NATIONAL UNIVERSITY OF SINGAPORE

ESE5001 ENVIRONMENTAL ENGINEERING PRINCIPLES

(Semester 2: AY2017/2018)

Time Allowed: 2 Hours

INSTRUCTIONS TO CANDIDATES

1. Please write your student number only. **Do not write your name.**

2. This assessment paper contains **THREE PARTS:**
3.

   PART A – AIR QUALITY
   PART B – WATER QUALITY
   PART C – WASTE MANAGEMENT

   and comprises SEVEN printed pages.

4. Answer **ALL** questions. All questions DO NOT carry equal marks.

5. This is an **"CLOSED BOOK"** assessment.

6. Please start each question on a new page in the answer booklets. There are 3 answer booklets provided and write your answer to the parts accordingly:

   PART A – AIR QUALITY
   PART B – WATER QUALITY
   PART C – WASTE MANAGEMENT

Air Quality

SECTION A: Multiple Choice Questions [15 Marks]

Indicate the letter of the correct answer in the answer sheet provided.
Each question = 1 mark

[1] The troposphere differs from the stratosphere in that it has
(a) 1,000 times less oxygen by volume
(b) 1,000 times more ozone by volume
(c) 1,000 times less ozone by volume
(d) 1,000 times more nitrogen
(e) 1,000 times less moisture by volume

[2] Which of the following is a primary pollutant, primarily the result of auto emissions, which ultimately results in acid deposition?
(a) Nitrogen dioxide
(b) Nitric acid
(c) Sulfur dioxide
(d) Sulfuric acid
(e) Carbonic acid

[3] A thermal inversion is the result of
(a) Precipitation
(b) Cold air drainage
(c) A lid of warm air on top of cooler, stagnant air
(d) A cold blanket of air that prevents warm air from rising
(e) Mixing of cool and warm air

[4] The people *least* vulnerable to air pollution are
(a) Infants
(b) Elderly people
(c) Adult males
(d) People with heart and respiratory disease
(e) Pregnant women

[5] Which of the following statements about the greenhouse effect is *false?*
(a) The amount of heat trapped in the troposphere depends on concentrations of greenhouse gases.
(b) The greenhouse effect is a new theory that explains the warming of the atmosphere.
(c) Heat trapped by greenhouse gases keeps the planet warm enough for life.
(d) The two predominant greenhouse gases are water vapor and carbon dioxide.
(e) It has been confirmed by numerous lab experiments and measurements of atmospheric temperatures at different altitudes.

[6] Carbon dioxide removed from the atmosphere through photosynthesis is only temporary for which of the following reasons?

(a) As plants mature they actually begin to emit higher concentrations of carbon dioxide than they absorb.
(b) Carbon stored in plants will return to the atmosphere as carbon dioxide when the plant dies and decomposes or burns.
(c) The process of photosynthesis only occurs when carbon dioxide concentrations are below 300 ppm in the atmosphere.
(d) The process of photosynthesis is an example of a negative feedback loop and results in more carbon dioxide being released when the plant decomposes.
(e) More than one of the above.

[6] The threat of global warming can be addressed by

(a) using energy more efficiently
(b) halting deforestation
(c) slowing population growth
(d) shifting to renewable resources
(e) all of these answers

[7] Which of the following statements is *false?*

(a) Ozone thinning is more substantial in the Northern Hemisphere than in the Southern Hemisphere.
(b) Up to 50% of the ozone over Antarctica is destroyed each year.
(c) Ozone loss in both the Arctic and Antarctic follows an annual cycle.
(d) 11–38% ozone loss has been reported in the Arctic springtime.
(e) None of these answers.

[8] The correct sequence of layers of the atmosphere from innermost to outermost is the ____.

(a) Mesosphere, stratosphere, thermosphere, and troposphere
(b) Troposphere, stratosphere, mesosphere, and thermosphere
(c) Stratosphere, thermosphere, troposphere, and mesosphere
(d) Thermosphere, stratosphere, mesosphere, and troposphere
(e) Thermosphere, mesosphere, stratosphere, and troposphere

[9] How is ozone produced in the stratosphere?

(a) Ozone is produced when oxygen molecules interact with ultraviolet radiation.
(b) Ozone is produced from oxygen generated by photosynthesis.
(c) Ozone is a greenhouse gas that is formed from combustion of fossil fuels.
(d) Ozone forms as a result of mixing between the troposphere and stratosphere.
(e) When ultraviolet radiation interacts with CO_2, ozone (O_3) is formed.

[10] Which of the following is primary pollutant that eventually results in acid deposition?
(a) Volatile organic compounds
(b) Methane
(c) Airborne particulates
(d) Carbon monoxide
(e) Sulfur dioxide

[11] What is a volatile organic compound?
(a) Organic matter that is unstable at warmer temperatures
(b) Acidic gases generated by combustion of fossil fuels
(c) Gases that exist in the atmosphere or evaporate from sources on earth
(d) Colorless and highly reactive gases
(e) Any solid particle or liquid compound that mostly come from natural sources.

[12] The formation of photochemical smog forms as a reaction between VOCs, NOx, heat, and ____.
(a) Ground level ozone
(b) Automobile exhaust
(c) Sulfur dioxide
(d) Carbon dioxide
(e) Sunlight

[13] Why do cities in warm and dry climates tend to have more air pollution?
(a) There are more automobiles in these areas.
(b) These locations are usually surrounded by mountains that trap the air pollution.
(c) There are more plants and trees that promote the formation of VOCs.
(d) There are more chemical reactions that can happen in dry climates.
(e) There are no natural pollution reduction factors such as precipitation and salty sea spray.

[14] What has released toxic ions of cadmium and aluminium into the soils, causing trees to weaken?
(a) air pollution
(b) photochemical smog
(c) volatile organic compounds
(d) nitric acid
(e) acid deposition

[15] What is likely the most effective way to reduce acid deposition?
(a) Offer tax breaks to companies that emit SO_2.
(b) Add phosphate fertilizer to acidified lakes.
(c) Add more topsoil to thin soil with little buffering capacity.
(d) Add lime to neutralize the acids.
(e) Implement prevention approaches that reduce or eliminate emissions.

SECTION B: Essay Questions [18 Marks]

[16] Global warming is actually not real and politicians and media should spend time debating more serious issues such as how to decrease poverty. To what extent do you agree with the above statement? Give a strong justification to support your statement.

[10 marks]

[17] Explain how chlorofluorocarbons (CFCs) deplete stratospheric ozone. Why is this depletion considered a long-term international problem? What was done to address this problem?

[8 marks]

WATER QUALITY

Total marks: 34 Marks

Question 1 [10 marks]

Derive the relationship between the observed yield and true yield. Comment on the relationship of the two parameters.

Question 2 [16 marks]

Use uniform percentage method to predict the population of a community at year 2030. The historical population data are listed as below.

Calculate the average flowrate and peak flowrate of wastewater at year 2030. Per capita consumption/discharge is currently at 140 L/day/capita and will be further reduced by 10% due to water saving campaign.

Year	Population of the community
1970	4,390
1980	6,211
1990	10,570
2000	19,381
2010	39,398
2020	65,901

Question 3 [8 marks]

Based on the main targets for drinking water treatment which are required to fulfill in drinking water regulation, develop the typical water treatment process train and provide the corresponding rationales.

Appendix

$PF=5(P)^{-0.16}$

WASTE MANAGEMENT

Question 1 [33 marks]

Plastic materials form an integral and important part of the global economy as they are inexpensive, lightweight and durable, and can be readily made into a variety of products for everyday applications.

The global production of plastic has increased twentyfold over the past fifty years, from 15 million tonnes in the 1960s to 311 million tonnes in 2014, and is expected to still double over the next 20 years. The production of plastics consumes significant amounts of fossil fuels, both as feedstock and energy. It is estimated that 4% of the world's annual oil production is used as feedstock for plastics, and a further 3%-4% is used as energy for their manufacturing processes. The production and disposal of plastics also generate carbon emissions, contributing to global warming.

Approximately 50% of plastics, by their very design, are meant for single-use applications. Single-use plastics include mainly small-form packaging, such as sachets, tear-off plastic sheets and sweet wrappers; multi-material packaging made of several materials adhere together to enhance packaging functionality; and plastics such as polyethylene (PE), polyethylene terephthalate (PET) and polypropylene (PP) that are widely used for the packaging of foods and drinks. While offering high functionality, these materials are often unsuitable for reuse due to hygiene reasons, and difficult to recycle due to contamination by food residues.

Globally, it is estimated that 95% of plastic packaging material value, or US$80 to 120 billion, is lost annually after the first use. When the costs of sorting and reprocessing are factored in, only 5% of material value is retained for subsequent use.

To enhance resource use efficiency, it is imperative to keep plastics as resources in the economic loop for as long as feasible. The move to reduce single-use plastics and look for viable recycling technologies for plastics has become a worldwide initiative, calling for a collective effort from government agencies, manufacturers and the broader industry, research and technology providers, and public communities.

In approximately 500 words, propose solution(s) to the plastic problem from a management point of view (for example by minimising the use of plastic) and/or engineering point of view (for example, looking at processing or packaging).

[33 marks]

- END OF PAPER-