請作答於試卷內之「非選擇題作答區」，請標明題號依序作答。

第一部份：Reading comprehension

Please refer to the following abstract by Kolpin et al. 2002 for questions 1-6

Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance

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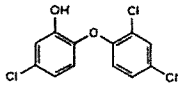
ABSTRACT To provide the first nationwide reconnaissance of the occurrence of pharmaceuticals, hormones, and other organic wastewater contaminants (OWCs) in water resources, the U.S. Geological Survey used five newly developed analytical methods to measure concentrations of 95 OWCs in water samples from a network of 139 streams across 30 states during 1999 and 2000. The selection of sampling sites was biased toward streams susceptible to contamination (i.e. downstream of intense urbanization and livestock production). OWCs were prevalent during this study, being found in 80% of the streams sampled. The compounds detected represent a wide range of residential, industrial, and agricultural origins and uses with 82 of the 95 OWCs being found during this study. The most frequently detected compounds were coprostanol (fecal steroid), cholesterol (plant and animal steroid), N,N-diethyltoluamide (insect repellant), caffeine (stimulant), triclosan (antimicrobial disinfectant), tri(2-chloroethyl)phosphate (fire retardant), and 4-nonylphenol (nonionic detergent metabolite). Measured concentrations for this study were generally low and rarely exceeded drinking-water guidelines, drinking-water health advisories, or aquatic-life criteria. Many compounds, however, do not have such guidelines established. The detection of multiple OWCs was common for this study, with a median of seven and as many as 38 OWCs being found in a given water sample. Little is known about the potential interactive effects (such as synergistic or antagonistic toxicity) that may occur from complex mixtures of OWCs in the environment. In addition, results of this study demonstrate the importance of obtaining data on metabolites to fully understand not only the fate and transport of OWCs in the hydrologic system but also their ultimate overall effect on human health and the environment.

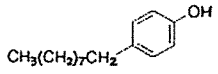
Reference: DW Kolpin, ET Furlong, MT Meyer, EM Thurman, SD Zaugg, LB Barber, HT Buxton, "Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance." Environmental Science & Technology, 2002, 36, 1202-1211

Triclosan



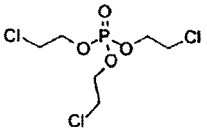
MW= 290
pKa = 7.9
log Kow = 4.8
Boiling point = 120°C
Melting point = 56°C

4-nonylphenol



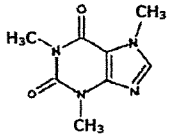
MW = 220
pKa = 10
log Kow = 5.8
Boiling point = 295 °C
Melting point = 42 °C

Tris(2-chloroethyl)phosphate



MW= 285
pKa = 7.8
log Kow = 1.7
Boiling point = 330 °C
Melting point = -55 °C

Caffeine



MW = 194
pKa = 14.0
log Kow = -0.07
Boiling point = 238 °C
Melting point = 178 °C

1. (10 points) Which one is a potential organic wastewater contaminants (OWCs)
(a) Polychlorinated biphenyls (PCBs)
(b) Cadmium
(c) *E. Coli*
(d) Chloramines
(e) Turbidity

見背面

2. (10 points) Concentrations of the pharmaceuticals, hormones and OWCs found are generally low. For example, caffeine was found at 20 μg/L level. Which one below does not express the same concentration found?
(a) 0.02 mg/L
(b) 20 micrograms per liter
(c) 0.02 parts per million
(d) 200 ppb
(e) 0.1 μM (0.1 μmol/L)

3. (5 points) Which compound is likely to be found as its deprotonated form in the river waters (having pH = 7.5, temperature = 20 °C)
(a) Triclosan
(b) 4-nonylphenol
(c) Tris(2-chloroethyl)phosphate
(d) Caffeine
(e) None of the above

4. **Part I** (5 points): Which compound is most likely to be sorbed onto the sediment based on the information given in the table?
(a) Triclosan
(b) 4-nonylphenol
(c) Tris(2-chloroethyl)phosphate
(d) Caffeine
(e) None of the above

Part II (5 points): please explain your choice

5. (5 points) In the abstract, it mentioned "Little is known about the potential interactive effects (such as synergistic orantagonistic toxicity)..." Please explain what is synergistic toxicity.

6. (10 points) In the abstract, it mentioned "...this study demonstrate the importance of obtaining data on metabolites to fully understand not only the fate and transport of OWCs in the hydrologic system but also their ultimate overall effect on human health and the environment." What is metabolites? And why is it important to also understand their occurrence in the water systems?

第二部分：申論題與計算題

7. (12 points) 土壤與地下水污染之整治復育技術方法眾多，其中土壤蒸氣萃取法(soil vapor extraction)、現地化學氧化法(In-Situ Chemical Oxidation)、滲透性反應牆法(permeable reactive barrier)、與監測式自然衰減法(monitored natural attenuation)均為常見與有效的處理技術，請敘述以上方法之原理與適用條件。

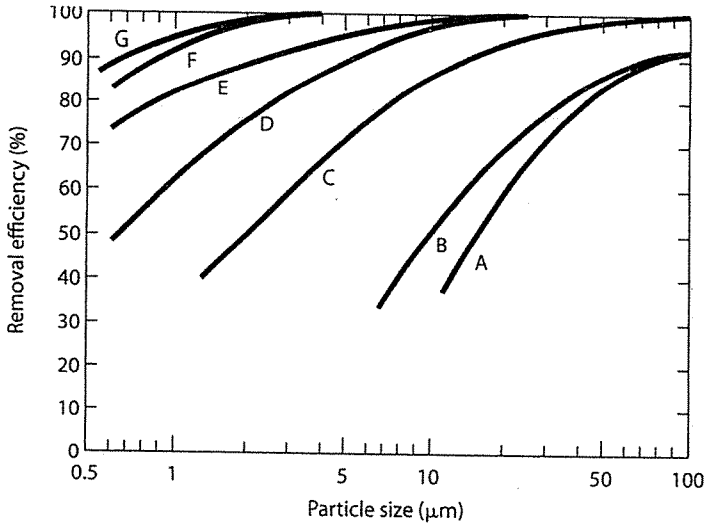
8. (15 points) 某一個燃煤電廠，排放的煙氣(150 °C, 1.01 atm)在未經處理之前，含有 230 ppmv 一氧化氮(NO), 170 ppmv 二氧化硫(SO_2), 105 ppmv 一氧化碳(CO), 10.5% by volume 水蒸氣($H_2O(g)$), 5.5% by volume 氧氣(O_2), 10% by volume 二氧化碳(CO_2)，並且含有 2.2 g/m^3 (真實狀態)之粒狀物。請問(1) NO 之質量濃度為何？(請以等量 NO_2，單位 mg/m^3 表示，並且須校正至 0 °C、1 atm、絕乾之標準狀態; (2)將前題所得之濃度校正至 7% O_2 含量值; (3)此電廠所排出之污染物，那些成分可能貢獻至我們在空氣品質監測站所觀察到的 PM2.5? 其可能形成 PM2.5 之機制為何？

接次頁

9. (8 points) 依照下表所示之水質分析結果，計算(1)鹼度(alkalinity)；(2)總硬度(total hardness)；(3)碳酸鹽硬度(carbonate hardness)；(4)非碳酸鹽硬度(noncarbonated hardness)。各元素分子量為：Ca=40; Mg=24.3; Sr=87.6; Na=23; K=39; C=12; H=1; O=16; S=32; Cl=35.5; N=14 (單位皆為 g/g-mole)

Cations	(mg/L)	Anions	(mg/L)
Ca^{2+}	12	HCO_3^-	75
Mg^{2+}	15	SO_4^{2-}	41
Sr^{2+}	3	Cl^-	25
Na^+	15	NO_3^-	10
K^+	15	pH	7.8

10. (15 points) 下圖代表各種不同之粒狀物污染防治設備其對應粒徑與去除效率示意圖。A-G 分別代表了 simple cyclone, spray tower wet scrubber, bag filter, settling chamber, electrostatic precipitator, high-efficiency cyclone, 及 venture scrubber。請問(1) A-G 曲線分別代表了那七種污染防治設備？請說明你的理由；(2)此圖是根據理論公式所估算出的結果；但在真實的狀況下，我們經常發現當粒狀物大小約介於 0.5 至 2 μm 時，某些污染防治設備(例如 D 或 E)的去除效率遠比理論公式估算值低，請從粒狀物去除機制解釋實際去除率遠低於理論去除率的原因。



試題隨卷繳回