Volunteer Park Capitol Hill, Seattle
Navigation Field Practice
The Mountaineers

To do the practice course, you'll need:
1. Printout of the course map (<u>soon to be</u> at a web link—now in Seattle folder)
2. Printout or tablet version of the course notes (you're reading them)
3. Compass (ideally with a baseplate and adjustable declination)
4. Pencil or pen
5a. SmartPhone with (nearly) free: Google Maps, iOS Apps: Altimeter, UTM Convert, Declination, Heading, Theodolite OR Android Apps (need counsel on these): Handy GPS, UTM Grid Ref, GPS Essentials
5b. SmartPhone with GPS app (Optional): Gaia both iOS & Android
6. Excellent near point vision or corrective lens for close work & headlamp
7. Burns & Burns (2015). Wilderness Navigation, 3rd edition (optional reference)

The skills you'll learn in this field exercise include:
A GPS SmartPhone App – Determining Point position, Setting a waypoint
B. Maps – Contours, Scale, Declination, Datum and UTM grid coordinates
C. Maps – Sense of direction, Orienting your map, Point position & Terrain matching
D. Compass – Direction and bearings
E. Maps - UTM grid coordinates
F. Compass - Shooting and following a bearing
G. Map and Compass – Measuring a bearing between points on the map
H. Compass - Following a bearing in low visibility or past an obstruction by leapfrogging
I. Compass & Map – Inclinometer to determine slope, Bearing of fall line
Note: These exercises use both feet and meters as you may encounter both online—stay alert to the measure.

Suggestion: Load the Apps, set your compass declination and work through the problem set at home, completing the boxed "table exercises," i.e. Q2, and the "field exercises" on your walk. Check your homework responses in the field with your navigation tools.

A - GPS SmartPhone App – Determining Point position, Setting a waypoint—Optional but very useful tool

The Global Positioning System is most useful in showing us where we are on a map—and we always carry a hard copy map as battery powered navigation tools might...you know, fail. If you are UTM savvy, proceed. Else look ahead to “E” for a UTM explanation. In this practice course, we emphasize UTM coordinates, Datum, Zone, Easting and Northing. Unless you tell your SmartPhone app or dedicated GPSer otherwise, it will default to the WGS84 (nearly identical to NAD83). And the set-up should also default to the True Bearing, not magnetic north. But check both.
Always give your GPS time to acquire satellites or (with SmartPhones) cell towers and satellites. The UTM coordinates should agree with the Trailhead position on your map. Set a waypoint, if you know how—beyond the scope of this practice session. There are many other practical uses for your GPS. Take a class. Read the manual. Practice before it really counts. You could redo this session using the GPS tool as your primary navigation device. Outings are safer and more enjoyable with thorough pre-trip navigation planning.

B - Map skills: Contours, Scale, Declination, Datum & UTM

The course begins at **Point 1** on the map, to the east of the high-pressure reservoir, 15m east of the Black Sun sculpture at a wooden bench facing the sculpture. Are you there?

Q1a – Who was the Black Sun sculptor? ______________
Q1b – Turning 180 degrees what kind of camels do you see?
____

The GPS questions assume you already know how to look up your UTM coordinates. The Declination, UTM Convert & Theodolite apps do this nicely.
Q1c – Use your SmartPhone (iOS) Declination, UTM Convert or Theodolite App to find your UTM coordinates.
Datum: WGS84 Zone 10 Easting____________Northing____________

History: In 1876 the City purchased 40 acres for $2,000 from a sawmill engineer, J. M. Colman (Colman Park) without specifying purpose other than "municipal".

Ordinance 642 in 1885 defined the purpose as "Washelli Cemetery" but two years later it was changed to "Lake View Park" and gravesites were ordered removed. By 1893, the Department had cleared about six acres of timber and planted a nursery supplemented with a greenhouse and hotbed.

Between 1887 and 1904 the park was improved with paths, lawns, beds of flowers, settees and tables for picnickers, and children’s swings, together with native growth, the only greenhouse in the system, and the high pressure reservoir. 1904-1909 the Olmsted Brothers prepared formal plans – gardens, a system of macadam drives, lily ponds, children’s wading pool and shelter, combination pergola, music pavilion and comfort station, and conservatory building - all completed by 1912. (Seattle City Parks Website)

First, take a look at your map. When using any map, it's good practice to get familiar with the contour interval, index contour interval, scale, declination, datum and UTM grid interval before you begin your trip. So, let's do it. This will take just a few minutes. The contour interval, usually printed on topo maps, tells you the vertical distance between each individual contour line.

Q2 – What is the contour interval of your map? ________ meters

An index contour is a contour line printed in a heavier line weight (aka bold) that has elevation values printed somewhere on it. These index lines allow you to determine elevation.

Q3 - What is the vertical distance between <u>index</u> contours on your map? ________ meters

All maps should have some indication of scale. Almost always you'll have a scale bar, and sometimes a ratio scale as well, such as 1:24,000, 1:50,000, etc. This map has just a simple scale bar. It's useful to figure out how far in feet one inch on the map represents. Put the inch rule on the baseplate of your compass (if it has one; if not, use cm) on the bar scale printed on the lower left corner of the map. (Another reason why you need a compass with a baseplate.) Come up with an approximate value for what one inch on the map equals in feet. (Jot it down on your map, under the scale bar, for future reference.)

Q4 - What is the scale of your map? 1 inch (cm) on your map equals about _______ feet (meters)
.

Declination is the difference in degrees between the geographic North Pole (True North) and magnetic north. This value changes depending where on earth you are, and a little bit with time (old maps may have a slightly different declination). Beware undated declinations printed on maps—declinations change over time.

Q5 - What is the current declination on Capitol Hill?
_________ degrees east.

Your compass should be adjusted to this setting already. Please do it now if it's not. (You were a smart navigator and bought a compass with adjustable declination, right?) You'll notice a UTM grid printed on the map as well. Normally on a smaller scale map (that shows a larger area) a UTM grid is printed every 1 km, or 1,000 meters. Here, it's different, because this is such a large scale map (that shows a small area).

Q6a – What distance do the UTM grid lines printed on your map represent?

___________ meters

(Navigation tip: Once you know the distance of each side of the square of a UTM grid, it can help you to quickly estimate distances. In this case, count squares and multiply by 50 meters to estimate the distance between points. Yes, you do have to "think metric" for this to work!

Q6b – What is the Horizontal Datum (or, simply, the Datum) of your map?

(Navigation tip: Look for the Horizontal Datum at the foot of your map or in the Legend. These Datums change from time to time as measurement tools and techniques improve. The Vertical Datum is simply the distance above mean sea level—changing slowly with global warming.)

Datum____________

We've been standing around long enough, so let's get warmed up. From here, we're going to walk to **Point 2**. But, before you leave, use your map to answer these questions. Determining elevation and distance are the two most common uses for topo maps, so we'll get a lot of practice in these two areas today. (Hint: if your compass has string/cord attached, use it along with the scale bar on your map to determine distances.)

Q7a – Per your map, what is the elevation of Point 1?

about_____feet/meters

Now is the time to check the elevation using the app on your SmartPhone and/or your wearable or handheld altimeter. Consider the topo map "ground truth" and set it at the known elevation. If your altimeter is using an internal barometer, changes in atmospheric pressure could alter the reading at a fixed altitude by as much as 500 ft with unstable weather.

Q7b – Per your altimeter, what is the elevation of Point 1?

about_____feet/meters

Go ahead, set a wearable altimeter (if you have one) to "ground truth" elevation.

Q8a - How far away is Point 2 from Point 1?

about_____feet/meters

Walk from Point 1 to Point 2, the 1906 Volunteer Park Water Tower. The base is 75.5 ft above the road pavement and you'll determine the top elevation. The Space Needle top elevation is 725ft. Be sure to read the tribute to L.B Youngs.

Q8b – What is the road elevation at the base of the tower?

about_____feet/meters

C – Map skills: General "sense of direction," Orienting the map, Point Position and Terrain Matching

Are you at Point 2 in front of the doorway? Good. Check your elevation and make a note. Deep breath, start climbing to the viewing deck.

Q9a – What is the elevation at the viewing deck?

about_____feet/meters

Q9b – What was the elevation gain from the street?

about_____feet/meters

Q9c – How many steps climbing up the tower?

____

Counting steps is like counting switchbacks or stream crossings. On the return, you can better estimate the time back to the trailhead or nail an important turning.

Before you get out your compass, try this.
Q9d - Do you have a good sense of where N, S, E and W are?
Try pointing to these directions. Think of why you know this (or don't know, as the case may be). Some people have a good "internal compass" and others do not. If you're not sure of your major directions, have faith - it's a skill that can be learned.
A typical first step in using a map in the field is to orient the map. That is, you align the map to the features you're actually looking at. If you're facing north, the north end of the map should be farthest away from you. Most of the time you know what direction you're facing, and orienting can be done without using the compass.
But if you have no idea what direction you're facing, you need to use the compass to orient the map to north. (Note: for this to work, you need to have the declination properly set on your compass as in question #5.)

Q10a – Follow these steps to orient your map to true north using your compass:
1. Rotate your compass bezel (dial) so North is at the "direction of travel" arrow.
2. Put the left edge of your compass baseplate on the left edge of the map.
3. Holding them together with one hand, slowly turn your whole body—move your feet--until the red end of the magnetic needle is "boxed" inside the red part of the orienting arrow. Red Fred is in the Shed.
The map, along with the compass and you, should now be facing geographic (true, not magnetic) north.

Reality check time. Look at the map, and look at the terrain around you. The map shows a street running roughly N-S just ahead, the Art Museum to the north, and the reservoir west (left) of you. Can you see these features on the ground?

GPS Q10a – Use your SmartPhone UTM Convert App to find UTM coordinates.
Datum: ______ Zone_____ Easting____________ Northing____________

Q11 – You'll soon be headed to Point 3. What general direction (N, S, NE, SW, etc.,) is it from Point 2 to Point 3?

____

D - Compass skills: Direction and Bearings

You're at the highest spot on Capital Hill with 360 degree vistas. Let's practice taking bearings.
The correlation between directions (N, S, SE, etc.) and numerical compass bearings (0 degrees, 180 degrees, 135 degrees, respectively) is indicated on your compass bezel (dial) in 2 degree increments. The bearing (technically speaking, an azimuth) is simply a direction given numerically in degrees from 0 (North) to 360.

Look at your compass bezel to answer the following questions.
Q12a - What is the bearing for South? __________degrees
Q12b - What is the bearing for East? __________degrees
Q12c - What is the bearing for SW? __________degrees
Q12d - What is the direction for the bearing 270°? __________
Q12e - What is the direction for the bearing 135°? __________

How to take a bearing with a compass that has a sighting mirror. (Before you do this, be sure your compass declination is properly set.) No mirror? See p. 9.
1 – Face the object to which you want to take a bearing.
2 - Making sure the direction of travel arrow is pointing away from you, cup the compass in your non-dominant hand. (Some use two hands and spin the bezel with their thumbs).
3 – Tilt the mirror to about 45 degrees so that you can see the needle in the mirror.
4 – Holding the baseplate of the compass steady, slowly turn rotate the compass housing until the red north half of the magnetic needle is "boxed" inside the red north half of the orienting arrow.
5 – The bearing to your object can now be read at the "read bearing here" marker/triangle on your compass baseplate. Point your compass at these

landmarks and read the bearings. Beware steel in grates, supports, broken wrists...

Q13a – Beloved 1963 World's Fair Space Needle? ________________

Q13b – Downtown Bellevue high-rise cluster? ________________

Q13c – Triple communication towers on Capitol Hill? ________________

Q13d – Holy Names Academy white dome topping? ________________

Descend to the street and cross east to the modest volunteer monument. A 1901 ordinance changed the name from "City Park" to Volunteer Park to honor the volunteers of the Spanish-American War (1898-1902). Cassius Beardsley designed the inscription on the boulder erected in 1952, "Lord God of hosts, Be with us yet, Lest we forget, Lest we forget" from the refrain in Rudyard Kipling's *Recessional*, (1897).
Q13e - Concerned about avalanche? Calculate the slope to Tower roof line.

Set your compass for a heading of 107 degrees and walk to the intersection of a paved, then graveled path, **Point 3**. Take a back Tower back bearing. Get ~273°?

E - Map skills: UTM grid coordinates

Are you now at **Point 3**, on a gentle slope in a well-tended lawn? Good. Here, we'll learn about UTM coordinates. UTM (Universal Transverse Mercator, in case you really cared) is the preferred method of specifying your precise location for land navigation. On your map the "eastings" run along the foot of the map, One block west of 10th Avenue you should see 0550 800 (distance in meters from the center of Zone 10). The "Northings" run on the L and R edges—see 5 275200 in the lower left corner (distance north of the Equator). It's much easier to use than latitude and longitude (which everyone has heard of, but hardly anyone really knows how to use for actual navigation! Lat/Long can specify a location just as precisely, but it's measured in minutes and seconds - far harder to figure out than UTM. Folks at sea continue to use Lat/Long).

Why are UTM coordinates useful? Even if you don't use a Global Positioning System (GPS) unit, UTM coordinates can be handy, as they allow you to precisely and easily specify any location (+/-100 meters) anywhere on earth.
Consider these situations:

1 – In town, your friend gives you the UTM coordinates for a great secret campsite. You mark it on your map so you can find it on your upcoming trip to the same area.
2 – Your climbing partner has suffered a severe injury, and you need help to evacuate him. You hike out with a first aid report form, including the UTM coordinates of the accident site so the rescue team can easily locate your partner.

UTM Tips:
Tip #1: Easting values increase going east and Northing values increase going north.
Tip #2: Make sure that the map Datum is the same as the GPS Datum.
Tip #3: The answer to question #6a will help you here.
Tip #4: Seattle is in Zone 10 (of 60 zones worldwide).

Using the UTM grid printed on your map, answer the next 5 questions using your map and/or your SmartPhone in the field. Round off to the nearest 10 meters; your answer should end in a zero.

Q14a – Point 3, Your present location
Datum: WGS84 Zone 10T Easting__________ Northing__________

Q15 – The Stevens School
Datum: WGS84 Zone 10T Easting__________ Northing__________

Q16 - If you went to this UTM coordinate, Easting 551340, Northing 5275360, would your feet be: a)wet or b)dry? _________

Q17 – In what quadrant of the map is this UTM coordinate? (NE, NW, SE, SW)? (circle one) Easting 551060 Northing 5276030
See how easy it is to use the UTM coordinate system?

Q18a – What is the elevation of Point 3 per your map?
__________ meters
Q18b – What is the elevation of Point 3 per your altimeter?
__________ meters
(Navigation Tip: We're surprised if the values are the same. All measures have error so we should keep in mind that our readings are approximate.)

F - Compass skills: Shooting and Following a Bearing

Let's practice shooting (taking) and following a bearing in the field with your compass. You may have a general sense that taking a bearing with a compass is one of its main uses, but why would you do this? There are two main reasons for taking a compass bearing in the field: 1) when you want to actually follow the bearing, 2) when you want to plot the bearing on a map or 3) to identify distant objects. We'll look at the first case today, as it's much more common.

<u>Consider this scenario</u>: From your high camp in clear afternoon weather, you can see that your preferred route to the summit tomorrow leads from your camp across a series of snowfields to a low pass about a mile away, and then up a ridgeline to the summit. From camp you take a compass bearing to the pass. The next morning when you leave camp, the cloud ceiling has dropped and visibility is just a few hundred feet. No worries! Your climbing team follows the bearing you took the previous day (using the "leapfrog" method, described below), reaches the pass, and continues on upward to the summit. (Note: It is rare in the mountains to be able to travel in a straight line for any significant distance.)

You already practiced sighting on given bearings at the Water Tower. Here's how to take a bearing with a compass that does <u>not</u> have a sighting mirror. (Before you do this, be sure your compass declination is properly set.)
1 – Face the object to which you want to take a bearing.
2 - Making sure the direction of travel arrow is pointing away from you, place the end of the compass near your belly button. (This allows you to look straight down on the arrow to get an accurate reading.)
3 – Holding the baseplate of the compass steady, slowly rotate the compass housing until the red north half of the magnetic needle is "boxed" inside the red north half of the orienting arrow.
4 – The bearing to your object can now be read at the "read bearing here" marker/triangle on your compass baseplate.

Now, let's learn how to follow a bearing. It's pretty easy!
1 – Turn the rotating housing (bezel) on your compass to the desired bearing.
2 – Making sure the direction of travel arrow is pointing away from you, hold the end of the compass near your belly button.
3 – Rotate your entire body until the red north end of the magnetic needle is "boxed" inside the red north orienting arrow.
4 – You are now facing the direction of the bearing. Look up and make note of an object (tree, rock, etc.) on your bearing line that you can clearly see, ideally fairly far away (100-300 meters).
Remember this point. Put your compass away (so you don't fall on your keister) and walk toward this point. When you get to this point, repeat steps 2, 3 and 4.

Q19 - A short "triangle" exercise on following bearings:
Start at **Point 3**. (Note: A pace is counted each time your left foot lands.)
• Walk 20 paces on a bearing of 45 degrees.

• Walk 20 paces on a bearing of 165 degrees.
• Walk 20 paces on a bearing of 285 degrees.
You should have walked a triangle, ending up where you started.

Break time? We'll soon continue to follow our bearing but first, we'll learn about measuring a bearing from the map for use in the field.

G - Map and Compass – Measuring a bearing between points on a map

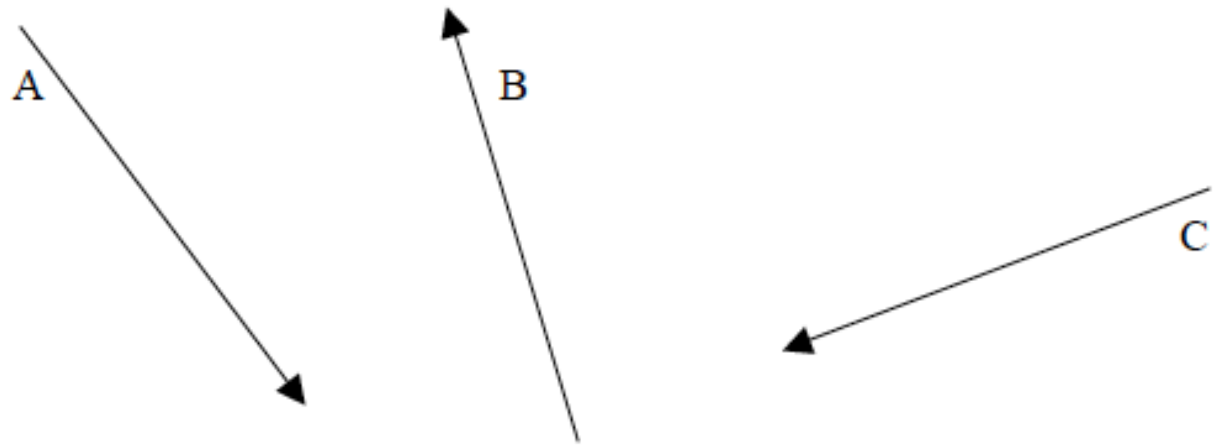
When would you have to do this? Consider this scenario:
You've made camp at a trail junction. The map shows that there is a small lake about a half mile away. This appears to be the only nearby source of water for your camp. You can't see the lake but the terrain is moderate and tree cover is sparse, so it appears that straight-line travel will be feasible to get to the lake. Using the map, you determine the bearing from your camp to the lake; then you follow this bearing to the lake to get water.

How to measure a bearing between points on the map
1 – Using one edge of the compass baseplate, put one part of the edge on your present location and another part of the same edge on your objective. (Think of using the edge of the baseplate as a ruler to simply draw a straight line between the two points.) Be sure the direction of travel arrow is pointing toward your objective.
2 – Rotate the compass dial so North is pointing to the north edge of your map. To make this as precise as possible, align the meridian lines on your compass housing (bezel) with the north/south UTM grid lines.
Important: Completely ignore both the magnetic compass needle AND the orienting arrow that's pointing to 350 degrees for this exercise, as you're using your compass as a protractor.
3 - Read the bearing.
Look at the arrows marked A, B and C below. First, estimate what the bearings will be. (Round off your answer to the nearest 10 degrees – your answer should end in a zero.)
Hint: Look back at Questions 13a to d if you need a refresher. Looking at a map and quickly estimating an approximate bearing before you actually get out the compass to measure is a solid reality check.

Q20 – Estimated bearing of:
A________ degrees B_________degrees C_________ degrees

Then, with your compass, determine the actual bearings for each of these lines. (Fold over the edge of the sheet of paper to make a "North line" on which to align your compass.)

Q21 - Actual bearing of:
A________ degrees B_________degrees C_________ degrees



Now, let's put it together with the map.

Q22 - What is the bearing on your map from the letter "b" in Observation Tower to the letter "y" in Cemetery? ________ degrees

Q23 – Does it look feasible to walk on a direct bearing from Point 3 to Point 4? Y / N

As we discussed before, it's often not possible to walk very far on a precise, straight line in the backcountry. However, getting a bearing from a map can give you a general starting direction. It's often "good enough" to then follow the path of least resistance through the terrain, staying more or less on the correct bearing.

Q24 - Here's a local example of following a bearing.
From **Point 3**, follow a heading of 350 degrees (you measured that bearing in Q22) towards **Point 4**.

In about 360 feet (109 meters) you'll encounter a magnificent Giant Sequoia, some 4 meters at the base. (Tree 25, if you've found the Volunteer Tree Walk map, http://www.seattle.gov/trees/docs/Volunteer%20Park%20Tree%20Walk%20Map.pdf.)

Lean against the north side of this grand tree and find another tree or object to site on using the 350 degree heading set in your compass. Leapfrog about 350 feet (~105 meters). There it is, a Western Red Cedar 15 feet across the base but your heading is just a few feet west of the base. Your destination is across the street, a water feature much loved by children and their parents on hot summer days. A fence blocks your way into the Lake View Cemetery. Find a seat at the south edge of the wading pool, one of the "Big Three" in the city.

Quick, three bearings from the spot at wading pool's edge where you look north along the seam (a radius) in the pool.

Q24a – The Men's Room to your west
__________Degrees

Q24b – The wading pool radius seam looking north
__________Degrees

Q24c – The pillared pavilion in the play area
__________Degrees

Q25 – Your UTM coordinates at Point 4?
Datum: WGS84 Zone 10T Easting___________ Northing___________

Q26 – Your altitude? **___________Feet/Meters**

H – Compass - Following a bearing in low visibility or past an obstruction by leapfrogging

Are you at **Point 4**? Congratulations you've summited Seattle's highest municipal wading pool.

When following a bearing in terrain with limited visibility, like trees or a snowfield in a whiteout, you need to choose intermediate points between you and your objective. (We touched on this before at question 24, following a bearing.) Dial in your bearing, look up, and choose an object on the bearing like a tree, rock, bush, etc. Then, put away your compass and walk to it. When you get there, find another object on the same bearing, walk to it, etc.

If you're on an open snowfield in a whiteout, the technique is roughly the same. But here, you'll need to send someone on your climbing team out along the bearing. When they are just about to go out of sight, signal for them to stop. Signal to them to go left or right to be aligned with your bearing. You and the rest of your team walk to that person, then send them out again, and repeat. This method is known as leapfrogging.

To travel from **Point 4** to **Point 5**, let's put together all the map skills you've learned today.

Q27 - What is the elevation of point 4? ________ **feet**
Q28 - What is the elevation of point 5? ________ **feet**
Q29 - What is the elevation difference between Points 4 and 5?
________**feet**

Q30 – On your map between Seattle Hebrew Academy and Stevens School, contours point uphill. Does this indicate a spur (ridge) or a valley?
Contour reading tip: Contours representing a spur/ridge always point downhill. Contours showing a valley/gully always point uphill.

Q31 - What general direction do you need to travel between Points 4 and 5?
(such as NE, SW, W, E, etc.) __________

Just by looking at the map, guess the approximate bearing between Point 4 and 5.
Q32 - Your guess at the approx. bearing between Points 4 and 5:
_______ **Degrees**
Q33a - Actual bearing from Point 4 to Point 5: (measure this from your map)
_______ **Degrees**

Using the skill your learned to plot a bearing on a map, proceed to **Point 5**. Use the leapfrog method if you are doing this exercise with a partner(s), or the "tree to tree" method if you are doing the course by yourself.
Walk to **Point 5**, the intersection of 16th Ave East and East Galer St.
Q33b - Your UTM coordinates at Point 5?
Datum: WGS84 Zone 10T Easting__________ Northing__________

I - Compass & Map – Inclinometer to determine slope, Bearing of fall line

Nearly finished. What is your bearing, from the map, to return to Black Sun?
_______ **Degrees**
Heading back up East Galer St, use your compass inclinometer (if you have one) to determine the steepness of the slope.

Q34 – First determine which way a basketball would roll if you gently rolled it off your hand. Take a bearing. This slope direction is also called the "fall line." _______ **Degrees**

Now set your compass heading to 270 degrees (West) on the index line so the free swinging clinometer arrow reads zero degrees on the inside scale when held level. **Q35 - Lay long edge along sidewalk. Crouch to read**

the degrees in the tiny inner scale (or sight across the street). Slope angle? _______ Degrees

Find your way back to Black Sun and your transportation using the full range of tools you've used today. You're near Metro Bus # 10 stops but don't miss the Volunteer Park Conservatory, Seattle Asian Art Museum, Dahlia gardens, Louisa Boren Park, Bruce Lee's gravesite or the GAR Civil War Cemetery next visit.

This navigation practice course is modeled on The Mazamas Mt. Tabor Map and Compass Training Course. Thanks to them for sterling work. If you're in the Portland area, give it a try. http://mazamas.org/resources/navigation-training/. Any errors or strange sections are entirely the responsibility of the Seattle Branch Mountaineers Navigation Committee. Comments to the committee chair. Find us at https://www.mountaineers.org/about/branches-committees/seattle-branch/committees/seattle-navigation-committee

Free or nearly free SmartPhone Apps
--**Altimeter** (iOS) provides elevation ft/meters, rough compass, Lat/Long (not UTM), street address, speed, sunrise/sunset, accuracy estimate, 2-finger swipe to reveal map, weather, torch and camera link. Free or $0.99
--**UTM Convert** (iOS) provides Lat/Long, UTM (in kilometers) and MGRS for current or any other location. Free
--**Declination** (iOS) provides current declination any place on earth. Location in Lat/Long and UTM. Free
--**Theodolite** (iOS and Android) provides UTM coordinates, elevation, bearing, slope(s), datums (~$5)

ANSWER KEY

Note: Answers are fairly approximate. If your elevations are within +/- 20 feet (6 meters) and degree measurements within +/- 5 degrees, you're doing fine.

1a. Isamu Noguchi
1b. Bactrian (feral herds OZ outback)
1c. 551 460E, 5275 405N
2. 5 meters
3. 25 meters
4. 1 inch = ~725 feet, 1cm= ~80m
5. 16 degrees east
6a. 100 meters
6b. WGS84
7a. About 446 feet, 133m
7b. Answers will vary, ~133m
8a. About 330 ft, 100m Pt1 to Pt2
8b. About 445 feet, 135m tower base
9a. 502ft. 152m view deck elevation
9b. 76ft, 23m elevation gain
9c. 107 steps
9d. n/a
10a. WGS84, 10, 551500E, 5275300N
11. Northeast (NE)
12a. 180° (South)
12b. 90° (East)
12c. 225° (Southwest)
12d. West (270°)
12e. Southeast (135°)
13a. 233°, Space Needle
13b. 134°, Downtown Bellevue
13c. 156°, Triple com towers
13d. 148°, Holy Names Cross
13e. Avy risk starts 25°-30° ??
14. WGS84, 10, 551600E, 5275290N
15. WGS84, 10, 552000E, 5275600N
16. Wet-a (In the reservoir!)
17. NW quadrant
18a. About 430 ft, 130m
18b. About 400 ft Answers will vary
19. Discrepancy = "error of closure"
20. A, B, C answers will vary
21. About A=140°, B=350°, C=250°
22. 354° (Nearly due north)
24a. 264° (Left end of bldg. to west)
24b. 332° (Wading pool radius)
24c. 69° (Beyond climbing structure)
25. WGS84, 10, 551548E, 5275628N
26. About 380 ft, 116m
27. 363 ft, 110m
28. About 53feet, 16m
29. Valley or ravine
30. NE
31. Will vary
32. 72°
33a. 229°
33b. WGS84, 10, 551738E, 5275674N
34. 84° (Nearly due east)
35. 14° (Modest slope)

(This Draft 12Dec2015/Peter Hendrickson)