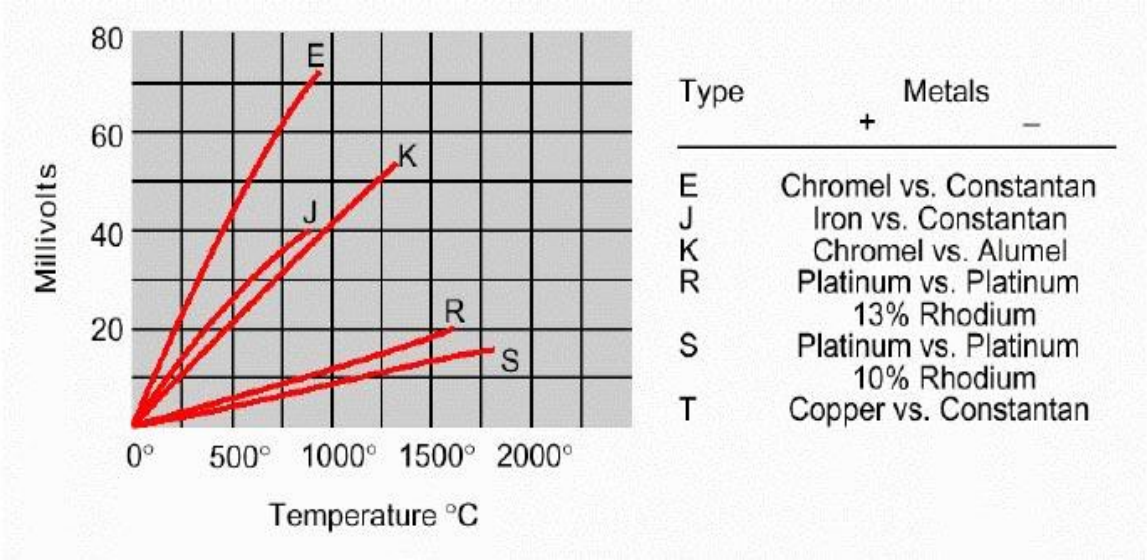
Signals

1) Explain what is meant by the following terms:
   i) *Accuracy*
   ii) *Resolution*
   iii) Precision
2) During maintenance, a sensor was discovered to be precise but not accurate. What steps should be taken to improve the performance of the sensor?
3) Distinguish between a signal and data. What process is necessary to change a signal into data?
4) Distinguish between *information* and *knowledge* in a signal. What process is necessary to change information into knowledge?
5) What is meant by the dynamic range of a sensor output?
6) A temperature sensor has a range of -200°C to +550°C and a resolution of 0.1°C. Calculate the dynamic range of the sensor in decibels.
7) What is meant by drift in the performance of a sensor?
8) What is meant by rise time in the performance of a sensor? Describe an experiment to measure the rise time of a thermocouple.
9) Looking at the chart below, give reasons why K-type thermocouples are the most commonly used in industry.



Type	Metals +	Metals −
E	Chromel vs. Constantan	
J	Iron vs. Constantan	
K	Chromel vs. Alumel	
R	Platinum vs. Platinum 13% Rhodium	
S	Platinum vs. Platinum 10% Rhodium	
T	Copper vs. Constantan	

10) What is the sensitivity of the K-type thermocouple above in mV/°C?
11) During calibration, a flowmeter measures takes a series of measurements of fluid flow and gets the following readings: 3.45kg/s, 3.56kg/s, 3.13kg/s, 3.38kg/s, 3.40kg/s, 3.33kg/s, and 3.35kg/s. The actual flow rate during calibration is 3.40kg/s. Looking at these readings, characterise the performance of the flowmeter with respect to accuracy, precision, and resolution.
12) Over several months, a light sensor measures takes a series of measurements of light intensity of a calibration standard and gets the following figures: 2.15Wm^{-2}, 2.18Wm^{-2}, 2.22Wm^{-2}, 2.24Wm^{-2}, 2.28Wm^{-2}, 2.32Wm^{-2}, 2.32Wm^{-2}, The actual light intensity should be constant and equal to 2.01Wm^{-2}. Looking at these measurements, characterise the performance of the light sensor.

Sensor Classification

13) Explain the difference between a first order sensor and a second order sensor. Give an example of each.
14) Explain the difference between an analogue and a digital sensor, giving an example of each.
15) What are the advantages and disadvantages of null mode sensors compared to deflection mode sensors?

Noise

16) How can fluctuation noise be distinguished from shot noise or Johnson noise based on its spectrum?
17) Discuss thermal noise (Johnson noise) in terms of its origins, its frequency spectrum, and steps that can be taken to reduce it.
18) A pressure sensor has a resistance of 2500Ω. It operates over a bandwidth of $2x10^6$Hz and produces a mean signal of 3.5V. Calculate the shot (quantisation) noise from this detector using the following equation: $V_{shot\ noise} = \sqrt{2eVR\Delta f}$. The charge on the electron is e= $1.6x10^{-19}$C.
19) A light detector has a resistance of 2500Ω. It operates over a bandwidth of $2x10^6$Hz and at a temperature of 310K. Use the equation $V_{thermal\ noise} = \sqrt{4kTR\Delta f}$ to calculate the thermal noise from this detector. Boltzmann's Constant has a value of k = $1.38x10^{-23}$J/K