1. In general, a linear instrument is one which can be expressed by only one of the following equations,
a. *ax y* =
b. *b ax y* + =
c. *b x A y* log =
d. *bx Ae y* =
e. *c bx ax y* +
between the steady input *x* and the steady output *y* , where the coefficients *a*, *b*, etc. are constant.

2. In general, there are six major functions in a data acquisition chain, consisting of:
a. Sensing, wiring, noise reduction, digitizing, transmission, presentation, and storage and playback
b. Calibration, conversion, filtering, digitizing, transmission, presentation, and storage and playback
c. Sensing, multiplexing, conversion, transmission, presentation, and storage and feedback
d. Sensing, conversion, manipulation, transmission, presentation, and storage and playback
e. None of the above

3. An instrument's accuracy refers to:
a. How close it's measurements compare with a laboratory or primary standard
b. Its ability to repeat the measurement after some time delay
c. Its ability to transmit the data with minimum signal loss
d. The lack of hysteresis
e. The ability to model the instrument by at most a second-order ordinary differential equation

4. A 12-bit digitizer has
a. 1012
b. 212
c. 122
d. 1210
e. mV
counts.

5. One of the following statement is the most appropriate in experiment planning
a. The types of variables to be investigated.
b. The control must be exerted on the experiment.
c. The financial resources are available.
d. All of a – c.
e. None of a – c.

6. The sensitivity of an instrument is
a. Solely a zero-order property
b. Solely a first-order property
c. Solely a second-order property
d. The slope of the output to the input
e. None of the above

7. The deviation of an instrument reading from a *known* value is the
a. Error
b. Drift
c. Hysteresis
d. Resonance
e. Phase lag

8. For a digital data acquisition system, filtering serves to
a. Amplify the signal and to increase bandwidth
b. Convert the raw signals into a voltage and to improve the signal quality
c. Improve signal-to-noise ratio and to linearize the data
d. Improve data resolution and prevent or minimize aliasing
e. Improve the signal-to-noise ratio and to prevent or minimize aliasing

9. One of the following is **NOT** a way of reducing noise in an electronic circuit for the purpose of improving signal-to-noise ratio
a. Shielding the electronics
b. Filtering the signal
c. Incorporating high-gain feedback into the circuitry
d. Ensure proper grounding
e. Sampling at a high rate

10. One of the following is **NOT** a purpose of calibration
a. Determine the resolution of an instrument
b. Determine the accuracy of an instrument
c. Comparison of an instrument with a primary standard
d. Comparison of an instrument with a secondary standard
e. Comparison of an instrument with a known input source

11. One of the following sets of parameters is required for modeling a first-order dynamic system
a. phase lag and amplitude ratio
b. time constant and amplitude ratio
c. time constant and sensitivity
d. dynamic range and sensitivity
e. dynamic range and signal-to-noise ratio

12. Consider a first-order system described mathematically by ( ) *t F x a*
dt
dx a o = + 1 .
The instrument's sensitivity is
a. *o a* 1
b. 1 1 *a*
c. *o a a*1
d. 1 *a ao*
e. *o a*

13. Consider the same first-order system as Problem 12. If the excitation is sinusoidal with an angular frequency of ω, such that ( ) *t A t F* ω sin = , then the magnitude ratio is given by
a. M (ω) = (1+
b. M (ω) ( )2 1 ωτ ω + = *M*
c. M (ω) ωτ ω + = 1 1 *M*
d. M (ω) ( )2 1 1 ωτ ω + = *M*
e. M (ω) ( ) ( )2 2 1 ωτ ωτ ω + = *M*
where τ is the time constant.

14. When an instrument, described by a first-order differential equation, is subjected to an oscillatory input, it will suffer
a. Heating and amplitude attenuation
b. Resonance and drift
c. Resonance and phase lag
d. Phase lag and amplitude attenuation
e. Phase lag and amplitude amplification

15. When an instrument, described as a first-order system, is subjected to a step input, the transient response is
a. Always sinusoidal
b. Always exponential
c. Sometimes sinusoidal depending on the time constant
d. Sometimes exponential depending on the time constant
e. An exponentially damped sinusoid

16. The time constant of a first-order measurement system is known to be 2 s. If the device is used to measure an oscillating signal with an angular frequency of 5 rad/s, the phase lag is approximately
a. 0o
b. 5.7o
c. 45o
***d.* 84°**
e. 90o

17. The time constant of a first-order system is defined as the time it takes for the system to reach
a. 0.5
b. 0.632
c. 0.707
d. 0.9
e. 1
of the final state when subjected to a step excitation.

18. For an instrument described as a first-order system, the phase lag is typically expressed in angular form. The phase lag is actually
a. A time delay
b. An amplitude attenuation
c. An analog response
d. Noise in the system
e. A nonlinear effect

19. One of the following sets of parameters is required for modeling a second-order dynamic system
a. Exponential rise time, phase lag and amplitude ratio
b. Damping ratio, sensitivity and natural frequency
c. Dynamic range, sensitivity and natural frequency
d. Time constant, amplitude ratio and sensitivity
e. Phase shift, hysteresis and saturation

20. When subjected to a step input, a second-order dynamic system that has a damping ratio of less than one will undergo
a. A resonating motion
b. An exponentially damped oscillation
c. An exponentially increasing oscillation
d. A logarithmically damped oscillation
e. An amplified oscillation

21. Consider a second-order system subjected to a harmonic excitation
t F kx
dt
dx c
dt
x d m o ω cos 2
2
= + +
The *m* , *c* and *k* coefficients are usually associated with
a. A mass, damper and spring respectively
b. A moment and two constants
c. A mass, a deflection and resonance

d. A mass, a strobe and a time delay
e. None of the above

22. The rise time of a second-order system may be reduced by
a. Raising its sensitivity
b. Reducing its "mass equivalent"
c. Reducing the damping ratio (or damping coefficient)
d. Amplifying its response
e. Tuning the system to resonate

23. Manufacturers of instruments with a second-order response would typically want their instruments to operate within an amplitude band of
a. ±10 %
b. ±3 %
c. ±36.8 %
d. ±10 dB
e. ±3 dB

24. Amplifiers are usually found in digital data acquisition systems because
a. Signals are noisy
b. Signals do not have enough bandwidth
c. Signals are usually small and do not make use of the dynamic range of the digitizer
d. Signals are nonlinear
e. Signals are multiplexed

25. The signal-to-noise ratio in dB is given by *noise signal SNR* 10 10 log 20 log 20 = . If the noise level of a useful signal is 0.1%, this is equal to
a. 20 dB
b. 30 dB
c. 60 dB
d. 100 dB
e. 1000 dB