Australian & New Zealand Society of Respiratory Science Inc.

CERTIFIED RESPIRATORY FUNCTION SCIENTIST (CRFS)

EXAMINATION STUDY GUIDE

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1.0 INTRODUCTION

The Certification Examination for Respiratory Function Scientists was developed to assess the professional knowledge of physiologists performing clinical respiratory function testing and to set a uniform minimum standard of knowledge appropriate to the competent performance of basic respiratory function testing in Australia and New Zealand.

During 1992 and 1993 the Australian and New Zealand Society of Respiratory Science (ANZSRS) conducted a series of meetings to describe the role and duties of Australasian clinical respiratory physiologists, and to gather other information that would define the content and complexity of the Certification Examination for Respiratory Function Scientists. Overseas organisations already providing credentialing examinations for respiratory physiologists, including the United States of America National Board for Respiratory Care, and the Canadian Association of Cardiopulmonary Technologists, were contacted for advice and assistance. The input of these organisations is gratefully acknowledged. The examination was subsequently developed utilising established examination development procedures by a committee composed of academics, respiratory scientists and physicians.

This study guide was developed to assist candidates to prepare for the Certification Examination for Respiratory Function Scientists. This study guide should be read in conjunction with the document titled 'CRFS Policies and Exam Rules'. Both documents are available from the ANZSRS website.

This document outlines the content upon which the examination is based together with a list of references which can be used to direct your study. Also included is a 100-question self-assessment examination. The questions in the self-assessment examination are similar in scope and difficulty to those in the actual Certification Examination, consequently the self-assessment examination gives a valuable insight into the depth of knowledge tested in the Certification Examination. The self-assessment examination includes an answer key.

The material in this study guide is not intended to be a substitute for a commitment to a thorough education in the theory and practical aspects of respiratory physiology and its interpretation.

2.0 ABOUT THE ANZSRS

The Australian and New Zealand Society of Respiratory Science (ANZSRS) Inc. was formed in 1980 to serve the professional needs of scientists employed in clinical respiratory function laboratories. The members of the ANZSRS are drawn from all regions of Australia and New Zealand.

The aims of the ANZSRS are to-

1. Provide a forum for scientific and technical communications between members.
2. Advance the knowledge and practice of respiratory function measurement and respiratory physiology.
3. Promote excellence in respiratory function measurement.
4. Support and encourage training and education in respiratory function measurement.
5. Facilitate dialogue with other professional societies with common interests.

The ANZSRS organises an annual scientific conference comprising presentations of original research, invited lectures and educational sessions.

In 1994 the ANZSRS developed and administered the first Australasian credentialling examination for clinical respiratory physiologists. The examination is held regularly throughout the year and in a number of locations throughout Australia and New Zealand.

Information about the activities of the ANZSRS, contact addresses and a copy of this guide can be found on the website www.anzsrs.org.au.

All correspondence to the ANZSRS, including requests for membership details and application forms, should be directed to the Secretary of the society.

3.0 STUDY GUIDE

3.1 Examination Advice

The advice offered is presented primarily to familiarise you with the examination directions.

1. Read all instructions carefully.
2. The certification examination will be timed. You will have 2 hours to answer 100 multiple-choice questions.
3. For best results pace yourself by periodically checking your progress against the available time. This will allow you to make any necessary adjustments.
4. As you take the examination, occasionally check the question number to be certain it matches the corresponding answer line. This check will ensure that you are marking your response to the appropriate question.
5. Be sure to record a single answer for each question, even the ones of which you are not completely sure. You can note the questions you wish to reconsider in the test booklet and return to them later. Avoid leaving any questions unanswered as this will maximise your chances of passing and prevent mismarking your answer sheet.

3.2 Examination Content

To begin your preparations in an organised and informed manner, you should know the areas that will be assessed by the examination. The content of the examination is listed below.

CRFS EXAMINATION CONTENT OUTLINE

1.0 Anatomy Of The Respiratory System

- 1.1 Macroscopic structure
- 1.2 Upper and lower respiratory tracts
- 1.3 Gas exchanging tissues
- 1.4 Pulmonary and bronchial circulations
- 1.5 Nerve supply to the lungs
- 1.6 Muscles of respiration
- 1.7 Anatomy of the systemic circulation

2.0 Function Of The Respiratory System

- 2.1 Ventilation
  - 2.1.1 Lung volumes and capacities
  - 2.1.2 Role of the respiratory centre, nerves, muscles and chemoreceptors in the control of ventilation
  - 2.1.3 Tidal breathing and dead space ventilation
  - 2.1.4 Distribution of ventilation
  - 2.1.5 Lung compliance and elastance

2.1.6 Airway resistance and conductance
2.1.6.1 Laminar and turbulent flow
2.1.6.2 Effect of gas density and viscosity
2.1.7 Volume-time, flow-volume and pressure-flow relationships
2.2 Pulmonary gas exchange
2.3 Gas transport in the blood
2.4 Perfusion
2.4.1 Anatomical and physiological shunts
2.5 Ventilation/perfusion matching
2.6 Autonomic Nervous System
2.6.1 Sympathetic and Parasympathetic systems

3.0 Terminology, Gas Laws And Correction Of Gas Volumes

3.1 Abbreviations, symbols and units
3.2 Gas laws
3.2.1 Ideal, Boyle's, Charles', Dalton's, Fick's (diffusion), Gay-Lussac's, Graham's, Henry's
3.2.2 Water vapour pressure
3.2.3 Definition and application of ATPD, ATPS, STPD and BTPS.

4.0 Instrumentation and Equipment

4.1 Principles of quality control
4.1.1 Analysis of quality control data
4.2 Principles of infection control in the respiratory laboratory
4.2.1 Cleaning procedures for respiratory equipment (disinfection and sterilisation)
4.2.2 Procedures to minimise cross-infection risks
4.3 Laboratory safety
4.3.1 Basic electrical safety
4.3.2 Storage and control of compressed gases
4.3.3 Cardiopulmonary resuscitation
4.4 Instrument characteristics: linearity, accuracy, precision, frequency response, hysteresis, damping, response time
4.5 Principles of operation, set-up and/or calibration of
4.5.1 Volume measuring devices (spirometers: water seal, wedge etc.)
4.5.2 Flow measuring devices (pneumotachometer, hot wire, etc.)
4.5.3 Aerosol delivery devices
4.5.3.1 Metered dose inhalers and spacers
4.5.3.2 Breath activated inhalers
4.5.3.3 Jet and ultrasonic nebulisers
4.5.4 Computers
4.5.4.1 Analog to digital conversion and sampling rates
4.5.5 Gas analysers (helium, oxygen, carbon monoxide, carbon dioxide, nitrogen, multi-gas)
4.5.6 Body plethysmograph
4.5.7 Pulse oximeters

4.6 Minimum performance specifications for:-
4.6.1 Volume measuring devices
4.6.2 Flow measuring devices
4.6.3 Gas analysers for DLCO measurements
4.7 Maintenance, performance of quality assurance and evaluation of quality assurance data for:-
4.7.1 Volume measuring devices
4.7.2 Flow measuring devices
4.7.3 Gas analysers for DLCO measurements

5.0 Pharmacology and Diagnostic Procedures

5.1 Pharmacology
5.1.1 Types of medications, their mode of action, duration of effect and secondary effects of drugs used to treat lung disease
5.1.2 Common medications with adverse pulmonary effects
5.1.2 Aerosol deposition in the lungs
5.1.3 Optimal technique for:-
5.1.3.1 Metered dose inhalers
5.1.3.2 Spacers
5.1.3.2 Breath activated inhalers

5.2 Diagnostic Procedures
5.2.1 Physiological basis for:
5.2.1.1 Spirometry
5.2.1.2 Flow-volume loop
5.2.1.3 Peak flow
5.2.1.4 Bronchodilator response
5.2.1.5 Lung volumes
5.2.1.5.1 Gas dilution
5.2.1.5.2 Nitrogen washout
5.2.1.5.3 Body plethysmography
5.2.1.6 Diffusing Capacity: single breath CO
5.2.2 Criteria for determining maximum effort, acceptable and reproducible efforts, distinction between poor technique, technical problems and the effect of abnormal function for:-
5.2.2.1 Spirometry
5.2.2.2 Flow-volume loop
5.2.2.3 Peak flow
5.2.2.4 Bronchodilator response
5.2.2.5 Lung volumes
5.2.2.5.1 Gas dilution
5.2.2.5.2 Nitrogen washout
5.2.2.5.3 Body plethysmography
5.2.2.6 Diffusing Capacity: single breath CO

6.0 Data Management

6.1 Application of statistical methods to respiratory function data

6.1.1 Mean, standard deviation, confidence intervals, coefficient of variation, normal distribution.
6.1.2 Linear regression
6.1.3 Predicted normal values and limits of normality
6.1.4 Derivation of reference equations

6.2 Clinical implications of height, armspan, age, sex, weight, race, posture, smoking and occupational history, medications, patient symptoms to respiratory function and the results of
6.2.1 Spirometry
6.2.2 Flow-volume loop
6.2.3 Peak flow
6.2.4 Bronchodilator response
6.2.5 Lung volumes
6.2.5.1 Gas dilution
6.2.5.2 Nitrogen washout
6.2.5.3 Body plethysmography
6.2.6 Diffusing Capacity: single breath CO

3.3 Study Resources List

This list of study references is intended to complement the content outline. All books listed are currently in print.

The list is comprised of suggestions only and is not representative of all the references which could assist candidates in preparing for the certification examination, nor is it intended that candidates review all the listed references. Examination questions are not necessarily referenced in any of the publications listed.

Note that references are grouped under headings which are most descriptive of the resource, thus a reference listed under **Anatomy** will not be found again under another heading, although its content may relate equally well to **Physiology**.

Recent ATS/ERS Lung Function Testing Standardisation Documents:

1. Miller MR et al. General considerations for lung function testing. Eur Respir J 2005; 26: 153-161.
2. Miller MR et al. Standardisation of spirometry. Eur Respir J 2005; 26: 319-338.
3. Wanger J et al. Standardisation of the measurement of lung volumes. Eur Respir J 2005; 26: 511-522.
4. MacIntyre N et al. Standardisation of the single-breath determination of carbon monoxide uptake in the lung. Eur Respir J 2005; 26: 720-735.
5. Pellegrino R et al. Interpretative strategies for lung function tests. Eur Respir J 2005; 26: 948-968.

Anatomy

1. Des Jardins T Cardiopulmonary Anatomy and Physiology: Essentials for Respiratory Care. (4th ed) Albany: Delmar Learning, 2002
2. Tortora GJ Principles of Human Anatomy. (7th ed) Harper and Row, 1994

Quality Control

1. Westgard JO Basic QC Practices: Training in Statistical Control for Healthcare Laboratories (2nd edition) Westgard QC Inc., 2002.

Pathophysiology

1. Ali J et al Pulmonary Pathophysiology. New York: McGraw-Hill, 1999

2. West JB Pulmonary Pathophysiology-the essentials. (6th ed) Baltimore: Williams and Wilkins, 2003

Pharmacology

1. Rau JL Respiratory Care Pharmacology. (6th ed) Chicago: Mosby Year Book, 2002

Physiology

1. Forster RE The Lung: Physiologic Basis of Pulmonary Function. (4th ed) Chicago: Mosby Year Book, 1994
2. Leff AR and Schumacker PT Respiratory Physiology. Philadelphia: WB Saunders, 1993
3. Levitzky MG Pulmonary Physiology. (6th ed) New York: McGraw-Hill, 2003
4. West JB Respiratory Physiology - the essentials. (7th ed) Baltimore: Williams and Wilkins, 2004

Pulmonary Function Testing

1. Cotes JE Lung Function-Assessment and Application in Medicine (6th ed) Oxford:
2. Blackwell Scientific Publications, 2006
3. Hughes JMB and Pride NB Lung Function Tests: Physiological Principles and Clinical
4. Application. WB Saunders 1999 ISBN 0-7020-2350-7
5. Hyatt RE et al Interpretation of Pulmonary Function Tests. Philadelhia: Lippincott Williams & Wilkins, 2003
6. Ruppel G Manual of Pulmonary Function Testing (8th ed) St Louis: Mosby Year Book, 2003

3.4 Self-Assessment Examination

This section includes a 100 question, multiple-choice examination that is similar in length and difficulty to the actual credentialling examination. The correct answers to the self-assessment questions are attached at the end of the questions. The CRFS Examination also consists of 100 multiple-choice questions and has a time limit of 2 hours. Therefore, when you take this self-assessment examination, allow yourself no more than 2 hours so you have the same amount of time as you will have during the actual CRFS Examination.

Remember that these self-assessment questions sample the scope of content that may be tested in the actual CRFS Examination. It is suggested that you take the self-assessment examination, score your results, and refer to references supporting the correct answer for any question you answered incorrectly or were unable to answer.

Practice Certification Examination for Respiratory Function Scientists

Directions: Each of the questions or incomplete statements is followed by four suggested answers or completions. Select the one that is best in each case and then blacken the corresponding space on the answer sheet.

ATPS to BTPS Conversion Table

Gas Temperature (degC)	Conversion Factor
20	1.102
21	1.096
22	1.091
23	1.085
24	1.080
25	1.075
26	1.068
27	1.063
28	1.057
29	1.051
30	1.045

Q1 A rotameter is used to calibrate:

A - an oxygen analyser
B - a pneumotachograph
C - a wedge spirometer
D - a body plethysmograph

Q2 FRC is usually:

A - decreased in patients with airway obstruction
B - higher when measured by plethysmograph than by the helium dilution method in patients with emphysema
C - increased in patients with obesity
D - higher when measured by the helium dilution method than by the nitrogen washout method in patients with airway obstruction

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Q3 The pressure-volume curve of the lung is a graphical representation of lung volume plotted against:

A - pleural pressure

B - elastic recoil pressure of the lung
C - oesophageal pressure
D - alveolar pressure

Q4 Equal pressure point (EPP) is:

A - a pressure which exists during forced inspiration
B - the point at which the pressure inside the airways equals the pressure outside the airways
C - a problem only with lung volumes above the normal tidal volume
D - not affected by changes in elastic recoil in the lung

Q5 The mechanism responsible for transporting the greatest amount of CO2 in the blood is:

A - carbamino compounds
B - dissolved CO_2
C - bicarbonate ion
D - carboxyhaemoglobin

Q6 With normal respiratory function and metabolic rate, an increase in cardiac output will result in:

A - increased arterial PO_2
B - decreased arterial-venous content difference for oxygen
C - decreased mixed venous oxygen content
D - no change in mixed venous oxygen content

Q7 A respiratory scientist enters a patient's room to perform oximetry and finds the patient unresponsive and not breathing. After calling for help, the scientist delivers 2 breaths. What should the scientist do next?

A - continue rescue breathing
B - perform oximetry as requested
C - begin chest compressions
D - check for a pulse

Q8 Adjacent alveoli are often interconnected by stomata called pores of:

A - Forster
B - Kohn
C - Henry
D - Low

Q9 Small airway resistance increases with which of the following?
1 - asthma
2 - emphysema
3 - beta-adrenergic blockade
4 - cholinergic blockade

A - 1, 2 and 3
B - 1 and 3
C - 2 and 4
D - 4 only

Q10 Hypoventilation **ALWAYS** results in:

A - hypoxia
B - hypercapnia
C - respiratory alkalosis
D - hypoxia and hypercapnia

Q11 Particles greater than 10 microns in diameter are deposited mainly in the:

A - pharynx
B - trachea
C - alveoli
D - bronchioles

Q12 Minute volume is calculated by knowing the:
1 - tidal volume
2 - anatomical dead space
3 - respiratory rate
4 - alveolar ventilation

A - 1, 2 and 3
B - 1 and 3
C - 2 and 4
D - 1, 2, 3 and 4

Q13 A body plethysmograph is used to measure airway resistance because:

A - without it we cannot measure flow
B - it is not sensitive to changes in volume
C - alveolar pressure can be determined
D - it overcomes diffractive interference from lung compliance scatter.

Q14 Physiologic dead space may be defined as:

A - perfusion without adequate ventilation
B - ventilation without adequate perfusion
C - ventilation/perfusion ratio of 0.8
D - residual volume

Q15 During respiratory function testing complaints of tingling of lips and extremities are usually associated with:

A - hyperventilation
B - hypoventilation
C - dyspnoea
D - atrial fibrillation

Q16 Functional Residual Capacity contains:

A - inspiratory reserve volume and tidal volume
B - vital capacity and residual volume
C - tidal volume and residual volume
D - expiratory reserve volume and residual volume

Q17 The approximate anatomic dead space of the average male is:

A - 300ml
B - 10ml per kg of body weight
C - 150ml
D - 50ml

Q18 In a cooperative normal patient, comparison of forced vital capacity and slow vital capacity will show:
A - the forced vital capacity should be the larger
B - the slow vital capacity should be the larger
C - both should be the same
D - no correlation at all

Q19 The motor nerve to the diaphragm is the:

A - tympanic
B - vestibular
C - abducent
D - phrenic

Q20 Which of the following factors might account for a decreased DLCO in the absence of pulmonary disease?

1 - measurements made at altitude
2 - decreased haemoglobin (anaemia)
3 - increased pulmonary capillary blood volume
4 - elevated carboxyhaemoglobin (COHb)

A - 1, 2, 3 and 4
B - 1, 3 and 4
C - 2, 3 and 4
D - 2 and 4

Q21 Pulmonary compliance is increased in:

A - sarcoidosis
B - kyphoscoliosis
C - emphysema
D - pulmonary edema

Q22 A COPD patient who is spontaneously breathing an FiO_2 of 0.50 becomes sleepy and unresponsive. The patient's reaction is most likely a result of:

A - insufficient oxygenation
B - increased $PaCO_2$
C - increased intracranial pressure
D - decreased cardiac output

Q23 Which of the following cause hypoxaemia?

A - shunt
B - diffusion limitation
C - ventilation/perfusion mismatch

D - all of the above

Q24 Laminar flow in the airways is:

A - little affected by the viscosity of the gas and strongly affected by the density of the gas
B - strongly affected by the viscosity of the gas and little affected by the density of the gas
C - strongly affected by both viscosity and density of the gas
D - dependent only upon the airway size

Q25 When a volume of room air is added to a spirometer that contains 10% He, the He concentration falls to 5%. If the spirometer originally contained 3L of air, how much volume was added?

A - 1L
B - 2L
C - 3L
D - 4L

Q26 A conscious, uncomfortable awareness of the need for increased breathing is defined as:

A - apnoea
B - eupnoea
C - dyspnoea
D - orthopnoea

Q27 Which of the following will occur as a result of performing He equilibration lung volume measurements with the patient in the supine, rather than the upright posture?

A - a decrease in RV
B - a decrease in FRC
C - an increase in TGV
D - an increase in TLC

Q28 The type of breathing pattern characterised by deep, rapid breathing with progressively increasing and decreasing tidal volumes followed by an apnoeic episode is called:

A - Biot's respiration
B - Cheyne-Stokes respiration
C - Kussmaul's respiration
D - hyperventilation

Q29 Which of the following are capable of sterilising equipment?

1 - autoclave
2 - ethylene oxide
3 - glutaraldehyde
4 - alcohols

A - 1 and 2
B - 2 and 3
C - 1 and 4
D - 1, 2 and 3

Q30 Spirometry after bronchodilator administration shows a 20% increase in FVC. This is highly suggestive of:

A - peripheral gas trapping
B - pulmonary fibrosis
C - pulmonary emboli
D - chronic bronchitis

Q31 According to ATS standards which of the following should be done to ensure reliable FEF determinations?

A - the test should be repeated twice to make calculation of data easier.
B - the results should be obtained from a manoeuvre of full exhalation to RV, to full inspiration to TLC, and then to full exhalation to RV.
C - the results should be measured from the best effort when the FEV_1 and FVC are reproducible within 5% of other curves.
D - the results should be averaged from all flow-volume loops.

Q32 A system utilising a one-way circuit and set-up for a He equilibration test is not satisfactory for FVC and FEV_1 measurements for which of the following reasons?

A - the addition of O_2 is not necessary
B - the soda lime canister increases expiratory resistance
C - absorption of CO_2 is not needed

D - the recording system is inadequate.

Q33 Pulmonary hypertension that results from pulmonary emphysema is characterised by an increase in which of the following:

1 - pulmonary artery pressure
2 - intrapulmonary vascular resistance
3 - right ventricular pressure

A - 1 only
B - 2 only
C - 1 and 3
D - 1, 2 and 3

Q34 A prebronchodilator expiratory flow-volume curve is attempted by a patient who cannot control his cough. An approximation of the curve may be obtained by instructing the patient to do which of the following?

A - take a full breath, then expel the air forcefully despite coughing
B - blow out forcefully, through pursed lips
C - do a forced inspiration first, then a normal expiration
D - breathe in partially, then blow out slowly.

Q35 After an upright normal subject takes a vital capacity breath of 100% O_2, the N_2 concentration at the apex exceeds that at the base of the lung because:

A - airway closure at the base delays filling of that region
B - airway resistance of lower zones is high
C - the ventilation-perfusion ratio is high at the apex
D - the apical alveoli expand less than those at the base

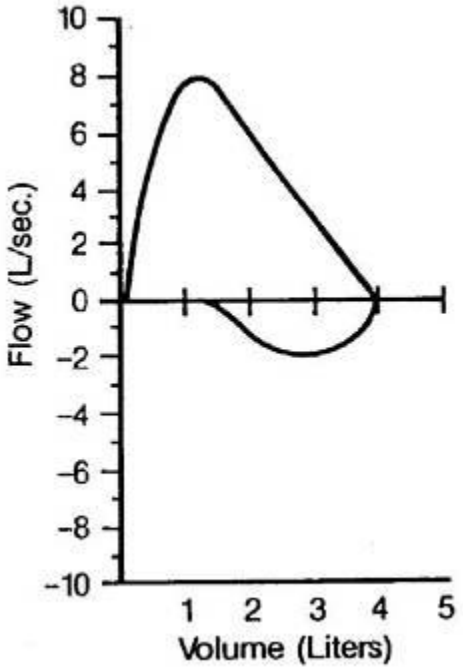
Q36 Which of the following are required to perform a single breath DLCO test using the traditional technique?

1 - spirometer
2 - 1 L sample bag
3 - 0.3% CO, 10% He, balance N_2
4 - 0.3% CO, 10% He, balance air

A - 1 and 3
B - 2 and 4
C - 1, 2 and 3

D - 1, 2 and 4

Q37 Which of the following statements best explains the ”maximum" flow-volume loop shown below?



A - patient removed the mouthpiece during exhalation
B - patient failed to inhale maximally following complete exhalation
C - loop demonstrates the presence of an intrathoracic lesion
D - loop demonstrates the presence of an extrathoracic lesion.

Q38 A respiratory scientist is measuring the SVC of a patient with a tracheostomy. When the spirometer is connected to the tracheostomy tube, results are as follows:

Trial	SVC (L)
1	4.05
2	3.75
3	2.00

All of the following are possible explanations for this variability **EXCEPT**

A - air is leaking around the tracheostomy tube through the stoma
B - air is leaking around the tracheostomy tube through the mouth
C - the tracheostomy tube is too small

D - the tracheostomy tube is intermittently blocked by being pressed against the tracheal wall

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Q39 Mast cells in human lungs:

A - are situated mainly in the mucosal layers of the airways
B - release mediators if stimulated with histamine inhalation
C - may have their mediator release reduced by pretreatment with cromoglycate
D - are mostly situated in central rather than peripheral airways

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Q40 Alveolar ventilation will increase in response to stimulation of:

A - the medullary chemorecepters by increased H^+ ion concentration in the cerebro-spinal fluid
B - the medullary chemorecepters by increased O_2 concentration in the cerebro-spinal fluid
C - the carotid chemoreceptors by decreased CO_2 concentration in the blood
D - the carotid chemoreceptors by increased pH of arterial blood

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Q41 If a patient fails to exhale fully while performing a VC manoeuvre during a He dilution lung volume determination which of the following errors will result?

A - an RV that is too low
B - an RV that is too high
C - a TLC that is too low
D - a TLC that is too high

Q42 When setting up a system for measuring lung volumes by the He dilution technique, which of the following components must be used?

1 - water absorber
2 - CO_2 absorber
3 - O_2 analyser
4 - CO_2 analyser

A - 2 only
B - 1 and 2
C - 2 and 4
D - 3 and 4

Q43 A computer using an 8 bit analog to digital converter is set for a voltage range of 0 to 10 volts. If it is attached to a spirometer that produces 1 volt for every 2 L of volume displacement, what is the smallest volume increment that the converter can detect?

A - 20 ml
B - 40 ml
C - 60 ml
D - 80 ml

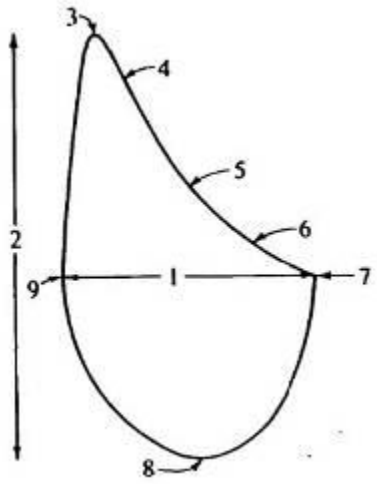
Q44 Which of the following would **MOST** likely prolong He equilibration time?

A - emphysema
B - pneumonia
C - obesity
D - sarcoidosis

Q45 Determination of thoracic gas volume in a body plethysmograph is based on the principle that:

A - flow is proportional to the square of pressure
B - pressure and volume vary inversely
C - gas volumes expand as temperature increases
D - volume varies directly with flow

Q46 RV on the diagram below is represented by which number?



A - 3
B - 5
C - 7
D - 9

Q47 The results of a patient's lung volume study are below:

	Predicted	**Observed**
VC (L)	3.00	3.27
FRC (L)	2.55	2.00
IC (L)	1.82	2.42
ERV (L)	1.18	0.85
RV (L)	1.37	1.15
TLC (L)	4.37	5.43
RV/TLC (%)	31	21

Which of the observed results should be recalculated?

A - TLC only
B - TLC and RV/TLC
C - RV, TLC AND RV/TLC
D - none

Q48 When setting up gas and water absorbers for single breath TLCO using CO and He analysers, which of the following is the correct order of the absorbers?

A - silica gel, soda lime
B - soda lime, silica gel
C - $CaSO_4$ (drierite), soda lime
D - silica gel, $CaSO_4$ (drierite)

Q49 The best test to verify the presence of airway narrowing in a patient who seems to be unco-operative and perhaps a malingerer is which of the following:

A - SGaw
B - FEV_1/FVC
C - FIF_{50}/FEF_{50}
D - Cdyn

Q50 Failure to accurately calibrate a wire mesh pneumotachograph, which consistently underestimates flow, may be caused by which of the following?

A - the flow source provides too high a flow
B - there is moisture accumulation in the mesh
C - the pneumotachograph has a hole in the mesh
D - turbulent flow has developed on the upstream side

Q51 When airway resistance is determined by using a body plethysmograph, the patient should be instructed to:

A - perform a forced expiratory manoeuvre
B - pant with an open glottis
C - exhale passively from end tidal inspiration
D - exhale passively from TLC

Q52 A patient is noted to have a reduced $FEF_{25-75\%}$ and FEV_1. The FVC and Raw are normal. Which of the following best explains these findings?

A - the site of dysfunction is in the peripheral airways
B - a fixed upper airway obstruction is present
C - there is decreased chest wall compliance
D - there was submaximal effort during the Raw measurement

Q53 A patient breathing 100% O_2 (ie FiO_2 = 1.00) is cyanotic and has a PaO_2 of 50 mmHg. The best explanation for these findings is:

A - increased COHb
B - diffusion limitation
C - ventilation/perfusion mismatch
D - a shunt

Q54 Increased ventilation during a He dilution test can be caused by all of the following **EXCEPT**:

A - patient anxiety
B - an exhausted CO_2 absorber
C - a leak in the circuit
D - no replenishment of O_2 consumed during the test

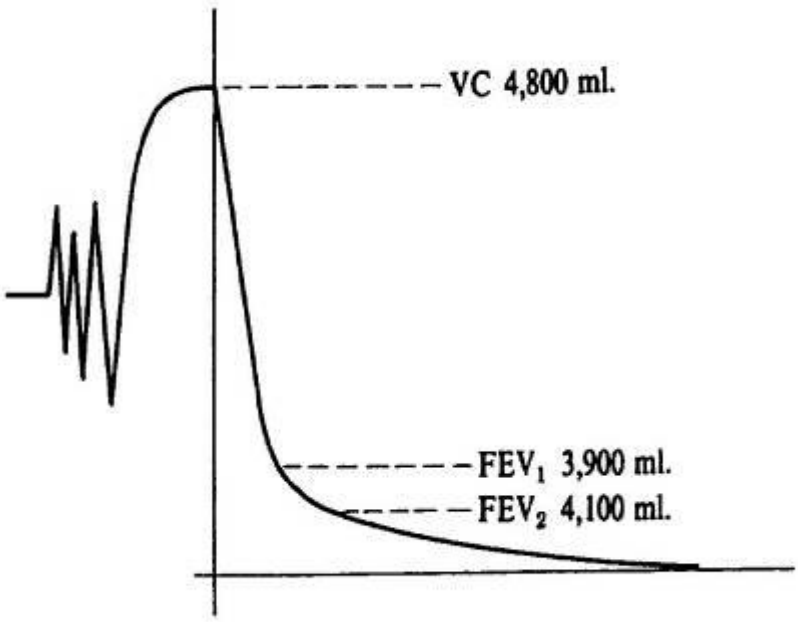
Q55 Which blood gas parameter will **ALWAYS** be abnormally low in a patient with a Hb of 8.0 g/dl?

A - O_2 content
B - CO_2 partial pressure
C - O_2 partial pressure
D - O_2 saturation

Q56 When performing whole body plethysmography to measure thoracic gas volume, patients are instructed to brace their jaws and cheeks with the hands for which of the following reasons?

A - to stabilise the mouthpiece and minimise motion artefact
B - to help ensure a good seal around the mouthpiece and prevent pressure leaks
C - to help stabilise the tongue and prevent it from blocking the mouth piece opening
D - to prevent any volume changes inside the mouth

Q57 The spirogram below was obtained from a 35 year old male who smokes two packs of cigarettes a day and frequently experiences a morning cough. Which of the following can be concluded from the graph:



A - The FEV_1/FVC ratio is within the normal range
B - the curve represents obstructive lung disease
C - a combined obstructive and restrictive defect is present
D - an advanced stage of restrictive defect is present

Q58 A 35 year old, 183 cm male complaining of shortness of breath with exercise has the following spirometry data:

VC	4.6 L
FVC	3.6 L
FEV_1	2.1 L
$FEF_{25-75\%}$	2.5 L/sec

Which of the following tests would be indicated as the next step in evaluation of the patient's problem?

A - measure RV/TLC ratio
B - exercise induced asthma study
C - bronchodilator response
D - single breath DLCO

Q59 Correct conclusions about a 180cm, 40 years old male subject who has an FEV_1/FVC ratio of 65% include which of the following?

1 - his FEV_1/FVC ratio is below normal
2 - he has obstructive lung disease
3 - he has restrictive lung disease
4 - he has diffusion impairment

A - 1 only
B - 3 only
C - 1, 2 and 4
D - 1 and 2

Q60 A patient has an FEV_1 of 1.91 litres (52% of the predicted value). Which of the following might result in this low value:

1 - small airways obstruction
2 - hesitation at the start of test
3 - restriction due to fibrosis
4 - an FVC greater than predicted

A - 1, 2, 3 and 4
B - 1, 3 and 4
C - 1, 2 and 3
D - 2 and 4

Q61 Carbon monoxide is used to measure transfer factor instead of oxygen because:

A - it does not react with haemoglobin
B - it diffuses more slowly than O_2
C - there is little or no CO dissolved in pulmonary capillary blood
D - all of the above

Q62 DLCO may be decreased in emphysema due to:

1 - increased distance from terminal bronchiole to alveolar-capillary membrane
2 - decreased surface area
3 - loss of pulmonary capillary bed
4 - ventilation/perfusion abnormalities

A - 1, 2, 3 and 4
B - 2, 3 and 4

C - 2 and 4
D - 3 only

Q63 A shift in the oxygen-haemoglobin dissociation curve to the right:

A - occurs in the pulmonary capillaries
B - is prevented by a rise in blood H^+ ion concentration
C - favours the passage of O_2 to the tissues
D - increases the affinity of tissue cells for O_2

Q64 According to the American Thoracic Society's recommendations, spirometer quality controls include which of the following:

1 - daily checks for leaks
2 - daily check of FVC and FEV_1 of at least one known subject
3 - daily check of volume accuracy with a 3 litre syringe
4 - quarterly calibration checks across the spirometer's range

A - 1, 2, 3 and 4
B - 1, 3 and 4
C - 2 and 3
D - 1 and 4

Q65 Which of the following may be used to perform quality control on a constant-volume, variable-pressure body plethysmograph for measuring TGV:

1 - comparison with gas dilution lung volume determinations
2 - a 3 litre syringe with occlusion valve
3 - an isothermal lung analog
4 - a known subject who has been tested at least 10 times when the plethysmograph was known to be functioning accurately

A - 1, 2, 3 and 4
B - 1, 2 and 3
C - 1, 3 and 4
D - 2 and 4

Q66 The residual volume of the lungs:

A - is the volume of air that remains in the lungs after expiring the resting tidal volume of air

B - is generally greater at age 75 than at age 45
C - is less than 1 litre in the adult
D - increases in atelectasis

Q67 Which of the following formulas is correct?

A - vital capacity = inspiratory reserve volume + expiratory reserve volume
B - alveolar minute ventilation = (respiratory rate) x (tidal volume - anatomical dead space)
C - vital capacity = inspiratory reserve volume + tidal volume
D - inspiratory reserve volume = vital capacity - resting tidal volume

---

Q68 The alveolar pressure is:

A - lower than the intrapleural pressure during inspiration
B - lower than the intrapleural pressure during expiration
C - higher than the intrapleural pressure during inspiration and expiration
D - lower than the intrapleural pressure during expiration

Q69 In emphysema there is an increased tendency for the bronchioles to collapse during a forced expiration. This is due to:

A - a decrease in the elastic recoil of the lungs
B - a loss of collagenous tissue from the lungs
C - a failure of bronchiolar chondroblasts
D - excessive tone in the bronchiolar smooth muscle

Q70 What happens when the ventilation/perfusion ratio of a lung unit decreases? The alveoli in that unit develop:

A - a higher PO_2
B - lower PCO_2
C - higher PO_2 and lower PCO_2
D - higher PCO_2

Q71 A baffle is used on a nebuliser to:

A - break the aerosol into smaller particles
B - entrain room air
C - alter oxygen concentration
D - heat the gas above room temperature

Q72 Pulmonary surfactant:

A - facilitates O_2 diffusion through alveolar membranes
B - facilitates CO_2 diffusion through alveolar membranes
C - increases surface tension of the alveolar membrane
D - decreases the likelihood of alveolar collapse during expiration

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Q73 The inspiratory flow-volume curve is particularly valuable for:

A - measuring the response to bronchodilator drugs
B - differentiating between chronic bronchitis and emphysema
C - detecting extra-thoracic airway obstruction
D - cleaning mucus from the airways

Q74 The respiratory pattern expected in a patient with grossly decreased lung compliance would be:

A - slow and shallow
B - rapid and shallow
C - slow and deep
D - rapid and deep

Q75 At which lung volume is the pressure-volume curve nearly linear?

A - at RV
B - at TLC
C - at over the entire range of vital capacity
D - in the range of tidal volume

Q76 In a normal patient, if tidal volume is 0.5L, rate is 15/min and the dead space to tidal volume ratio (V_D/V_T) is 0.30, what is the alveolar ventilation?

A - 2.25 L/min
B - 4.50 L/min
C - 5.25 L/min
D - 7.50 L/min

Q77 Which of the following is a pathological change common to asthma?

A - destruction of alveolar septa

B - destruction of pulmonary capillaries
C - epithelial desquamation
D - dilation of bronchial smooth muscle

Q78 What is the respiratory exchange ratio of a patient with the following values?

O_2 uptake of 300 ml/min
Minute volume of 5.00 L/min (STPD)
Expired CO_2 concentration of 5.00%

A - 0.60
B - 0.75
C - 0.83
D - 1.20

Q79 Regarding a single breath DLCO measurement, the initial alveolar PCO is calculated from:

A - mixed venous PCO_2
B - inspiratory vital capacity
C - dilution of an inert trace gas
D - pulmonary capillary blood volume

Q80 The difference between intrapleural pressure and alveolar pressure is equivalent to which of the following:

A - pleural pressure
B - transmural pressure
C - intrathoracic pressure
D - transpulmonary pressure

Q81 A square wave signal is applied to a strip chart recorder and the tracing shown below is obtained. What does the tracing indicate?

A - overshoot
B - undershoot
C - damping
D - sine wave generation

Q82 Which of the following devices has the highest frequency response?

A - wedge spirometer
B - turbine peak flowmeter
C - water-seal spirometer
D - differential pressure pneumotachograph

Q83 Pulmonary function tests is an obese patient will commonly show:

A - a reduced ERV
B - a reduced $FEF_{25-75\%}$
C - an increased FRC
D - an increased IRV

Q84 Which of the following are used to calculate Raw with a body plethysmograph?

A - pleural pressure and flow at the mouth
B - mouth pressure, box pressure and flow at the mouth
C - pleural pressure and box volume
D - mouth pressure, box pressure and box volume

Q85 Under conditions of zero flow with the airway occluded, mouth pressure is approximately equal to:

A - alveolar pressure
B - barometric pressure
C - oesophageal pressure
D - intrapleural pressure

Q86 In a normal adult, PEF is **PRIMARILY** dependent upon:

A - patient effort
B - lung compliance
C - patient position
D - chest wall compliance

Q87 Which of the following studies would produce the most accurate determination of TLC in a patient with severe emphysema?

A - whole body plethysmography
B - helium dilution
C - nitrogen washout
D - single breath oxygen

Q88 During inspiration, the box pressure of a constant volume body plethysmograph:

A - decreases
B - increases
C - remains constant
D - varies in proportion to the patient's weight

Q89 A variable pressure (constant volume) body plethysmograph is calibrated for volume by:

A - direct measurement with a wedge spirometer
B - opening shutters and noting the pressure drop
C - noting the pressure change when a known volume of air is displaced
D - a pneumotachograph with flow integration to calculate pressure

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Q90 A response in which the output is a straight line function of the input is descriptive of:

A - linearity
B - maximum gain
C - frequency response
D - hysteresis

Q91 A patient's vital capacity measured by a rolling dry seal spirometer at ambient temperature (24˚C) pressure saturated (ATPS) is 3.00L. When adjusted to BTPS conditions, the corrected vital capacity is approximately:

A - 2.70 L
B - 2.85 L
C - 3.25 L
D - 3.45 L

Q92 In order to measure flow using a pneumotachograph system which of the following electromechanical devices must also be used?

A - pressure gauge
B - spirometer
C - differential pressure transducer
D - rotameter

Q93 Why should you wait 10 to 15 minutes after a helium dilution FRC measurement before repeating it on a patient with emphysema?

A - the patient must return to normal O_2 consumption
B - a buildup of He in the lungs could be toxic
C - all the He must be cleared from the patient's lungs
D all He must be cleared from the spirometer and the meter recalibrated

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Q94 Dynamic collapse of airways occurs:

A - during vigorous inspiration
B - mostly in the respiratory bronchioles where walls are thin
C - in major bronchi during violent expiration because these airways have lower internal pressure than do smaller airways further upstream (nearer the alveoli)
D - only in unusual disease conditions

Q95 Which of the following symptoms is **NOT** common in asthma:

A - early morning breathlessness
B - persistent cough
C - an increased sensitivity to inhaled histamine
D - pleuritic chest pain

Q96 Inhaled ipratropium bromide:

A - is synergistic with salbutamol in the treatment of asthma
B - is tasteless
C - stimulates the bronchial cholinergic receptors
D - reaches peak effect slower than salbutamol

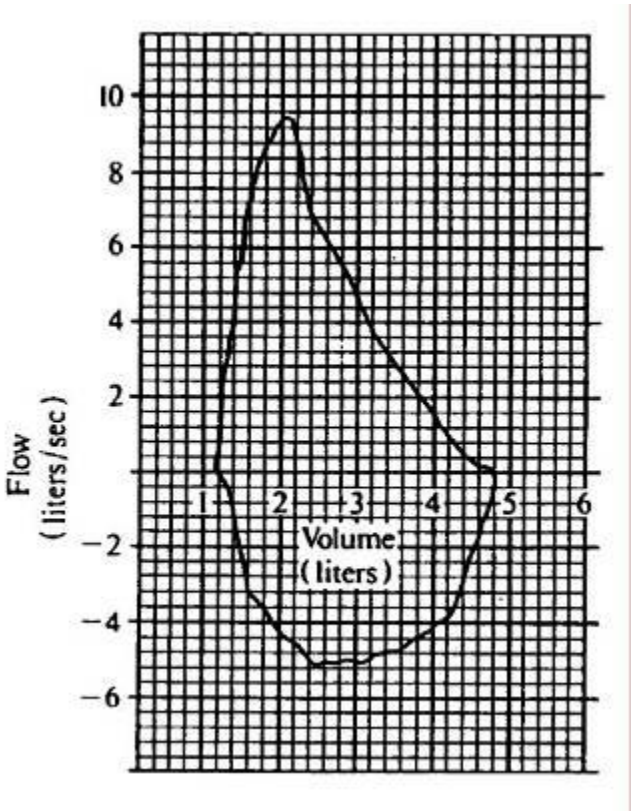
Q97 Which of the following is a common side effect of steroid metered dose aerosol inhalers:

A - cataracts
B - adrenal suppression
C - osteoporosis
D - candidiasis

Q98 All of the following statements about maximal expiratory airflow are true **EXCEPT**:

A - it is affected by lung volume
B - it is affected by lung elastic recoil
C - it is effort-independent at high lung volumes
D - it is reduced at high lung volumes in severe asthma

Questions 99 and 100 refer to the flow-volume loop below, which was recorded at ATPS (26^{o} C).



Q99 Which of the following values should be reported for PEF?

A - 4.7 L/sec
B - 8.8 L/sec

C - 9.4 L/sec
D - 10.0 L/sec

Q100 Which of the following should be reported for FVC?

A - 3.36 L
B - 3.60 L
C - 3.84 L
D - 4.80 L

END OF EXAMINATION QUESTIONS

3.5 Answer Key To Self-Assessment Examination

The answers to questions on the previous 100 question self-assessment examination are indicated below.

Question	Answer	Question	Answer	Question	Answer
1	B	34	A	67	B
2	B	35	D	68	C
3	B	36	D	69	A
4	B	37	B	70	D
5	C	38	C	71	A
6	B	39	C	72	D
7	D	40	A	73	C
8	B	41	B	74	B
9	A	42	B	75	D
10	B	43	D	76	C
11	A	44	A	77	C
12	B	45	B	78	C
13	C	46	C	79	C
14	B	47	B	80	D
15	A	48	B	81	A
16	D	49	A	82	D
17	C	50	C	83	A
18	C	51	B	84	B
19	D	52	A	85	A
20	D	53	D	86	A
21	C	54	C	87	A
22	B	55	A	88	B
23	D	56	D	89	C
24	B	57	A	90	A
25	C	58	C	91	C
26	C	59	D	92	C
27	B	60	C	93	C
28	B	61	C	94	C
29	D	62	A	95	D
30	A	63	C	96	D
31	C	64	B	97	D
32	B	65	C	98	C
33	D	66	B	99	D
				100	C