



# Knowledge Probe (Pre-Assessment) Instructor Guide

## Notes to Instructor

The *MEMS: Making Micro Machines Learning Module* supports the film of the same name with activities and assessments. The film is an overview of MEMS (microelectromechanical systems), produced and directed by Ruth Carranza of Silicon Run Production. A DVD can be ordered through the SCME website while supply lasts (<http://scme-nm.org>) or you can purchase it or access it online via Silicon Run (<http://siliconrun.com/our-films/mems/>).

This Knowledge Probe (KP) is to assess the participants' current knowledge of MEMS, MEMS applications, fabrication, packaging, and design. This KP should be completed prior to viewing the film and completing the activities. The KP and the final assessment can be compared after viewing the film and completing the activities in order to assess knowledge gained.

This KP is part of the *MEMS: Making Micro Machines Learning Module*. Below are the contents of this learning module:

- **Knowledge Probe – Pre-assessment**
- Activity 1 – Microfluidics
- Activity 2 – Optical MEMS
- Activity 3 – Sensors
- Supplement – Film Script
- Final Assessment

This assessment consists of 20 multiple choice or true/false questions. The correct answer is in **red**.

## Introduction

This knowledge probe is part of the learning module based on the film MEMS: Making Micro Machines, an overview of microelectromechanical systems, produced and directed by Ruth Carranza of Silicon Run Production. The purpose of this knowledge probe is to determine your knowledge of MEMS, MEMS applications, fabrication, packaging and design prior to viewing the film and completing the activities. You are not expected to know all of the answers to the questions below. Just answer them to the best of your current knowledge.

There are twenty (20) questions.

1. MEMS is an acronym for
  - a. Micro Energy Manufacturing Systems
  - b. Microelectromechanical Systems**
  - c. Microelectronics Memory Systems
  - d. Micro Electron Machines and Semiconductors
  - e. Many Engineers Making Stuff
  
2. MEMS are tiny micromachines that can consist of several types of components. Which of the following types of components would you find in a MEMS?
  - a. Mechanical
  - b. Electrical
  - c. Optical
  - d. Fluidic
  - e. All of the above could be found in MEMS**
  
3. MEMS inertial sensors sense change in which of the following?
  - a. Acceleration
  - b. Pressure
  - c. Rotation
  - d. Color
  - e. a and c**
  
4. The MEMS device used to trigger airbag deployment is a(n)
  - a. Pressure Sensor
  - b. Actuator
  - c. Gyroscope
  - d. Accelerometer**
  - e. Light Meter

5. Which of the following components is used in a MEMS pressure sensor to sense changes in pressure, for example blood pressure or tire pressure?
  - a. Proof mass
  - b. Membrane**
  - c. Gyroscope
  - d. Moveable mirror
  - e. a and c
  
6. Digital Mirror Devices are used in which of the following applications?
  - a. Digital projectors**
  - b. Medical imaging equipment
  - c. Computer monitors
  - d. Data communication networks
  
7. MEMS incorporate microfluidic structures in which of the following applications?
  - a. Inertial Sensors
  - b. Digital Mirror Devices
  - c. Inkjet print heads**
  - d. Blood Pressure Monitors
  - e. b and c
  
8. In a thermal inkjet print head, which of the following pushes the ink from the micronozzle after the resistive heater is turned on?
  - a. Convection Cycle
  - b. Microdroplet
  - c. Bubble**
  - d. Powder
  - e. Pixel
  
9. What is the optical MEMS device that consists of an array of millions of micromirrors?
  - a. Digital Mirror Device (DMD)**
  - b. Millions of Mirrors Device (MMD)
  - c. Digital Pixel Device (DPD)
  - d. Mirror Array (MA)
  
10. What type of MEMS components move other MEMS devices such as micromirrors?
  - a. Pressure Sensors
  - b. Actuators**
  - c. Gyroscopes
  - d. Accelerometers
  - e. Yokes

11. Which of the following MEMS fabrication process steps transfers a pattern into a light sensitive film on the wafer's surface?
  - a. Etch
  - b. Photolithography**
  - c. Chemical vapor deposition
  - d. Sputtering
  - e. Deep Reactive Ion Etch (DRIE)
  
12. Which of the following MEMS fabrication process steps is used to remove unwanted material from a thin film on the surface of the wafer or from within the wafer substrate?
  - a. Etch**
  - b. Photolithography
  - c. Chemical vapor deposition
  - d. Sputtering
  
13. Much of the technology used to fabricate microelectronics (e.g., CMOS chips) can be applied to making MEMS devices.
  - a. True**
  - b. False
  
14. In MEMS fabrication what is the layer called that provides spacing between two or more moving components by first being deposited and then later removed?
  - a. Structural layer
  - b. Conductive layer
  - c. Sacrificial layer**
  - d. Masking layer
  - e. Insulating layer
  
15. Which of the following fluidic properties allows a liquid to refill a microchannel without the use of valves or pumps?
  - a. Stiction
  - b. Torsion
  - c. Energy transfer
  - d. Capillary action**
  - e. Laminar flow
  
16. Which of the following is an advantage of the micronozzles in an inkjet print head being less than 100 microns?
  - a. A higher viscosity of ink
  - b. Greater print resolution (more pixels)
  - c. Minimal turbulence in the flow of the ink
  - d. Self-filling microchannels (no need for a mechanical pump)
  - e. b and d**

17. In the game Guitar Hero, accelerometers measure the movement of the guitar by measuring a change in which of the following electrical characteristics of the accelerometer?
- a. resistance
  - b. inductance
  - c. voltage
  - d. capacitance**
  - e. electromagnetic
18. Which of the following personnel is NOT needed as a member of the design team for a new MEMS device?
- a. Mechanical engineer
  - b. Electrical engineer
  - c. Marketing personnel
  - d. Systems engineer
  - e. All of the above are needed as members of the design team**
19. Before a MEMS device is sent to manufacturing, a model of the design must be constructed and tested to ensure that the design meets the customer requirements and specifications.
- a. True**
  - b. False
  - c. Most of the time, but not always
20. Which of the following macro-sized devices is LEAST likely to be redesigned to micro size due to impracticality?
- a. A rotary motor
  - b. Hydraulic pump
  - c. A gear drive
  - d. Stadium Lights**
  - e. A syringe

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