Problem #1 Explanation:

pH 7.56, PaCO2 20, HCO3 20, PaO2 88

Steps to Interpretation

Step 1. Check pH – is it *Acidemia* or *Alkalemia*?
Answer: Alkalemia
Reasoning: Normal pH range is 7.35-7.45
Greater than 7.45 = alkalemia

Step 2. Check PaCO2 – is *Respiratory* the primary cause?
Answer: Yes
Reasoning: Normal PaCO2 = 35-45 mmHg.
PaCO2 is < 35 (abnormal)
If PaCO2 is abnormal and goes in the *opposite direction* of pH, then it is a *respiratory* cause.
Again think of CO2 as an acid
(↓ **CO2** + H2O → ↓ **H+** + ↓ HCO3) = ↑ **pH**

$$\frac{HCO_3}{\downarrow PaCO_2} = \uparrow pH$$

Step 3. Check HCO3 – is *Metabolic* the primary cause?
Answer: No
Reasoning: Normal HCO3 = 22-26 mEq/L
HCO3 is 20 and outside of normal range.

Although HCO3 is abnormal, it is going in the opposite direction of pH (↓HCO3; ↑ pH)
If HCO3 is abnormal and goes in the *same direction* as pH, then it is a *metabolic* cause.
(↑ HCO3 → ↑ pH; ↓ HCO3 → ↓ pH)

Step 4. Is the body compensating?
Answer: Perhaps.
Calculation in Step 6 is required to determine if the change in HCO3 is due to hydrolysis or compensation.
Reasoning: HCO3 is less than normal, so either the kidney is compensating (lowering HCO3 in order to lower pH) or it is due to the hydrolysis reaction.

Step 5: Determine the Technical Classification
Reasoning: ↑ pH, ↓ PaCO2, ↓ HCO3
Answer:
Technical classification is a *partially compensated respiratory alkalosis* (see page 14 of Oakes' ABG Pocket Guide)
Functional classification is a *chronic respiratory alkalosis* (see page 16 of Oakes' ABG Pocket Guide).

Calculations are required to confirm this classification.

Step 6. Determine if Compensation is Appropriate or are there other Primary Causes

Respiratory is the primary cause:

PaCO2 and pH Relationship:

PaCO2 has ↓ 20 mmHg, pH has ↑ 0.16.

This is consistent with an acute change due to hydrolysis (every ↓ 10 mmHg PaCO2 → ↑ 0.08 pH) (therefore, 2 x 0.08 = 0.16) (7.40 + 0.16 = 7.56)

PaCO2 and HCO3 Relationship:
PaCO2 has ↓ 20mmHg, HCO3 has ↓ 4 mEq
This is consistent with an acute change due to hydrolysis (every ↓ 10 mmHg PaCO2 → ↓ 2 mEq HCO3) (therefore, 2 x 2 = 4) (24 – 4 = 20)
This is not considered compensation.

Answer: Where the decrease in HCO3 is due to hydrolysis, and not compensation by the kidneys, the ABG is consistent with acute (uncompensated) respiratory alkalosis (and not partially compensated respiratory alkalosis).
There is no evidence of other primary causes (more on this later).

Steps 7 - 10
These will be considered later as we move on past the introductory basics.

Step 11. Final Interpretation
Acute (Uncompensated) Respiratory Alkalosis

Summary: As mentioned above, calculations are always required to confirm whether the Technical Classification is the same as the Final Interpretation. Here is an instance where the Technical Classification differs from the Final Interpretation.

Without calculating for hydrolysis, reliance on only a Technical Classification (and/or the Functional Classification) in this situation, would lead one to erroneously conclude that the kidney is partly compensating, when it is not and that this is chronic, when it is acute.

Note: Technical Classification is taught (and needed) as an organizational starting point and Functional Classification is the common terminology used for Technical Classification, especially among physicians.

REMEMBER: CLASSIFICATION DOES NOT ALWAYS EQUAL INTERPRETATION!

Explanation to Problem # 2:

A 16 y/o male presents to the ER, obtunded, and rapid, shallow breathing, with progressive weakness over the last month.

pH 6.98, PaCO2 40, HCO3 7, PaO2 48

Step 1.
Acidemia

Step 2.
Respiratory is not a primary cause

Step 3.
Metabolic is the primary cause

Step 4.
Is the body compensating? No

Step 5: Classification
Technical classification is *uncompensated metabolic acidosis*
Functional classification is *metabolic acidosis*

Step 6. Is Compensation Appropriate or other Primary Causes ?

Baseline	Disorder #1	Disorder #2
pH 7.40	7.14	6.98
PaCO2 40	↑ 20	→ 40 ↑
HCO3 24	→ 7 →↑↑	

Disorder #:

1. **HCO3 decreases to 7**

pH will go to 7.14 (24 – 7 = 17; 17 x 0.015 = 0.26; 7.40 - .26 = 7.14) and PaCO2 will decrease to 20 (17 x 1.2 = 20; 40 – 20 = 20). The expected PaCO2 compensation should be 20.

The difference between the expected 20 and the actual 40 indicates the respiratory system is not able to keep up the compensation and is now actually contributing to a respiratory acidosis. (A normal PaCO2 is not normal in this situation!). The patient's physical assessment of rapid, shallow breathing with progressive weakness is consistent with this result.
Also, one must remember, that an uncompensated metabolic acidosis almost never exist.

2. Based upon the patient's condition, one might surmise an acute rise of PaCO2 from 20 to 40, due to the inability to sustain hyperventilation for a month.

The pH would drop from the expected 7.14 (due to the metabolic cause) to the 6.98, due to the respiratory failure (40 – 20 = 20; 2 x 0.08 = 0.16; 7.14 – 0.16 = 6.98).

Therefore, the blood gas represents a ***mixed metabolic acidosis and a respiratory acidosis.***
This confirms that the disorder has two primary causes and that the Technical Classification is incorrect. The metabolic acidosis is not only uncompensated, the respiratory system is failing and actually adding to the problem.

Initial classification indicates NO respiratory problem, yet final interpretation is indicative of ventilator failure!
Again, a huge difference in diagnosis and management!

Steps 7 - 10
These will be considered later as we move on past the introductory basics.

Step 11. Final Interpretation
Mixed Metabolic Acidosis and Respiratory Acidosis

Answer to Problem # 3:

A 25 y/o patient presents in the ER with a history of sickle cell anemia, cirrhosis of the liver, and vomiting for the past 3 days.

pH 7.55, PaCO2 66, HCO3 56, PaO2 53, Na^+ 166, Cl^- 90

Technical Classification: Partially Compensated Metabolic Alkalosis
Final Interpretation: Metabolic Alkalosis, with Anion Gap Metabolic Acidosis, and Respiratory Acidosis, with moderate hypoxemia

This is another example of how an "*Interpretation*" is different than a "*Classification*".

Oakes' ABG Pocket Guide shows how to easily elucidate Triple Disorders !

Oakes' ABG Instructional Guide walks you through 50 problems, step by step, from how to do single, then double, then triple disorders, including simplifying Anion Gaps and Bicarbonate Gaps.

The Importance of Patient Assessment
The ABG appears consistent with the patient's clinical picture.
This patient has sickle cell anemia with hypoxemia potentially causing lactic acidosis (an anion gap metabolic acidosis) and severe prolonged vomiting likely causing a metabolic alkalosis.
(***Oakes' ABG Pocket and Instructional Guides*** make determining anion and bicarbonate gaps very easy).

Calculations actually elucidate the fact that the pH is much lower than expected from the HCO3 (indicative of the metabolic acidosis) and that the respiratory system is "over-compensating" - which the body does not do - and is therefore indicative of a secondary respiratory disorder.

The purpose, therefore, of determining compensation is to elucidate other primary causes and confirm the fact that what appears to be, in this case a simple metabolic alkalosis, is an oversimplification of a much more complicated situation.

This also leads us to understanding the importance of knowing the patient's diagnoses and interpreting ABGs in light of the patient's condition(s).
ABGs should never be interpreted alone in real clinical situations.

Answer to Problem # 4:

The patient is a chronic, COPD patient in acute exacerbation due to a bout of pneumonia.

pH 7.46, PaCO2 40, HCO3 31, PaO2 58

Technical Classification: M*etabolic alkalosis (uncompensated)*
Actual Interpretation: Acute Respiratory Alkalosis superimposed on a Chronic Respiratory Acidosis

Final Interpretation is quite a bit different from basic classification.

Oakes' ABG Study Guide explains how to determine abnormal baselines and calculate changes from these baselines.

Answer to Problem # 5:

A CHF patient on a ventilator, who is receiving diuretic therapy.

pH 7. 59, PaCO2 25, HCO3 24, PaO2 95, Na^+ 148, Cl^- 95

Technical Classification: Uncompensated Respiratory Alkalosis

Final Interpretation: Respiratory Alkalosis, Anion Gap Metabolic Acidosis and Metabolic Alkalosis

Compensation calculations reveal a secondary metabolic alkalosis and an anion gap metabolic acidosis. (All of which is very easily accomplished with ***Oakes' Guides***)

Final Note:

Any ABG sample could be the result of ANY combination of acid-base disorders. The more information we have about a patient the more likely we can narrow it down as to how the ABG result "fits" with the patient's condition.
With that being said, although the previous were not definitive answers, they are the most likely answers based on the information available.

All these problems in the ABG Challenge are included in ***Oakes' ABG Instructional Guide*** (free within this website) to show how the answers were derived. The ***ABG Instructional Guide*** begins with the basics and step-by-step advances to more complex double and triple disorders. Over 50 sample problems are discussed in detail in the ***Guide.***

The vast majority of Respiratory Therapists and other health care workers learn to classify ABGs. Classification is only the first step.

Proper and complete interpretation requires compensation calculations, as well as the determination of electrolyte gaps.

What happens when we simply classify an ABG? Often a simple classification of an ABG is an incomplete and/or incorrect diagnosis of what is really going on in the body.

This, in turn, can lead to different and perhaps inappropriate management of the patient.

Oakes' ABG Pocket Guide with accompanying ***Oakes' ABG Instructional Guide*** will show how to easily and simply *interpret* ABGs to elucidate potential complex bodily disorders, which in turn should lead to improved patient management.

We believe you will find the books one of the greatest investments of your career.

Thank you so much for taking the time and effort to take this test