

# Alcohol

Most common poison

Controversial



Essential?



Or evil?

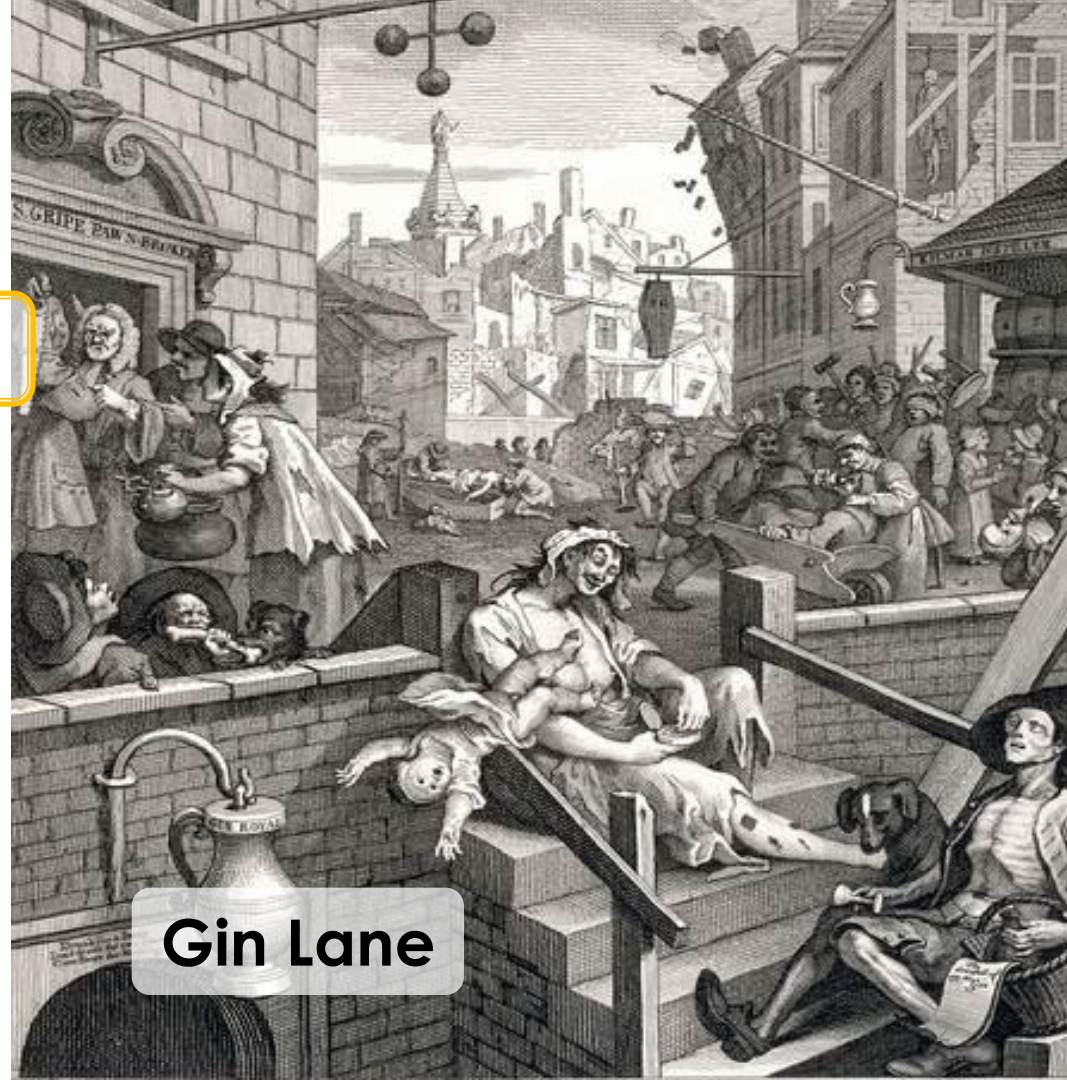
# Alcohol

Show evils of alcohol



Gin

Gin consumption  
was enormous



**Gin Lane**

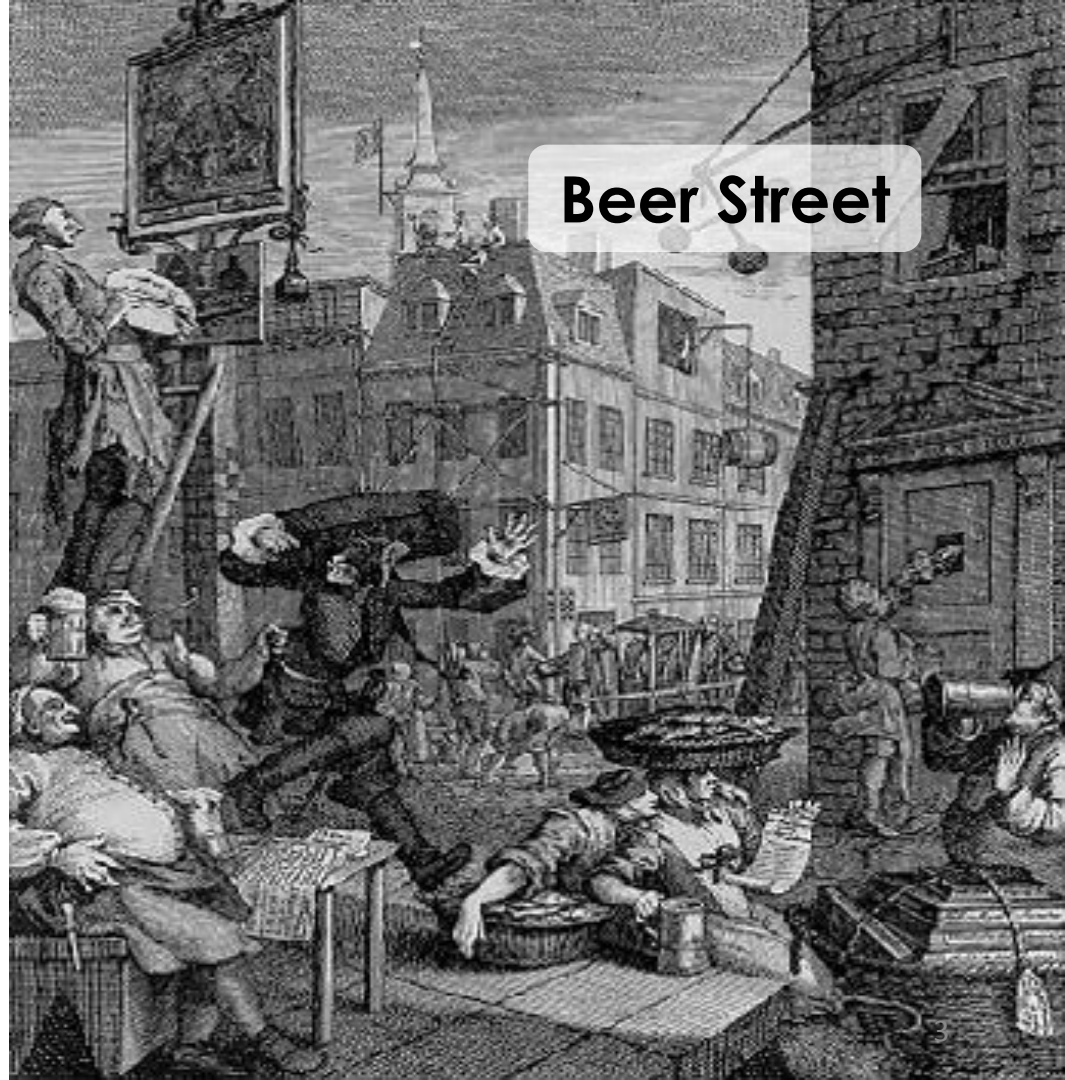
# Alcohol

Beer contains  
less alcohol



Better than gin

**Beer Street**



# Distribution of alcohol

What happens when someone drinks alcohol?

# Distribution of alcohol

Rate of adsorption depends on



Kind of drink



Stomach contents

Distributed via the cardio-vascular system

# Effect of alcohol

Depress the Central Nervous System (CNS)



Depress inhibitions



Depress ability to make judgments



Depress ability to react to situations



Depress reflex times

# Alcohol

- 1 How much is too much (legally)?
- 2 Blood alcohol concentration (BAC) after a drink?
  - ➔ Calculated from the amount of alcohol consumed

# How much is too much (legally)?

Amount of alcohol consumed (g)

Person's weight (kg)

$$c = a / pr$$

Max. conc. (g/ 1000 ml)

Widmark factor

➔ Usually converted to  
mg/ 100 ml of blood

➔ Men:  $r = 0.68$

➔ Women:  $r = 0.55$

## Scenario

If a man of 70 kg drinks a double whisky, what is the concentration of alcohol in his blood?

1 Whisky = 43% alcohol

2 A single = 25 cm<sup>3</sup>

3 Density of ethanol = 0.79 gcm<sup>-3</sup>

Amount of alcohol consumed  
=  $0.43 \times 50 \text{ cm}^3 \times 0.79 \text{ gcm}^{-3} = 17.0 \text{ g}$

## Scenario

$$c = a / pr$$



$$c = 17 / (70 \times 0.68)$$



$$c = 0.36 \text{ g per } 1000 \text{ ml of blood}$$



$$c = 0.036 \text{ g per } 100 \text{ ml of blood}$$



$$c = 36 \text{ mg per } 100 \text{ ml of blood}$$

# Effect of alcohol

Effect of alcohol on the brain?



Vary according to amount of alcohol

# Effect of alcohol

| Blood alcohol conc. (mg/100 ml) | Effects                                                                    |
|---------------------------------|----------------------------------------------------------------------------|
| <50                             | No obvious effect                                                          |
| 50 – 100                        | Loss of coordination and sensory perception, some slurred speech           |
| 100 – 150                       | Marked loss of coordination, poor sensory perception, possibly nausea      |
| 150 – 200                       | Drunkenness, nausea, inability to stand, vomiting                          |
| 200 – 300                       | Probably coma                                                              |
| >300                            | Coma and anaesthesia, impaired circulation and respiration, possible death |
| >450                            | Probable death due to respiratory paralysis                                |

# Elimination of alcohol

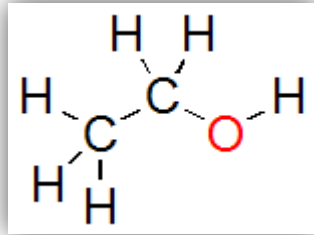
Alcohol present in nature



Fermentation of food

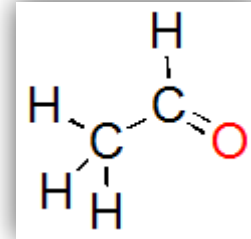
Biomechanism for eliminating alcohol from body

# Elimination of alcohol



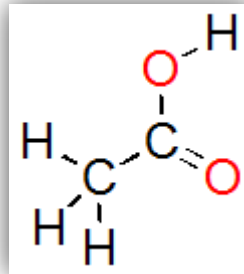
**C<sub>2</sub>H<sub>5</sub>OH**  
**Ethanol**

Alcohol dehydrogenase  
(liver, small intestine)

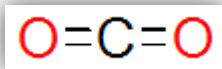


**CH<sub>3</sub>CHO**  
**Acetaldehyde**

Aldehyde  
dehydrogenase  
(liver)



**CH<sub>3</sub>CO<sub>2</sub>H**  
**Acetic acid**



**CO<sub>2</sub>**  
**Carbon dioxide**

## Elimination of alcohol

95% - 98% of alcohol consumed end up as  $\text{CO}_2$

2% - 5% excreted by kidneys and lungs

# Distribution of alcohol

Uniformly throughout the body

Except parts with low water content



Bones, fat, hair

Higher in arterial blood than in venous blood during absorption

# Distribution of alcohol

Usually measure blood alcohol

➔ Same concentration as in the brain

➔ Gas chromatography

Roadside ➔ Measure breath alcohol

Post-mortem ➔ Blood, urine, vitreous humor

## Henry's Law

How is breath alcohol related to blood alcohol?

# Henry's Law

How is breath alcohol related to blood alcohol?

Blood alcohol to breath alcohol



2300: 1 ratio

Multiply breath alcohol to get blood alcohol

# Breath alcohol

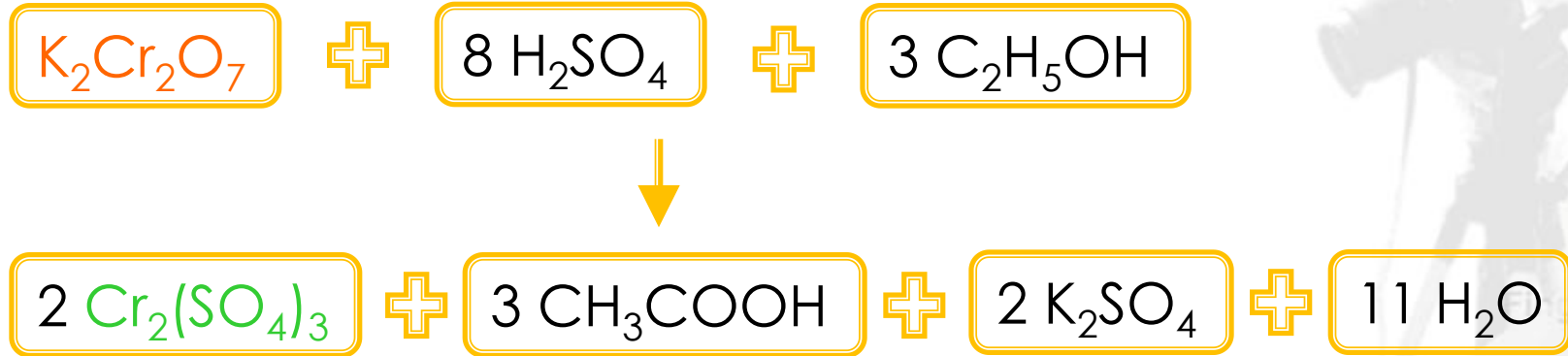
Measured at roadside  
using breathalyzers

Chromium chemistry



Breathalyzer

## Breath alcohol



Amount of  $\text{K}_2\text{Cr}_2\text{O}_7$  converted to  $\text{Cr}_2(\text{SO}_4)_3$



Measure loss of absorbance at 420 nm

# Blood Alcohol Curve

Car accident



One driver drives off



Caught hours later

Blood alcohol level  
at time of accident?

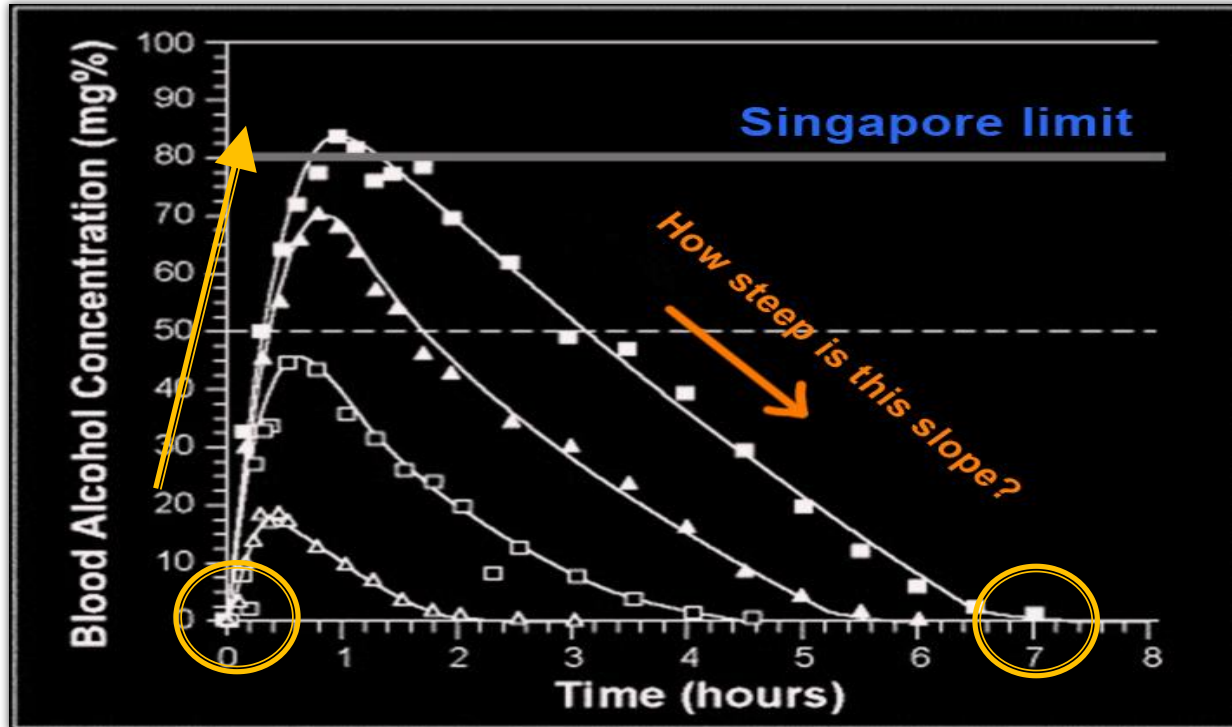


# Blood Alcohol Curve

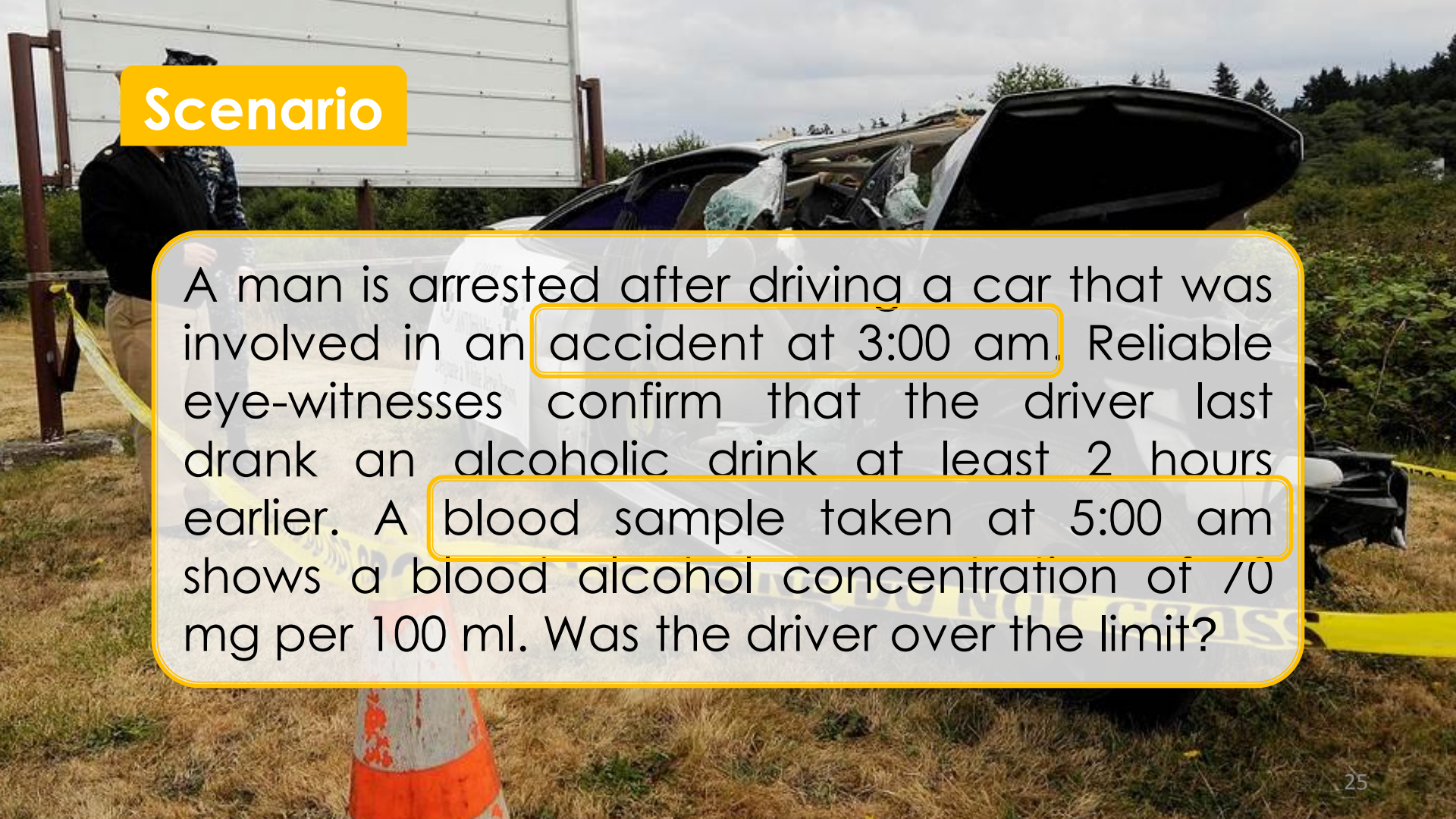
Back calculate from time of test to time of accident

Plot BAC against time

# Blood Alcohol Curve



## Scenario



A man is arrested after driving a car that was involved in an accident at 3:00 am. Reliable eye-witnesses confirm that the driver last drank an alcoholic drink at least 2 hours earlier. A blood sample taken at 5:00 am shows a blood alcohol concentration of 70 mg per 100 ml. Was the driver over the limit?

## Scenario

Length of time between last drink and accident is enough to assume that alcohol absorption has ceased



Down slope of blood alcohol curve

How fast people's bodies eliminate alcohol

## Method 1

Lowest elimination rate



$\beta = 12.5$  mg ethanol per 100 ml blood per hour



$$C_t = C_0 - t\beta$$

# Method 1

$$C_t = C_0 - t\beta$$



$C_t$  = blood alcohol conc. at time of measurement



$C_0$  = blood alcohol conc. at time of interest



$t$  = time elapsed



$\beta$  = alcohol elimination rate

## Method 1

Lowest elimination rate

→  $\beta = 12.5 \text{ mg ethanol per 100 ml blood per hour}$

→  $C_t = C_0 - t\beta$  →  $C_0 = C_t + t\beta$

→  $C_0 = 70 + 2(12.5) = 95 \text{ mg per 100 ml}$

## Method 1

Highest elimination rate

→  $\beta = 25 \text{ mg ethanol per 100 ml blood per hour}$

→  $C_t = C_0 - t\beta$  →  $C_0 = C_t + t\beta$

→  $C_0 = 70 + 2(25) = 120 \text{ mg per 100 ml}$

Conclusion: Man was **above** legal limit

## Method 2

Lowest elimination rate

→ 12.5 mg ethanol per 100 ml blood per hour

→ 2 hours at 12.5 mg per hour = 25 mg

→ Add that 25 mg to the 5 am measurement

→  $70 + 25 = 95$  mg per 100 ml

## Method 2

Highest elimination rate

→ 25 mg ethanol per 100 ml blood per hour

→ 2 hours at 25 mg per hour = 50 mg

→ Add that 50 mg to the 5 am measurement

→  $70 + 50 = 120$  mg per 100 ml

## Methods 1 & 2

Both methods give same conclusion



Man was **above** legal limit

Alcohol generates most work for toxicologists