1) C

The alveolar gas equation is expressed as: \( PAO_2 = FIO_2(P_B - P_{H2O}) - PaCO_2/RQ \)

\( FIO_2 \): Fraction inspired oxygen, \( P_B \): atmospheric barometric pressure at sea level (760 mmHg), \( P_{H2O} \): barometric pressure of water (47 mmHg), \( PaCO_2 \): partial pressure of arterial carbon dioxide, \( RQ \): respiratory quotient (0.8)

2) C

Using the above equation, the \( PAO_2 \) with \( FiO2 \) 0.21 at sea level is 101 mmHg, assuming normal A-a gradient of 10, the expected \( PaO2 \) is about 90

Estimated A-a gradient = 2.5 X (0.25 X Age)

3) D

Using the above equation, the \( PAO2 = 650 \) mmHg, the \( PaO2 \) is 450 mmHg, so difference is very wide of 200 mmHg indicating abnormal physiology.

4) D

As the \( PaCO2 \) decrease, the \( PAO_2 \) will increase and vice versa

\[ \frac{50}{0.8} - \frac{30}{0.8} = 25 \text{ mmHg} \]

5) D

According to the PCO$_2$ equation, \( PaCO_2 = VCO_2 \times 0.863 / Valv \)

\[ = 268 \times 0.863 / 3.9 \]

\[ = 59.3 \]

6) B

According to the Bohr’s equation. The dead space \( VD \)

\[ \frac{V_d}{V_t} = \frac{P_a CO_2 - P_e CO_2}{P_a CO_2} \]

\[ VD = 500 \times (50-40) / 50 \]
7) B

According to the Winter’s formula: the expected PaCO$_2$ = 1.5 X (HCO$_3$) + 8 ± 2
= 21 -25

The measured PaCO$_2$ is higher than expected and thus pointing to hypoventilation (respiratory acidosis), if number is less than 21 then hyperventilation (respiratory alkalosis).

8) B

The oxygen content formula: $\text{CaO}_2 = (1.34 \times \text{Hgb} \times \text{SaO}_2) + (0.003 \times \text{PaO}_2)$

9) B

**Oxygen delivery:** $\text{DO}_2 = \text{CO} \times \text{CaO}_2$

$\quad = 2.5 \times 11.5$
$\quad = 278 \text{ ml/min}$

10) C

**Mechanical power of ventilator** = VE X (Peak pressure + PEEP + Flow/6) / 20

VE: minute ventilation

$\quad = 9 \times (30 + 8 + 8.3) / 20$
$\quad = 20.83$

Mechanical power is highly related to VILI (Ventilator Induced Lung Injury)