

## HOMEWORK ASSIGNMENT #6

due in class on Friday, October 25

Student No: \_\_\_\_\_ Name (Print): \_\_\_\_\_

Note: All homework assignments are due in class one week after being assigned. They must be on standard  $8\frac{1}{2} \times 11$  size paper and they must be stapled. Assignments which are not stapled will not be accepted. I will not bring a stapler to class. Please enter your student number and name (as it appears on the registrar's list) in the spaces above. SURNAME FIRST IN CAPITALS, and given name second. Please put your answers in the boxes (if provided) and submit these pages for your assignment.

1. A culture of bacteria is found to contain  $10^4$  bacteria per  $cm^3$  at the start of an experiment. After 1 day there are  $10^6$  bacteria. Assume that the number of bacteria increases at a rate that is proportional to the number of bacteria present.

(a) Determine the doubling time of the bacteria.

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(b) How many will there be after 2 days?

2. In a chemical reaction it is found that a substance is broken down at a rate proportional to the amount of substance remaining. It was observed that 10 g of the substance decreased to 8 g in 1 hr.

(a) What is the differential equation satisfied by  $A(t)$ , the amount of substance remaining at time  $t$ ?

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(b) How long will it take until only 1 gm is left?

3. The time of death of a murder victim can be estimated from the temperature of the body if it is discovered early enough after the crime has occurred. Suppose that in a room whose ambient temperature is  $A = 20$  degrees centigrade, the temperature of the body upon discovery is  $T = 30$  degrees, and that one hour later it is  $T = 25$  degrees.

(a) What is the differential equation satisfied by  $T(t)$ , the temperature of the body  $t$  hours after discovery?

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(b) Determine the approximate time of death. You may assume that just prior to death, the temperature of the victim was 37 degrees.

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4. A tank that holds 1000 litres is initially full of water to which 100 kg of salt has been added. (The mixture was stirred so that the salt concentration was then 0.1 kg/litre). A concentrated solution of salt, containing 0.25 kg/litre is pumped into the tank continuously, at the rate 10 litres/min and the mixture (which is continuously stirred to keep it uniform) is pumped out at the same rate.

(a) Derive a differential equation for the amount of salt in the tank.

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(b) How much salt will there be in the tank after 10 minutes?

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(c) How much salt will there be in the tank after 1 hr?

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5. For what values of  $a$  does the curve  $y = a^x$  intersect the curve  $y = x$ ?