

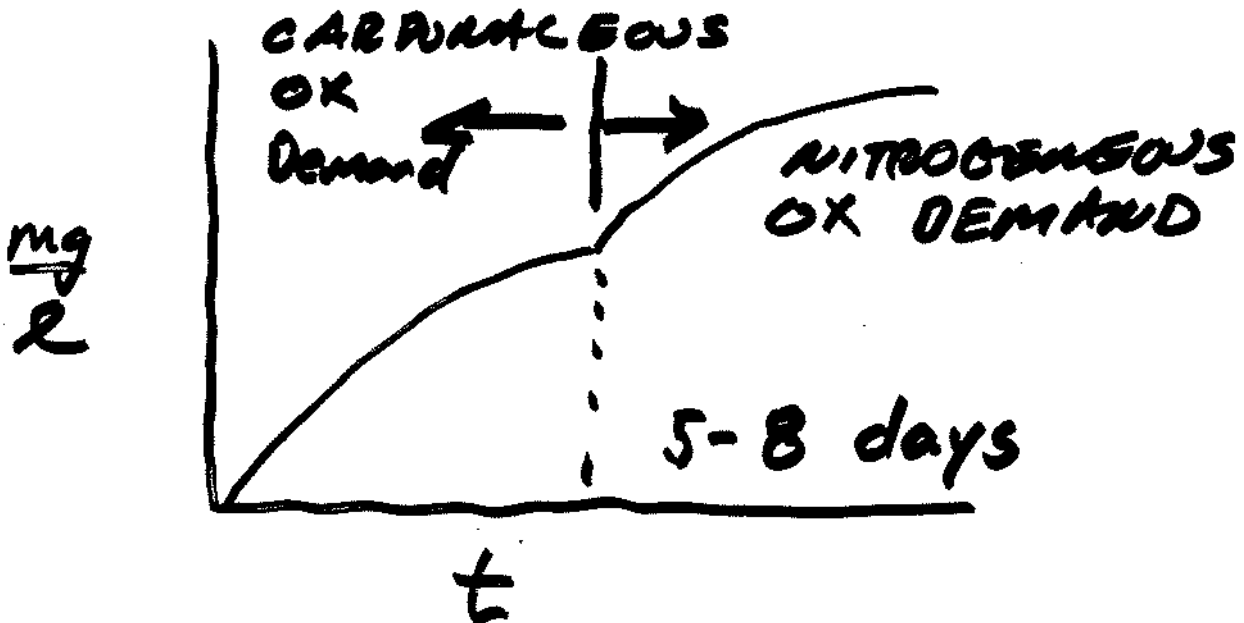
WATER POLLUTION

MEASURE ORGANIC POLLUTION

INDIRECT : BIOCHEMICAL
OX DEMAND (BOD)



DO CONSUMED OVER TIME



BOD TEST

- WW HAS BUGS

↳ Multiple Dilutions

- WW NO BUGS

CREATES OR Demand.



GENERAL EQ

$$BOD = \frac{(D_1 - D_2) - (B_1 - B_2)F}{P}$$

D_1 = DO OF DILTED WW SAMPLE @ START

D_2 = DO " @ time = t

B_1 = DO OF SEEDED VIL WATER

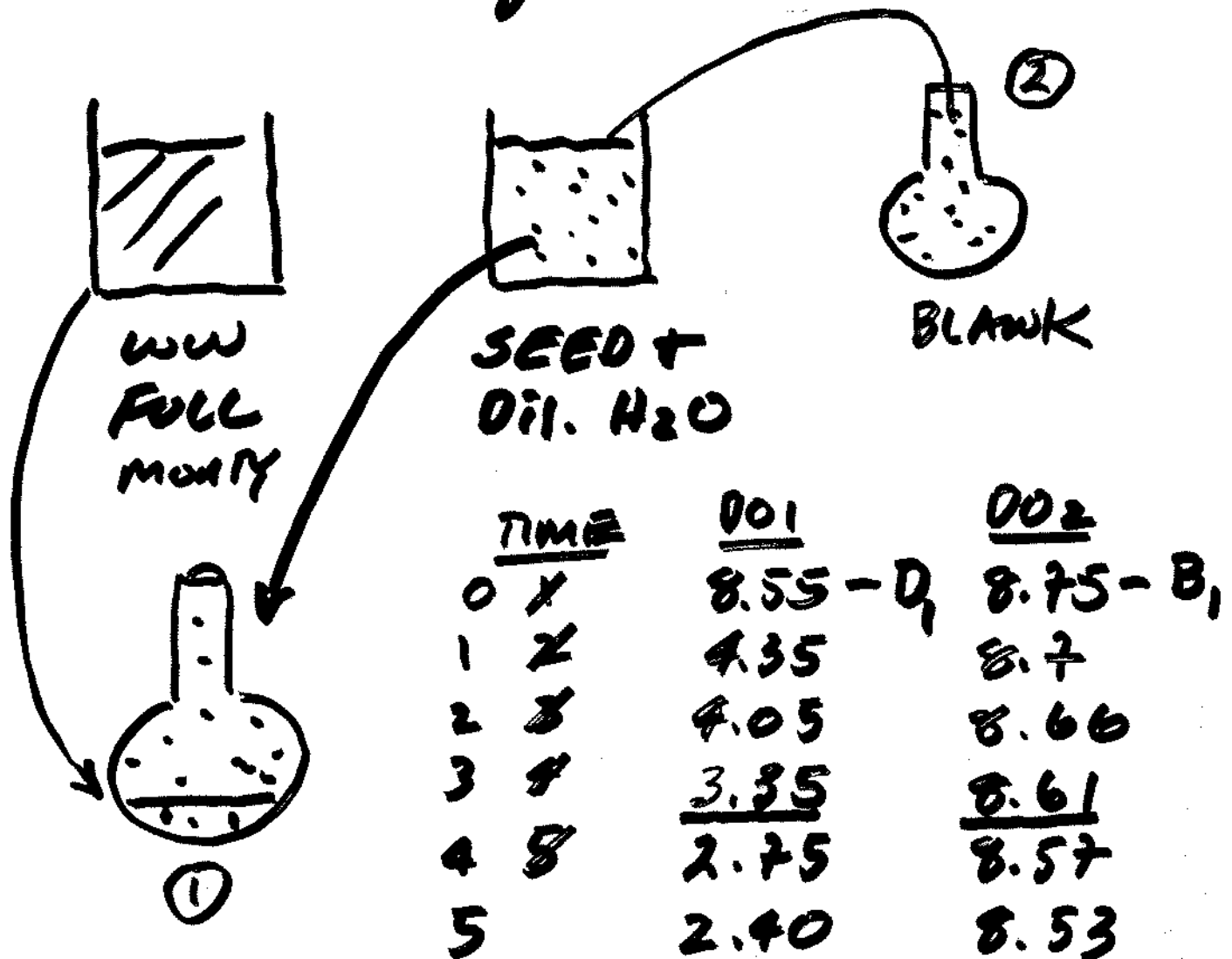
B_2 = " " " @ time = t

$$F = \frac{\% \text{ seed in test}}{\% \text{ seed in blank}} = \frac{\% \text{ seed in sample}}{\% \text{ seed blank}}$$

$p =$ Fract of ww used ³
in test sample

$$p = \frac{V_{ww}}{V_{Dil} + V_{ww}} \cdot \frac{H_2O}{H_2O}$$

Ex: ww is DILUTED BY A FACTOR OF 10 + DO measured. Find 3-day BOD.



SAMPLES 300 mL BOTTLES

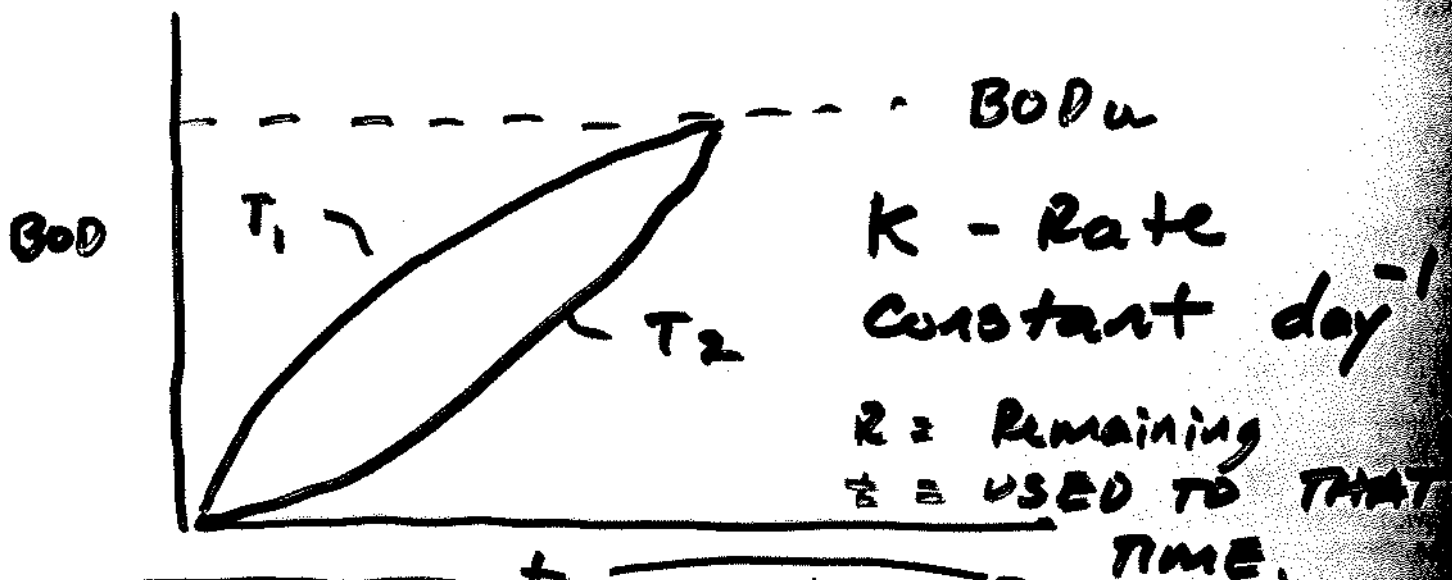
$$p = \frac{30 \text{ ml}}{300 \text{ ml}} = 0.1$$

$$f = \frac{0.9}{1.00} = 0.9$$

$$\text{BOD}_3 = \frac{(8.55 - 3.35) - (8.75 - 8.61) \cdot 0.9}{0.1}$$

$$= 50.74 \text{ mg/l}$$

BOD KINETICS: SPEED OF A CHEM. REACTION.



$$\text{BOD}_R = BOD_u (e^{-kt})$$

$$\text{BOD}_t = BOD_u (1 - e^{-kt})$$

$$\text{BOD}_5 = BOD_u (1 - e^{-5k})$$

(BOD₅)

↳ compare

k = Rate const.

temp
WASTE/BUTS

ADJUST k FOR TEMP.

$$k = k_{20} \Theta^{T-20} \quad \text{°C}$$

$$\Theta_{TYP} = 1.047 \quad \uparrow \text{ MUNICIPAL WASTE W.}$$

EXAMPLE

5 day BOD OF A SAMPLE IS 190 mg/L ($k_{20} = 0.25 d^{-1}$) IF THE WASTE DISCHARGED INTO A STREAM ($T = 30^{\circ}C$) HOW LONG TO REACH 86% OF "STABILIZATION"

$$BOD_t = BOD_0 (1 - e^{-kt})$$

$$BOD_0 = \frac{BOD_5}{1 - e^{-5k}} \quad k = 0.25 \Theta_{20-30} \quad k_{30} = 0.396 d^{-1}$$

6

$$BOD_u = \frac{190 \text{ mg/l}}{1 - e^{-5(0.396)}}$$

$$= 266.3 \text{ mg/l}$$

$$BOD = 0.86 (266.3) \text{ mg/l}$$

$$= 229 \text{ mg/l}$$

$$\frac{BOD_t}{BOD_u} = \frac{BOD_u (1 - e^{-kt})}{BOD_u}$$

$$\frac{BOD_t}{BOD_u} = 1 - e^{-kt}$$

$$e^{-kt} = 1 - \frac{BOD_t}{BOD_u}$$

$$-kt = \ln \left(1 - \frac{BOD_t}{BOD_u} \right)$$

$$t = \frac{\ln \left(1 - \frac{BOD_t}{BOD_u} \right)}{-k}$$

$$t = \frac{\ln \left(1 - \frac{229}{266.3} \right)}{-0.396} = 4.96 \text{ d}$$

OXYGEN SAG / RIVER (STREETER PHELPS)

6.1

$$D = \frac{k_d BOD_a}{k_r - k_d} \left(10^{-k_d t} - 10^{-k_r t} \right) + D_a (10^{-k_r t})$$

$D =$ OXYGEN DEFICIT $(DO_{SAT} - DO_{H_2O})$

$BOD_a =$ BOD_u of mixture

$k_d =$ DEOXY COEFFICIENT d^{-1}

$k_r =$ REOXY COEFFICIENT d^{-1}

$D_a =$ INITIAL OX. DEFICIT OF THE MIXTURE.

WASTE

