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Are you ready to learn about the Respiratory Therapy Formulas, Calculations, and Equations? I sure hope so because that is what this guide is all about.

Inside of this book, we’ve created an all-in-one stop that you can use as a reference for each and every formula that you’ll see as a Respiratory Therapy Student.

Some are hard. Some are easy.

But the good news is, I have faith that you can master them all if you set your mind to it. Practice (and lots of repetitions) makes perfect. So the more time you spend going through these formulas, the more likely it is that you’ll actually learn and memorize this information.

And as you’ll see, we’ve even included some practice questions that can provide additional help as well.

So if you’re ready, let’s go ahead and dive right in. 😊

**Note:** In general, the formulas and calculations may vary from publication to publication. With that said, we’ve attempted to provide the ones that will be most helpful for the Respiratory Therapy Board Exams.
First and foremost, before we get into the calculations, let’s first learn the formulas. These are the formulas and equations that you will be required to learn in Respiratory Therapy School.

**Minute Ventilation (Ve)**
\[ V_e = \text{Respiratory Rate} \times \text{Tidal Volume} \]

**Alveolar Minute Ventilation (VA)**
\[ V_a = (\text{Tidal Volume} - \text{Deadspace}) \times \text{Respiratory Rate} \]

**Airway Resistance (Raw)**
\[ \text{Raw} = (\text{PIP} - \text{Plateau pressure}) / \text{Flow} \]

**Mean Airway Pressure (Paw)**
\[ \text{Paw} = ((\text{Inspiratory Time} \times \text{Frequency}) / 60) \times (\text{PIP} - \text{PEEP}) + \text{PEEP} \]

**Work of Breathing (WOB)**
\[ \text{WOB} = \text{Change in Pressure} \times \text{Change in Volume} \]

**Alveolar-Arterial Oxygen Tension Gradient (P(A-a)O2)**
\[ \text{P}(\text{A-a})\text{O}_2 = \text{PAO}_2 - \text{PaO}_2 \]

**Alveolar Oxygen Tension (PAO2)**
\[ \text{PAO}_2 = (\text{P}_B - \text{P}_{H2O}) \times \text{FiO}_2 - (\text{PaCO}_2 / 0.8) \]

**Arterial/Alveolar Oxygen Tension (a/A) Ratio**
\[ \text{(a/A) Ratio} = \text{PaO}_2/\text{PAO}_2 \]

**Arterial Oxygen Content (CaO2)**
\[ \text{CaO}_2 = (\text{Hb} \times 1.34 \times \text{SaO}_2) + (\text{PaO}_2 \times 0.003) \]

**End-Capillary Oxygen Content (CcO2)**
CcO₂ = (Hb x 1.34 x SaO₂) + (PAO₂ x 0.003)

**Mixed Venous Oxygen Content (CvO₂)**
CvO₂ = (Hb x 1.34 x SvO₂) + (PvO₂ x 0.003)

**Shunt Equation (Qₛ/Qₜ)**
Qₛ/Qₜ = (CcO₂ – CaO₂) / (CcO₂ – CvO₂)

**Modified Shunt Equation (Qₛ/Qₜ)**
Qₛ/Qₜ = ((PAO₂ – PaO₂) x 0.003) / ((CaO₂ – CvO₂) + (PAO₂ – PaO₂) x 0.003)

**Arterial-Mixed Venous Oxygen Content Difference (C(a-v)O₂)**
C(a-v)O₂ = CaO₂ – CvO₂

**Oxygen-to-Air Entrainment Ratio (O₂:Air)**
O₂:Air = 1 : (100 – FiO₂) / (FiO₂ – 2)

**Arterial Oxygen Saturation Estimation (SaO₂)**
SaO₂ = PaO₂ + 30

**PaO₂/FiO₂ Ratio (P/F Ratio)**
P/F Ratio = PaO₂ / FiO₂

**Oxygenation Index (OI)**
OI = ((Paw x FiO₂) / PaO₂) x 100

**Oxygen Consumption (VO₂)**
VO₂ = Cardiac Output x C(a-v)O₂

**Oxygen Extraction Ratio (O₂ER)**
O₂ER = (CaO₂ – CvO₂) / CaO₂

**FiO₂ Estimation for Nasal Cannula**
FiO₂ = 20 + (4 x Liter Flow)
**Oxygen Cylinder Duration**
Duration = (Gauge Pressure x Tank Factor) / Liter Flow

**Liquid Oxygen System Duration**
Duration = (344 x Liquid Weight) / Flow

**Cardiac Index (CI)**
CI = Cardiac Output / Body Surface Area

**Cardiac Output (Qt)**
Qt = Heart Rate x Stroke Volume

**Cardiac Output (CO) Fick's Method**
CO = (O₂ Consumption / CaO₂ – CvO₂)

**Cerebral Perfusion Pressure (CPP)**
CPP = Mean Arterial Pressure – Intracranial Pressure

**Mean Arterial Pressure (MAP)**
MAP = (Systolic BP + (2 x Diastolic BP)) / 3

**Stroke Volume (SV)**
SV = Cardiac Output / Heart Rate

**Maximum Heart Rate (HRₘₐₓ)**
HRₘₐₓ = 220 – Age

**Heart Rate on an EKG Strip (HR)**
HR = 300 / # of large boxes between R waves

**Respiratory Quotient (RQ)**
RQ = VCO₂ / VO₂

**Systemic Vascular Resistance (SVR)**
SVR = (MAP – CVP) x (80 / Cardiac Output)
Pulmonary Vascular Resistance (PVR)

\[ \text{PVR} = (\text{MPAP} - \text{PCWP}) \times (80 / \text{Cardiac Output}) \]

Static Compliance (C_{st})

\[ C_{st} = \text{Tidal Volume} / (\text{Plateau Pressure} - \text{PEEP}) \]

Dynamic Compliance (C_{dyn})

\[ C_{dyn} = \text{Tidal Volume} / (\text{Peak Pressure} - \text{PEEP}) \]

Deadspace to Tidal Volume Ratio (V_D/V_T)

\[ (V_D/V_T) = (\text{Paco}_2 - \text{PECO}_2) / \text{PaCO}_2 \]

Children Dosage Estimation

Child Dose = \((\text{Age} / \text{Age} + 12) \times \text{Adult Dose})

Infant Dosage Estimation

Infant Dose = \((\text{Age in Months} / 150) \times \text{Adult Dose})

Anion Gap

Anion gap = Na\(^+\) – (Cl\(^-\) + HCO3\(^-\))

Body Surface Area (BSA)

\[ \text{BSA} = (((4 \times \text{Body Weight}) + 7) / (\text{Body Weight} + 90) \]

Elastance

Elastance = Change in Pressure / Change in Volume

Smoking Use Calculation (Pack Years)

Pack Years = (\text{ Packs Smoked per Day}) \times (\text{Number of Years Smoked})

Suction Catheter Size Estimation

Catheter Size = (\text{ Internal Diameter} / 2) \times 3

Endotracheal Tube Size Estimation in Children

Tube Size = (\text{ Age} + 16) / 4
Boyle's Law
\[ P_1 \times V_1 = P_2 \times V_2 \]

Charles' Law
\[ \frac{V_1}{T_1} = \frac{V_2}{T_2} \]

Gay-Lussac's Law
\[ \frac{P_1}{T_1} = \frac{P_2}{T_2} \]

LaPlace's Law
\[ P = \left(2 \times \text{Surface Tension}\right) / \text{Radius} \]

Celsius to Fahrenheit Temperature Conversion
\[ ^\circ F = \left(^\circ C \times 1.8\right) + 32 \]

Fahrenheit Celsius Temperature Conversion
\[ ^\circ C = \left(^\circ F - 32\right) \times 1.8 \]

Celsius to Kelvins Temperature Conversion
\[ K = ^\circ C + 273 \]

Helium/Oxygen Conversion (He/O\(_2\))
Actual Flow = Given Flow Rate x Factor

Total Lung Capacity (TLC)
\[ \text{TLC} = \text{IRV} + V_T + \text{ERV} + \text{RV} \]
\[ \text{TLC} = \text{VC} + \text{RV} \]
\[ \text{TLC} = \text{IC} + \text{FRC} \]

Vital Capacity (VC)
\[ \text{VC} = \text{IRV} + V_T + \text{ERV} \]
\[ \text{VC} = \text{IC} + \text{ERV} \]
\[ \text{VC} = \text{TLC} - \text{RV} \]

Inspiratory Capacity (IC)
IC = IRV + $V_T$
IC = TLC – FRC
IC = VC – ERV

Functional Residual Capacity (FRC)
FRC = ERV + RV
FRC = TLC – IC

Time Constant (t)
t = Compliance x Resistance

Ideal Body Weight (IBW)
IBW = 50 kg + (2 x Number of Inches over 5 feet)

Tidal Volume ($V_T$)
$V_T$ = Flow Rate x Inspiratory Time

Exhaled Tidal Volume ($V_T$)
$V_T$ = Minute Ventilation / Frequency

Corrected Tidal Volume ($V_T$)
$V_T$ = Expired Tidal Volume – Tube Volume

Pressure Support Ventilator Setting (PSV)
PSV = ((Peak Pressure – Plateau Pressure) / Set Flow) x Peak Flow

Rapid Shallow Breathing Index (RSBI)
RSBI = Rate / Tidal Volume

Endotracheal Tube Size Estimation in Children
Tube Size = (Age + 16) / 4

Minimum Flow Rate in Mechanical Ventilation
Flow Rate = Minute Ventilation x I:E Ratio Sum of Parts
Now that you know the formulas, that means it's time for us to put them to use. In this section, we're going to walk you through an example problem for each of the equations that you need to know as a Respiratory Therapy Student.

For these practice problems, as long as you know the formula, the math is very simple. All you have to do is just plug the numbers in.

So if you’re ready, let’s go ahead and get started.😊
Minute Ventilation ($V_E$)

A patient has the following bedside spirometry results:

- Respiratory Rate = 12
- Tidal volume = 450 mL
- Dead Space = 147 mL
- Vital Capacity = 1.2 L

Based on this data, what is the patient’s minute ventilation?

**Formula:**

$$V_E = \text{Respiratory Rate} \times \text{Tidal Volume}$$

$$V_E = 12 \times 450$$

$$V_E = 5,400 \text{ mL/min}$$

Divide by 1,000 to convert mL to L.

$$V_E = 5.4 \text{ L/min}$$
Alveolar Minute Ventilation ($V_A$)

A patient has the following bedside spirometry results:

- Rate = 12
- Tidal Volume = 450 mL
- Dead Space = 147 mL
- Vital Capacity = 1.2 L

Based on this data, what is the patient’s minute ventilation?

**Formula:**

\[ V_A = (\text{Tidal Volume} - \text{Deadspace}) \times \text{Respiratory Rate} \]

\[ V_A = (450 - 147) \times 12 \]

\[ V_A = 3,636 \text{ mL/min} \]

Divide by 1,000 to convert mL to L.

\[ V_A = 3.6 \text{ L/min} \]
Airway Resistance (Raw)

An adult patient that is receiving mechanical ventilation has a PIP of 30 cm H2O and a plateau pressure of 10 cm H2O with a set flow rate of 60 L/min. What is the airway resistance?

**Formula:**

\[ \text{Raw} = \frac{(\text{PIP} - \text{Plateau pressure})}{\text{Flow}} \]

\[ \text{Raw} = \frac{(30 - 10)}{1} \]

\[ \text{Raw} = 20 \text{ cm H2O/L/sec} \]
Mean Airway Pressure (Paw)

The following data was obtained on a 63-year-old female patient who is receiving ventilatory support:

- Rate = 12/min
- Tidal Volume = 450 mL
- Inspiratory Time = 1.3 seconds
- PIP = 25
- PEEP = 5

Calculate the mean airway pressure:

**Formula:**

\[ \text{Paw} = \left( \frac{\text{Inspiratory Time} \times \text{Frequency}}{60} \right) \times (\text{PIP} - \text{PEEP}) + \text{PEEP} \]

\[ \text{Paw} = \left( \frac{1.3 \times 12}{60} \right) \times (25 - 5) + 5 \]

\[ \text{Paw} = \left( \frac{15.6}{60} \right) \times (25 - 5) + 5 \]

\[ \text{Paw} = 0.26 \times (25 - 5) + 5 \]

\[ \text{Paw} = 5.2 + 5 \]

\[ \text{Paw} = 10.2 \text{ cmH2O} \]
Work of Breathing (WOB)

An adult patient is intubated and receiving mechanical ventilation. Given the following data, calculate the work of breathing:

- $\Delta P = 6.9 \text{ cmH}_2\text{O}$
- $\Delta V = 0.8 \text{ L}$

**Formula:**

$\text{WOB} = \text{Change in Pressure} \times \text{Change in Volume}$

$\text{WOB} = 6.9 \times 0.8$

$\text{WOB} = 5.5 \text{ cmH}_2\text{O/L}$
Alveolar-Arterial Oxygen Tension Gradient (P(A-a)O₂)

The following data was obtained on an adult patient:

- PaO₂ = 87 mmHg
- PAO₂ = 107 mmHg

What is the alveolar-arterial oxygen tension gradient?

**Formula:**

\[ P(A-a)O_2 = PAO_2 - PaO_2 \]

\[ P(A-a)O_2 = 107 - 87 \]

\[ P(A-a)O_2 = 20 \text{ mmHg} \]
Alveolar Oxygen Tension (PAO$_2$)

The following data was obtained on an adult patient:

- FiO$_2$ = 50%
- PaCO$_2$ = 35 mmHg
- $P_B$ = 760 mmHg
- $P_{H2O}$ = 47 mmHg

What is the PAO$_2$?

**Formula:**

$$PAO_2 = (P_B - P_{H2O}) \times FiO_2 - \left(\frac{PaCO_2}{0.8}\right)$$

$$PAO_2 = (760 - 47) \times 0.40 - \left(\frac{35}{0.8}\right)$$

$$PAO_2 = (713 \times 0.40) - 43.75$$

$$PAO_2 = 241.5 \text{ mmHg}$$
Arterial/Alveolar Oxygen Tension (a/A) Ratio

A patient has a PaO₂ of 108 mmHg and a PAO₂ of 300 mmHg. What is the arterial/alveolar oxygen tension ratio?

Formula:
(a/A) Ratio = PaO₂ / PAO₂

(a/A) Ratio = 108 / 300

(a/A) Ratio = 0.36 mmHg

(a/A) Ratio = 35%
Arterial Oxygen Content (CaO₂)

An adult patient has a PaO₂ of 95 mmHg, an oxygen saturation of 96%, and a hemoglobin of 13 g/dL. What is the arterial oxygen content?

**Formula:**

\[ \text{CaO}_2 = (\text{Hb} \times 1.34 \times \text{SaO}_2) + (\text{PaO}_2 \times 0.003) \]

\[
\text{CaO}_2 = (13 \times 1.34 \times 0.96) + (95 \times 0.003)
\]

\[
\text{CaO}_2 = 16.72 + 0.285
\]

\[
\text{CaO}_2 = 17 \text{ vol%}
\]
End-Capillary Oxygen Content (CcO₂)

An adult patient has a PAO₂ of 88 mm Hg, an oxygen saturation of 94%, and a hemoglobin of 16 g/dL. What is the end-capillary oxygen content?

**Formula:**

\[ CcO₂ = (Hb \times 1.34 \times SaO₂) + (PAO₂ \times 0.003) \]

\[ CcO₂ = (16 \times 1.34 \times 0.94) + (88 \times 0.003) \]

\[ CcO₂ = 20.15 + 0.264 \]

\[ CcO₂ = 20.4 \text{ vol}% \]
Mixed Venous Oxygen Content (CvO₂)

An adult patient has a PvO₂ of 38 mm Hg, a mixed venous saturation of 74%, and a hemoglobin of 14 g/dL. What is the mixed venous oxygen content?

**Formula:**

\[
\text{CvO}_2 = (\text{Hb} \times 1.34 \times \text{SvO}_2) + (\text{PvO}_2 \times 0.003)
\]

\[
\text{CvO}_2 = (14 \times 1.34 \times 0.74) + (38 \times 0.003)
\]

\[
\text{CvO}_2 = 13.88 + 0.114
\]

\[
\text{CvO}_2 = 14 \text{ vol}\
\]
Shunt Equation \((Q_S/Q_T)\)

The following data was provided for an adult patient:

- \(C_{cO_2} = 20.8 \text{ vol}\%\)
- \(C_{aO_2} = 19.3 \text{ vol}\%\)
- \(C_{vO_2} = 13.9 \text{ vol}\%\)

Calculate the physiologic shunt percentage for this patient.

**Formula:**

\[
Q_S/Q_T = \frac{(C_{cO_2} - C_{aO_2})}{(C_{cO_2} - C_{vO_2})}
\]

\[
Q_S/Q_T = \frac{(20.8 - 19.3)}{(20.8 - 13.9)}
\]

\[
Q_S/Q_T = 1.5 / 6.9
\]

\[
Q_S/Q_T = 0.22
\]

Multiply by 100 to convert to a percentage.

\[
Q_S/Q_T = 22 \%
\]
Modified Shunt Equation ($Q_s/Q_T$)

The following data was provided for an adult patient:

- $\text{PaO}_2 = 155 \text{ mmHg}$
- $\text{PAO}_2 = 650 \text{ mmHg}$
- $\text{CaO}_2 = 19.9 \text{ vol%}$
- $\text{CvO}_2 = 13.2 \text{ vol%}$

Calculate the shunt percentage for this patient.

**Formula:**

$$Q_s/Q_T = \frac{((\text{PAO}_2 - \text{PaO}_2) \times 0.003)}{((\text{CaO}_2 - \text{CvO}_2) + (\text{PAO}_2 - \text{PaO}_2) \times 0.003)}$$

$$Q_s/Q_T = \frac{((650 - 155) \times 0.003)}{((19.9 - 13.2) + (650 - 155) \times 0.003)}$$

$$Q_s/Q_T = 1.49 / 6.7 + 495 \times 0.003$$

$$Q_s/Q_T = 1.49 / 8.19$$

$$Q_s/Q_T = 0.18$$

Multiply by 100 to convert to a percentage.

$$Q_s/Q_T = 18\%$$
Arterial-Mixed Venous Oxygen Content Difference \((C(a-v)O_2)\)

An adult patient in the ICU has a \(CaO_2\) of 19.2 vol% and a \(CvO_2\) of 14.7 vol%. Calculate the Arterial-Mixed Venous Oxygen Content Difference:

**Formula:**
\[
C(a-v)O_2 = CaO_2 - CvO_2
\]

\[
C(a-v)O_2 = 19.2 - 14.7
\]

\[
C(a-v)O_2 = 4.5 \text{ vol%}
\]
Oxygen-to-Air Entrainment Ratio ($O_2$:Air)

What is the air-to-oxygen entrainment ratio of 60%?

Formula:

$O_2$:Air = $1 : (100 - FiO_2) / (FiO_2 - 2)$

$O_2$:Air = $1 : (100 - 60) / (60 - 2)$

$O_2$:Air = $1 : (40 / 58)$

$O_2$:Air = $1 : 0.7$
**Arterial Oxygen Saturation Estimation (SaO₂)**

An adult patient has a PaO₂ of 63 mmHg. What is the estimated SaO₂?

**Formula:**
\[
\text{SaO₂} = \text{PaO₂} + 30
\]

Estimated SaO₂ = 63 + 30

Estimated SaO₂ = 93 mmHg
**PaO\(_2\)/FiO\(_2\) Ratio (P/F Ratio)**

An adult patient who is receiving oxygen at an FiO\(_2\) of 40% has a PaO\(_2\) of 88 mmHg. What is the PaO\(_2\)/FiO\(_2\) ratio?

**Formula:**

\[
P/F \text{ Ratio} = \frac{\text{PaO}_2}{\text{FiO}_2}
\]

\[
P/F \text{ Ratio} = \frac{88}{0.4}
\]

\[
P/F \text{ Ratio} = 220 \text{ mmHg}
\]
**Oxygenation Index (OI)**

The following data was obtained on an adult patient:

- \( \text{FiO}_2 = 40\% \)
- \( \text{PaO}_2 = 80 \text{ mmHg} \)
- Mean Airway Pressure = 9.8 cmH2O

What is the oxygenation index?

**Formula:**

\[
\text{OI} = \left( \frac{\text{Paw} \times \text{FiO}_2}{\text{PaO}_2} \right) \times 100
\]

\[
\text{OI} = \left( 9.8 \times 0.4 \right) / 80 \times 100
\]

\[
\text{OI} = \left( 3.92 / 80 \right) \times 100
\]

\[
\text{OI} = 0.049 \times 100
\]

\[
\text{OI} = 4.9
\]
Oxygen Consumption (VO₂)

What is the total oxygen consumption of an adult patient with the following data:

- Cardiac Output = 6.2 L/min
- C(a-v)O₂ = 5 vol%

**Formula:**

\[ VO₂ = \text{Cardiac Output} \times C(a-v)O₂ \]

\[ VO₂ = 6.2 \times 0.05 \]

\[ VO₂ = 0.31 \text{ L/min} \]

Multiply by 1,000 to convert mL to L.

\[ VO₂ = 310 \text{ mL/min} \]
Oxygen Extraction Ratio (O₂ER)

An adult patient has an arterial oxygen content of 18 vol% and a mixed venous oxygen content of 13 vol%. What is the oxygen extraction ratio?

Formula:

\[ \text{O}_2\text{ER} = \frac{(\text{CaO}_2 - \text{CvO}_2)}{\text{CaO}_2} \]

\[ \text{O}_2\text{ER} = \frac{18 - 13}{18} \]

\[ \text{O}_2\text{ER} = 0.2778 \]

\[ \text{O}_2\text{ER} = 27.8 \text{ vol}\% \]
FiO₂ Estimation for Nasal Cannula

An adult patient receiving oxygen therapy via nasal cannula at 4 L/min. What is the estimated FiO₂?

**Formula:**

\[ \text{FiO}_2 = 20 + (4 \times \text{Liter Flow}) \]

\[ \text{FiO}_2 = 20 + (4 \times 4) \]

\[ \text{FiO}_2 = 20 + 16 \]

\[ \text{FiO}_2 = 36\% \]
Oxygen Cylinder Duration

A patient is receiving oxygen via nasal cannula at 2 L/min from a size E tank with 2,200 psig. How long will the tank deliver oxygen?

Everything you need to perform the calculation is given in the question except for the tank factors.

Cylinder Tank Factors:

- D Cylinder = 0.16
- E Cylinder = 0.28
- G Cylinder = 2.41
- H Cylinder = 3.14
- M Cylinder = 1.56

For this question, the patient is using an E cylinder which means that you will use a tank factor of 0.28 for the equation.

Now all you have to do is plug the numbers in.

**Formula:**

\[
\text{Duration} = \frac{(\text{Gauge Pressure} \times \text{Tank Factor})}{\text{Liter Flow}}
\]

\[
\text{Duration} = \frac{(2,200 \times 0.28)}{2}
\]

\[
\text{Duration} = 616 / 2
\]

\[
\text{Duration} = 308 \text{ minutes}
\]

Divide by 60 to convert minutes to hours.

**Duration = 5 hours and 8 minutes**
Liquid Oxygen System Duration

A liquid oxygen system with a weight of 3 lbs is being used and the patient is receiving oxygen via nasal cannula with a flow of 2 L/min. How long will the liquid oxygen system last?

**Formula:**

$$\text{Duration} = \frac{344 \times \text{Liquid Weight}}{\text{Flow}}$$

Duration = (344 x 3) / 2

Duration = 1,032 / 2

Duration = 516 minutes

Divide by 60 to convert minutes to hours.

$$\text{Duration} = 8 \text{ hours and 36 minutes}$$
Cardiac Index (CI)

A 59-year-old female patient has a cardiac output of 5 L/min and a body surface area of 2.7 m². What is the cardiac index?

**Formula:**

\[
\text{CI} = \frac{\text{Cardiac Output}}{\text{Body Surface Area}}
\]

\[
\text{CI} = \frac{5}{2.7}
\]

\[
\text{CI} = 1.85 \text{ L/min/m}^2
\]
Cardiac Output ($Q_T$)

A 57-year-old male patient has a heart rate of 94 beats/min and a stroke volume of 44 mL/beat. What is the cardiac outlook?

**Formula:**

\[ Q_T = \text{Heart Rate} \times \text{Stroke Volume} \]

\[ Q_T = 94 \times 44 \]

\[ Q_T = 4,136 \text{ mL/min} \]

\[ Q_T = 4.1 \text{ L/min} \]
Cardiac Output (CO) Fick’s Method

The following data was obtained on an adult patient:

- Body Surface Area = 1.7 m²
- CaO₂ = 21 vol%
- CvO₂ = 16 vol%

Calculate the cardiac output using Fick’s method:

**Formula:**

\[ CO = \left( \frac{O_2 \text{ Consumption}}{CaO_2 - CvO_2} \right) \]

First, you need to calculate the O₂ Consumption multiply the Body Surface Area by 130.

O₂ Consumption = 130 x 1.7

O₂ Consumption = 221

Now, just plug the rest of the numbers into the formula.

\[ CO = \left( \frac{221}{21 - 16} \right) \]

\[ CO = \left( \frac{221}{0.05} \right) \]

\[ CO = 4,420 \text{ mL/min} \]

Divide by 1,000 to convert mL to L.

\[ CO = 4.42 \text{ L/min} \]
Cerebral Perfusion Pressure (CPP)

An adult patient has an MAP of 88 mmHg and an ICP of 15 mmHg. Calculate the cerebral perfusion pressure:

**Formula:**

\[ \text{CPP} = \text{Mean Arterial Pressure} - \text{Intracranial Pressure} \]

\[ \text{CPP} = 88 \text{ mmHg} - 15 \text{ mmHg} \]

\[ \text{CPP} = 73 \text{ mmHg} \]
Mean Arterial Pressure (MAP)

An adult patient has a blood pressure measurement of 130/90 mmHg. What is the mean arterial pressure?

**Formula:**

\[
\text{MAP} = \frac{(\text{Systolic BP} + (2 \times \text{Diastolic BP}))}{3}
\]

\[
\text{MAP} = \frac{(130 + (2 \times 90))}{3}
\]

\[
\text{MAP} = \frac{310}{3}
\]

\[
\text{MAP} = 103.3 \text{ mmHg}
\]
Stroke Volume (SV)

A 58-year-old female patient has a heart rate of 92/min and a cardiac output of 6 L/min. What is her stroke volume?

**Formula:**

\[ SV = \frac{\text{Cardiac Output}}{\text{Heart Rate}} \]

\[ SV = \frac{6}{92} \]

\[ SV = 0.065 \text{ L} \]

Multiply by 1,000 to convert to mL.

\[ SV = 65 \text{ mL} \]
Maximum Heart Rate ($HR_{\text{max}}$)

What is the maximum heart rate of a 44-year-old female patient?

**Formula:**

$$HR_{\text{max}} = 220 - \text{Age}$$

$HR_{\text{max}} = 220 - 44$

$HR_{\text{max}} = 176 \text{ beats/min}$
Heart Rate on an EKG Strip (HR)

An adult patient has the following EKG strip:

![EKG strip image]

What is the patient's heart rate?

**Formula:**

\[
HR = \frac{300}{\# \text{ of large boxes between R waves}}
\]

There are 3 large boxes between the R waves on the EKG strip.

\[
HR = \frac{300}{3}
\]

HR = 100 beats/min
Systemic Vascular Resistance (SVR)

An adult patient has the following measurements:

- Cardiac Output = 4.0 L/min
- Central Venous Pressure = 9 mmHg
- Mean Arterial Pressure = 75 mmHg

What is the calculated Systemic Vascular Resistance?

**Formula:**

\[ SVR = (\text{MAP} – \text{CVP}) \times \left(\frac{80}{\text{Cardiac Output}}\right) \]

\[ SVR = (75 – 9) \times \left(\frac{80}{4}\right) \]

\[ SVR = 66 \times 20 \]

\[ SVR = 1,320 \text{ dynes/sec/cm}^5 \]
Pulmonary Vascular Resistance (PVR)

An adult patient has the following measurements:

- Cardiac Output = 5.0 L/min
- Mean Pulmonary Artery Pressure = 23 mmHg
- Pulmonary Capillary Wedge Pressure = 7 mmHg

What is the calculated Pulmonary Vascular Resistance?

**Formula:**

\[
PVR = (\text{MPAP} - \text{PCWP}) \times \left(\frac{80}{\text{Cardiac Output}}\right)
\]

\[
PVR = (23 - 7) \times \left(\frac{80}{5}\right)
\]

\[
PVR = 16 \times 16
\]

\[
PVR = 256 \text{ dynes/sec/cm}^5
\]
Static Compliance ($C_{st}$)

An adult patient who is receiving mechanical ventilation has a tidal volume of 450 mL, peak pressure of 30 cmH2O, plateau pressure of 22 cmH2O, and a PEEP of 5. What is the static compliance?

**Formula:**

$$C_{st} = \frac{\text{Tidal Volume}}{(\text{Plateau Pressure} – \text{PEEP})}$$

$$C_{st} = \frac{450}{(22 - 5)}$$

$$C_{st} = 26.5 \text{ mL/cmH2O}$$
**Dynamic Compliance ($C_{dyn}$)**

An adult patient who is receiving mechanical ventilation has a tidal volume of 450 mL, peak pressure of 30 cmH2O, plateau pressure of 22 cmH2O, and a PEEP of 5. What is the static compliance?

**Formula:**

$$C_{dyn} = \frac{\text{Tidal Volume}}{(\text{Peak Pressure} - \text{PEEP})}$$

$$C_{dyn} = \frac{450}{(30 - 5)}$$

$$C_{dyn} = 18 \text{ mL/cmH2O}$$
Deadspace to Tidal Volume Ratio ($V_D/V_T$)

An adult patient has a PaCO$_2$ of 44 mmHg and a PECO$_2$ of 34 mmHg. What is the deadspace to tidal volume ratio?

**Formula:**

$$\frac{V_D}{V_T} = \frac{(\text{PaCO}_2 - \text{PECO}_2)}{\text{PaCO}_2}$$

$$\frac{V_D}{V_T} = \frac{44 - 34}{44}$$

$$\frac{V_D}{V_T} = 10 / 44$$

$$\frac{V_D}{V_T} = 23\%$$
Children Dosage Estimation

What would be to appropriate dose for a 9-year-old boy when the adult dose is 44 mg?

**Formula:**
Child Dose = (Age / Age + 12) x Adult Dose

Child Dose = (9 / (9 + 12)) x 44
Child Dose = (9 / (9 + 12)) x 44
Child Dose = 0.429 x 44
Child Dose = 18.9 mg
**Infant Dosage Estimation**

What would be an appropriate dose for a 13-month-old infant when the adult dose is 37 mg?

**Formula:**

Infant Dose = (Age in Months / 150) x Adult Dose

Infant Dose = (13 / 150) x 37

Infant Dose = 0.087 x 37

Infant Dose = 3.2 mg
**Anion Gap**

A patient has the following data:

- $\text{Na}^+ = 144 \text{ mEq/L}$
- $\text{Cl}^\cdot = 104 \text{ mEq/L}$
- $\text{HCO}_3^- = 24 \text{ mEq/L}$

Calculate the anion gap:

**Formula:**

$$\text{Anion Gap} = \text{Na}^+ - (\text{Cl}^\cdot + \text{HCO}_3^-)$$

Anion Gap = $144 - (104 + 24)$

**Anion Gap** = 16 mEq/L
Body Surface Area (BSA)

What is the body surface areas of an adult female patient who weighs 153 lbs?

First, you must convert pounds to kilograms.

153 lbs / 2.2 = 69.5 kg

\[
\text{Formula:}
\]

\[
\text{BSA} = \frac{(4 \times \text{Body Weight}) + 7}{(\text{Body Weight} + 90)}
\]

\[
\text{BSA} = \frac{(4 \times 69.5) + 7}{(69.5 + 90)}
\]

\[
\text{BSA} = 1.74 \, \text{m}^2
\]
Elastance

An adult patient is intubated and receiving mechanical ventilation. Given the following data, calculate the elastance:

- \( \Delta P = 6 \text{ cmH}_2\text{O} \)
- \( \Delta V = 0.7 \text{ L} \)

**Formula:**

\[
\text{Elastance} = \frac{\Delta P}{\Delta V}
\]

\[
\text{Elastance} = \frac{6}{0.7}
\]

**Elastance = 8.6 cmH}_2\text{O/L}**
Smoking Use Calculation (Pack Years)

A 54-year-old male patient has been smoking 2 packs of cigarettes per day for 27 years. Her smoking history would be recorded as:

**Formula:**
Pack Years = (Packs Smoked per Day) x (Number of Years Smoked)

Pack Years = 2 x 27

Pack Years = 54
Suction Catheter Size Estimation

A 62-year-old male patient with retained secretions is intubated with a size 8 endotracheal tube. What size catheter would you recommend for suctioning this patient?

**Formula:**

\[
\text{Catheter Size} = \left( \frac{\text{Internal Diameter}}{2} \right) \times 3
\]

Catheter Size = \( \frac{8}{2} \times 3 \)

Catheter Size = 12 Fr
Endotracheal Tube Size Estimation in Children

Intubation is indicated for a 4-year-old child in the emergency department. What size tube would you select?

**Formula:**
Tube Size = \( \frac{\text{Age} + 16}{4} \)

Tube Size = \( \frac{4 + 16}{4} \)

Tube Size = 5.0 mm
Celsius to Fahrenheit Temperature Conversion

A temperature of 30 °C is what temperature in Fahrenheit?

**Formula:**

°C \( F = (\text{°C} \times 1.8) + 32\)

°C \( F = (30 \times 1.8) + 32\)

°C \( F = 86\)
Fahrenheit Celsius Temperature Conversion

A temperature of 69 °F is what temperature in Celsius?

**Formula:**

°C = (°F - 32) x 1.8

°C = (69 - 32) x 1.8

°C = 66.6
Celsius to Kelvins Temperature Conversion

A temperature of 33 °C is what temperature in Kelvins?

**Formula:**

\[ K = °C + 273 \]

\[ K = 33 + 273 \]

\[ K = 306 \]
**Helium/Oxygen Conversion (He/O₂)**

A patient is receiving a 70%Helium/30%Oxygen is running that is running on a flow rate of 8 L/min. What is the actual flow rate of this He/O₂ gas mixture?

To complete this calculation, you must remember the Heliox factors:

- 80/20% Mixture = 1.8
- 70/30% Mixture = 1.6

**Formula:**

\[
\text{Actual Flow} = \text{Given Flow Rate} \times \text{Factor}
\]

For this patient, the question tells you that they are receiving a 70/30% mixtures, which means that you must use 1.6 as the factor within the equation.

Actual Flow = 8 x 1.6

**Actual Flow = 12.8 L/min**
Vital Capacity (VC)

After performing pulmonary function tests on an adult patient, the following results were obtained:

- Tidal Volume = 600 mL
- Inspiratory Reserve Volume = 3,000 mL
- Expiratory Reserve Volume = 1,300 mL
- Residual Volume = 1,100 mL
- Vital Capacity = 4,900 mL

What is the vital capacity?

<table>
<thead>
<tr>
<th>Formulas:</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC = IRV + VT + ERV</td>
</tr>
<tr>
<td>VC = IC + ERV</td>
</tr>
<tr>
<td>VC = TLC – RV</td>
</tr>
</tbody>
</table>

VC = 3,000 + 600 mL + 1,300

VC = 4,900 mL
Inspiratory Capacity (IC)

After performing pulmonary function tests on an adult patient, the following results were obtained:

- Tidal Volume = 600 mL
- Inspiratory Reserve Volume = 3,000 mL
- Expiratory Reserve Volume = 1,300 mL
- Residual Volume = 1,100 mL
- Vital Capacity = 4,900 mL

What is the inspiratory capacity?

Formulas:

- \( IC = IRV + V_T \)
- \( IC = TLC - FRC \)
- \( IC = VC - ERV \)

\[
IC = 3,000 + 600 \\
IC = 3,600 \text{ mL}
\]
Functional Residual Capacity (FRC)

After performing pulmonary function tests on an adult patient, the following results were obtained:

- Tidal Volume = 600 mL
- Inspiratory Reserve Volume = 3,000 mL
- Expiratory Reserve Volume = 1,300 mL
- Residual Volume = 1,100 mL
- Vital Capacity = 4,900 mL

What is the functional residual capacity?

**Formulas:**
- FRC = ERV + RV
- FRC = TLC – IC

FRC = 1,300 + 1,100

FRC = 3,300 mL
Total Lung Capacity (TLC)

After performing pulmonary function tests on an adult patient, the following results were obtained:

- Tidal Volume = 600 mL
- Inspiratory Reserve Volume = 3,000 mL
- Expiratory Reserve Volume = 1,300 mL
- Residual Volume = 1,100 mL
- Vital Capacity = 4,900 mL

What is the total lung capacity?

Formulas:

\[
\text{TLC} = \text{IRV} + V_T + \text{ERV} + \text{RV} \\
\text{TLC} = \text{VC} + \text{RV} \\
\text{TLC} = \text{IC} + \text{FRC}
\]

\[
\text{TLC} = 3,000 + 600 + 1,300 + 1,100
\]

\[
\text{TLC} = 6,000 \text{ mL}
\]
Time Constant (t)

A 63-year-old male patient who is receiving ventilatory support has a compliance of 0.09 L/cmH2O and a total resistance of 4 cmH2O/L/sec. Calculate the time constant:

Formula:

\[ t = \text{Compliance} \times \text{Resistance} \]

\[ t = 0.09 \times 4 \]

\[ t = 0.36 \text{ seconds} \]
Ideal Body Weight (IBW)

A 61-year-old female patient is receiving positive pressure ventilatory support. The patient’s height is 5’7”. What is her ideal body weight?

Formula:

\[ \text{IBW} = 50 \text{ kg} + (2 \times \text{Number of Inches over 5 feet}) \]

\[ \text{IBW} = 50 + (2 \times 7) \]

\[ \text{IBW} = 50 + 14 \]

\[ \text{IBW} = 64 \text{ kg} \]
Tidal Volume ($V_T$)

An adult patient who is intubated and receiving ventilatory support has a flow rate of 7 L/min and an inspiratory time of 0.7 seconds. What is the tidal volume?

**Formula:**

$$V_T = \text{Flow Rate} \times \text{Inspiratory Time}$$

First, you need to convert the flow rate from L/min to mL/sec.

7 L/min = 7,000 mL/60 seconds

$$7,000 / 60 = 116.7 \text{ mL/sec}$$

Now just plug the numbers in.

$$V_T = 116.7 \times 0.7$$

$$V_T = 8.2 \text{ mL}$$
**Exhaled Tidal Volume (V\textsubscript{T})**

An adult patient who is receiving mechanical ventilation displays the following data:

- Rate = 12/min
- Minute Ventilation = 7.2 L/min

What is the exhaled tidal volume?

**Formula:**

\[ V_T = \text{Minute Ventilation} / \text{Frequency} \]

\[ V_T = \frac{7.2}{12} \]

\[ V_T = 0.6 \text{ L} \]

Multiply by 1,000 to convert L to mL.

\[ V_T = 600 \text{ mL} \]
Corrected Tidal Volume ($V_T$)

The following data was obtained on an adult patient who is receiving mechanical ventilation:

- Expired tidal volume = 600 mL
- PIP = 30 cmH2O
- PEEP 5 cmH2O
- Tubing compression factor = 3 mL/cmH2O

What is the corrected tidal volume?

First, you need to calculate the tube volume.

 Tube Volume = Pressure Change x 3 mL/cmH2O

 Tube Volume = (30 – 5) x 3

 Tube Volume = 75 mL

**Formula:**

$$V_T = \text{Expired Tidal Volume} – \text{Tube Volume}$$

$$V_T = 600 – 75$$

$$V_T = 525 \text{ mL}$$
Pressure Support Ventilator Setting (PSV)

An intubated patient is receiving mechanical ventilation in the SIMV mode with the following settings:

- VT = 400 mL
- Rate = 12 breaths/min
- PIP = 40 cm H2O
- Pplat = 20 cm H2O
- Inspiratory flow = 60 L/min or (1 L/sec)

The patient is breathing spontaneously with a spontaneous rate of 12 breaths/min and a spontaneous peak inspiratory flow of 30 L/min (0.5 L/sec). What is the level of PSV that is needed to overcome the imposed work of breathing?

Formula:

$$PSV = \left( \frac{\text{Peak Pressure} - \text{Plateau Pressure}}{\text{Set Flow}} \right) \times \text{Peak Flow}$$

$$PSV = \left( \frac{40 - 20}{1} \right) \times 0.5$$

$$PSV = 10 \text{ cmH2O}$$
Rapid Shallow Breathing Index (RSBI)

An adult patient who is on the ventilator has a rate of 16/min and a tidal volume of 500 mL. What is the rapid shallow breathing index?

**Formula:**

\[ \text{RSBI} = \frac{\text{Rate}}{\text{Tidal Volume}} \]

\[ \text{RSBI} = \frac{16}{500} \]

\[ \text{RSBI} = 8,000 \text{ breaths/min/mL} \]

Divide by 100 to convert to breaths/min/L.

\[ \text{RSBI} = 80 \text{ breaths/min/L} \]
Endotracheal Tube Size Estimation in Children

A 6-year-old boy needs to be intubated in the emergency department. What size ET tube would you recommend?

**Formula:**

\[
\text{Tube Size} = \frac{(\text{Age} + 16)}{4}
\]

Tube Size = (6 + 16) / 4

Tube Size = 5.5

Always round up to the next biggest size.

\[
\text{Tube Size} = 6 \text{ mm}
\]
**Minimum Flow Rate in Mechanical Ventilation**

An adult patient is receiving mechanical ventilation with the following settings:

- Tidal Volume = 550 mL
- Rate = 12/min
- I:E ratio = 1:3

**What is the required minimum flow rate?**

First, you need to calculate the Minute Ventilation.

\[
V_E = \text{Rate} \times \text{Tidal Volume}
\]

\[
V_E = 12 \times 550 \text{ mL}
\]

\[
V_E = 6,600 \text{ mL}
\]

You can convert mL to L by dividing by 1,000.

\[
V_E = 6.6 \text{ L}
\]

Now you can easily calculate the Minimum Flow Rate

**Formula:**

\[
\text{Flow Rate} = V_E \times (I:E \text{ Ratio Sum of Parts})
\]

Minimum Flow Rate = 6.6 × (3 + 1)

**Minimum Flow Rate = 26.4 L/min**
In this section, we’ve provided some additional practice questions so that you can practice and test your knowledge.

Going through practice questions is a helpful technique that you can use to truly learn and memorize all of the equations. 😊

1. What is the most important calculation for the TMC Exam?
Ideal Body Weight (IBW) because it is needed to determine the patient’s initial tidal volume setting for mechanical ventilation. You will need to calculate a patient’s IBW multiple times on the TMC Exam.

We break this down even further inside of our Hacking the TMC Exam video course.

2. A patient receiving mechanical ventilation has a PIP of 60 cmH2O and a plateau pressure of 45 cmH2O. The ventilator flow rate is set at 60 L/min. What is the patient’s airway resistance?
15 cm H2O/L/sec

3. What is the A-a gradient and why is its significant?
The A-a gradient is the alveolar arterial oxygen gradient and represents the driving force of oxygen from the alveolar sac into the artery.

4. What is the normal value of the A-a gradient?
The A-a gradient is normally around 10 mmHg.

5. After obtaining a patient’s PFT results, they have a VC of 3.4, FRC of 5.8, and an ERV of 1.2. What is the patient's TLC?
8.0
6. The physician has requested the dynamic compliance measurement for an adult patient who is receiving mechanical ventilation. This value can be obtained by dividing the patient’s tidal volume by what? (PIP – PEEP)

7. The doctor has requested the static compliance measurement for an adult patient who is receiving mechanical ventilation. This value can be obtained by dividing the patient’s tidal volume by what? (Pplat – PEEP)

8. What is a normal carbon dioxide production? 200 mL/min

9. What is the formula for alveolar partial pressure of carbon dioxide (PACO2)?
   \[ \text{PACO}_2 = \text{VCO}_2 \times 0.863 / \text{VA} \]

10. What is the formula for Deadspace/Tidal Volume Ratio?
   \[ \text{VD/VT} = (\text{PaCO}_2 - \text{PeCO}_2) / \text{PaCO}_2 \]

11. What is the patient’s VD/VT if their PaCO2 is 40 mmHg with a mixed expired CO2 of 28 mm Hg?
    0.3

12. What is the patient’s VD/VT if their PaCO2 is 58 mmHg with a mixed expired CO2 of 32 mmHg?
    0.45

13. What is the formula for Boyle’s Law?
    \[ P_1 \times V_1 = P_2 \times V_2 \]

14. What is the formula for Charles law?
    \[ V_1 / T_1 = V_2 / T_2 \]
15. What is the formula for Combined Gas law?
\[
\frac{(P_1 \times V_1)}{T_1} = \frac{(P_2 \times V_2)}{T_2}
\]

16. An H cylinder is half full (full = 2200) and the patient is receiving oxygen via nasal cannula at 3 L/min. How long will the cylinder last in minutes and in hours?
1151 minutes and 19.18 hours

17. An E cylinder is at 1400 psi and the flow rate is 2.5 L/minute. How many minutes will the tank last?
156.8 minutes

18. If a patient has smoked 2 packs of cigarettes daily for the past 35 years, what would their pack year history be?
70 pack years

19. What is the formula for Minute Ventilation?
\[
MV = \text{Respiratory Rate} \times \text{Tidal Volume}
\]

20. A 36-year-old female patient has a respiratory rate of 12 and tidal volume of 500 mL. What is the minute ventilation?
6 L/min

21. A 78-year-old male patient with a history of COPD has a respiratory rate of 20 and tidal volume of 650 mL. What would his minute volume be in Liters?
13 L/min

22. What is the formula for partial pressure?
\[
\text{Partial Pressure} = \text{Barometric Pressure} \times \text{Fractional concentration of Gas}
\]

23. What is the PO2 in dry air at a barometric pressure of 760 mmHg?
\[
760 \times 0.21 = 159.6
\]
24. How do you calculate the PO2 of humidified air?
   Partial Pressure = (Barometric Pressure – Water Vapor Pressure) x Fractional concentration of gas

25. What is the PO2 of humidified tracheal air?
   \((760 - 47) \times 0.21 = 149.7\)

26. If the alveolar gas has a PO2 of 100 mmHg, what is the PO2 of the pulmonary capillary blood?
   100 mmHg

27. In air, what is the mol percentage of Nitrogen?
   78%

28. In air, what is the mol percentage of oxygen?
   21%

29. In air, what is the mol percentage of Argon?
   1%

30. At a normal body temperature, what is the partial pressure of water vapor?
   47 mmHg

31. PA and Pa in the alveolar gas equation represents the gas pressures in what locations?
   PA represents the gas pressure in the alveoli. Pa represents the gas pressure in the artery.

32. In the alveolar gas equation, what does R represent?
   R represents the V:Q ratio of carbon dioxide and is dependent upon the type of metabolism that a person is undergoing.

33. What two factors determine cardiac output?
   Heart Rate and Stroke volume
34. What is the formula for Cardiac Index?
CI = Cardiac Output / BSA

35. A Cardiac Index below what value can be life-threatening?
< 2.2

36. What is the formula for Stroke Index?
SI = Stroke Volume / BSA

37. What is the Fick Equation?
CO = VO2 / CaO2 – CvO2

38. What does the Deadspace-to-Tidal Volume Ratio measure?
It measures the percentage of the tidal volume that is dead space which does not participate in gas exchange.

39. What is the normal value for (Vd/Vt)?
20 to 40% (or up to 60% for patients on the ventilator)

40. What is the formula to Vd/Vt?
Vd/Vt = (PaCO2 – PeCO2 / PaCO2) x 100

41. What is the average PCO2 of the exhaled air that can be measured by a capnograph?
PeCO2

42. If you know the patient’s tidal volume but the deadspace must be calculated, what formula should be used?
Vd/Vt x Vt

41. What is the tubing compliance when the measured volume is 100 mL and the static pressure is 65 cm H2O?
1.5 mL/cm H2O

42. While setting up a new patient on the ventilator the plateau pressure is 47 cm H2O and the tidal volume is set at 100 mL. The
average PIP reached during the delivery of a breath is 28 cm H2O. What is the amount of volume that was lost in the ventilator tubing?
60 mL

43. What is the average tidal volume for a patient who has a minute ventilation of 10 L/min and rate 12/min?
833 mL

44. What is inspiratory time when the tidal volume is set at 800 mL and a flow rate of 40 L/min?
1.2 seconds

45. What is the I:E ratio for a ventilator that is set to deliver a tidal volume of 850 mL at a frequency of 15/min with a flow rate of 45 L/min?
1:2.5

46. What is the expiratory time when the rate is set to 25/min and the inspiratory time is 0.75 seconds?
1.65 seconds

47. What flow rate would be necessary in order to deliver a tidal volume of 600 mL with a constant waveform at a respiratory rate of 15/min with an I:E of 1:4?
45 L/min

48. What tidal volume setting for mechanical ventilation would be appropriate for a 5'2" female patient with normal lungs?
400 mL

49. How should the initial minute ventilation setting be adjusted for an adult patient who has a body temperature of 40 °C?
Increase it by 30% because the minute ventilation would have to be increased by 10% for each degree above 37° C.
50. What is the number of pack years for a COPD patient who has smoked 2 packs per day for 27 years?
Pack Years = (2 x 27) = 54

51. A 52-year-old female patient has been smoking 1.5 packs of cigarettes per day for 30 years. Her smoking history would be recorded as:
45 pack-years

52. A patient is receiving 3 L/min of oxygen from an E-cylinder at 1200 psi. What is the approximate duration of flow?
112 minutes

53. A 5-foot, 6-inch-tall 130-lb. female patient with normal lungs has a tidal volume of 480 mL and is breathing at a rate of 12 breaths/min. What is her alveolar ventilation?
4.20 L/min

54. A patient 43-year-old male patient is receiving volume controlled ventilation at a rate of 12/min. The expiratory time is 3.30 seconds. What is the inspiratory time?
1.70 seconds

55. What is the formula for Work of Breathing?
WOB = Change in Pressure x Change in Volume
As a bonus, we wanted to give you access to a few sample TMC Practice Questions so that you can get a look and feel of how the formulas and calculations will be used on the exam.

1. A 61-year-old male patient who weighs 165 lbs is receiving volume control A/C ventilation with a tidal volume of 500 mL. He has the following data:
   PEEP 5
   PIP 35
   Pplat 30

   What is the patient's static compliance?
   A. 16.7 mL/cm H2O
   B. 20.0 mL/cm H2O
   C. 25.7 mL/cm H2O
   D. 30.0 mL/cm H2O

   For the TMC Exam, you need to know how to calculate both static and dynamic compliance. That means you should know the formulas for both.

   - **Static Compliance** = Exhaled $V_T$ / (Pplat – PEEP)
   - **Dynamic Compliance** = Exhaled $V_T$ / (PIP – PEEP)

   So for this one, the question asks for the patient's static compliance. To get the answer, all you have to do is plug the numbers in the formula.

   Static Compliance = 500 / (30 – 5)
   Static Compliance = 20

   **The correct answer is:** B. 20.0 mL/cm H2O
2. An adult patient with pneumonia was intubated and placed on pressure control ventilation with an FiO2 of 40% and a PEEP of 10 cm H2O. The chest x-ray shows bilateral infiltrates. After being on the ventilator for 30 minutes, an ABG is obtained with the following results:
   - pH 7.47
   - PaCO2 33 torr
   - PaO2 60 torr
   - SaO2 90%
   - HCO3 25 mEq/L
   - BE +2 MEq/L

You would describe the patient’s condition as being consistent with which of the following:
   A. Mild ARDS
   B. Moderate ARDS
   C. Severe ARDS
   D. Moderate hypoxemia

The first thing that should stand out is the fact that the PaO2 is only 60 torr. That is very low considering the patient is getting an FiO2 of 40% with a PEEP of 10 cm H2O.

The patient’s P/F ratio is 150 which you can calculate by dividing the PaO2 by the FiO2. This indicates that the patient has ARDS in the moderate form. For patients with moderate or severe ARDS, you should recommend the initiation of the ARDSnet protocol.

So by breaking down the question, you can determine that the correct answer has to be B.

**The correct answer is:** B. Moderate ARDS

3. A 63-year-old male patient is receiving mechanical ventilation with a rate of 12/min and an I:E ratio of 1:3. What is the length of the patient’s inspiration?
A. 1.0 second  
**B. 1.25 seconds**  
C. 1.5 seconds  
D. 2.0 seconds

In order to get this one correct, you needed to know how to calculate inspiratory time.

The first step is to calculate the total cycle time by simply dividing the 60 seconds by the rate.

\[
60/12 = 5 \text{ seconds}
\]

Next, determine how much of the inspiratory time takes of the total cycle time.

\[
\frac{1}{(1+3)} \times 100 = 25\%
\]

Then, 25% of 5 seconds = 1.25 seconds.

**The correct answer is:** B. 1.25 seconds

---

**Well, How’d You Do?**

These were just a few examples to give you an idea of some of the types of questions that you may see on the TMC Exam.

Most importantly, when it comes to Formulas and Calculations, don’t panic!

Sure, some of the calculations are difficult, but keep in mind that they make up a very small percentage of the exam. So you will be just fine.
If you want to learn more about our strategy regarding the equations for the exam, be sure to check out our Hacking the TMC Exam video course.

Also, as I mentioned earlier, the more repetitions, the better. So be sure to keep practicing with as many TMC Practice Questions as possible. The practice questions that we provided for you here were actually taken straight from our TMC Test Bank.

It’s one of our bestselling products where we break down hundreds of practice questions that cover every topic you need to know for the TMC Exam.

Each question comes with a detailed rationale that explains exactly why the answer is correct. Thousands of students have already used it to pass the TMC Exam.

Are you next?

If you thought the practice questions above were helpful, definitely consider checking it out.

Click Here to Learn More
One More Thing!

Before you go, I just wanted to remind you about our Practice Questions Pro membership.

As you can most likely already tell, our practice questions are loaded with helpful tidbits of information that can help you prepare for (and) pass the TMC Exam.

Now, you can get these TMC Practice Questions sent to your inbox on a daily basis.

And the more practice questions you see, the better.

This way, over time, you can master every single topic that you need to know to increase your chances of passing the exam on your first (or next) attempt.

For many students, it’s very convenient to wake up each day and have a new TMC Practice Question in the inbox waiting for you.

If this is something that sounds interesting to you, definitely consider signing up.

Click Here to Get Daily Practice Questions via Email
So there you have it!

You now have access to all the formulas and calculations that you must know, not only for Respiratory Therapy School, but for the board exams as well.

**Now it’s up to you to learn and master this information.**

I definitely recommend going through each formula several times until the information sticks. Your future self will be glad that you did.

No worries, I have faith that you can do it!

Keep working and studying hard and you will be just fine. Thank you so much for reading all the way to the end.

I wish you the best of luck on your journey, and as always, breathe easy my friend. 😊


