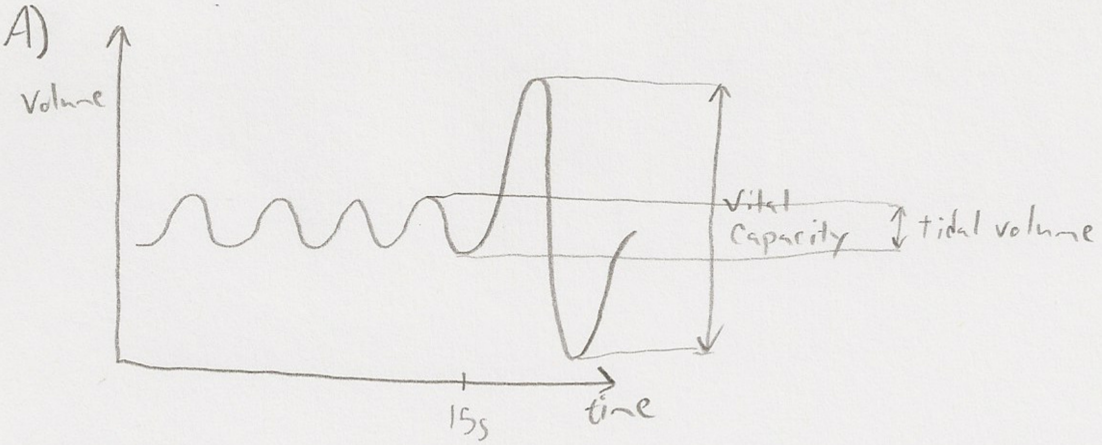
Midterm 2 Solutions

① A)



B) $\text{IRV} = 3300\text{mL} - 400\text{mL} = \boxed{2900\text{mL}}$

$\text{ERV} = \text{VC} - \text{IC} = 4200\text{mL} - 3300\text{mL} = \boxed{900\text{mL}}$

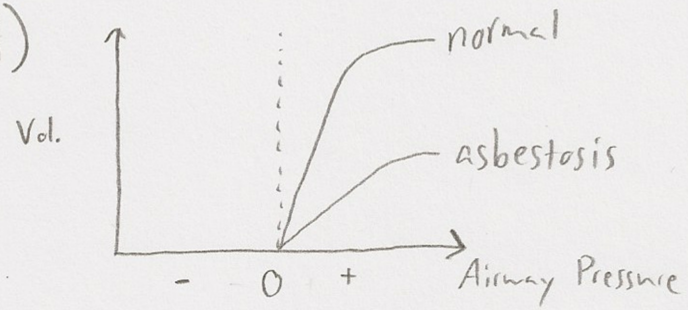
C) $$V_D = V_T \times \frac{P_{aCO_2} - P_{ECO_2}}{P_{aCO_2}} = 400\text{mL} \cdot \frac{42\text{mmHg} - 28\text{mmHg}}{42\text{mmHg}} = \boxed{133.3\text{mL}}$$

$$\dot{V}_A = (V_T - V_D) \cdot RR = (400\text{mL} - 133.3\text{mL}) \cdot \frac{16\text{ breaths}}{1\text{ min}} = \boxed{4267.2\frac{\text{mL}}{\text{min}}}$$

D) $$P_{ACO_2,new} = \frac{\dot{V}_{CO_2} \cdot K}{\dot{V}_{A,new}} = \frac{\frac{\dot{V}_{A,old} \cdot P_{ACO_2,old}}{\cancel{K}} \cdot \cancel{K}}{\dot{V}_{A,new}} = \frac{\dot{V}_{A,old} \cdot P_{ACO_2,old}}{\dot{V}_{A,new}}$$

$$= \frac{4267.2\frac{\text{mL}}{\text{min}} \cdot 42\text{mmHg}}{(400\text{mL} - 133.3\text{mL}) \cdot 40\frac{\text{breaths}}{\text{min}}} = \boxed{16.8\text{ mmHg}}$$

② A)



B) ① Normal Twin has higher FRC => higher compliance. Asbestosis twin has lower compliance => ↑ tendency of lungs to collapse => lower FRC

② Asbestosis Twin has higher FEV_1/FVC. => Both FEV_1 and FVC are ↓ w/ ↓ compliance but FVC is ↓ more, resulting in ↑FEV_1/FVC.

c). Emphysema ⇒ ↑ compliance in lungs ⇒ During forced expiration, pleural pressure is greater than airway pressure.

↑ tendency for airways to collapse ⇒ feeling of air "trapped"

- Pursed lips increase airway pressure and prevent airways from collapsing.

③ A) $P_{I_{O_2}} \text{ dry} = F_{I_{O_2}} \times P_{atm} = 0.21\cdot(760 \text{ mm Hg}) = \boxed{160 \text{ mm Hg}}$

$P_{I_{O_2}} \text{ humidified} = F_{I_{O_2}} \times (P_{atm} - P_{H_2O}) = 0.21(760 \text{ mm Hg} - 47 \text{ mm Hg}) = \boxed{150 \text{ mm Hg}}$

B) $A\text{-}a \text{ grad} = P_{A_{O_2}} - P_{a_{O_2}} \Rightarrow P_{a_{O_2}} = P_{A_{O_2}} - (\cancelto{0}{A\text{-}a \text{ grad}})$

$$P_{a_{O_2}} = P_{A_{O_2}} = P_{I_{O_2}} - \frac{P_{A_{CO_2}}}{R} = 160 \text{ mm Hg} - \frac{42 \text{ mm Hg}}{0.75} = \boxed{104 \text{ mm Hg}}$$

C) O_2 is a vasodilator

Pneumonia ⇒ $\downarrow \dot{V} \Rightarrow \downarrow O_2 \Rightarrow$ vasculature constricts ⇒ $\downarrow \dot{Q}$

④ A) $\dot{V} = \frac{2000 \text{ mL}}{1440 \text{ min}} = 1.39 \frac{\text{mL}}{\text{min}}$

$$C_{K^+} = \frac{[U]_{K^+} \cdot \dot{V}}{[P]_{K^+}} = \frac{42 \frac{\text{mEq}}{\text{L}} \cdot 1.39 \frac{\text{mL}}{\text{min}}}{4.2 \frac{\text{mEq}}{\text{L}}} = 13.9 \frac{\text{mL}}{\text{min}}$$

$$C_{inulin} = \frac{[U]_{inulin} \cdot \dot{V}}{[P]_{inulin}} = \frac{374 \frac{\text{mg}}{\text{dL}} \cdot 1.39 \frac{\text{mL}}{\text{min}}}{9 \frac{\text{mg}}{\text{dL}}} = 57.76 \frac{\text{mL}}{\text{min}}$$

$$CR_{K^+} = \frac{C_{K^+}}{C_{inulin}} = \frac{13.9 \frac{\text{mL}}{\text{min}}}{57.76 \frac{\text{mL}}{\text{min}}} = \boxed{0.24}$$

Blocking principal cells ⇒ $\begin{matrix} \uparrow [P]_{K^+} \\ \downarrow [U]_{K^+} \end{matrix} \Rightarrow \downarrow C_{K^+} \Rightarrow \boxed{\downarrow CR_{K^+}}$

B) $\text{Filtered Load} = GFR \cdot [P]_{K^+} = 57.76 \frac{mL}{min} \cdot 4.2 \, {}^{mEq}/_{L} \cdot {}^{1L}/_{1000mL} \cdot {}^{60\,min}/_{1hr} = \boxed{14.56 \, {}^{mEq}/_{hr}}$

$\text{Rate of Elim} = \dot{V}\,[U]_{K^+} = 1.39 \frac{mL}{min} \cdot 42 \, {}^{mEq}/_{L} \cdot {}^{1L}/_{1000mL} \cdot {}^{60\,min}/_{1hr} = \boxed{3.5 \, {}^{mEq}/_{hr}}$

$\%\text{ reabsorbed} = \frac{\text{Filtered} - \text{Excreted}}{\text{Filtered}} = \frac{14.56 \, {}^{mEq}/_{hr} - 3.5 \, {}^{mEq}/_{hr}}{14.56 \, {}^{mEq}/_{hr}} \times 100 = \boxed{76\%}$

C) $[P]_{OSm} = 2 \cdot [P]_{Na^+} + \frac{\text{glugose}}{18} + \frac{BUN}{2.8} = 2 \cdot 135 + \frac{110}{18} + \frac{19}{2.8} = \boxed{282.9 \frac{mOsm}{L}}$

$C_{H_2O} = \dot{V} - \frac{[U]_{OSm} \cdot \dot{V}}{[P]_{OSm}} = 1.39 \frac{mL}{min} - \frac{850 \frac{mOsm}{L} \cdot 1.39 \frac{mL}{min}}{282.9 \frac{mOsm}{L}} = \boxed{-2.79 \frac{mL}{min}}$

D)

$\uparrow$ ADH $\Rightarrow$ $\uparrow$ H_2O reabsorption $\Rightarrow$ $\downarrow C_{H_2O}$ (becomes more negative)

⑤ A) $GFR = K_f[(P_{GC} - P_{BS}) - \pi_{GC}]$

$\Delta P = \frac{GFR}{K_f} + \pi_{GC} = \frac{100 \, {}^{mL}/_{min}}{75 \, {}^{mL}/_{min/mmHg}} + 20\,mmHg = \boxed{21.3\,mmHg}$

B) $FF = \frac{GFR}{RPF} = \frac{100 \, {}^{mL}/_{min}}{450 \, {}^{mL}/_{min}} = \boxed{0.22}$

$RBF = \frac{RPF}{1 - Hct} = \frac{450 \, {}^{mL}/_{min}}{1 - 0.47} = \boxed{849 \, {}^{mL}/_{min}}$

C) ① + ② Constrict Afferent Art. $\Rightarrow \downarrow P_{GC} \Rightarrow \downarrow RPF \Rightarrow \downarrow GFR$

Less blood is flowing to glomerulus.

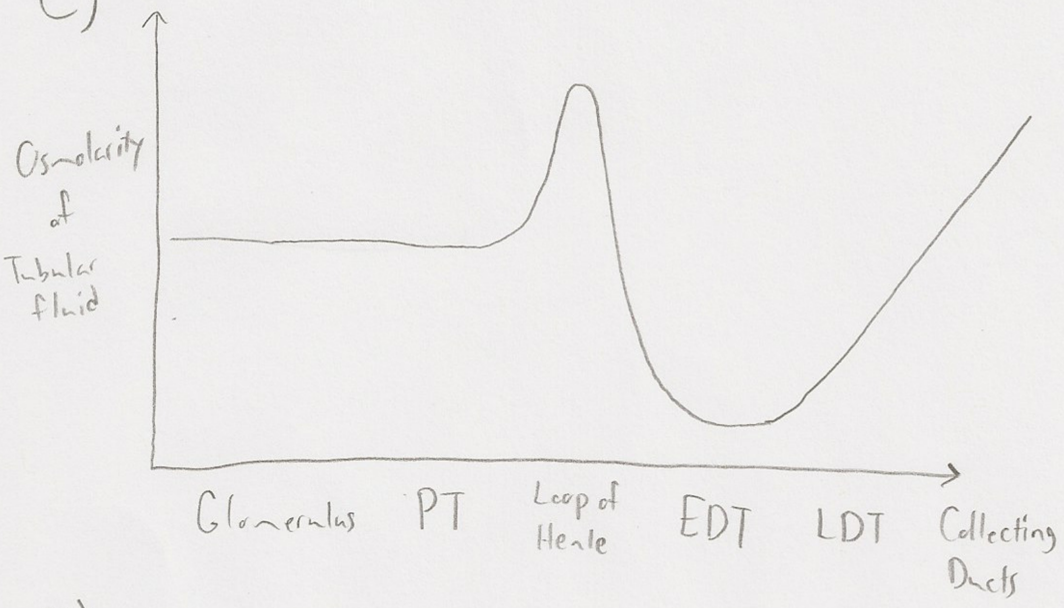
⑥ A) Proline, like other amino acids is co-reabsorbed w/ Na^+ at the proximal tubule.

B) In the cortical collecting duct, ADH => premiable to H_2O / not permiable to Urea => Urea Conc. ↑ and reabsorbed in inner medulla

Urea Recycling

Drug => permiable to H_2O / permiable to Urea => Urea Conc. ↓ and not reabsorbed in inner medulla => No urea recycling

C)



D) Neurological: Osmoreceptors => Thirst

Hormonal : ADH => Reabsorption