

Study Tips

- complete all labs and worksheets before exam
- go over the text and video review questions, some will be on the exam
- use study guide in combination with notes and online powerpoint slide shows
- go back through the in class / lab exercises, make sure you can work the math / units; review map skills
- spend a couple days studying, the exam will be short answer / essay and there is much material.
- don't wait until the last minute!
- carefully go through the notes, some of the material we briefly discussed, but did not spend much time on in class... but the notes will give you the detail.

Exam Procedures: (1) Midterm exam will be 100 points; (2) Part 1 – Closed book, short answer/essay questions. See key-word/review recommendations below; (3) Part 2 Open Book- lab-style quantitative questions.

Reading Assignments for Review

Text: Introduction to Hydrology https://people.wou.edu/~taylors/es476_hydro/text_chap1_intro.pdf

Text: Hydrologic Cycle https://people.wou.edu/~taylors/es476_hydro/text_chap2_hydro_cycle.pdf

Text: Properties of Water https://people.wou.edu/~taylors/es476_hydro/dingman_water_properties.pdf

Journal: Global Water Budget https://people.wou.edu/~taylors/es476_hydro/trenberth_etal_2007_global_water_budget.pdf

Text: Meteorology / Atmosphere https://people.wou.edu/~taylors/es476_hydro/cech_chap2_weather.pdf

Journal: Oregon Climate Change

https://people.wou.edu/~taylors/es476_hydro/Chang_Jones_2011_Oregon_Climate_change_Water_Resources.pdf

Text: Surface Water Hydrology https://people.wou.edu/~taylors/es476_hydro/cech_chap3_surface_water.pdf

Key Terms and Concepts

Introductory Notes

https://people.wou.edu/~taylors/es476_hydro/intro.pdf

hydrology
spatial scale
temporal scale
mass
energy
flux
mass transfer functions
evaporation
condensation
precipitation
runoff
infiltration
transpiration
~~deterministic vs. stochastic~~
processes
hydrologic cycle (sketch it)
convection
advection

groundwater
surface water
global water storage
residence time
compartments
oceans
groundwater
lakes
glaciers
ice caps
transpiration
evapotranspiration
runoff
infiltration
vegetative interception
ice sheets
oceans
springs
soil moisture
atmospheric moisture
fresh water storage

Global Water Budget

https://people.wou.edu/~taylors/es476_hydro/budfigs.pdf

- Sketch hydro cycle in detail
- understand global precip. distribution
- know the basic distribution of water resources
- why is there high runoff in PNW?

Water Budget Equations:

Input-Output = change in Storage

$$I - O = \Delta S$$

$$P = R + E + \Delta S$$

I = input, O = output, ΔS = change in storage, P = precipitation, R = stream runoff, E = evapotranspiration (all expressed as water volume equivalents over unit time)

Water Chemistry

https://people.wou.edu/~taylor/es476_hydro/watr_chem.pdf

atoms
isotopes
oxygen isotopes
carbon isotopes
ion
cation
anion
complex ion
dissolved ions in water
molecules
compounds
mixtures
atomic forces
bonding forces
octet rule
stable-8 configuration
valence shell
electron shells
lewis dot model
atomic no.
atomic mass
no. protons
no. neutrons
no. electrons
ionic bonding
~~metallic bonding~~
covalent bonding
~~dot model reactions~~
aqueous solutions
solute
solvent
saline solution
salinity
sheath of hydration
dissolution
concentration
~~mass percent~~
~~parts per thousand~~
~~parts per million~~
~~parts per billion~~
density
hydrogen bonds
polar covalent bonds
viscosity
weight density

Hydro - Physics Overview

https://people.wou.edu/~taylor/es476_hydro/physrevw.pdf

Know how to define and quantify the following...

mass
length
time
temperature
force
angle (degrees)
area
volume
velocity
acceleration
discharge
pressure
force
energy/work
~~power~~
~~momentum~~
mass density
weight density
viscosity

other physics concepts to consider:

heat
heat flow
heat capacity
volume expansion/contraction
density-driven rise / fall
"hot air balloon model"
heat transfer
conduction
convection
radiation
material phases
solid
liquid
gas
Heat
Molecular kinetic energy
states / phase changes
condensation
evaporation
melting
freezing
(consider these in terms of heat loss and heat gain)
physical properties of water

liquid / fluid
heat capacity
polar molecule
solvent
covalent bonds
density-viscosity-temp relations

Hydrometeorology

https://people.wou.edu/~taylor/es476_hydro/meteor.pdf

meteorology
weather
climate
temperature
humidity
precipitation
rain-snow-sleet
clouds
air pressure
water vapor
heat capacity
~~latent heat~~
particulate matter
dust
Troposphere Structure
condensating nuclei
altitude vs. temp variation
altitude vs. press. variation
Earth-Sun Relation
rotational axis
north pole
south pole
equator
axial tilt (23.5 deg.)
global solar radiation budget
water vapor
precipitation
solid, liquid, gas
heat energy
evaporation
condensation
freezing
~~sublimation~~
humidity
~~specific humidity~~
relative humidity
vapor saturation
saturation capacity
temperature vs. humidity
temperature vs. air volume
hot air balloon model

dew point / vapor saturation
dew
fog
clouds
rain
condensating nuclei
cloud droplets
~~adiabatic heating~~
~~stable vs. unstable air~~
rising air mass
sinking air mass
forceful lifting
convergent lifting
orographic lifting
frontal wedging
air pressure
force / unit area = pressure
altitude vs. air pressure
millibar – psi- pascal
pounds per sq. inch
barometer

Trenberth et al Reading 2007

Global Water Budget

https://people.wou.edu/~taylors/es476_hydro/trenberth_etal_2007_global_water_budget.pdf

P = precipitation
E = evapotranspiration
E – P
Hydrologic cycle
Reservoirs
Storage
Exchanges
Flux
Surface flow
Groundwater flow
Ocean-ice
Vapor transport
Permafrost
Soil moisture
Solar radiation
Latent heating
Soil moisture storage
Sea surface temperatures
Atmospheric moisture
Climate change
 $P = R + E + \Delta S$
E-P = runoff
PRISM models
Climate models

Ice volumes
Cryosphere
Energy supply
Precipitation network

Flood Climatology

Hirschboeck Readings

http://www.wou.edu/las/physci/taylor/es476_hydro/hirschboeck_et_al_2001_flood_hydroclimatology.pdf

Flood-causing weather

~~convective thunderstorms~~
~~tropical storms/hurricanes~~
~~extratropical cyclones~~
~~frontal systems~~
~~rapid snowmelt~~
~~runoff~~
~~antecedent soil moisture~~
~~snow cover~~

Air Uplift Mechanisms

~~Thermal convection~~
~~large-scale frontal convergence~~
~~orographic lifting~~

Convictional Processes

~~Thunderstorm Activity~~
~~flashy, intense ppt~~
~~Fla/ Gulf, highest occurrence~~
~~Mesoscale Convective Complex~~
~~"MCC's" and MCS's~~
~~huge, multiple celled, highly organized thunderstorm complexes~~

Tropical Cyclones

~~largest atmospheric features~~
~~convective processes~~
~~tropical low press. systems~~
~~sources: western N. Atlantic, Gulf, Caribbean~~
~~critical temps of sea surface: >79 F~~
~~Large Scale Atmospheric Convergence~~
~~Extratropical Cyclones~~
~~cyclone tracks as westerlies across U.S./Midwest~~
~~Orographic Lifting~~

Antecedent soil moisture

soil moisture content

~~summer > ET, < flood potential, < soil moisture~~
~~Snow Cover, Frozen Ground and Snowmelt~~
~~Frozen ground = impervious surface; > flood potential~~
~~spring rain on snow, + snow melt = flood~~

Surface Water Hydrology

https://people.wou.edu/~taylors/es476_hydro/surfwatr.pdf

drainage basin
watershed
drainage divide
interfluvium
groundwater-surface water discharge
drainage area
cross-sectional area
flow velocity
channel width
channel depth
volume/time
continuity equation $Q = VA$
~~Mannings Equation~~
~~Roughness~~
Slope / gradient
stream lengths
drainage density
~~shreve magnitude~~
~~stream ordering~~
~~1st order, 2nd order, etc.~~
peak discharge
peak annual flow
peak monthly flow
rational runoff equation
rational runoff coefficient
rainfall intensity
~~flood recurrence interval~~
~~flood magnitude~~
~~flood frequency~~
~~flood frequency curve~~
~~flood hydrograph – what is it?~~
Seasonal flood climatology

GO BACK OVER THE SLIDE SHOWS ON THE CLASS WEB SITE; MAKE SURE YOU UNDERSTAND THE PRINCIPLES ILLUSTRATED IN THE SLIDE IMAGES

Big Concept Ideas / Essay Question Possibilities / Lab Skills

Can you sketch and discuss the hydrologic cycle? Including all the reservoirs, exchanges, fluxes and storage values? What are the primary atmospheric processes that trigger precipitation events? Can you list, describe, and sketch the mechanisms?

What types of meteorological conditions lead to flooding in the Pacific Northwest? ~~What about largest flood events in the U.S. as a whole?~~

~~Can you list the equations and discuss the difference between energy, force, pressure, and work?~~

Can you summarize the physical and chemical properties of water?

Why is water a good solvent? Sketch the water molecule.

How are density and buoyancy related to heat in the system?

Can you discuss the global distribution of water in reference to ocean, rivers, lakes, atmosphere, glaciers, etc.

Summarize the physical and chemical properties of water.

~~Summarize the units and equations for the following: work, pressure, force, acceleration, acceleration due to gravity, newtons, pascals, millibars, continuity equation, storage equation, newton's second law, density vs. weight density~~

What are the four primary lifting mechanisms related to precipitation events.

What is the general circulation model of the Earth's atmosphere? What is the influence of the Coriolis effect on the general circulation model.

Compare and contrast cyclones to anticyclones.

Can you perform simple and complex unit conversions?

Do you understand dimensional analysis and unit algebra?

Do you know how to manage positive and negative exponents with respect to unit algebra?

Can you perform the following quantitative skills: plotting a graph

re-arranging equations; solving for unknown variables in an equation; manipulating exponents and bases

convert between metric and english systems of measurement; calculate the equation for a line from a graph

write an equation if given a description of a quantitative problem; Draw Sketches from word problems

convert between mass and volume using density

Can you perform the following quantitative skills from the applied problems labs:

determine volumes of water in a reservoir

calculating rates of discharge, evaporation and input into a hydrologic system

converting between various measures of area, length, volume, and discharge

determine the total input and withdrawal from a simple hydrologic system (calculating water budgets)

determine the discharge of runoff using weir techniques

calculate the volume of lake water using the frustrum of a cone

solve the input-output conservation equation

Can you perform the following quantitative skills from the contouring exercises

draw contour lines on rainfall data (isohyets)?

- identify contour intervals and interpolate between data points

- Can you use the planimeter and cross-section paper to determine areas?

- ~~Determine average precipitation using the arithmetic, thiesen, and isohyetal methods?~~

- Can you work with map scales?

Work the continuity equation for channel discharge-velocity-cross-sectional area

~~Work Manning's equation for streamflow velocity;~~ calculate areas-volumes of watershed inputs and outputs

Determine evaporation loss volumes and precipitation volume gains

Lab and Class Exercises Covered by the Open Book Part of the Exam

Applied problems in hydrology

Introduction to quantitative methods in hydrology

Water budget calculations

~~Pressure calculations and conversions~~

Isohyet contouring / precipitation problems; Water in – water out book keeping problem