ANSWER KEY

G202 LAB EXERCISE - INTRODUCTION TO TOPOGRAPHIC MAPS

Part 1 - Refer to the lab manual for the following questions.

1-1. What are the latitude and longitude coordinates of points A and B in Figure 8.1?

PT. A: LAT = 20°N LONG = 120°W.

PT B: LAT = 40°S LONG = 20°W.

1-2. Using a protractor, what is the azimuth compass bearing from point C to point D in Figure 8.2?

1-3. In Figure 8.3, locate points X and Z using the Township-Range-Section method of location (Public Land Survey System).

	X	Z
Township	T1S	T1S
Range	R2W	R2W
Section	SW¼ SE¼ SEC 11	NE¼ SE¼ SEC. 11

1-4. Referring to Figure 8.3B, how many acres are covered in 1 section (1 square mile = 640 acres)?

$1\ \text{SECTION} = 1\text{mi} \times 1\text{mi} = (1\text{mi}^2)\left(640\ \frac{\text{ac}}{\text{mi}^2}\right) = 640\text{ac}.$

1-5. Complete the topographic map depicted in Figure 8.14 (p. 150). Label each contour line using a contour interval of 40 meters. Start with 0 m elevation at sea level.

SEE ATTACHED SHEET

1-6. Referring to Figure 8.15 (p. 151), label the elevation of each contour line on this map.

SEE ATTACHED SHEET

1-7. Using the example topographic map in Fig. 8.17 (p. 154), draw a topographic profile along line A-A'. Plot your profile on the graph paper provided in the lab manual. Start with an elevation of 500 ft at the origin of the y-axis, and use a vertical scale of 1 in = 100 ft.

A) What is the horizontal fractional scale of the map?

1:24000

B) What is the fractional scale of the vertical axis of your profile (hint: convert 1in =100 ft to a dimensionless fractional scale)?

$1\text{in} = 100\text{ft} \Rightarrow 100\text{ft}\left(\frac{12\text{in}}{\text{ft}}\right) = 1200\text{in}$ $\quad 1\text{in} = 1200\text{in}$ $\quad 1:1200$

C) Refer to the example on p. 153 of your lab manual ("step 4") and determine the vertical exaggeration of your profile.

$V.E. = \frac{V\ \text{SCALE}}{H\ \text{SCALE}} = \frac{1/1200}{1/24{,}000} = \left(\frac{1}{1200}\right)\left(\frac{24{,}000}{1}\right) = \times 20$

1-8. Refer to Figure 8.4 (p. 143) of your lab manual, and answer the following questions:

A. What cultural feature is located in the northwest corner of Section 31, T.2N., R.6W.?

JOHN ELLIOT TREE MEMORIAL

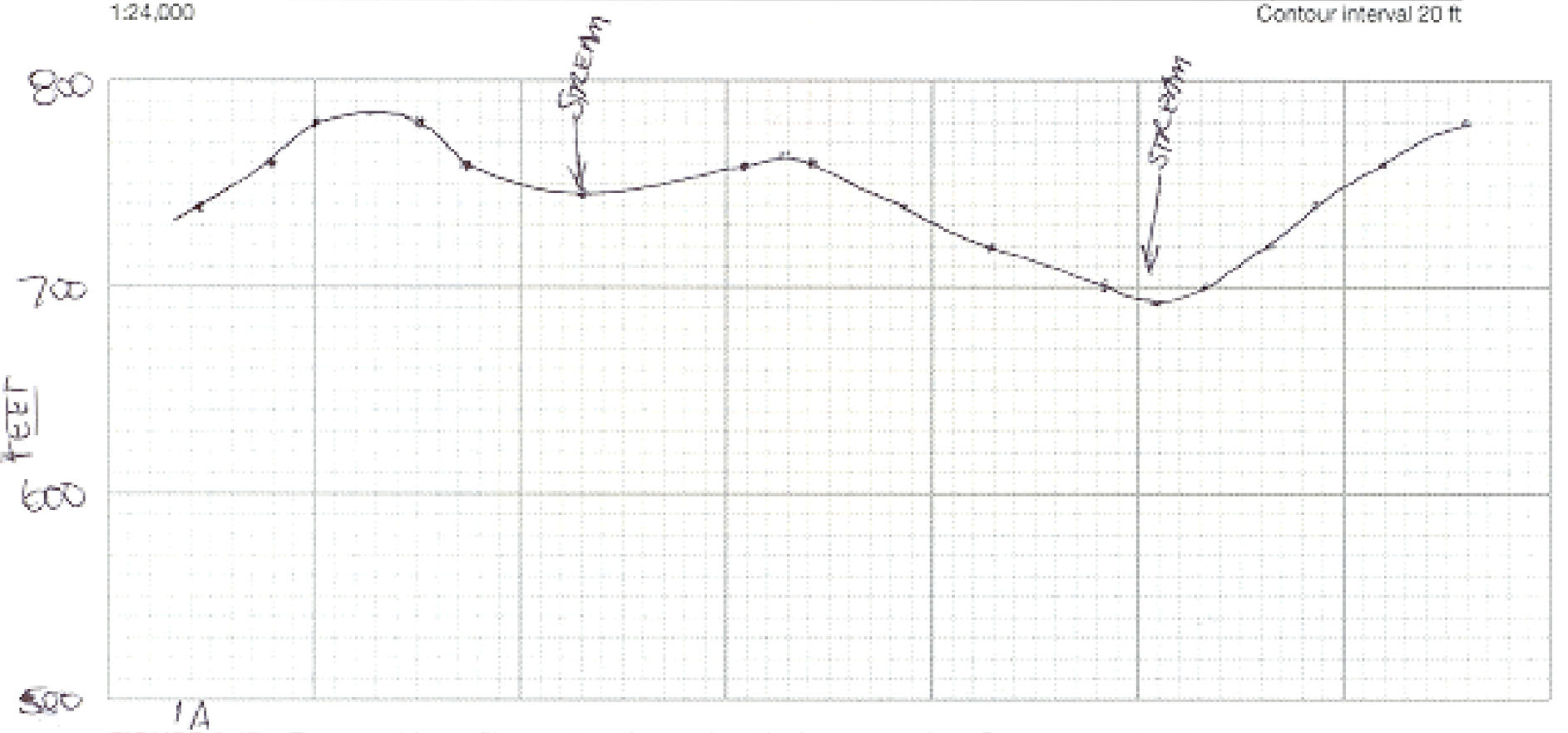


FIGURE 8.17 Topographic profile construction and vertical exaggeration. Can you construct a topographic profile for line **A–A′** and calculate its vertical exaggeration?

B. What is the contour interval of this map? COUNT CONTOUR LINES
INDEX CONTOURS = 400ft CONTOUR INTERVAL = 400ft/5 LINES = 80 ft

C. How much land area (in square miles) is contained within 1 Township of the Public Land Survey grid? (hint look at fig. 8.3)? 1 TOWNSHIP = 6mi x 6mi = 36 mi²

D. What is the distance in km from the railroad intersection in Grapeland (Sec 31, T1N, R6W) to the Day Canyon Guard Station (sec. 17, T1N, R6W). ≈ 5.7 Km

E. In what direction does the stream in Day Canyon flow? How do you know?

SOUTH - SOUTHEAST → CONTOUR LINES "V" UPSTREAM AND ELEVATION DECREASES TO THE SOUTH.

E. Calculate the average gradient of the stream in Day Canyon from Cucamonga Peak to the gaging station located at Sec. 8, T1N, R6W.

Stream gradient = (vertical elevation change)/(horizontal distance)

Step 1, Locate the two points on the stream in Day Canyon, as described above. ✓

Step 2, Determine the elevation of the two points, by using the contour lines (elevation is in feet). Determine the difference of elevation between the two points (this is the vertical elevation change). You can determine this directly by knowing the contour interval, and counting the number of contour lines between the two points. $\Delta V = 3200$ ft

Step 3, Determine the horizontal map distance between the two points, as measured along the twists and turns of the stream course (i.e. not the "straight line distance") (distance is in miles). $\Delta H = 3.6$ mi

Step 4. Divide the elevation difference in Step 2 by the horizontal map distance in Step 3, your answer will be in ft/mi. This is the gradient of the stream.

GRAD = $\Delta V/\Delta H = (3200\text{ ft})/(3.6\text{ mi}) = 889$ ft/mi

Part 2. - Refer to the Monmouth Quadrangle (maps located on table in lab)

2-1) What is the fractional scale, contour interval, and magnetic declination of this map?
a) Scale: 1:24,000 b) Contour Interval: 10 ft c) Declination: 20½° E.

2-2) What quadrangle maps are located immediately adjacent to the Monmouth Quad.?
a) North: RICKREALL b) South: LEWISBURG c) East: SIDNEY d) West: AIRLIE NORTH

2-3) What is the quadrangle size series of this map (in long. and lat.)? 7.5 minute

2-4) What is the date of publication of this map? 1970

2-5) What is the name of the major river system flowing through this area. Of What larger drainage basin(s) does this river form a part of? WILLAMETTE RIVER — FORMS LOWER PORTION OF COLUMBIA RIVER BASIN

2-6) What is the approximate elevation of the Natural Sciences Building based on the map representation? 210 - 212 ft ABOVE SEA LEVEL

2-7) Given the fractional scale determine the following 1:24,000 → 1in = 2000 ft

5 inches on the map= 10,000 Feet on ground = 1.89 Miles on ground.

10 inches on the map= 6096 Meters on ground = 6.1 Kilometers on ground.
(1 m = 3.281 ft)

2-8) A. What is the road distance in miles along Rt. 99 between Helmick State Park and Monmouth city limits? 4.18 mi

B. What is the distance in kilometers? $(4.18\text{ mi})\left(\frac{1\text{ km}}{0.62\text{ mi}}\right) = 6.74\text{ km}$

2-9) A. What is the highest point of elevation represented on this map?
955 ft (SALEM HILLS)

B. What is the lowest point of elevation represented on this map?
140 ft (WILLAMETTE RIVER)

C. What is the maximum relief.
MAX RELIEF = High − Low = 955 ft − 140 ft = 815 ft

2-10) A. What is the longitude and latitude location of the road intersection at Buena Vista
LONG. = 123° 9' 8" W. LAT = 44° 46' 9" N.

B. What is the longitude and latitude location of Davidson Hill?
LONG. = 123° 11' 26" W. LAT. = 44° 45' 59" N.

C. What is the straight line distance in miles between these two points?
1.9 mi

D. What is the azimuth bearing FROM Davidson Hill TOWARDS Buena Vista?
84°

E. What is the quadrant bearing FROM Buena Vista TOWARDS Davidson Hill?
S. 84° W.

2-11) A. What is the nature of the topographic slope in the vicinity of the town of Monmouth? What is the local relief between WOU and the Willamette adjacent to Independence?
BROAD FLAT RIVER TERRACE; RELIEF ≈ 210 ft − 136 ft = 74 ft

2-12) Determine the elevations of the following locations:
A. Wigrich ≈ 170 ft
B. Oak Hill (SC) ≈ 476 ft

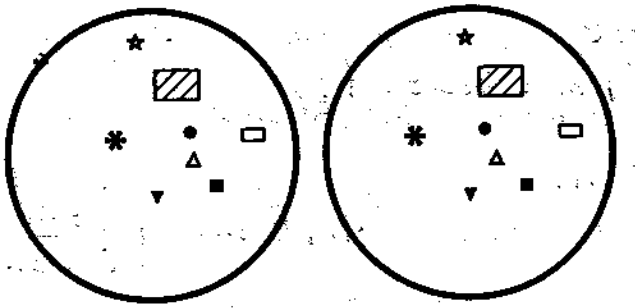
Part 3 - Introduction to Aerial Photographs

3-1. Read over p. 155-156 in your lab book, and provide a general discussion as to what air photos are, and how are they used to obtain 3-D stereoscopic views.

AIR PHOTOS ARE TAKEN FROM AN AIRPLANE;
1) PHOTOS HAVE OVERLAPPING FLIGHT LINES
2) PHOTO IMAGES ARE MATCHED
3) VIEW PHOTO PAIRS THROUGH STEREOSCOPE
4) STEREOSCOPE ⇒ 3-D IMAGE

USES OF AIR PHOTOS: TO INVESTIGATE LAND FORMS & GEOLOGIC FEATURES FROM A BIRDS-EYE PERSPECTIVE

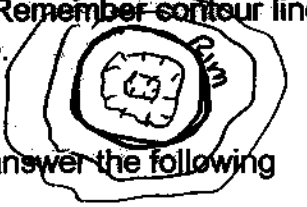
3-2. Test of Stereo vision: to test your ability to see in 3-D, use a student pocket stereoscope and view the image below. Observe the apparent height of the shapes, and rank from highest = 1, to lowest = 8.



A. Left and right images.

● 1 (HIGH)
✱ 2
△ 3
■ 4
▼ 5
▭ 6
▨ 7
☆ 8 (LOW)

3-3. Refer to Fig. 8.21 (p. 159). View the photos of Meteor Crater, AZ in stereo (using the pocket stereoscopes), and draw a generalized topographic map of the crater in the box provided on the Figure. Just generalize the contours without regard to specific elevations. Remember contour lines connect points of equal elevations, draw your lines with this concept in mind.



3-4. Refer to Air Photo Station 1 in the lab. View the images in stereo and answer the following questions.

A. What is the dominant type of surface environment? (fluvial, glacial, coastal, or other?)
COASTAL + VOLCANIC CONES

B. What is the dominant type of climate (warm or cold? wet or dry?)
WARM, WET, VEGETATED (TREES)

C. Is this area vegetated or non-vegetated?
VEGETATED

D. Do you see evidence for human landuse? If so, list your observations.
YES — URBAN LAND USE / CITIES IN VALLEY

E. Hypothesize as to what you think the cone-shaped geologic feature is in the lower right of the photograph. VOLCANIC CONE

F. Hypothesize as to where you think these photos were taken in the U.S.. What is your line of reasoning? HAWAII = COAST – ISLAND – VOLCANO

3-5. Refer to Air Photo Station 2 in the lab. View the images in stereo and answer the following questions.

A. What is the dominant type of surface environment? (fluvial, glacial, coastal, or other?)
GLACIAL

B. What is the dominant type of climate (warm or cold? wet or dry?)
COLD, WET

C. Is this area vegetated or non-vegetated?
NON-VEGETATED / ALPINE

D. Do you see evidence for human landuse? If so, list your observations.
NOT MUCH...

E. Hypothesize as to what you think the dominant mode of surface erosion is in this area. What is your evidence? GLACIAL EROSION OF ROCK AND VALLEYS

F. Hypothesize as to where you think these photos were taken in the U.S. What is your line of reasoning?. ALASKA — MAJOR VALLEY GLACIERS IN A NORTHERN LATITUDE

3-6. Refer to Air Photo Station 3 in the lab. View the images in stereo and answer the following questions.

A. What is the dominant type of surface environment? (fluvial, glacial, coastal, or other?)
FLUVIAL / RIVERS

B. What is the dominant type of climate (warm or cold? wet or dry?)
WARM — HUMID

C. Is this area vegetated or non-vegetated?
VEGETATED

D. Do you see evidence for human landuse? If so, list your observations.
NOT MUCH, MAYBE SOME ROADS & LOGGING

E. Hypothesize as to what you think the horseshoe shaped objects are in the center of the photo. How might they form? OXBOW LAKES — CUT OFF OF RIVER BENDS

F. Hypothesize as to where you think these photos were taken in the U.S.. What is your line of reasoning? MISSISSIPPI / LOUISIANA — HUMID, RIVER ENVIRONMENT

LABORATORY NINE

Topographic Maps and Aerial Photographs

OBJECTIVES

A. Be able to locate features on topographic maps using map symbols and colors, latitude and longitude, the U.S. Public Land Survey System (PLS), the Universal Transverse Mercator System (UTM), and compass bearings.
B. Be able to interpret four kinds of map scales (ratio scales, fractional scales, verbal scales, graphic bar scales) and convert one scale to another.
C. Be able to construct topographic maps by drawing contour lines based on points of known elevations for areas of Earth's surface.
D. Be able to interpret contour lines to measure gradients and relief and identify hills, saddles, ridges, spurs, valleys, closed depressions, steep slopes, gentle slopes, vertical cliffs, and overhanging cliffs.
E. Be able to construct topographic profiles and calculate their vertical exaggeration.
F. Understand how stereo pairs (stereograms) of aerial photographs are obtained and used in geological studies.

STUDENT MATERIALS **(Remind students to bring items you check below.)**

_____ laboratory manual
_____ laboratory notebook
_____ pencil with eraser
_____ metric ruler (cut from GeoTools sheet 1)
_____ protractor (cut from GeoTools sheet 3)
_____ UTM templates cut from GeoTools sheets 1–3 as needed
_____ calculator
_____ pocket stereoscope (optional, or provided by instructor)
_____ topographic quadrangle map assigned by your instructor (or provided by instructor)
_____:

INSTRUCTOR MATERIALS **(Check off items you will need or provide.)**

_____ multiple copies (at least one per group of students) of a topographic quadrangle map including your campus, or another region of interest to students, for part 9D (or have students obtain one based in your instructions)
_____ pocket stereoscopes for Part 9E (or obtained by students)

_____:

INSTRUCTOR NOTES AND REFERENCES

1. General information. Refer to Laboratory 9 on the Internet site at http://www.prenhall.com/agi for additional information and links related to all parts of this laboratory.
2. Reading Fine Print. Some printed words and numerals on topographic maps are very small and difficult for some students to read. Plastic sheet magnifiers aid in map reading. They can be purchased in most bookstores for a few dollars (or less) each. They also come in large sheet or credit card sizes.
3. Mount Garibaldi aerial photographs (Part 9E). Refer to this useful reference on this region, including a color map: Mathews, W.H.. 1958. Geology of the Mount Garibaldi Map area. *Geological Society of America Bulletin* 9:11–198.
4. Raised Relief Maps. Raised relief maps of topographic quadrangles are a very useful aid for having students understand how to read topographic maps. Such maps are available commercially, perhaps even for your region.
5. Topographic map construction. You may want to modify this laboratory with a part on topographic map construction in the field. See Bart, H.A.. 1991. A hands-on approach to understanding topographic maps and their construction. *Journal of Geological Education* 39:303–305.

ANSWERS TO QUESTIONS IN LABORATORY 9

Part 9A: Introduction to Topographic Maps

1. See completed Figure 9.4 on the next page of this instructor resource guide.

2. 40° south latitude, 20° west longitude

3. orchards, scrub, vineyards

4. Index contours are spaced 400 feet apart, and there are four lines and five spaces (five contour intervals) between them. So the contour interval is 400 feet ÷ 5 = **80 feet**.

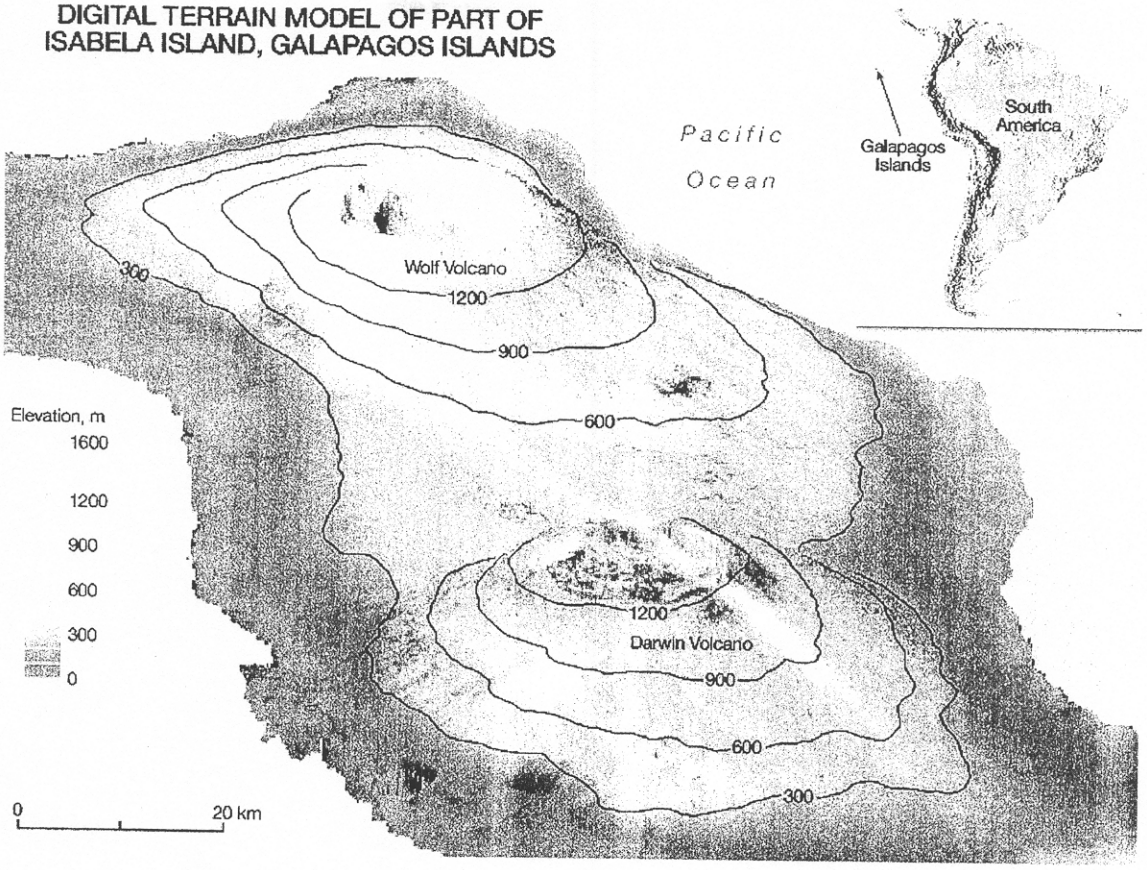
5a. 1/62,500
5b. 62,500
5c. 0.99 mile (62,500 in ÷ 63,360 in/mile = 0.99 mile)

6. center SW1/4, NE1/4, SE1/4, sec. 11, T1S, R2W

7. A township is 6 miles x 6 miles, or 36 square miles. Since 1 square mile contains 640 acres, there are 36 x 640 acres in a township, or **23,040 acres** altogether.

8. This area is ¼ of ¼ of 1 section, and a section is 640 acres or 1 square mile. So the area is 0.0625 x 640 acres, or 40 acres. 40 acres x $500/acre = $20,000.

Completed Figure 9.4 (Question 1)



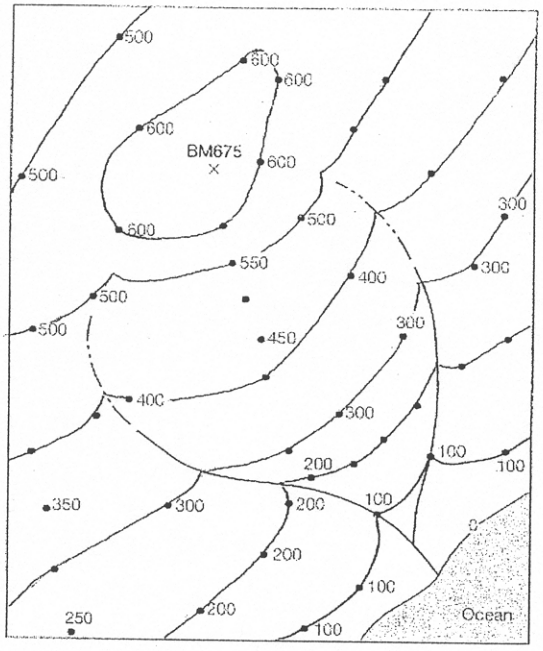
9a. Zone 11. The northeast corner of this 7.5 minute map is located at 117°30' west longitude, and zone 11 is from 120°–114° west longitude (see Figure 9.12).

9b. Zone 11, 454000m E, 3789813m N (approximately 3790000m N)
Students can also write this as Zone 11, $^{4}54^{000}$m E, $^{37}89^{813}$m N.

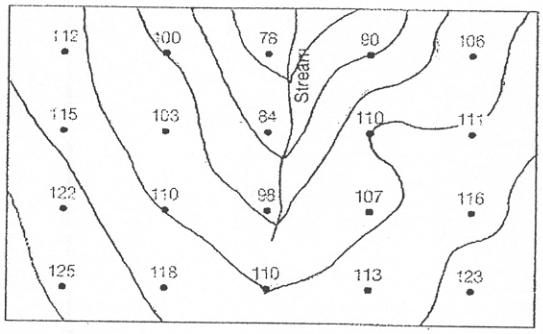
10. north 24° east; azimuth of 24°

11. south 24° west; azimuth of 204°

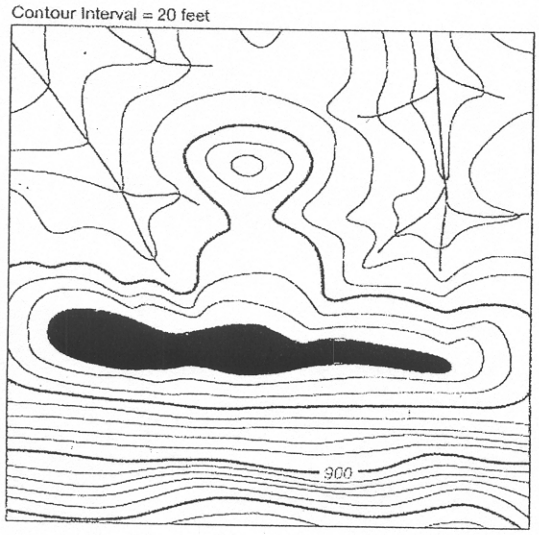
12. 15 meters = 15,000 mm
1/24,000th of 15,000 mm = 15,000mm/24,000 = **0.625 mm** (i.e., less than 1 mm)



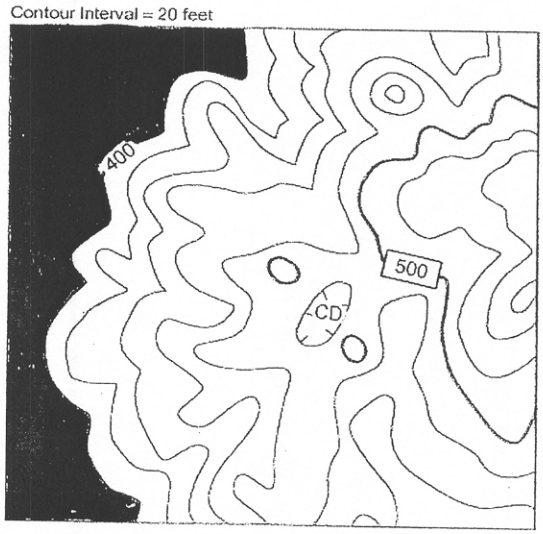
13. Completed Figure 9.15



14. Completed Figure 9.16

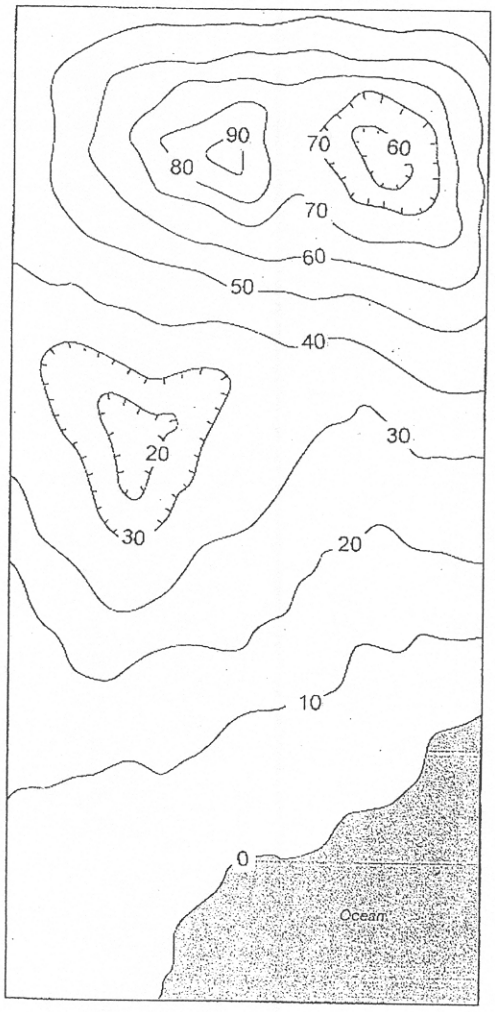


15. Completed Figure 9.17



16. Completed Figure 9.18

17. Completed Figure 9.19 (below)



18a. The contour interval is **20 meters**.

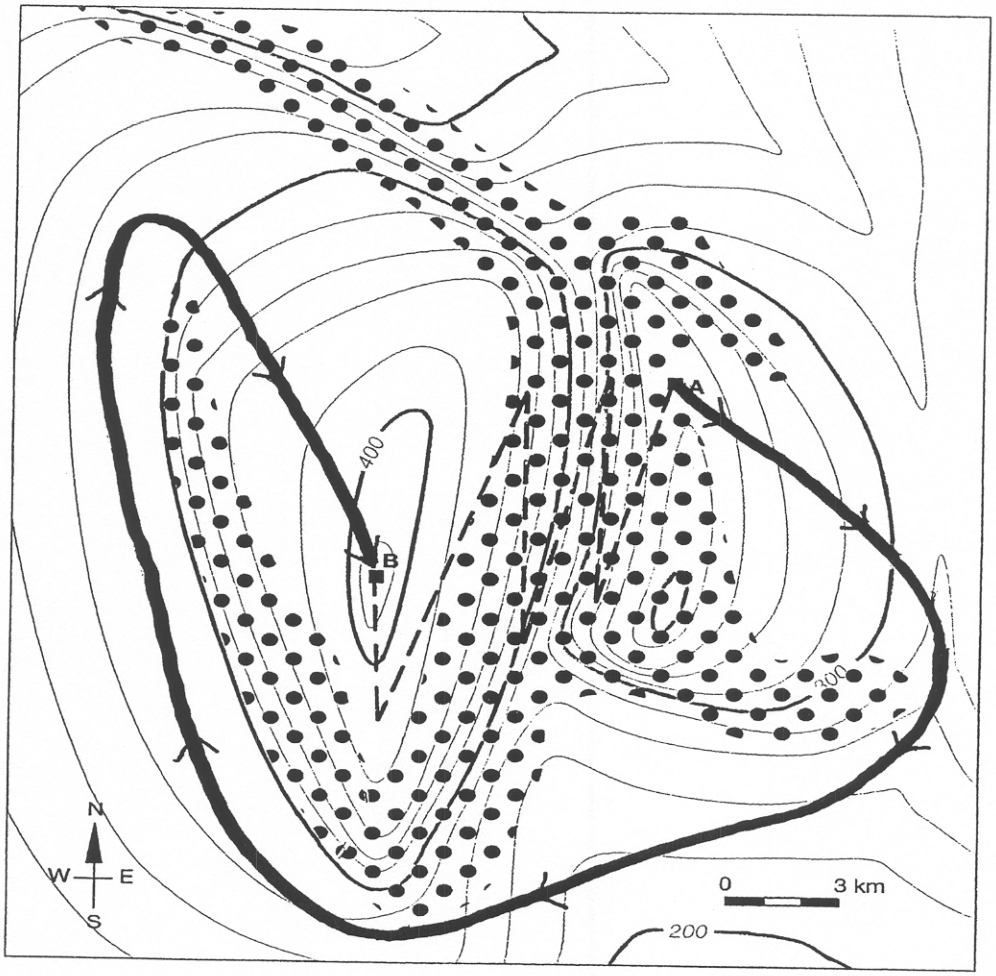
18b. 420 meters – 180 meters = **240 meters** (Student answers may be 10–20 m higher.)

18c. 40 meters ÷ 3 km = 13 m/km

18d. One kilometer is about 4.5 mm long on this map and the contour interval is 20 m. So any area where the contour lines are closer than 4.5 mm is an area where the slope exceeds 20m/km.

18e. Using the method described in Question 18d, the areas of Figure 9.18 with slopes steeper than 20m/km have been shaded (below). Thus, the black line from A to B is the one route you could drive to avoid gradients over 20 m/km. The dashed line from A to B is another route you could drive to avoid gradients over 20m/km by having a road with many "switch-backs."

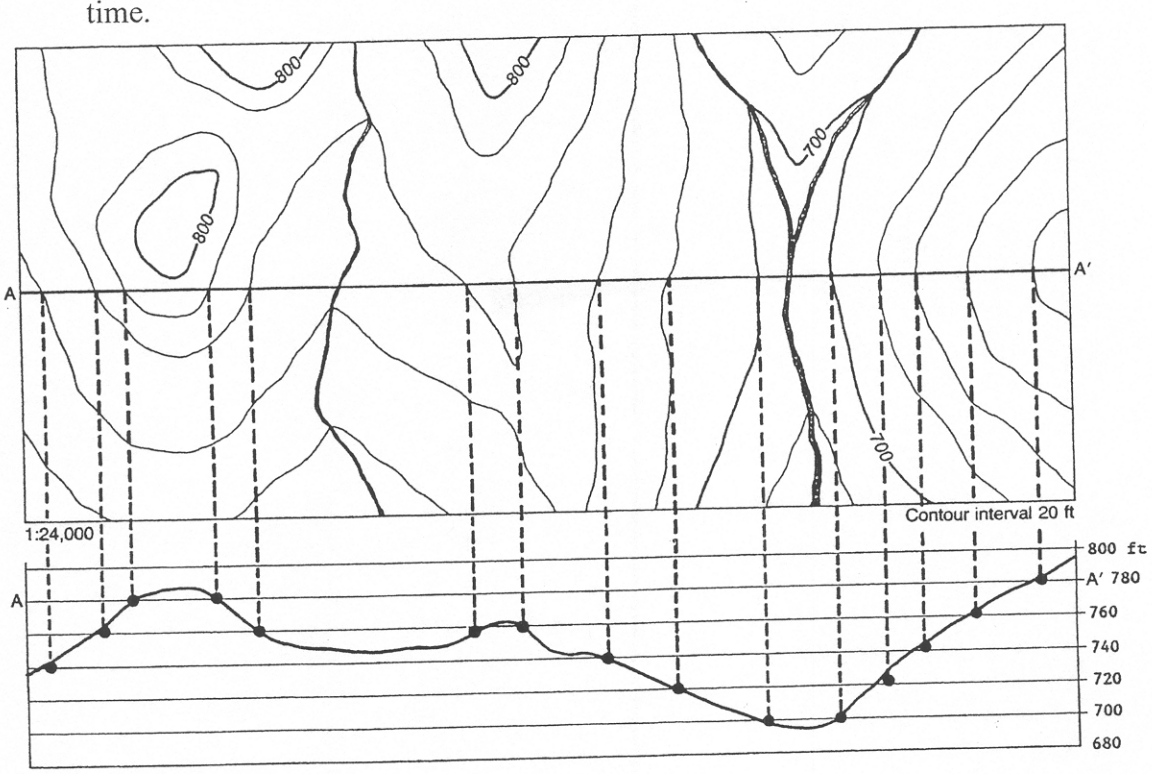
Completed Figure 9.18: Question 18e



= gradients over 20 meters per kilometer.

Part 9B: Topographic Profiles and Vertical Exaggeration

19. Completed topographic profile in Figure 9.22. NOTE: student profiles will vary in vertical scale and vertical exaggeration unless you specify them ahead of time.



Part 9C: Analysis of the Ontario, California Topographic Map

20. a spring

21a. center NE1/4, sect. 27, T2N, R7W
21b. Zone 11, 443000m E, 3787900m N (or Zone 11, $^{4}43^{000}$m E, $^{37}87^{900}$m N)
21c. 8441 feet

22. 5.6 km or 3.5 miles

23. Day Canyon Guard Station is at 2520 feet. Grapeland is at about 1360 feet. Difference in elevation is about **1160 feet**.

24. 1160 feet (the answer to Question 21) equals 353 meters, and the distance between the two locations is 5.6 km or 3.5 miles (the answer to Question 20). So the average gradient is 353m/5.6km = **63 m/km**, or 1160 feet/3.5 miles = **331 feet/mile**.

25. southeast (The V-patterns of contour lines crossed by the stream open in that direction. The closed apex of each V points upstream, like the tip of an arrow.)

26. The highest elevation on the map is 8859 feet (Cucamongo Peak in sec. 35, T2N, R7W). The lowest elevation on the map is about 1150 feet (south edge of the map). So total relief of the map is 8859 ft – 1150 ft = **7709 feet**.

Part 9D: Analysis of a Topographic Quadrangle Map

Make your own key below based on the map viewed by your students.

27.

28.

29.

30.

31.

32.

33.

34.

35.

36.

37.

38.

39.

40.

41.

42.

43.

44a.

44b.

44c.

44d.

45.

46.

47.

48.

Part 9E: Aerial Photographs

49. The cinder cone seems to be the least distorted in the middle photograph because the cone was almost directly beneath the airplane when the photograph was taken. In the other photographs, the cone is farther from the center point and is more distorted.

50. On the topographic map, the distance from the top of the small cinder cone (north of Mount Price) to the Battleship Islands is about 4.5 cm. The same distance measured on the middle aerial photograph is about 6.5 cm.
Therefore, the nominal scale is (6.5 cm / 4.5 cm) x (1/50,000) = 1/72,222
or about **1:72,222**.

51. These broad pathways are valleys floored by material that forms the crescent-shaped "waves." These features are probably large **lava flows** erupted from Mount Price. The crescent shapes are transverse ridges of the flowing lava (now igneous rock). The narrow ridges are **lava levees that formed at the edges of flows.** The levees were apparently breached near Garibaldi Lake and the two fans of lava flowed into the lake. The black extrusive igneous rock formed by cooling of the lava is probably basalt.

52. The rock north of the outlet channel is different from that to the south. The rock to the south is not forested and it seems to be basalt because it has lava pressure ridges. The rock to the north is forested and has a smoother texture, lacking pressure ridges. Therefore, the rock to the north is probably bedrock older than the adjacent lava flows. Mathews (1958) mapped the "Clinker Mountain Lava Flow" south of the outlet channel and Cretaceous sedimentary rocks north of the outlet channel.

53. Garibaldi Lake formed when lava flows dammed a river.