COMPENSATION RULES

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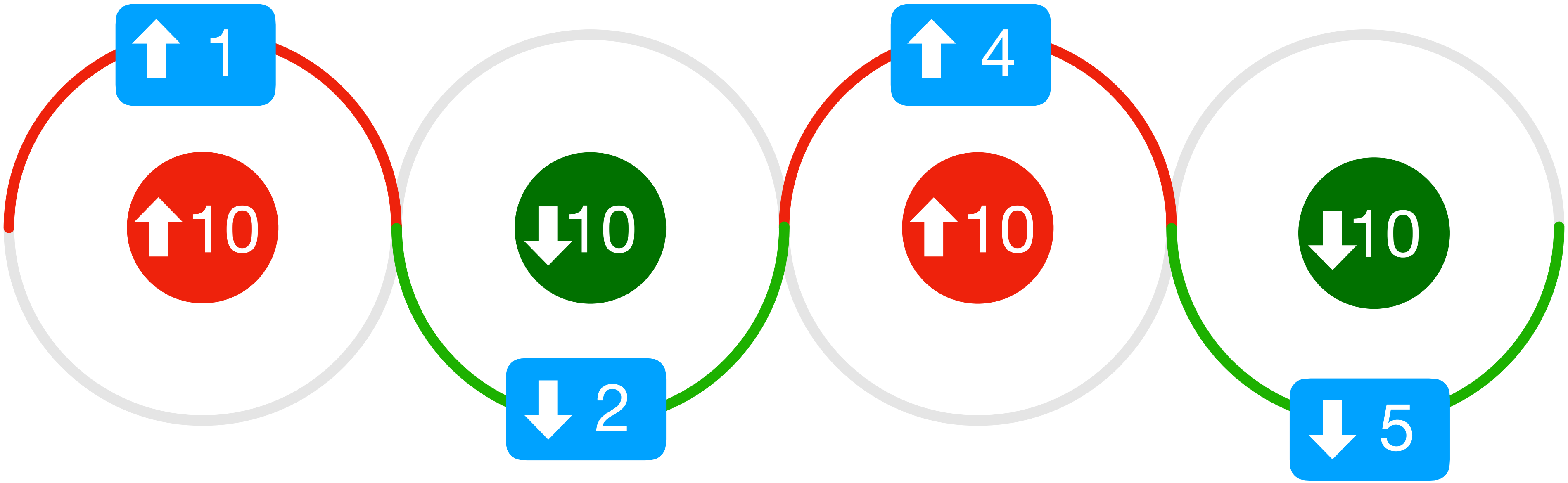
Acute Respiratory Acidosis	Acute Respiratory Alkalosis	Chronic Respiratory Acidosis	Chronic Respiratory Alkalosis



HCO_3^- ⬆1 mmol for every 10mmHg⬆in CO_2>40

Acute **AC**idosis
1 *for 10*

HCO_3^- ⬇2 mmol for every 10mmHg ⬇in CO_2<40

Acute **AL**kalosis
2 *for 10*

HCO_3^- ⬆4 mmol for every 10mmHg⬆in CO_2>40

Chronic **AC**idosis
4 *for 10*

HCO_3^- ⬇5 mmol for every 10mmHg ⬇in CO_2<40

Chronic **AL**kalosis
5 *for 10*

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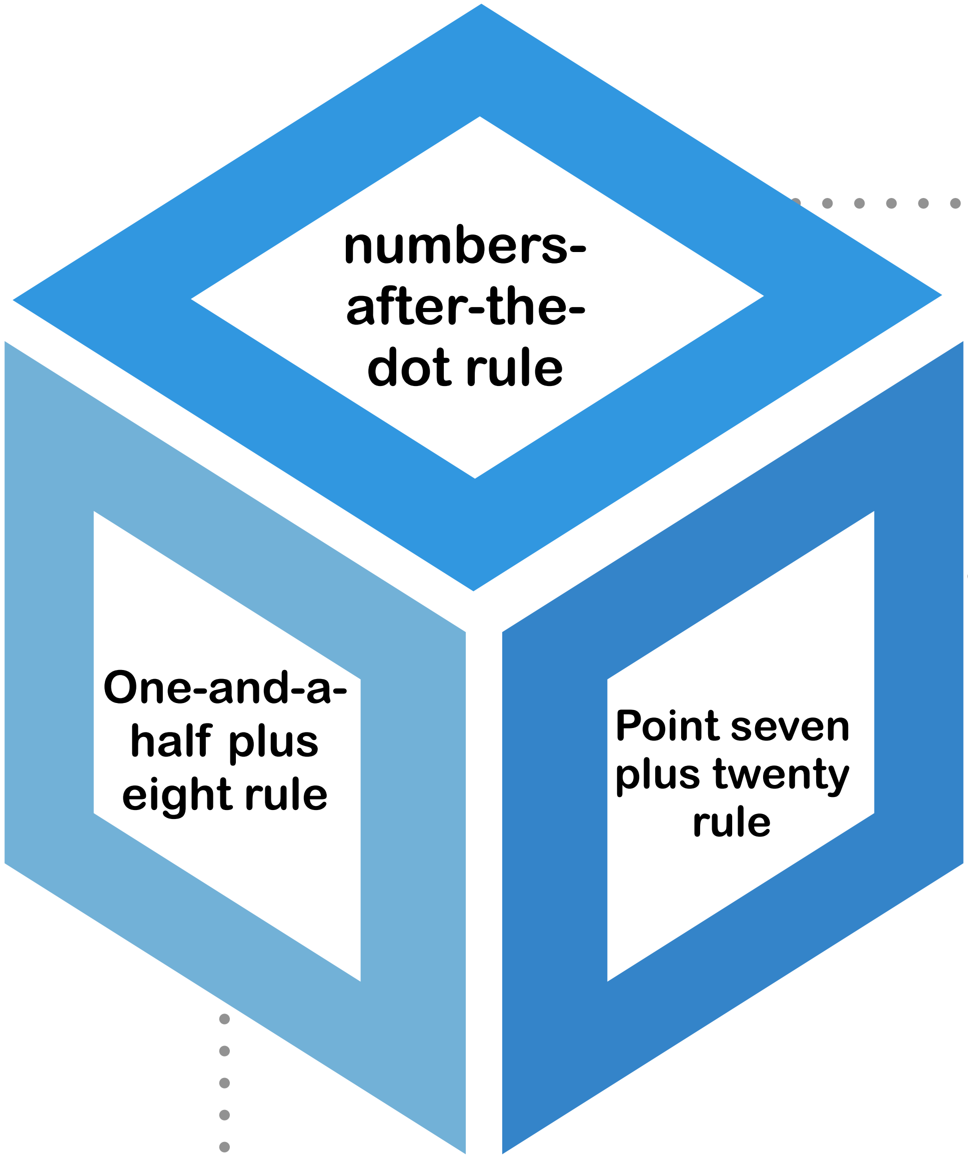
ACID BASE CHEATS



ANY METABOLIC DISORDER

expected CO_2 = digits after the pH decimal point

only works where there is a single process

METABOLIC ALKALOSIS

expected CO_2 = 0.7 x [HCO_3] + 20

METABOLIC ACIDOSIS

expected CO_2 = 1.5 x [HCO_3] + 8

If the pH is normal, there must be

- 2 or more problems *(mixed picture)*
- no problem *(never in the exam)*
- pregnant patient *(compensated respiratory alkalosis)*

THE 3 ACIDOSIS EXAM RULES

ANION GAP → DELTA RATIO → OSMOLAR GAP

Rule 1

If you see a metabolic acidosis, you **must** calculate the **anion gap**

$$\text{ANION GAP} = [Na]-[HCO_3]-[Cl]$$

Normal 12 (range 6-15)
Albumin correction = AG +¼(44-albumin)

Rule 2

If the anion gap is elevated, you should calculate the **delta ratio**

$$\text{DELTA RATIO} = \frac{\uparrow \text{ in AG}}{\downarrow \text{ in } [HCO_3]}$$

$$\text{DELTA RATIO} = \frac{\text{AG} - 12}{24 - [HCO_3]}$$

<0.8 = combined HAGMA & NAGMA
1-2 = uncomplicated HAGMA
>2 = pre-existing metabolic alkalosis

Rule 3

If you see a measured osmolality, you **must** calculate the **osmolar gap**

$$\text{OSMOLAR GAP} = \text{osmolality} - \text{osmolarity}$$

osmolality is *measured*
osmolarity is *calculated*
calc osmolarity =
2[Na]+urea+glucose

ANION GAP

ANION GAP $= [Na]-[HCO_3]-[Cl]$

HAGMA

>12

LACTATE	
TOXINS	ethanol, methanol, ethylene glycol mannitol, salicylates
KETONES	diabetic, alcoholic or starvation ketoacidosis
RENAL	

LTKR: 'Left Total Knee Replacement'

NAGMA

USED CRAP

8-12

- **U**reterostomy
- **S**mall bowel fistula
- **E**xtra chloride
- **D**iarrhoea
- **C**arbonic anhydrase inhibitors
- **R**enal tubular acidosis
- **A**ddison's disease
- **P**ancreatic duodenal fistula

LAGMA

⬇unmeasured anions	albumin, dilution
⬆unmeasured cations	multiple myeloma, lithium OD, ⬆[Ca] or [Mg]
analytical error	⬆[Na], viscosity or lipids

<8

OSMOLAR GAP

OSMOLAR GAP = osmolality - osmolarity

RAISED

>10

MIME ELK

- **M**ethanol/mannitol
- **I**sopropyl alcohol
- **M**ethylene glycol
- **E**thanol
- **E**thylene glycol
- **L**actate
- **K**etones

NORMAL

- **P**yroglutamic acid
- **S**alicylates

0-10

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Maintenance of Alkalosis:
Volume depletion
Chloride depletion
Potassium depletion
Low GFR

METABOLIC ALKALOSIS

- Vomiting
- Diuretic use
- Steroids
- Post hypercapnoea

RESPIRATORY ALKALOSIS

ALWAYS
Hyperventilation

RESPIRATORY ACIDOSIS

- Hypoventilation
- ⬆ CO_2 production (MH)
- ⬆ inspired CO_2 (rebreathing)

PATTERN RECOGNITION & SPOT DIAGNOSIS

If this is in the stem, then think...

- Urinary pH = RTA
- Polyuria post TBI = mannitol
- 'Young female' = pregnancy
- High glucose = DKA, HHS
- Fluclox/paracetamol with renal/hepatic impairment = pyroglutamic acidosis
- High cholesterol = myxoedema coma
- Osmolality = toxic alcohols

A-a GRADIENT

$= PAO_2 - PaO_2$

= alveolar (calc) - arterial (measured)

Normal A-a gradient <15 mmHg

⬆ 1-2 mmHg with each decade

⬆ 5-7 mmHg for every 10% ⬆ FiO_2

Beware the effects of altitude

Hypoventilation does NOT ⬆ A-a gradient

Wherever an FiO_2 is given, you MUST calculate the A-a gradient

$$PAO_2 = FiO_2(P_B - P_{H2O}) - (PaCO_2/RQ)$$

P_B is barometric pressure
P_{H2O} is pressure due to water vapour
RQ is respiratory quotient

Breathing room air at sea level:
$PAO_2 = 0.21x(760-47) - (40/0.8)$
$= 150-100$
$=100$ mmHg

Shortcut:
$PAO_2 \approx FiO_2 \times 500$

CAUSES OF HYPOXIA with a...

Normal A-a (<15)
- Alveolar hypoventilation
- Low PiO_2
  - FiO_2 <0.21
  - P_B <760 mmHg

Raised A-a (≥15)
- V/Q mismatch
- R➡L shunt (intrapulmonary or cardiac)
- Diffusion defect

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