

## ACTIVATED CARBON

**Scoring** — (a) 1 point; (b) 2 points; (c) 1 point; (d) 3 points; (e) 3 points

(a) Activated carbon is used for several environmental quality purposes. Name one *specific objective* for improving water quality in which activated carbon is commonly used. Name one *specific objective* for improving air quality in which activated carbon is commonly used.

(b) The properties of activated carbon are typically quantified in terms of an *isotherm* (from the Greek: *isos* = equal + *therm* = heat). Given a specific combination of contaminant, fluid and activated carbon, describe a procedure by which isotherm data can be obtained.

(c) In drinking water treatment, one has a choice of using granular activated carbon (GAC) or powdered activated carbon (PAC). In addition to cost, name one other major factor that would be considered in deciding to use one product form versus the other.

For parts (d) and (e) assume that the following isotherm applies for the system of interest (activated carbon, fluid, and contaminant):

$$q = 190 C^{0.33}$$

In this equation,  $q$  expresses the equilibrium amount of sorbed contaminant (mg contaminant per g of activated carbon), and  $C$  measures the equilibrium aqueous contaminant concentration (mg of contaminant per L of water).

(d) Drinking water is found to contain 0.02 mg/L of the contaminant. What dose of PAC must be added to the water (g/L) to reduce the equilibrium contaminant concentration to 0.002 mg/L?

(e) Drinking water is found to contain 0.2 mg/L of the contaminant. The water is passed through a column of GAC. The volume flow rate of water is  $300 \text{ L s}^{-1} = 0.3 \text{ m}^3 \text{ s}^{-1}$ . The column height is 1 m, its cross-sectional area is  $40 \text{ m}^2$ , and it contains  $4 \times 10^7 \text{ g}$  of GAC. Estimate the magnitude of the breakthrough time. In other words, what is the approximate period that this filter can be effectively operated before the GAC would have to be replaced or regenerated? [Hint: You may assume that the time scale for equilibration within the GAC bed is fast.]

*Unit conversions*

$$1 \text{ m}^3 = 1000 \text{ L} = 10^6 \text{ cm}^3$$

$$1 \text{ tonne} = 1000 \text{ kg} = 10^6 \text{ g}$$

$$1 \text{ g} = 10^3 \text{ mg} = 10^6 \text{ } \mu\text{g}$$

$$1 \text{ d} = 24 \text{ h} = 1440 \text{ min} = 86400 \text{ s}$$