3B

$V = 50\ L$

$D = 0.115\ h^{-1}$

$Q^{IN} = 24.50\ L/min$

$G_{IN} = 18.55\ g/L$

$X = 4.87\ g/L$

IN:	$X_O = 0.2105$	$X_{CO_2} = 0$	$X_N = 0.7895$
OUT:	$X_O = 0.1894$	$X_{CO_2} = 0.0267$	$X_N = 0.7839$

$$n_{TOTAL}^{IN} = \frac{PQ^{IN}}{RT} = \frac{(1\ atm)(24.50\ \frac{L}{min})(1000\ \frac{mmol}{mol})}{(0.08206\ L\,atm/mol\,K)(273.15K)} = 1093.0\ \frac{mmol}{min}$$

$n_N^{IN} = (0.7895)(1093.0) = 863.0\ mmol/min$

$n_O^{IN} = (0.2105)(1093.0) = 230.1\ mmol/min$

$n_N^{OUT} = n_N^{IN}$ (NOTE $n_{TOTAL}^{OUT} \neq n_{TOTAL}^{IN}$)

$n_{TOTAL}^{OUT} = (863.0)/0.7839 = 1100.8\ mmol/min$

$n_O^{OUT} = 208.5\ mmol/min$

$n_{CO_2}^{OUT} = 29.4\ mmol/min$

i) $OUR = \frac{n_O^{IN} - n_O^{OUT}}{V} = \left(\frac{230.1 - 208.5}{50}\right)\left(\frac{60\ min}{h}\right) = \underline{\underline{25.9\ \frac{mmol}{Lh}}}$

$CER = \frac{n_{CO_2}^{OUT} - n_{CO_2}^{IN}}{V} = \left(\frac{29.4}{50}\right)\left(\frac{60\ min}{h}\right) = \underline{\underline{35.3\ \frac{mmol}{Lh}}}$

ii) $q_o = \frac{25.9 \text{ mmol/Lh}}{4.87 \text{ g/L}} = \underline{\underline{5.32 \text{ mmol/gh}}}$

iii) $Q_{MET} = (0.12)(25.9 \text{ mmol/Lh})(50\text{L}) = \underline{\underline{155 \text{ Kcal/h}}}$

↑ MUST HAVE THESE UNITS

iv) CO_2: $\left(35.3 \frac{\text{mmol}}{\text{Lh}}\right)(50\text{L})\left(\frac{1 \text{ mmol C}}{\text{mmol } CO_2}\right) = 1765 \text{ mmol/h}$

BIOMASS: $\left(4.87 \text{ g/L}\right)\left(0.115 \text{h}^{-1}\right)\left(\frac{\text{mol C}}{24.7 \text{g}}\right)\left(\frac{1000 \text{ mmol}}{\text{mol}}\right)(50\text{L})$

$= 1134 \text{ mmol/h}$

GLYCEROL: $\left(16.12 \text{g/L}\right)\left(0.115 \text{h}^{-1}\right)\left(\frac{\text{mol}}{92.094 \text{g}}\right)\left(\frac{1000 \text{ mmol}}{\text{mol}}\right)(50\text{L})\left(\frac{3 \text{ mol C}}{\text{mol Gly}}\right)$

$= 3017 \text{ mmol/h}$

% C RECOVERY $= \frac{1134 + 1765}{3017} = \underline{\underline{96.1\%}}$

v) $Y_{X/S}^{OBS} = \frac{4.87 \text{ g/L}}{16.12 \text{ g/L}} = \underline{\underline{0.302 \text{ g/g}}}$

vi) ABSENCE OF GLYCEROL IN EFFLUENT IS NOT A CONCLUSIVE WAY TO SHOW SYSTEM IS GLYCEROL-LIMITED. THE BEST WAY IS TO DECREASE CONC. OF GLYCEROL IN FEED AND OBSERVE WHETHER THE BIOMASS CONC. DECREASES... $Y_{X/S}^{OBS}$ SHOULD REMAIN SAME.