STRETCHLEARN · WORKBOOK

Map & Compass Navigation — Workbook

This workbook is your field companion to the Map & Compass Navigation course. Each section pairs directly with a course module and contains hands-on exercises, structured worksheets, and ready-to-use checklists you can carry into the backcountry. Complete the exercises in order — skills build on each other, and the templates are designed to be printed and laminated for field use.

Topographic Maps — Reading the Landscape on Paper

Practice decoding topo maps: scale, grids, contour patterns, symbols, and terrain identification before touching a compass.

Exercise: Contour Landform Identification Drill

Obtain a 1:50 000 NTS sheet or 1:24 000 USGS quad for an area you know well. Work through the following prompts using only the map — do not look up answers online. After completing the exercise, walk the area and verify your answers in the field.

• Find three distinct summits on your map and read their elevations. Calculate the elevation difference between the highest and lowest. How many contour lines separate them at your map's contour interval?

• Locate two valleys on your map. Trace each drainage downstream until it reaches a larger watercourse. What UTM coordinate is the confluence of the larger feature?

• Identify one saddle (col) on the map. What is its elevation? Name the two summits it separates and calculate the vertical rise from the saddle to each summit.

• Measure the straight-line distance and estimate total elevation gain for a route from a trailhead to the nearest summit using the scale bar and contour counting. Apply Naismith's Rule to estimate one-way travel time.

Worksheet: Map Anatomy Reference Card

Fill in the fields below from your own topo map. Keep this card clipped to the inside of your map case as a quick reference for this map sheet.

Map sheet name and NTS/USGS tile number

Scale ratio (e.g. 1:50 000)

Contour interval (metres)

Map datum (NAD83 or WGS84)

Publication or revision year

Declination at map centre (from NRCan/NOAA — not from map margin)

Date you looked up declination

Annual rate of declination change (degrees/year)

UTM zone number for this sheet

Easting and northing of your trailhead (6-digit UTM)

Checklist: Pre-Trip Map Preparation Checklist

[ ] Downloaded or printed the correct topo sheet covering the route plus 5 km margin
[ ] Confirmed the datum matches your GPS receiver setting
[ ] Looked up current declination on NRCan or NOAA — not map margin value
[ ] Identified the contour interval and verified it on the margin
[ ] Traced the planned route in pencil and marked all waypoints with UTM coordinates
[ ] Annotated escape routes in a different colour
[ ] Waterproofed the map (laminated or placed in a waterproof map case)
[ ] Made a second copy for your emergency contact

The Compass — Principles, Declination, and Bearing

Build accurate, repeatable compass skills through structured drills, declination calculation practice, and bearing log documentation.

Exercise: Bearing Accuracy Drill — Field Measurement

Find an open field, park, or trail with at least 200 m of unobstructed sightlines. Set up the drill as described and record your results honestly — the numbers do not need to be impressive, they need to be accurate baselines for improvement.

• Place a marker (a pack, a cone, a distinctive rock) at a known point. Walk 200 m away. Take a bearing to the marker, close your eyes and walk 20 steps, re-check compass, then walk to the marker. Measure your lateral error in metres on arrival. Repeat 5 times and record each error.

• From a known starting UTM coordinate, take a bearing of 045° magnetic, pace 100 m, record your arrived UTM on a GPS. Calculate the lateral error from the expected position. What was the source of error — bearing reading, pace count, or terrain deviation?

• Apply the aiming-off technique: set a bearing deliberately 8° to the right of a target 300 m away on a linear trail. Walk the bearing, arrive at the trail, then turn left to find the target. Measure how far along the trail the target was from your arrival point.

• Practice the 90-degree offset detour around a fixed obstacle (a building or fenced area). Walk 10 paces at 90° right, cross the obstacle front, 10 paces at 90° left, then resume original bearing. Measure position error after rejoining original bearing.

Worksheet: Bearing Accuracy Log

Record each bearing drill session here. Track improvement over multiple sessions. Consistency matters more than absolute accuracy — a navigator who reliably achieves ±5° is more dependable than one who occasionally hits ±1° but averages ±12°.

Date and location of drill

Terrain type (open, light forest, dense forest, fog/low-vis)

Compass model used

Declination applied (value and direction)

Bearing attempted (degrees magnetic)

Distance of bearing leg (metres)

Lateral error on arrival (metres, left or right)

Identified source of error

Adjustment made for next attempt

Checklist: Compass Care and Pre-Use Checks

[ ] Compass stored away from magnets, speakers, and electronics (minimum 30 cm separation)
[ ] Needle spins freely and settles within 3 seconds when held horizontal
[ ] No visible bubble in the compass housing fluid (bubble indicates a cracked compass — replace)
[ ] Bezel rotates smoothly and clicks or slides to the nearest 2° increment
[ ] Declination adjustment set to current value (if adjustable model)
[ ] Baseplate clean and scratch-free (scratched baseplate distorts magnifying lens reading)
[ ] Compass carried on body (shirt pocket or neck lanyard) — not buried in pack

Position Finding — Triangulation and Resection

Practise resection and intersection to fix positions and locate unknown features, and develop terrain association fluency through structured prediction exercises.

Exercise: Three-Bearing Resection Field Exercise

Go to an area where you can see at least three mapped landmarks (summits, towers, or lake outlets) simultaneously. Do not pre-mark your position — the objective is to find it purely through resection. Bring your topo map, compass, pencil, and GPS (keep GPS in your pocket until you have plotted your paper fix).

• Identify three visible landmarks that are clearly marked on your map and are spaced at least 60° apart in azimuth from your position. Name each landmark and confirm it matches its map symbol.

• Take magnetic bearings to all three landmarks, convert each to a map bearing (apply current declination), and plot all three back-bearing lines on your map. Record the size of the triangle of error and estimate the centroid.

• Now check your GPS position. How far is your resection fix from the GPS reading? If the discrepancy is greater than 200 m, identify which bearing was most likely in error and retake it.

• Sketch the three bearing lines and triangle of error in the worksheet on the next page. Label each landmark, bearing value, and the final estimated position.

Worksheet: Resection and Intersection Field Record

Complete this worksheet during or immediately after each position-finding exercise. Accurate records allow you to identify systematic errors in your compass work.

Date, time, and general location

_____

Landmark A name and UTM coordinate (from map)

_____

Raw magnetic bearing to Landmark A

_____

Declination correction applied

_____

Corrected map bearing to Landmark A

_____

Landmark B name and UTM coordinate

_____

Raw magnetic bearing to Landmark B

_____

Corrected map bearing to Landmark B

_____

Landmark C name and UTM coordinate (if used)

_____

Corrected map bearing to Landmark C

_____

Estimated position UTM from resection (easting, northing)

_____

GPS-confirmed UTM at same location

_____

Error distance between resection fix and GPS (metres)

_____

Probable cause of error if greater than 150 m

_____

Checklist: Position Confirmation Routine

[ ] Last confirmed position noted with UTM coordinate and time
[ ] Three or more visible landmarks identified and verified against map
[ ] Bearings taken to at least two landmarks spaced more than 60° apart
[ ] Declination correction applied to each bearing before plotting
[ ] Lines plotted on map with baseplate edge, not freehand
[ ] Triangle of error checked — if larger than 1 cm at map scale, re-shoot
[ ] Plotted position checked against surrounding terrain features for consistency
[ ] GPS coordinate used to verify paper fix, not to replace it

Route Planning and GPS Integration

Build a complete, field-ready route plan and navigation kit checklist, and practise integrating GPS as a backup verification tool.

Exercise: Plan a Day Route from Scratch

Choose a backcountry day route you have not done before, within your current fitness level. Plan it entirely on a topo map before consulting any trail description, app, or online report. Use the worksheet template below to document every leg. After completing the hike, compare your plan to what you actually experienced.

• Identify your trailhead (UTM coordinate), summit or destination, and at least three intermediate waypoints. For each leg, measure the map bearing, distance, and elevation change. Apply Naismith's Rule to calculate total time including a 15% contingency buffer.

• On your map, draw two escape routes — the fastest exits to a road or trailhead if you need to abort from the halfway point and from the furthest waypoint. Record the bearing and distance for each escape leg.

• Select three landmarks visible from the route that could be used for resection. Confirm they appear on the map and are spaced adequately for a reliable fix.

• After completing the route, annotate your map with what you actually found: actual travel times per leg, water source status (flowing or dry), trail condition, and any features not shown on the map.

Worksheet: Route Plan and Trip Log

Fill in the planning columns before the trip. Fill in the actual columns in the field or on return. Leave calculated total cells blank — fill in each individual leg, then sum manually.

Trip name and date

Trailhead UTM and GPS waypoint name

Emergency contact name and phone number

Expected return time (the turnaround time commitment)

Leg 1: start and end waypoint names

Leg 1: planned bearing (magnetic)

Leg 1: planned distance (km)

Leg 1: planned elevation change (m gain/loss)

Leg 1: planned Naismith time (minutes)

Leg 1: actual departure time

Leg 1: actual arrival time

Leg 1: actual elapsed minutes

Leg 1: navigation notes (features confirmed, errors corrected)

Leg 2: same fields as Leg 1

Leg 3: same fields as Leg 1

Weather at departure and any changes noted

Water sources found and condition (flowing / dry / stagnant)

Checklist: Navigation Kit Assembly Checklist

[ ] Topo map waterproofed and covering route plus 5 km margin in all directions
[ ] Baseplate compass with declination adjustment, needle verified to settle within 3 seconds
[ ] Declination value written on map margin (from NRCan or NOAA, current date)
[ ] Pencil and small notepad in map case (not a pen)
[ ] Ruler or UTM roamer for measuring grid coordinates
[ ] Printed route plan with all waypoints in UTM, escape routes, and emergency contacts
[ ] GPS receiver (dedicated Garmin or phone with offline topo) — battery full, datum set to match map
[ ] Spare batteries for GPS (lithium AA for cold weather performance)
[ ] Second copy of route plan left with emergency contact before departure
[ ] InReach or PLB (personal locator beacon) charged and registered for remote routes

Your Action Plan

1. Download and print a 1:50 000 NTS sheet (or 1:24 000 USGS quad) for your nearest backcountry area and spend 30 minutes identifying every major landform type on it before your first field outing
2. Look up current magnetic declination for your region on NRCan or NOAA and write it on your map with the lookup date — repeat this step at the start of every new season
3. Calibrate your personal pace count over a GPS-measured 100 m course at flat, uphill, and downhill gradients with your typical loaded pack
4. Complete the bearing accuracy drill (5 × 200 m legs) in an open park, recording lateral error each time until your average error is below 10 m
5. Execute a three-bearing resection exercise in the field, plot your fix on paper, then check it against GPS — repeat until paper and GPS fixes agree within 100 m
6. Plan a full day route (trailhead to destination) on a topo map using the Route Plan worksheet, calculating bearings, distances, elevation change, and Naismith time for each leg before hiking it
7. Walk the planned route, running terrain association continuously — predict each feature before it appears and annotate your map with confirmations and discrepancies
8. After the route, overlay your GPS track on CalTopo or Gaia desktop and identify the legs where you drifted furthest from your planned bearing, diagnosing the cause
9. Assemble and inspect your complete navigation kit against the checklist, replacing any worn items and confirming GPS datum setting and battery charge
10. Plan and complete one route in conditions of reduced visibility (early morning fog, overcast, or deliberately navigating a wooded section without visible landmarks) using compass and pace

count only