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MULTIPLE CHOICE

1. A subject who complains of shortness of breath has an FVC of 2.57 L, but her VC is 2.99 L. These findings suggest which of the following?
   a. Pulmonary fibrosis
   b. Chest wall abnormality
   c. Emphysema
   d. Fixed upper airway obstruction

   ANS: C
   FVC is often lower than VC in patients with obstructive diseases if forced expiration causes airway collapse. This pattern is often seen in emphysema because of loss of tethering support of the airways.

   DIF: 2 REF: p. 48 OBJ: EL-1
   MSC: NBRC: CPFT 3B-3

2. A 47-year-old man with a history of cough has the following spirometry results:

	Measured	**Predicted**
FVC (L BTPS)	3.85	4.01
FEV_1 (L BTPS)	2.14	3.33

   These findings show the presence of which of the following?
   a. Reversible airway obstruction
   b. Moderate obstructive disease
   c. Normal lung function
   d. Incorrectly selected predicted values

   ANS: B
   While the ratio of FEV_1/VC defines obstruction, the severity of obstruction is defined by the degree to which the FEV_1 is reduced. Moderate FEV_1= 60% to 69% of predicted; 2.14 ÷ 3.33 = 64%.

   DIF: 2 REF: p. 51 OBJ: EL-2
   MSC: NBRC: CPFT 3C-3

3. A 22-year-old patient with dyspnea performs three spirometry trials.

	Trial 1	**Trial 2**	**Trial 3**
FVC (L BTPS)	4.21	4.49	4.65
FEV_1 (L BTPS)	3.88	3.91	3.93

   The pulmonary function technologist should do which of the following?
   a. Report the values from Trial 3.
   b. Report the largest sum of FVC and FEV_1.
   c. Average the data from Trials 2 and 3.
   d. Perform at least one more maneuver.

   ANS: D

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The two largest values for both FVC and FEV_1 should be within 150 ml (or within 100 ml if the FVC is 1 L or less). The second largest value is simply subtracted from the largest value for both FVC and FEV_1 to determine repeatability. If repeatability is not met, additional acceptable trials should be performed.

DIF: 3 REF: p. 53 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

4. Why should all values from a series of peak flow measurements be reported?
   a. PEF may decrease with repeated efforts.
   b. A minimum of three values must be averaged.
   c. Peak flowmeters do not need to be precise.
   d. Forced exhalation produces a bronchodilator effect.

   ANS: A
   At least three maneuvers should be performed and recorded, along with the order in which the values were obtained. All readings are recorded to detect effort-induced bronchospasm.

   DIF: 2 REF: p. 62 OBJ: None
   MSC: NBRC: CPFT 2B-9

5. Which of the following determines the shape of the "effort-independent" portion of the expiratory F-V curve?
   1. Abdominal pressure during forced expiration
   2. Elastic recoil of the lung
   3. Flow resistance in the small airways
   4. Cross-sectional area of the trachea

   a. 1 and 2
   b. 2 and 3
   c. 1, 3, and 4
   d. 4 only

   ANS: B
   Elastic recoil determines the pressure applied to gas in the lung during a forced expiration. This pressure is determined by the recoil of the lung and chest wall. Resistance to flow in the airways is the second factor affecting the shape of the flow-volume curve.

   DIF: 1 REF: p. 55 OBJ: AL-3 MSC: NBRC: None

6. A patient being evaluated for disability has the following spirometry results:

	Measured	**Predicted**
FVC (L)	4.00	4.10
FEV_1 (L)	2.00	3.30
MVV (L/min)	105	110

   What do these findings indicate?
   a. The patient has moderate obstructive disease.
   b. The patient has restriction.
   c. The patient's FEV_1 is larger than measured.
   d. The patient did not make a good effort on the MVV.

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ANS: A
While the ratio of FEV_1/FVC defines obstruction, the severity of obstruction is defined by the degree to which the FEV_1 is reduced. Moderate FEV_1= 60% to 69% of predicted; 2.00 ÷ 3.30 = 61%.

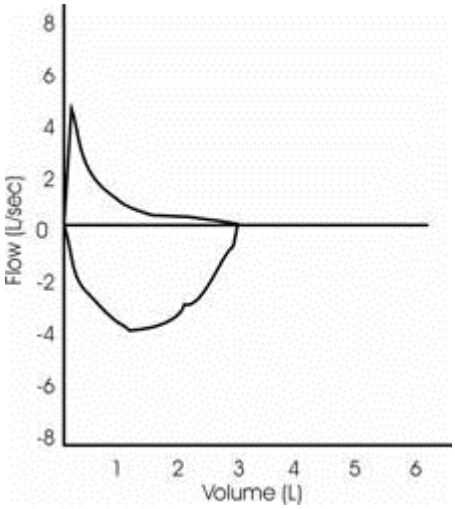
DIF: 2 REF: p. 51 OBJ: AL-2
MSC: NBRC: CPFT 3C-3

7. Before bronchodilator studies, inhaled β-adrenergic agents should be withheld for how long?
   a. 0.5 to 1.5 hours unless corticosteroids are being used
   b. 4 to 12 hours for regular or long-acting preparations
   c. 24 hours for most inhalers
   d. 24 to 48 hours

   ANS: B
   See Table 2-2, Chapter 2.

   DIF: 1 REF: p. 66 OBJ: EL-4
   MSC: NBRC: CPFT 2A-6

8. Which answer is consistent with the following flow-volume curve?



   a. Normal forced expiratory flow pattern
   b. Variable intrathoracic obstruction
   c. Airways obstruction
   d. Fixed large airway obstruction

   ANS: C
   See Interpretive Strategies 2-3, Chapter 2.

   DIF: 2 REF: p. 58 OBJ: AL-3
   MSC: NBRC: CPFT 3C-3

9. A subject has spirometry repeated before and after inhaled bronchodilators. The following data are obtained:

	Predicted	**Before Drug**	**After Drug**

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FVC	5.20	4.90	5.30
FEV_1	4.10	3.10	3.30
PEF	9.20	7.77	8.92

Which of the following statements best describes these findings?

a. There is mild obstruction with significant response to bronchodilators.
b. There is mild obstruction without significant change after bronchodilators.
c. There is a paradoxical response to bronchodilators.
d. Spirometry is within normal limits.

ANS: B

While the ratio of FEV_1/VC defines obstruction, the severity of obstruction is defined by the degree to which the FEV_1 is reduced. Mild FEV_1 is greater than 70% predicted (3.10 ÷ 4.10 = 75%). Bronchodilator response is significant if the percent change is 12% or there is an absolute increase greater than 200 ml.

DIF: 3 REF: p. 51 | p. 68 OBJ: EL-4
MSC: NBRC: RPFT 3C-3

10. A 50-year-old woman with dyspnea has the following spirometry results:

	Measured	**Predicted**
FVC (L BTPS)	3.99	4.10
FEV_1 (L BTPS)	3.44	3.33

These findings are consistent with which of the following?

a. Reversible airway obstruction
b. Mild obstructive disease
c. Normal lung function
d. Invalid predicted values

ANS: C

Data are within normal limits. (FEV_1/FVC 86%; FEV_1 97% of predicted.)

DIF: 2 REF: p. 51 OBJ: EL-2
MSC: NBRC: CPFT 3C-3

11. A 17-year-old patient with asthma performs three spirometry trials:

	Trial 1	**Trial 2**	**Trial 3**
FVC (L BTPS)	3.21	3.44	3.49
FEV_1 (L BTPS)	2.88	2.91	2.93

The pulmonary function technologist should do which of the following?

a. Report the values from Trial 3.
b. Average the data from Trials 2 and 3.
c. Calibrate the spirometer and repeat all three trials.
d. Perform at least one more maneuver.

ANS: A

Spirometry acceptability and repeatability criteria were achieved. Report the largest FVC and FEV_1.

DIF: 3 REF: p. 62 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

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12. A subject being tested for possible environmental exposure to asbestos produces the following spirometry results:

	Measured	Predicted
FVC (L)	4.00	4.07
FEV_1 (L)	3.44	3.37
MVV (L/min)	52	135

The pulmonary function technologist may conclude that:

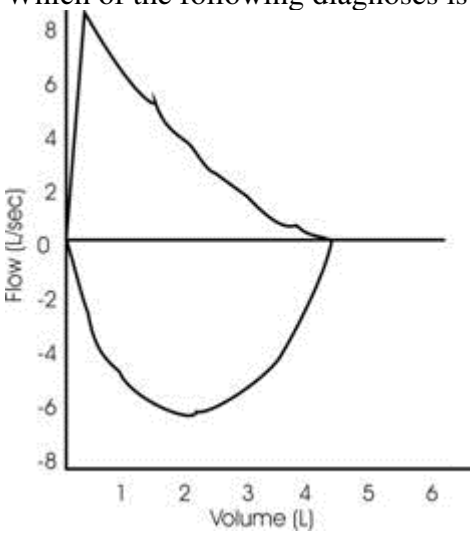
a. The patient has restriction.
b. The patient has moderate obstructive disease.
c. The patient's FEV_1 is not valid.
d. The patient did not make a good effort on the MVV.

ANS: D

If the measured MVV is less than 80% of ($FEV_1 \times 40$), poor patient effort or neuromuscular weakness may be suspected.

DIF: 3 REF: p. 66 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

13. Which of the following diagnoses is consistent with the following flow-volume curve?



a. Variable intrathoracic obstruction
b. Fixed extrathoracic obstruction
c. Small airway obstruction
d. Normal expiratory and inspiratory flows

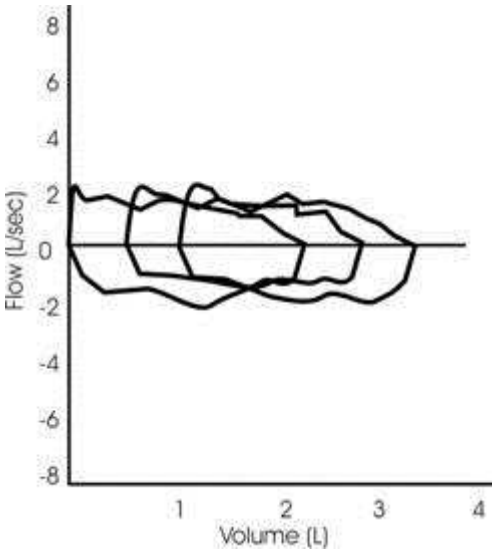
ANS: D

See Interpretive Strategies 2-3, Chapter 2.

DIF: 2 REF: p. 58 OBJ: AL-3
MSC: NBRC: CPFT 3C-3

14. Which answer is consistent with the following three superimposed flow-volume loops?

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a. Normal airway function
b. Small airway obstruction
c. Variable intrathoracic restriction
d. Fixed extrathoracic obstruction

ANS: D
See Interpretive Strategies 2-3 and Figure 2-14, Chapter 2.

DIF: 2 REF: p. 58 | p. 61 OBJ: AL-3
MSC: NBRC: CPFT 3C-3

15. A subject has an FVC of 1.8 L (39% of predicted). The same individual has a slow VC of 2.7 L. Which of the following might explain these findings?
1. Normal findings in severe restrictive disease
2. Airway compression in obstructive lung disease
3. Poor effort or early termination of the FVC
4. Representative findings in early small airway disease

a. 1, 3, and 4
b. 2 and 3
c. 1 and 4
d. 2 only

ANS: B
FVC is often lower than VC in patients with obstructive diseases, if forced expiration causes airway collapse. This pattern is often seen in emphysema because of loss of tethering support of the airways. Poor effort during the FVC maneuver can also affect the results.

DIF: 3 REF: p. 48 OBJ: EL-3
MSC: NBRC: RPFT 3C-3

16. A subject produces the following simple spirometry results:

	Measured	**Predicted**
FVC (L, BTPS)	4.5	4.0
FEV_1 (L, BTPS)	3.6	3.2

These findings are consistent with:

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a. Combined obstruction and restriction
b. Moderate obstructive disease
c. Normal lung function
d. Incorrectly selected predicted values

ANS: C
Data are within normal limits. (FEV_1/FVC 80%; FEV_1 113% of predicted.)

DIF: 3 REF: p. 51 OBJ: EL-2
MSC: NBRC: RPFT 3C-3

17. A subject referred for pulmonary function tests because of shortness of breath has an FEV_1 of 98%. This finding is suggestive of:
a. Restrictive lung disease
b. Obstructive lung disease
c. Normal lung function
d. Upper airway abnormality

ANS: C
Data are within normal limits.

DIF: 3 REF: p. 51 OBJ: AL-2
MSC: NBRC: RPFT 3C-3

18. The $FEF_{25\%-75\%}$ depends on which of the following?
a. FVC
b. PEF
c. FEV_1
d. $FEV_{1\%}$

ANS: A
$FEF_{25\%-75\%}$ is measured from a segment of the FVC.

DIF: 1 REF: p. 52 OBJ: None MSC: NBRC: None

19. In diseases that cause obstruction of the small airways, the MEFV curve may assume a concave appearance because of:
1. Loss of elastic recoil
2. Turbulent gas flow patterns
3. Increased specific conductance
4. Increased airway resistance
a. 1, 2, and 3
b. 2, 3, and 4
c. 2 and 3
d. 1 and 4

ANS: D
The degree of concavity increases because of reduced flows resulting from loss of elastic recoil. Increased airway resistance would also cause flow limitation.

DIF: 2 REF: p. 58 OBJ: AL-4 MSC: NBRC: None

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20. A patient produces the following spirometry results:

	Actual	Predicted
FVC (L)	4.0	4.1
FEV_1 (L)	2.0	3.3
MVV (L/min)	45	110

These findings indicate that:

1. Obstruction is present.
2. Restriction is present.
3. The FEV_1 is overestimated.
4. The MVV is underestimated.

a. 1, 2, and 3
b. 2, 3, and 4
c. 1 and 4
d. 2 and 3

ANS: C
While the ratio of FEV_1/VC defines obstruction (50%), the severity of obstruction is defined by the degree to which the FEV_1 is reduced. Moderate FEV_1= 60% to 69% of predicted; 2.00 ÷ 3.30 = 61%. If the measured MVV is less than 80% of ($FEV_1 \times 40$), poor patient effort or neuromuscular weakness may be suspected.

DIF: 3 REF: p. 51 | p. 58 OBJ: AL-2
MSC: NBRC: CPFT 2C-6

21. In addition to the FEV_1 and FVC, which of the following is useful in gauging subject effort during spirometry?

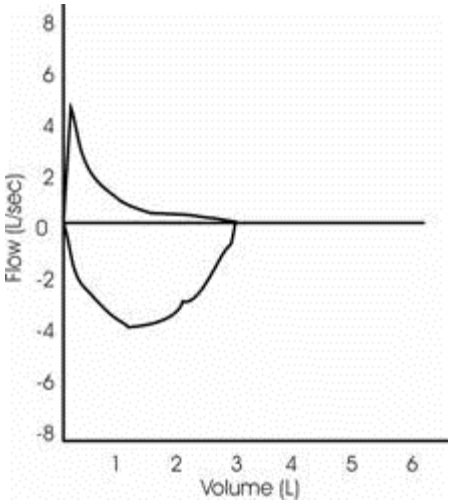
a. PEF
b. $FEF_{50\%}$
c. $FEF_{25\%-75\%}$
d. $\dot{V}max_{25}$

ANS: A
Other methods of selecting the best test have been suggested and are sometimes used. PEF may be used to assess patient effort for an FVC maneuver.

DIF: 1 REF: p. 55 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

22. Which answer is consistent with the flow-volume curve shown?

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a. Normal forced expiratory flow pattern
b. Variable intrathoracic obstruction
c. Airway obstruction
d. Fixed extrathoracic obstruction

ANS: C
See Interpretive Strategies 2-3, Chapter 2.

DIF: 2 REF: p. 58 OBJ: AL-3
MSC: NBRC: CPFT 3C-3

23. According to the 2005 ATS-ERS repeatability standards, of the three acceptable tracings, the two largest FVC values and the two largest FEV_1 values in a subject with a vital capacity greater or equal to 1.0 L should be within how many milliliters?
a. 50
b. 100
c. 150
d. 200

ANS: C
The two largest acceptable values for both FVC and FEV_1 should be within 150 ml (or within 100 ml if the FVC is 1 L or less). The second largest value is simply subtracted from the largest value for both FVC and FEV_1 to determine repeatability.

DIF: 1 REF: p. 47 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

24. Back extrapolation is the method used to determine "time zero" when measuring which of the following parameters?
a. FVC
b. FEV_1
c. $FEF_{25\%-75\%}$
d. MVV

ANS: B
To accurately determine FEV_1, the back-extrapolated volume should be less than 5% of the FVC or less than 150 ml, whichever is greater.

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DIF: 1 REF: p. 47 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

25. A subject performed four acceptable FVC maneuvers.

	Predicted	Maneuver 1	Maneuver 2	Maneuver 3	Maneuver 4
FEV_1	4.80	4.83	4.60	4.23	4.03

What do the results most likely represent?
a. Variable effort
b. Malingering
c. Inability to understand the test
d. Maneuver-induced bronchospasm

ANS: D
Positioning loops side by side or superimposing can also help detect decreasing flows with repeated efforts. This pattern may be seen because FVC maneuvers can induce bronchospasm.

DIF: 2 REF: p. 55 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

26. A 62-year-old female complaining of shortness of breath has the following spirometry results. Ambient temperature is 26° C (conversion factor = 1.068).

	FEV_1	FVC
Trial 1	2.10	2.65
Trial 2	1.96	3.11
Trial 3	1.99	2.99

What is the subject's reportable FEV_1 in BTPS conditions?
a. 2.10 L
b. 2.17 L
c. 2.24 L
d. 2.65 L

ANS: C
The data appear acceptable and repeatable. The largest FEV_1 should be reported, which is 2.10. Multiply this value by the BTPS correction factor ($2.10 \times 1.068 = 2.24$ L).

DIF: 3 REF: p. 64 OBJ: AL-1
MSC: NBRC: CPFT 3A-4

27. What are the recommended dosages for assessing bronchodilator response, according to the ATS-ERS spirometry guidelines?
a. Four doses of albuterol (100 µg) or ipratropium bromide (40 µg)
b. Two doses of albuterol (100 µg) or ipratropium bromide (80 µg)
c. Four doses of albuterol (80 µg) or ipratropium bromide (80 µg)
d. Two doses of albuterol (80 µg) or ipratropium bromide (40 µg)

ANS: A

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The ATS-ERS guidelines' recommended dose of albuterol is 400 µg, delivered as four inhalations of 100 µg each by MDI, separated by 30-second intervals. For ipratropium bromide, the recommended dose is 160 µg, delivered as four inhalations of 40 µg each by MDI.

DIF: 1 REF: p. 66 OBJ: AL-1
MSC: NBRC: CPFT 2A-1

28. What is the calculated bronchodilator response in this subject?

	Pre-Drug	**Post-Dilator**
FVC	4.5	4.8
FEV	2.8	3.9

a. 39%
b. 6%
c. 1.1 L
d. 71%

ANS: A
Percent change in FEV_1 is calculated. Post-FEV_1–pre-FEV_1/pre-FEV_1 ([(3.9 – 2.8) ÷ 2.8] × 100 = 39%).

DIF: 2 REF: p. 67 OBJ: EL-4
MSC: NBRC: CPFT 3C-11a

29. According to the ATS-ERS recommendations, what are the criteria for measuring an accurate height in a subject before testing?
1. Shoes off
2. Feet apart
3. Heels flat against wall
4. Standing upright

a. 1 and 4
b. 1, 2, and 4
c. 1, 3, and 4
d. All of the above

ANS: C
The height should be measured without shoes, with the feet together, standing upright ,with shoulders, buttocks, and heels flat against the wall or stadiometer, and the head tilted so that the lower orbital level and the external auditory meatus (Frankfurt plane) are level; measurements should be recorded to the nearest 0.1 cm.

DIF: 1 REF: p. 29 ch 1 OBJ: None
MSC: NBRC: CPFT 2A-6

30. Which of the following would be considered key components of the FVC maneuver?
a. Maximal inspiration, blast of expiration, and complete exhalation
b. Maximal inspiration and exhalation for at least 6 seconds
c. Forceful exhalation, exhalation for at least 6 seconds in adults and 3 seconds in children younger than the age of 10

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d. No cough in the first second and a fast start (back extrapolation <150 ml)

ANS: A
There are three distinct phases to the FVC maneuver, as follows: (1) maximal inspiration, (2) a ‘‘blast’’ of exhalation, and (3) continued complete exhalation to the end of the test.

DIF: 1 REF: p. 51 | p. 67 OBJ: EL-1
MSC: NBRC: CPFT 2B-6

31. A 48-year-old female complaining of cough has the following spirometry results:

	Pre-Drug	% Predicted	Post-Dilator
FVC	3.32	94	3.58
FEV_1	2.34	79	2.75
FEV_1/FVC	70.4		76.7

How would you interpret her spirometry results?
a. Normal spirometry with no significant response to bronchodilator
b. Mild obstruction with a positive response to bronchodilator
c. Mild obstruction with no significant response to bronchodilator
d. Normal spirometry with a positive response to bronchodilator

ANS: B
While the ratio of FEV_1/FVC defines obstruction, the severity of obstruction is defined by the degree to which the FEV_1 is reduced. Mild FEV_1 is greater than 70% of predicted. Bronchodilator response is significant if FEV_1 increases greater or equal to 12% or an absolute increase is greater or equal to 200 ml.

DIF: 3 REF: p. 51 OBJ: AL-2
MSC: NBRC: RPFT 3C-3

32. A 63-year-old male complaining of shortness of breath and muscle weakness has the following pulmonary function results:

	Measured	% Predicted
FVC	4.27	96
FEV_1	3.29	93
FEV_1/FVC	77.1	

These findings are consistent with:
a. Normal study
b. Borderline obstruction
c. Neuromuscular weakness (e.g., ALS)
d. Mild obstruction

ANS: A
Data are within normal limits.

DIF: 2 REF: p. 51 OBJ: EL-2
MSC: NBRC: CPFT 3C-3

33. A 69-year-old female complaining of cough and shortness of breath has the following pulmonary function results:

	Measured	% Predicted

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FVC	1.54	58
FEV_1	1.22	57
FEV_1/FVC	79.2	

These findings are consistent with:

a. Severe obstruction
b. Moderate restriction with no evidence of obstruction
c. Severe restriction with concomitant obstruction
d. Variable extrathoracic obstruction

ANS: B
If both FVC and FEV_1 reduced proportionately, restriction is present.

DIF: 2 REF: p. 51 OBJ: EL-3
MSC: NBRC: CPFT 3C-3

34. A subject has the following spirometry results:

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
FVC	1.48	1.67	1.42	1.38
FEV_1	1.18	1.38	1.22	1.18

What do the results most likely represent?

a. Variable effort
b. Maneuver induced bronchospasm
c. Unacceptable maneuvers
d. Repeatable maneuvers

ANS: A
The two largest values for both FVC and FEV_1 should be within 150 ml (or within 100 ml if the FVC is 1 L or less). The second largest value is simply subtracted from the largest value for both FVC and FEV_1 to determine repeatability. Because the repeatability criteria were not achieved, the efforts are too variable.

DIF: 2 REF: p. 47 OBJ: EL-1
MSC: NBRC: CPFT 2C-6

35. The following data were obtained while performing a spirometry test on a 43-year-old patient.

	Trial 1	**Trial 2**	**Trial 3**
FVC	3.90 L	4.15 L	4.30 L
FEV_1	3.25 L	3.60 L	3.50 L

What should the technologist do next?

a. Perform another trial.
b. Report the FVC and FEV_1 from Trial 3.
c. Report the FVC and FEV_1 from Trial 2.
d. Report the FVC from Trial 3 and the FEV_1 from Trial 2.

ANS: D
Spirometry acceptability and repeatability criteria were achieved. Report the largest FVC and FEV_1.

DIF: 3 REF: p. 47 OBJ: AL-1

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MSC: NBRC: CPFT 3B-3

36. Which of the following parameters does *not* have to be corrected to BTPS?
    a. FEV_1/FVC ratio
    b. $FEF_{25\%-75\%}$
    c. FVC
    d. FEV_1

    ANS: A
    The FVC and FEV_t are both reported in liters corrected to BTPS. $FEV_{t\%}$ is the ratio of FEV_t to FVC, expressed as a percentage.

    DIF: 1 REF: p. 66 OBJ: None MSC: NBRC: None

37. A 52-year-old female has a 30-pack-year history of cigarette smoking and has shortness of breath. Room temperature is 26° C (conversion factor = 1.068).

	FEV_1	**FVC**
Trial 1	2.00	2.50
Trial 2	1.98	3.01
Trial 3	1.95	2.96

    What is the subject's reportable FEV_1 in BTPS conditions?
    a. 2.00 L
    b. 2.11 L
    c. 2.14 L
    d. 2.67 L

    ANS: C
    The data appear acceptable and repeatable. The largest FEV_1, which is 2.00, should be reported. Multiply this value by the BTPS correction factor ($2.00 \times 1.068 = 2.14$ L).

    DIF: 2 REF: p. 66 OBJ: AL-1
    MSC: NBRC: CPFT 3A-4

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