSIGNMENT 51

Building location and form can also depend on solar and wind conditions at the site.

- What is the altitude and azimuth of the sun at 10am on August 21st?
- Which of the trees is shading the building at this time?
- Which diagram represents wind movement during the day? WHich is night?





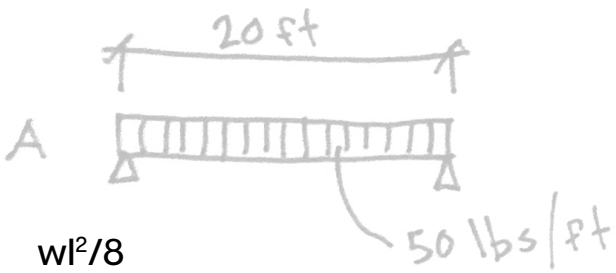
REFERENCES

YouTube: Hyperfine - Sun Path Diagram
Building Construction Illustrated (Ch. 1 Section on Solar Radiation)
Sun, Wind and Light (Building Locations on Slopes)

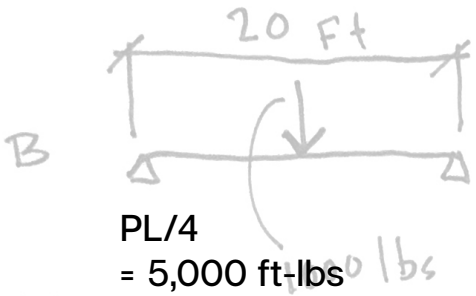
YOUR NOTES

ANSWERS

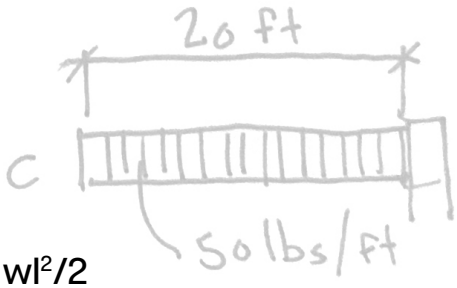
ASSIGNMENT 1



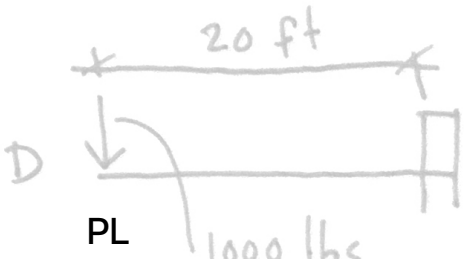
$wl^2/8$
= 2,500 ft-lbs



PL/4
= 5,000 ft-lbs



$wl^2/2$
= 10,000 ft-lbs



PL
= 20,000 ft-lbs

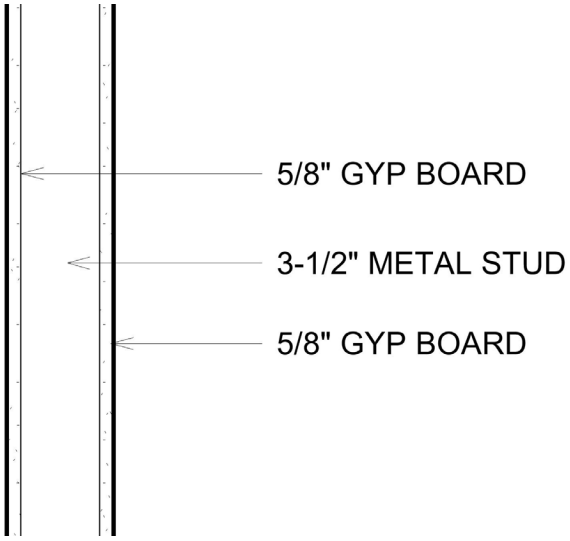
MAX MOMENT FORMULAS

D bends the most, A bends the least. This is a question about bending MOMENTS. You can find these formulas in Architectural Graphic Standards or at the link above, or by googling.

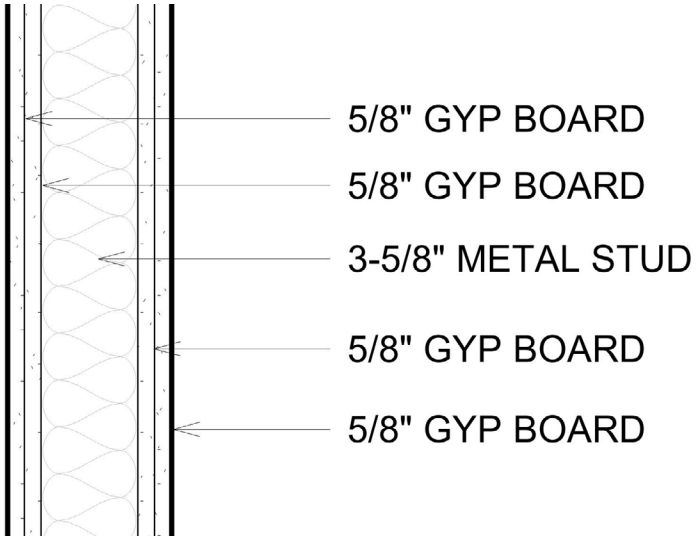
The beam itself weighs 600lbs. A W12x30 is 12 inches tall and weighs 30 lbs per linear foot. (20ft x 30lbs/ft = 600lbs) I didn't size this beam, so I don't know if it could actually support any of these loads. In this question the size of the beam does NOT matter. You can see from the formulas that the bending moment doesn't acount for any physical properties of the beam. It is only concerned with how much weight there is, what the span is and how much support there is. Watch the 2nd video link above for a good description of this stuff.

So do you actually have to memorize all the moment formulas? No, I don't think so. But you should be familiar enough with them to know that a beam with a point load will generally bend more than a beam with a uniform distributed load, and a cantilever will bend more than a beam supported on both ends. I would feel most safe standing on the beam supported at both ends, and that's the one that turns out to bend the least.

ASSIGNMENT 2



1 HR RATED WALL



2 HR RATED WALL

RATED WALL ASSEMBLIES

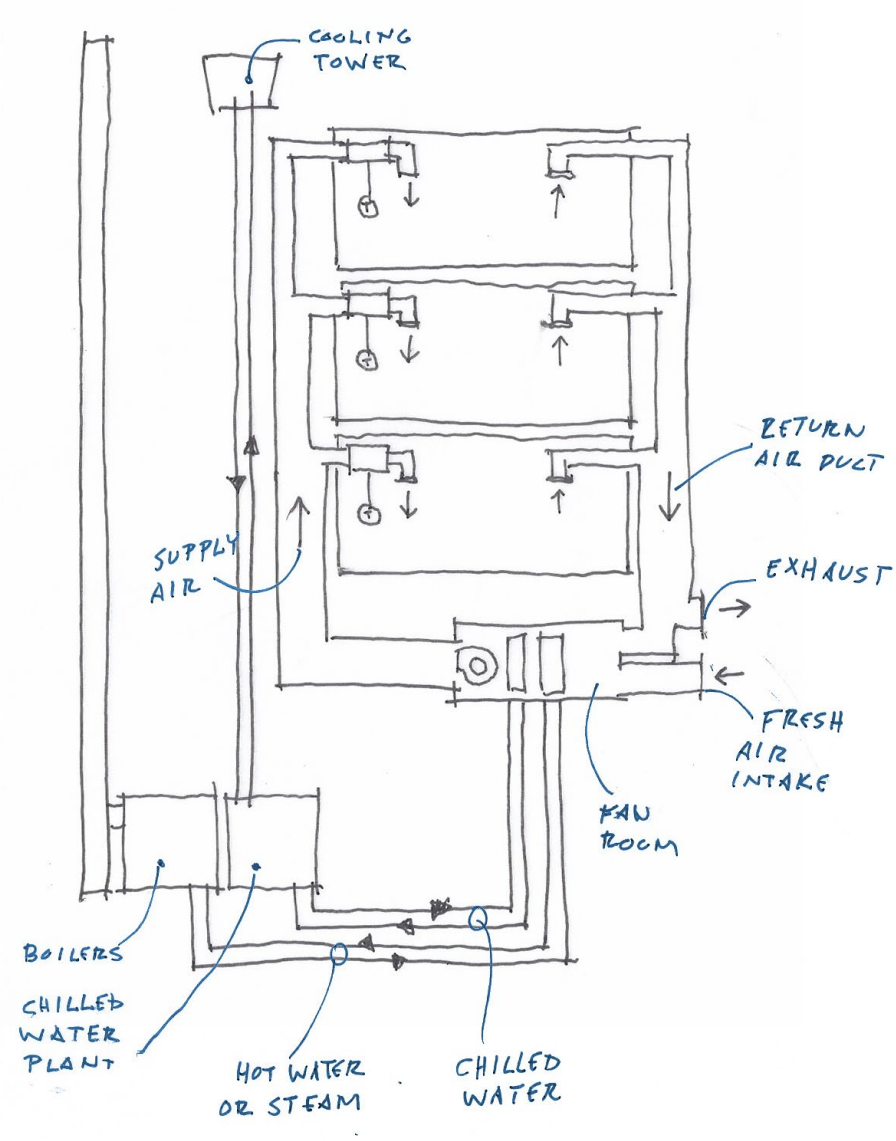
From Table 508.4, Group A and Group R require a 1-hr separation when the building is equipped with sprinklers. You can use a 3.5” steel stud with one layer of 5/8” gyp board on each side. Find this in the UL Wall Selector.

From Table 508.4 Group I-3 and Group M require a 2-hour separation when there are no sprinklers. You can get the 2hour rating by using a 3-5/8” stud and adding another layer of 5/8” gyp to each side. For the STC you can choose a variety of methods, including air gaps, resilient channels or insulation.

On the ARE you will probably be asked to find the thinnest, or the cheapest wall. Lots of ways to build these things, but adding layers of 5/8” gyp is typically the fastest way to get to your rating.

Don’t try to memorize the contents of Table 508.4, but do try to memorize that your required separations are on Table 508.4, so you can quickly find it in the provided resources if needed.

ASSIGNMENT 13



Component B is the chilled water plant, producing something cold. You can tell because it's connected via a supply and return to a cooling tower. Component A is the heating plant, it's only connected to an exhaust. If B is the chilled water plant, then the lines running into the building have chilled water.

According to Architect Studio Companion, Centralized All-Air Variable Air Volume Systems are used in all project types EXCEPT Apartments. This is probably because you can't simultaneously heat and cool different zones without some additional equipment.

Some advantages of VAV System (ASC pg 168):
Simple...low first cost
Maximum control of air quality and velocity
Can handle large changes in heating/cooling load
Minimal noise
Maximum flexibility for rental spaces over time

ASSIGNMENT 36

MATERIAL	K	THICKNESS	R
BRICK	5	3-5/8”	.73
AIR	1	1”	1
CMU	7	7-5/8”	1.09
ROCK WOOL INSULATION	.3	3-1/2”	11.7
GYP BOARD	.8	5/8”	.78

K-Value is the conductivity of a material. It is the number of BTU that go through 1 sq. ft. of a material that is 1 inch thick in 1 hour.

This is similar to U-Factor except U is supposed to be used for entire assemblies. We often use U incorrectly as the straight inverse of R, which is not technically correct (I did this in an earlier question).

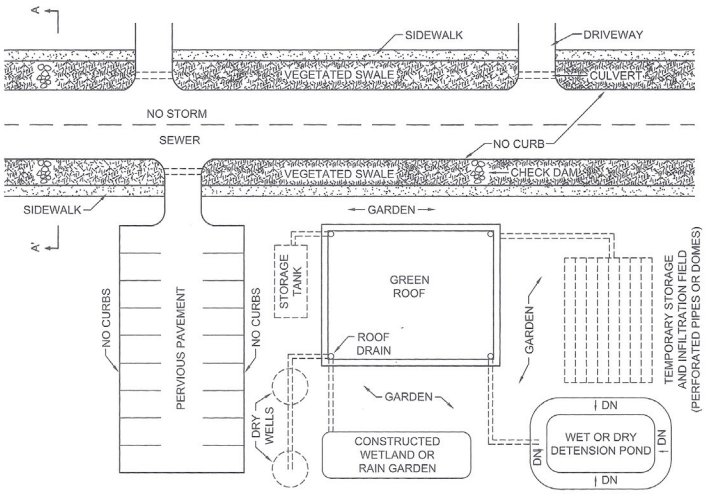
R is the real inverse of K.

Increasing the thickness of a material does NOT increase the K-Value, because K is defined by 1 inch thick material. To account for thickness of a material use R = X / K where X is the thickness in inches.

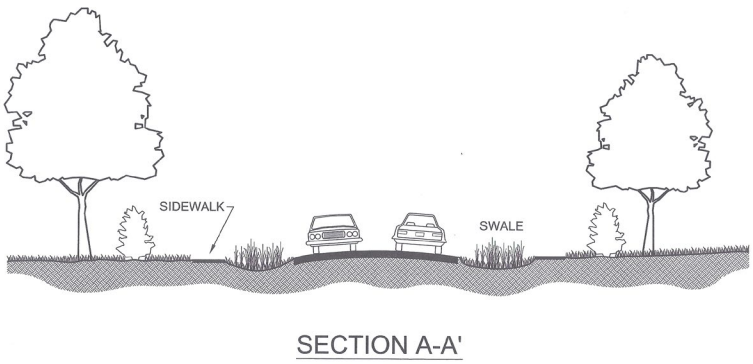
See chart above.

Remember, U-Factor is 1 over the sum of all the R-values. In this case 1 / .73 + 1 + 1.09 + 11.7 + .78 = .065

ASSIGNMENT 46



PLUMBING, ELECTRICITY & ACOUSTICS Fig. 14.5o



PLUMBING, ELECTRICITY & ACOUSTICS Fig. 14.5k

From PEA (pg 143) Current goals of stormwater management include:

- Delaying runoff in order to minimize peak flow into storm sewers and streams. (This is a big one, especially for areas like mine that have Combined Sewer Overflow) This is done through DETENTION PONDS, i.e. the water is getting detained for a bit before continuing on its way.
- Replenish Groundwater
- Increase evapotranspiration (one side effect of which is cooling)
- Clean water by passing it through soil before it reenters water systems
- To prevent heat pollution from hot stormwater that has been in contact with roofs and pavement and other hot surfaces.

See the diagrams above, taken directly from PEA.

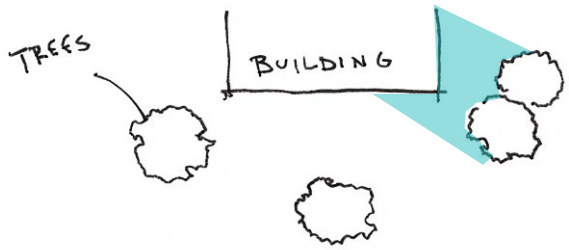
Parking lots obviously get pervious surfaces.

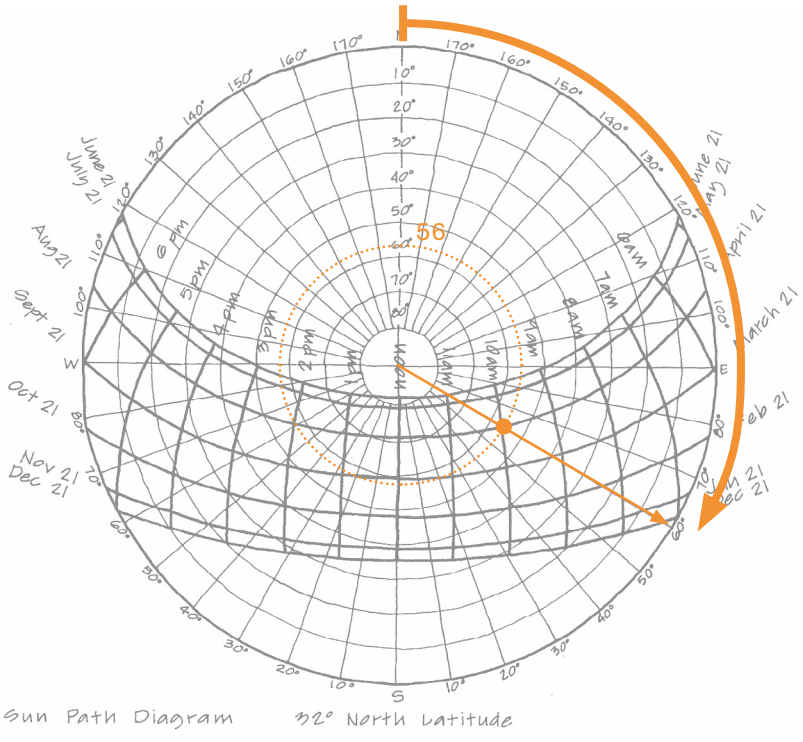
Anything with dashed lines represents something under the ground, which would be a cistern or other type of storage tank. This is good for areas that need to be travelled on or otherwise not suitable for larger scale planting.

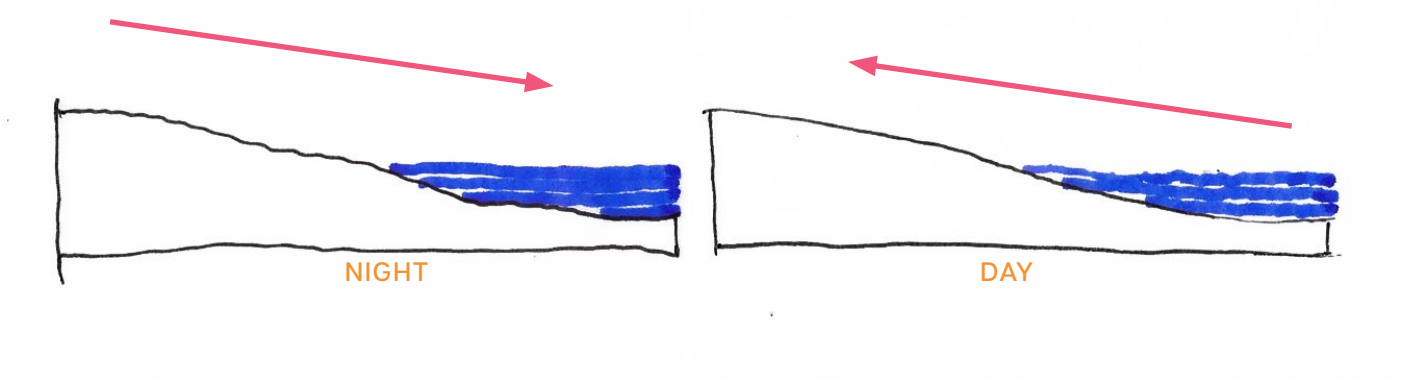
Any recessed area is likely a pond of some sort, either retention (water stays there permanently) or detention (see earlier answer). I'm not sure how to tell them apart just from a plan. Maybe if there is another nearby stream or actual path to a body of water it might be a detention pond.

Swales are used to move stormwater. The flow of water can be slowed with check dams, which are basically piles of rock.

ASSIGNMENT 51







According to the chart, the sun is at an azimuth of 120° with an altitude of about 56°. This seems high to me, but 32° North Latitude passes through southern states like Mississippi, Louisiana and northern parts of Texas. The 120° azimuth is not read directly off the chart, but you can see that the azimuth line is 30° south of East, and azimuth is usually reported in degrees East of North, so 90+30 = 120.

This is more or less a morning sun, so coming from the East.

See diagram for wind movement. According to Sun, Wind and Light wind will move from the cooler surface to the warmer surface. Air above the hot surface will rise and be replaced by air movin from above the cooler surface. Large bodies of water heat and cool slower than nearby land areas. So during the day wind is moving from the water to the land, and at night wind moves from the land to the water.

Solar/water conditions are not directly related in this assignment, but the chances are you will be presented with questions on the exam that require you to combine some of these strategies. If I were faced with a question like this I would look for obvious bad choices and obvious good choices to narrow my options down. On a question about best location/orientation for a building (that is not about zoning), you will never have a building with a North-South axis.