

**THE
CCT PRIMER
SOLUTIONS TEXT**

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SECTION II

GENERAL METROLOGY -- TEST QUESTIONS

2.1. The SI unit of length is the:

- a. Inch
- b. Centimeter
- c. Yard
- d. Meter

Solution: The SI system has defined units for seven basic characteristics that underlie every measurement. *CCT Primer* Table 2.1 lists those units. The unit for length is listed as the meter. The other answer choices given are all units of length in other measurement systems, but not in SI.

Answer d is correct.

Reference: *CCT Primer*, Section II - 3.

2.2. The Pascal, the SI unit of pressure, is:

- a. A base SI unit
- b. A derived SI unit
- c. A European fundamental unit
- d. A secondary unit

Solution: The SI system has definitions for many derived units. *CCT Primer* Table 2.3 lists those units. The unit for pressure, the Pascal, is listed in that table.

Answer b is correct.

Reference: *CCT Primer*, Section II - 6/7.

2.3. Which SI multipliers have abbreviations in capital letters?

- a. Those with factors > 0.001
- b. Those with factors > 1
- c. Those with factors > 1000
- d. Those with factors > 100

Solution: Refer to *CCT Primer* Table 2.7. It shows all of the defined SI multipliers and their abbreviations. All abbreviations for multipliers up to and including 10^3 (kilo) are not capitalized. All abbreviations for larger multipliers are capitalized.

Answer c is correct.

Reference: *CCT Primer*, Sections II - 9 and V - 4.

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2.4 The speed of light is considered to be a constant:

- a. Below the surface of the Earth
- b. By a few physicists
- c. When used for standards work
- d. Only in elementary physics classes

Solution: The speed of light is considered to be a constant everywhere in the universe. This assumption is continually being challenged at the most advanced research levels, but for any practical purpose such as everyday metrology and calibration, it is a constant.

Answer c is correct.

Reference: *CCT Primer*, Section II - 11.

2.5. The melting point of Gallium is a fixed point in the ITS-90 temperature system. The uncertainty of the value of this temperature is:

- a. 150 mK
- b. Zero
- c. 100 μ K
- d. 273.16 K

Solution: The ITS-90 temperature scale defines the exact value for each of the fixed points used as the basis for the scale. Since the values are definitions, their uncertainty is zero. The realization of the fixed point, in the form of a gallium cell, does have uncertainty.

Answer b is correct.

Reference: *CCT Primer*, Section II - 15/16.

2.6. A certificate for a traceable calibration must show evidence to support:

- a. How each step in the pyramid is traceable
- b. How the measurement uncertainty calculation was carried out
- c. The path of measurements back to the NMI
- d. The existence of a traceability path if needed for an audit

Solution: Identifying and documenting every step in the calibration pyramid could be difficult and more to the point, unnecessary. Usually, a calibration certificate simply identifies the traceable instruments and standards used for that particular calibration, and auditing the rest of the pyramid is left to the assessor should he or she wish to pursue it.

Answer d is correct.

Reference: *CCT Primer*, Section II - 36/37.

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- 2.7. The realization of a temperature fixed point is:
- 273.16 K
 - A physical object such as a freezing point cell
 - Defined at a known temperature by the ITS-90 standard
 - Not defined by any standard

Solution: The realization of a temperature fixed point refers to a physical object or experiment in which the definition of that fixed point is constructed and operated. Once in operation, the object reaches a temperature very close to the definition. ITS-90 specifies a series of fixed temperature points, each represented by the freezing or melting temperature of a pure substance.

Answer b is correct.

Reference: *CCT Primer*, Section II - 15/16.

- 2.8. Traceability is required when operating under ISO 9001 and related standards:
- At every step of the calibration pyramid
 - At every step of the calibration pyramid below national measurement standards
 - Only between the NMI and international standards
 - Only when government regulations or private contract require it

Solution: It is not appropriate to check or audit the values provided by national measurement standards. Everything below that must be traceable.

Answer b is correct.

Reference: *CCT Primer*, Section II - 34/35 (and logic).

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- 2.9. The ACME company's calibration procedure for their model VU-1 sound level meter calls for the exclusive use of ACME sound level calibrator model SLC-1. A technician has a rush job to calibrate a VU-1, but the SLC-1 is back at the factory in Europe for repair and calibration. He/she should:
- Use the technical description of the SLC-1 to locate an equivalent calibrator
 - Compare the VU-1 under test with a new VU-1 from stock, and certify the customer's unit if they are close to the same
 - Assemble a set of test equipment that is far better at generating the required signals than is the SLC-1, and proceed with the calibration
 - Stop work and notify the customer that the calibration cannot be completed until the proper IM&TE is available

Solution: The question requires reference to the company's calibration procedure. That document clearly states that the SLC-1 is the only piece of IM&TE that can be used for the job, and this fact overrides any technical considerations. One alternative that might be possible is not shown as an answer. The technician could appeal to the laboratory's quality manager for a temporary suspension of the rule based on the principles of temporary quality planning, and would then proceed with the work using the normal rules for substitution of IM&TE.

Note: This is based on an actual situation in an accredited laboratory.

Answer d is correct.

Reference: *CCT Primer*, Section II - 41/44.

- 2.10. In order to calibrate a digital ammeter, it is necessary to have:
- A digital voltmeter
 - A source or generator of current
 - Another digital ammeter as a reference standard
 - A convenient place to plug it in

Solution: A digital ammeter is calibrated by connecting it into a circuit that provides current to flow through it. Other calibrated or known means are used to measure the current in the circuit. The correctness of the reading of the unknown can be determined by comparing it to the known current.

The known means may be determined using a digital voltmeter or a digital ammeter, or it may be known by other means such as using an electronic calibrator. Thus, while answers **a** and **c** might be correct, they are not the only methods and are therefore not necessary.

Answer b is correct.

Reference: *CCT Primer*, Section II - 26/30.
