SCIENCE OLYMPIAD 2016-2017

HYDROGEOLOGY Part I&II

FMHS C Division Invitational

Exploring the World of Science

Directions:

- **Do not begin the test until the event supervisor tells you to do so.**
- **You should have a test booklet (this packet) and an answer sheet; put your school name and team number on both.**
- **You may separate the packet pages once the test begins.**
- **You may write on the test booklet but only your answer sheet will be graded.**
- **Tie-breakers, in this order: Part 1 Section 3 #1, #2; Part 1 Section 1 #1, #3, #5, #6, #7, #10, #11, #12, #13, #14.**

School: _____

Team # _____

Part 1 Section 1: Multiple Choice--*Choose the best answer from those provided.*

1. Nested piezometers are most often used to determine:
    a. Areal extent of contamination
    b. Vertical hydraulic gradient
    c. Horizontal hydraulic gradient
    d. Location of a point contaminant source
2. Which of the following would tend to decrease infiltration?
    a. Low porosity
    b. Steep slope
    c. Vegetation
    d. A & B
    e. A, B, & C
3. Which of the following is true of karst landscapes?
    a. They provide groundwater to roughly a quarter of the world's population
    b. They are particularly vulnerable to groundwater contamination
    c. They commonly lack fluvial drainage
    d. A & B
    e. A, B, & C
4. As particle size decreases....
    a. Infiltration decreases, porosity decreases, adsorption of contaminants increases
    b. Infiltration decreases, porosity increases, adsorption of contaminants decreases
    c. Infiltration increases, porosity stays constant, adsorption of contaminants decreases
    d. Infiltration decreases, porosity stays constant, adsorption of contaminants increases
5. Influent streams.....
    a. Are continually recharged by inflow of groundwater
    b. Commonly have reduced discharge in downstream reaches
    c. Have surface water levels below adjacent water table level
    d. A & B
    e. B & C
6. Groundwater flow rates depend in part upon
    a. Water table gradient
    b. Porosity
    c. Elevation above sea level
    d. A & B
    e. A, B, & C
7. Saltwater intrusion is exacerbated by
    a. Pumping that exceeds local recharge
    b. Global sea-level rise
    c. Artificial recharge
    d. A & B
    e. A, B, & C

8. Acid mine drainage is considered a water contamination problem primarily because
    a. It contributes to dissolution of limestone bedrock
    b. It can mobilize toxic heavy metals
    c. It can release CO_2 when in contact with basic natural waters
    d. None of the above
9. Viruses
    a. Are a potential contaminant in surface water but not in groundwater
    b. Commonly contribute to clogging of well screens
    c. May travel faster than average groundwater flow velocity
    d. All of the above
10. The hyporheic zone
    a. Is typically anoxic
    b. Naturally attenuates some pollutants
    c. Is present only beneath influent streams
    d. A & B
    e. A, B, & C
11. DNAPLs are particularly troublesome groundwater contaminants in part because
    a. They float on the water table, and thus spread to cover large areas
    b. They are highly water-soluble
    c. They may migrate downward through the saturated zone
    d. A & B
    e. B & C
12. This remediation method removes contaminants above and below the water table, but it is not effective for inorganics.
    a. Carbon absorption
    b. Surfactant-enhanced recovery
    c. Dual phase extraction
    d. Direct chemical oxidation
13. This remediation method is used in areas of halogenated volatile organic contamination, but can also be used for groundwater contaminated with metals or explosives.
    a. Catalytic reductive dehalogenation
    b. Cometabolism
    c. In situ thermal treatment
    d. Liquid phase carbon adsorption
14. This remediation method typically uses resins or zeolites, and can be used for inorganic or radionuclide contamination, but regeneration of the active medium results in a secondary waste stream.
    a. Air sparging
    b. Surfactant-enhanced recovery
    c. Ion exchange
    d. Chemical oxidation

Part 1 Section 2: Matching--*Match the best term from the list to each description below. Some terms will not be used; no terms will be used twice.*

adhesion	advection	anisotropic	aquiclude
aquifer	aquitard	attenuation	baseflow
capillary fringe	cohesion	depletion	dispersion
elevation head	evapotranspiration	heterogenous	homogeneous
hydraulic head	hydraulic conductivity	isotropic	leaching
overpumping	percolation	phreatic zone	pressure head
specific capacity	specific retention	specific yield	subsidence
sustainable yield	transmissivity	vadose zone	velocity head

Copy list from other test, add transmissivity; delete subduction, virtual permeability, & pellicular water

1. Describes a porous medium in which hydraulic conductivity is the same in all directions.

2. The component of peizometric head due to the column of water above the measuring point.

3. The component of stream flow that is continually contributed by groundwater.

4. Layer of extremely low hydraulic conductivity that prevents groundwater flow.

5. Spreading of a contaminant longitudinally and transverse to groundwater flow due to differences in pore-size and flow velocity.

6. Describes a porous medium in which hydraulic conductivity varies by location.

7. Ratio of the water volume that remains in a porous medium against the force of gravity to the total volume of the medium.

8. Maximum groundwater volume that can be extracted from an aquifer without causing undesired consequences.

9. Measure of the ability of the entire thickness of an aquifer to produce water.

10. The pumping rate of a well divided by its drawdown.

Part 1 Section 3: Calculations
Use the space below for your work, and put your answer on your answer sheet. Only your answer sheet will be graded.

Questions 1&2 are based on the following situation: A confined, unconsolidated aquifer has a hydraulic conductivity of 29.0 m/day. The aquifer has an average thickness of 182m, and an average width of 1.35 km. Piezometer A has a water level of 842m. Piezometer B is directly downgradient and 2414m away from A, and has a water level of 817m. Effective porosity is 0.25.

1. Use Darcy's Law to calculate the daily discharge of the aquifer.

2. Calculate the average linear flow velocity for water in the aquifer.

Part 2: Determination of groundwater flow under static conditions.
The second page of your answer sheet has a scenario involving three wells, A, B, and C. You must assume the drawing is to-scale to answer the questions. Distances are given on the map. Use the information given to determine the groundwater flow direction and the groundwater gradient. Follow the steps below.

1. Land surface elevation and depth to static water table are given for wells A, B, and C. Calculate static water level. This is not graded.
2. Use static water levels plus distances shown on the map to determine the direction of groundwater flow. Draw an arrow on your answer sheet to show groundwater flow direction. Your answer must be correct within $+/-5^0$ to receive credit.
3. Calculate the average water table gradient. Round to ten thousandths.

You may write in the space below, but only your answer sheet will be graded!