Hydrogeology Answers: See score scaling at the end to get total score out of 100 points
All questions are worth 1 point unless otherwise specified.

Part I (58 points total)

1. A
2. Confined: A body of groundwater surrounded by confining layers; Unconfined: An aquifer in which the water table is at or near atmospheric pressure and is the upper boundary of the aquifer; Perched: Localized zone of saturation above the main water table created by an underlying layer of impermeable material. (4 points total: 1 point for naming all correctly; 1 point for each correct answer)
3. 2.7
4. The volumetric discharge is directly proportional to the cross-sectional area and the hydraulic gradient, and the constant of proportionality is a linear constant called the hydraulic conductivity. (2 points)
5. Manometer; piezometer (2 points; 1 point for each correct answer)
6. Completely, partially/not (2 points; 1 point for each correct answer)
7. Drawdown, or lowering of groundwater levels near the well; Reduction of groundwater flow to nearby surface water features. (4 points; 2 for each)
8. Permeability, aquifer dimensions, quality of water. (3 points)
9. C
10. B
11. Creosote - wood preservative, DNAPL; Gasoline - fuel, LNAPL (2 points; .5 points for each answer)
12. <500ppm salt
13. Great Artesian Basin, 1.7 million km^2 (2 points)
14. Ganges Plain of northern India and Bangladesh; sediments contain organic matter that generates anaerobic conditions in the aquifer. These conditions result in the microbial dissolution of iron oxides in the sediment and, thus, the release of the arsenic. (3 points; 1 for identifying region; 2 for explanation)
15. Bioaugmentation, bioventing, biosparging, bioslurping, phytoremediation, permeable reactive barriers (2 points; .5 points for each)
16. Vadose zone, is split up into the soil water zone, the intermediate vadose zone, and the capillary fringe (3 points: 1 for name; 2 for zones)

17. Point source pollution: pollutants are discharged from any identifiable point; Ex. discharges from wastewater treatment plants, chemicals produced from a certain factory; Nonpoint source pollution: pollution discharged over a wide land area, not from specific location; Ex. excess fertilizers, herbicides, insecticides from agricultural lands and residential areas; oil, grease, toxic chemicals from urban runoff and energy production, etc (3 points: 1 for difference; 2 for examples)
18. It is a drainage area that has no outflow to the ocean unlike the groundwater basin and only collects inside the basin.
19. A septic system is used to treat household sewage and wastewater by allowing the solids to decompose and settle in a tank, then letting the liquid be absorbed by the soil in a drainage field.
20. C
21. The porosity of the rock expressed as a percentage
22. Lower water consumption; reduced maintenance costs; high rainfall retention; reduced waste and pollution (2 points)
23. B
24. B
25. C
26. D
27. Residence Time
28. A stream or river that loses water into the ground as it flows downstream.
29. The water table is below the bottom of the stream channel.
30. Mineral weathering, gradual withdrawal of an ocean, irrigation, high levels of salt in water, movement of water table, climatic trends favoring accumulation, land clearing, salt runoff (2 points)
31. C
32. How much a material allows liquids or gases (accept water) to pass through it. If a geological unit is not permeable enough, water will not get inside it and if it is too permeable then it will not hold its water. (2 points: 1 for definition; 1 for explanation)
33. A single bed of sedimentary rock, generally consisting of one kind of matter representing continuous deposition.
34. D

35. Water that exists within, and in equilibrium with,magma or water-rich volatile fluids that are derived from magma.

Part II (15 points total)

Flow Direction

Step 1:

Well with highest water table elevation: A / Elevation: 2519

Well with lowest water table elevation: F/ Elevation: 2381

Remaining well: G / Elevation: 2393

Difference in elevation between highest and lowest wells: 138

Difference in elevation between highest and middle wells: 126

Step 2:

Somewhere between the highest and lowest well the groundwater elevation will be equal to the middle well elevation. Distance from highest well to that position: 24789

Step 3:

Direction groundwater will flow in: 194° +/- 10°

Gradient

Step 1:

Distance Y: 24206

Step 2:

Gradient (i): .0052

Horizontal Velocity

Step 1:

K (conductivity): 241.2

n (porosity): .32

Step 2:

Velocity: 3.92

Part III: (42 points)

1. Well G

2. Gravel; 241.20

3. From well F to Well G: V=Ki/n= (241.2 ft/day)*((2381 ft — 2371 ft)/16542 ft) /.32 = .456 feet/day; 16542 feet/(.456 feet/day) = 36276 days (1 point each for: correct Darcy equation, correct work to find velocity; correct calculated velocity; correct work to find time; correct calculated time)

4. From well F to Well G: V=Ki= (241.2 ft/day)*((2381 ft — 2371 ft)/16542 ft) = .146 feet/day; 16542 feet/(.146 feet/day) = 113301 days (see #3 for scoring)

5. Any three of: A pumping well completely changes groundwater flow rather than only in a small area around well; the soil between wells has layers of uniform conductivity and porosity; water only moves through the layer of highest conductivity; there is a constant gradient between a conic depression and its surroundings

6. Any three of: A pumping well completely changes groundwater flow rather than only in a small area around well; the soil between wells has layers of uniform conductivity and porosity; water only moves through the layer of highest conductivity; there is a constant gradient between a conic depression and its surroundings

7. Production of dyes, pesticides, medicines; research purposes

8. Three Point

9. See completed table below; Definition is worth 2 points for each technique; other categories worth 1 point each

10. Monitored Natural Attenuation; it's effective against PAHs and is cheaper than using activated carbon. (1 point each for: correct technique, consideration of effectiveness, consideration of cost)

Remediation Technique	Definition	In-/Ex-Situ?	Type of Remediation (Physical, Biological, Other etc.)	Cost (Low, Medium, High)	Applicable to Contaminant? (y/n)
Activated Carbon Treatment	Activated carbon filters chemicals from contaminated water; contaminants sorb to the carbon granules, which are removed from the water	Ex-Situ	Physical	High	Yes
Monitored Natural Attenuation	Rely on natural processes to decrease contaminant concentrations	In-Situ	Other	Low	Yes
Bioaugmentation	Add cultured microorganisms to biodegrade contaminants, and increase enzyme concentration to increase degradation rates	In-Situ	Biological	Low	No

Score Scaling:

Part I: _____(out of 58) x 15/29 = _____(out of 30)

Part II:_____(out of 15) x 2/3 = _____(out of 10)

Part III:_____(out of 42) x 10/7 = _____(out of 60)

Add scaled scores together to get total score out of 100 points