IISME SUMMER FELLOWSHIP 2005

# EDUCATION TRANSFER PLAN

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SFUSD

## A Career in Math and Science

Starting with a comparison of salaries earned according to the length of stay in school, this unit aims to introduce students to different career choices and to help students learn various aspects of math and science including statistics, geometry and measurement, density, and quantum mechanics using the context of computer chips production.

### Day1

Students will receive a table comparing salaries earned according to the number of years at school (Appendix 1). They will use EXCEL to create a bar graph showing the information. Students will also start a journal; the first entry would be on how much education they intend to pursue.

### Day 2

Students will receive a list of career options (Appendices 2 & 3). They will then work in groups of four on a computer and use information from the website: http://www.careers.org/career-reference/occupations/cref-index.html to find out the median salaries and requirements of the jobs listed. Students will write into their journal what possible career they would like to go into.

### Day 3

The teacher will use the list of career options to conduct a class survey to find out students' interest in those careers. Students will organize the data (Appendix 4) and use Excel to create a bar graph to show the information. Students will write into their journal what area and what level of education they might want to get before they can start the career of their choice.

Day 4
The teacher will show a web video on **"Atoms: The Space Between"** available online http://www.teachersdomain.org/6-8/sci/phys/matter/atoms/index.html and use the printout from the same website to conduct a class discussion on atoms.

Day 5
The teacher will show a web flash interactive on **"Periodic Table of Elements"** available online http://www.teachersdomain.org/6-8/sci/phys/matter/ptable/index.html.
Students will use a copy of the 'Periodic Table of Elements' to do a scavenger hunt activity, available online http://www.teachersdomain.org/9-12/sci/phys/matter/lp_pertable/ to get themselves familiar with names and properties of elements.
Students will do a research on the element 'Silicon' for homework.

Day 6
The teacher will show a web video on **"Quantum Mechanics"** to help students understand the idea of electrons, available online http://www.teachersdomain.org/9-12/sci/phys/matter/quantum/index.html, and use the printout from the same website to conduct a class discussion on electrons.

Day 7
The teacher will show a Power Point presentation on the history and development of semi-conductors (Appendix 5).
Students will write into their journals on what they think about all those scientists who contributed in the development of the IC industry.

Day 8
The teacher will show a Power Point presentation on the manufacturing process of silicon chips (Appendix 6).
Students will write into their journals on how technology changes the way people live.

Day 9
The teacher will introduce the use of a clean room in the IC industry and have students set up proportions to find out the amount of dust particles in clean rooms of different dimensions (Appendix 7).

Day 10

The teacher will introduce 'meter' as the metric measure for length and use the video **"Powers of Ten"** available online http://www.micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html, to deliver the idea of significant numbers and very large/small numbers.

Day 11

The teacher will explain the definition and applications of significant numbers and scientific notation. Students will practice on problems involving significant numbers and scientific notation.

Day 12

The teacher will introduce some specifications of wafers (Appendix 8) and will have students calculated the area based on a given diameter. Students will also calculate different volumes and compute the density of silicon.

Day 13

Using the results from previous lesson, students will explore how the areas and volumes change with the diameters. Students will use the data and EXCEL to plot graphs showing diameter vs. area. Students will discuss how area changes with diameter.

Day 14

The teacher will use the ten career options identified earlier and conduct a class survey to find out students' current interest in those careers. Students will organize the data and use Excel to create a bar graph to show the information. Students will write into their journal how the new graph differs from the one that they created earlier.

Homework. Students will go online and do a search on requirements leading to a career in the IC industry.

FINAL ASSESSMENT

Students will prepare a portfolio on what they have learned over the course of this unit (Appendix 9). The portfolio will be assessed using a rubric (Appendix 10).

Appendix 1

# EARNING VS EDUCATION

Use the data in the following table to create a bar graph.

| EDUCATION | MEAN ANNUAL EARNING ($) |
|---|---|
| High School Dropout | 18978 |
| High School Graduate | 27915 |
| Associate Degree | 35958 |
| Bachelor Degree | 51207 |
| Master's Degree | 62512 |
| Doctorate Degree | 88471 |
| Professional Degree | 115212 |

Appendix 2

# CAREER CHOICES

DIRECTIONS: Fill in Columns 4 and 5 by using information from the website: http://www.careers.org/career-reference/occupations/cref-index.html.

| | OCCUPATION | JOB | MEDIAN SALARY | REQUIREMENTS |
|---|---|---|---|---|
| 1 | Management | Sales Manager | | |
| | | Marketing Manager | | |
| 2 | Financial | Accountant | | |
| | | Insurance Underwriter | | |
| 3 | Engineering | Electrical Engineer | | |
| | | Computer Hardware Engineer | | |
| 4 | Mathematics | Computer Programmer | | |
| | | Computer Systems Analyst | | |
| 5 | Science | Physicist | | |
| | | Medical Scientist | | |
| 6 | Social Service | Mental Health Counselor | | |

| | | | | |
|---|---|---|---|---|
| 7 | Legal | Lawyer | | |
| 8 | Teaching | Middle School Teacher | | |
| 9 | Media | Fashion Designer | | |
| 10 | Health | Surgeon | | |
| 11 | Protective Service | Police Patrol Officer | | |
| 12 | Food Preparation | Waiter/Waitress | | |
| 13 | Personal Care | Child Care Worker | | |
| 14 | Sales | Retail Salesperson | | |
| 15 | Communications | Teller | | |
| 16 | Agricultural | General Farmworker | | |
| 17 | Construction | Construction Laborer | | |
| 18 | Maintenance & Repair | Home Appliance Repairer | | |
| 19 | Assembling | Butcher/Meat Cutter | | |
| 20 | Transportation | Bus Driver, School | | |
| | | Bus Driver, Transit and Intercity | | |
| 21 | Military | Soldier<br>(Search with www.goarmy.com) | | |

Appendix 3

# CAREER CHOICES

(Teacher's Version)

DIRECTIONS: Fill in Columns 4 and 5 by using information from the website: http://www.careers.org/career-reference/occupations/cref-index.html.

| | OCCUPATION | JOB | MEDIAN SALARY | REQUIREMENTS |
|---|---|---|---|---|
| 1 | Management | Sales Manager | 92 900 | |
| | | Marketing Manager | 98 200 | |
| 2 | Financial | Accountant | 54 100 | |
| | | Insurance Underwriter | 51 800 | |
| 3 | Engineering | Electrical Engineer | 78 900 | |
| | | Computer Hardware Engineer | 89 600 | |
| 4 | Mathematics | Computer Programmer | 71 700 | |
| | | Computer Systems Analyst | 68 200 | |
| 5 | Science | Physicist | 84 000 | |
| | | Medical Scientist | 64 500 | |
| 6 | Social Service | Mental Health Counselor | 38 400 | |

| | | | | |
|---|---|---|---|---|
| 7 | Legal | Lawyer | 117 800 | |
| 8 | Teaching | Middle School Teacher | 52 400 | |
| 9 | Media | Fashion Designer | 55 200 | |
| 10 | Health | Surgeon | 145 600 | |
| 11 | Protective Service | Police Patrol Officer | 61 900 | |
| 12 | Food Preparation | Waiter/Waitress | 16 000 | |
| 13 | Personal Care | Child Care Worker | 19 100 | |
| 14 | Sales | Retail Salesperson | 19 700 | |
| 15 | Communications | Teller | 21 700 | |
| 16 | Agricultural | General Farmworker | 16 000 | |
| 17 | Construction | Construction Laborer | 30 500 | |
| 18 | Maintenance & Repair | Home Appliance Repairer | 34 200 | |
| 19 | Assembling | Butcher/Meat Cutter | 28 600 | |
| 20 | Transportation | Bus Driver, School | 27 000 | |
| | | Bus Driver, Transit and Intercity | 36 600 | |
| 21 | Military | Soldier<br>(Search with www.goarmy.com) | 19 000 | |

Appendix 4

# CAREER CHOICES SURVEY

DIRECTIONS: Fill in Columns 4 and 5 by using information from the website: http://www.careers.org/career-reference/occupations/cref-index.html.

| | OCCUPATION | JOB | TALLY | NUMBER OF PEOPLE CHOOSING THIS JOB |
|---|---|---|---|---|
| 1 | Management | Sales Manager | | |
| | | Marketing Manager | | |
| 2 | Financial | Accountant | | |
| | | Insurance Underwriter | | |
| 3 | Engineering | Electrical Engineer | | |
| | | Computer Hardware Engineer | | |
| 4 | Mathematics | Computer Programmer | | |
| | | Computer Systems Analyst | | |
| 5 | Science | Physicist | | |
| | | Medical Scientist | | |
| 6 | Social Service | Mental Health Counselor | | |

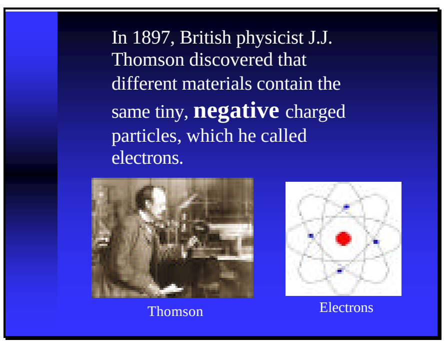
| | | | | |
|---|---|---|---|---|
| 7 | Legal | Lawyer | | |
| 8 | Teaching | Middle School Teacher | | |
| 9 | Media | Fashion Designer | | |
| 10 | Health | Surgeon | | |
| 11 | Protective Service | Police Patrol Officer | | |
| 12 | Food Preparation | Waiter/Waitress | | |
| 13 | Personal Care | Child Care Worker | | |
| 14 | Sales | Retail Salesperson | | |
| 15 | Communications | Teller | | |
| 16 | Agricultural | General Farmworker | | |
| 17 | Construction | Construction Laborer | | |
| 18 | Maintenance & Repair | Home Appliance Repairer | | |
| 19 | Assembling | Butcher/Meat Cutter | | |
| 20 | Transportation | Bus Driver, School | | |
| | | Bus Driver, Transit and Intercity | | |
| 21 | Military | Soldier<br>(Search with www.goarmy.com) | | |

Appendix 5

Power Point Presentation: History and Development of Semiconductors

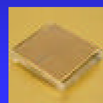
Slide 1


Slide 2



Slide 3

In certain materials, such as metals, some of the electrons could have enough energy for them to move freely inside the material, hence transferring electricity. These materials are called **CONDUCTORS** .


GOLD


ALUMINUM

Slide 4

**Electrical Conductors:**

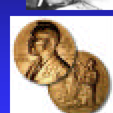
Silver, copper, gold, aluminum, iron, steel, brass, bronze, mercury, graphite, dirty water, wet concrete

**Electrical Insulators:**

Glass, rubber, oil, asphalt, fiberglass, porcelain, ceramic, quartz, (dry) cotton, (dry) paper, (dry) wood, plastic, air, pure water

Slide 5

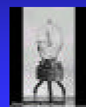
In 1906 Thomson was awarded the Nobel Prize in physics for his research into the discharge of electricity in gases.


Nobel medal (Front & back)

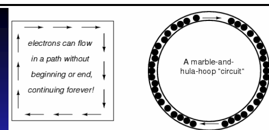
Slide 6

In 1904, British engineer John A. Fleming developed the first **bi-polar vacuum tube**, which allows electric current to flow only in one direction.

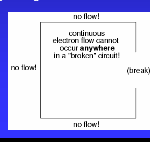

Fleming


Vacuum tube

Slide 7



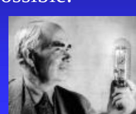

•A *circuit* is an unbroken loop of conductive material that allows electrons to flow through continuously without beginning or end.

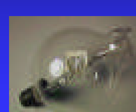



Switch control (I/O)

Slide 8

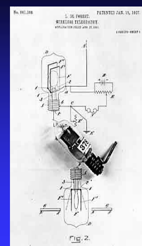
In 1906, American physicist Lee de Forest invented the **tri-polar vacuum tube**, which could amplify a small signal and made wireless voice transmission possible.


Lee De Forest


Vacuum Tube

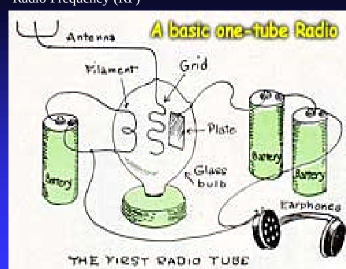
Slide 9

De Forest called his device the Audion Tube. At the right is the original Audion patent, dated January, 1907. The Audion was used to receive, amplify, or transmit radio signals.



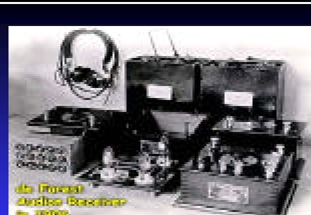
Slide 10

Radio Frequency (RF)




Audio Frequency (AF)

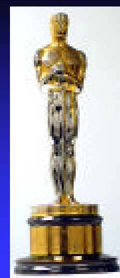
Slide 11




In 1914, de Forest sold his innovation to AT&T for $50,000.

Slide 12

Deforest never received a Nobel prize. But he was awarded an Oscar in 1959 for his invention which brought sound to the motion picture.



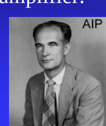
Slide 13

De Forest is called “the Father of Radio”

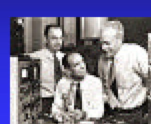
Vacuum tube radios

Slide 14

In 1947, William Shockley, Walter Brattain & John Bardeen invented the **TRANSISTOR**, which is a semi-conductor-based amplifier.

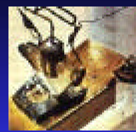



Shockley



Shockley, Brattain & Bardeen

Slide 15



The first transistor

Today's transistor

Slide 16

**Semi-conductors,** such as silicon and germanium allow electrons flow through them in a controllable manner under special conditions. This property makes semi-conductors useful in the production of transistors.

Slide 17

Silicon makes up 27.8% of the earth's crust. It is the second most abundant element in nature, surpassed only by oxygen.

*Silicon can be found in quartz, flint, and beach sand amongst many others. And it is the main component in building materials like cement, brick, and glass.*

Slide 18

Symbol: Si

Atomic Number: 14

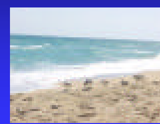
Atomic Mass: 28.0855

Proton: 14 Neutron: 14

Electronic Configuration: 2, 8, 4

Classification: Metalloid


Quartz


Sand

Slide 19

**Vacuum Tube**

**vs.**

**Semi-conductor based Transistor**

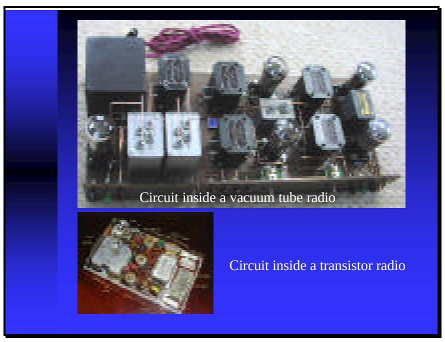
The vacuum tube is hot, bulky, fragile and short-lived. The transistor is much smaller, could do the job faster, more reliably and with 1 million times less power.

Slide 20

So the transistor quickly replaced the vacuum tube in its role to control currents, amplify signals and serve as a switch in a circuit.

Slide 21


Slide 22

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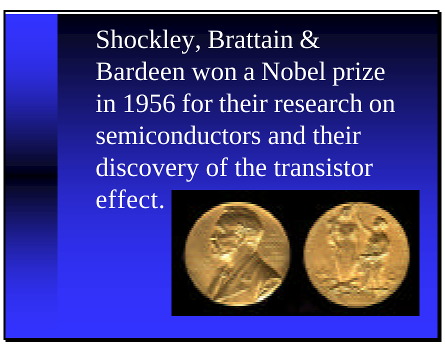


Slide 24

In 1958, American engineers Jack Kilby and Robert Noyce

Kilby

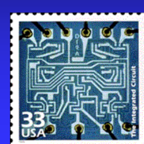
Noyce

separately invented the first **integrated circuits (IC).**

Slide 25

The integrated circuit also known as the CHIP is a piece of semiconductor with many transistors all etched into it.

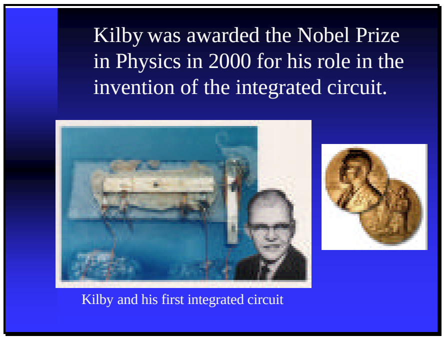
This invention opened up a new world of micro-electronic applications.




Slide 26

The chips manage data by controlling electron flow to make words, numbers, sounds, images and colors. They are used worldwide by manufacturers of electronic appliances and indirectly by nearly every human on earth.

Slide 27

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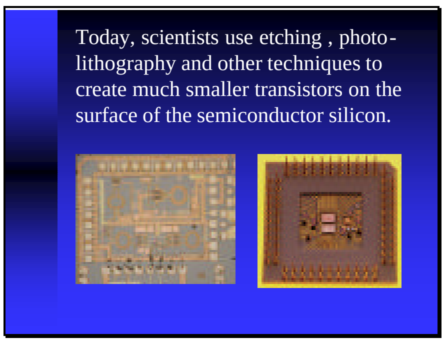


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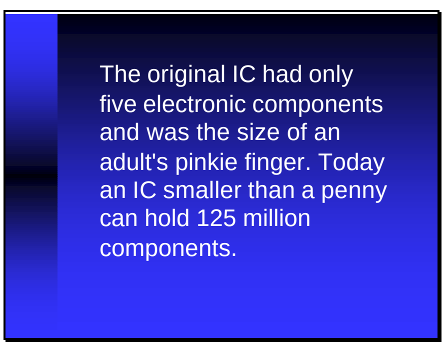

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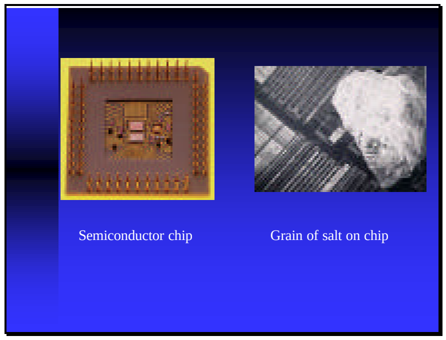
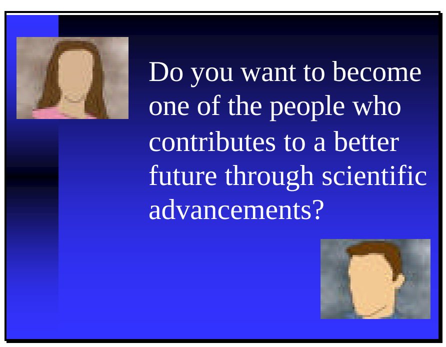



Slide 31

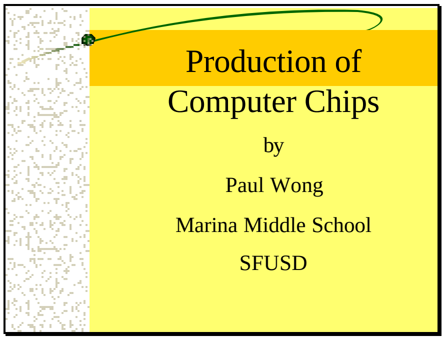

Slide 32



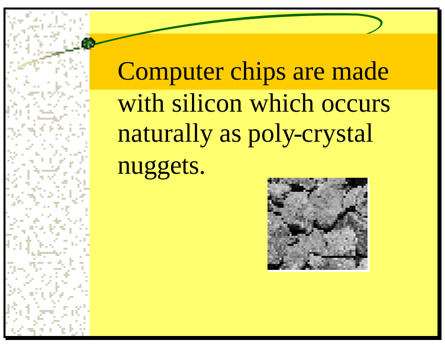
Appendix 6

Power Point Presentation: Production of Computer Chips

Slide 1



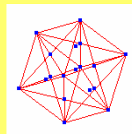

Slide 2



Slide 3

Three dimensional structure of a

Single Crystal Silicon

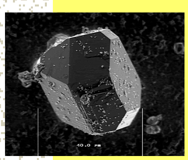


Slide 4

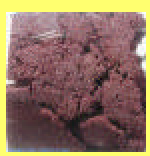
A poly-crystal silicon is formed by many small single crystals with different orientations and cannot be used for semiconductor devices.

Slide 5

Poly-crystal silicon nuggets are melted with small quantities of Group III or Group IV elements such as boron and phosphorus, in order to have the desired electrical properties.

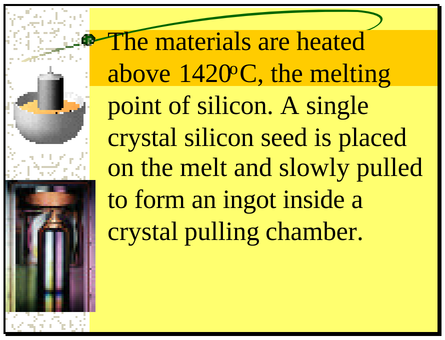


Boron



Phosphorus

Slide 6

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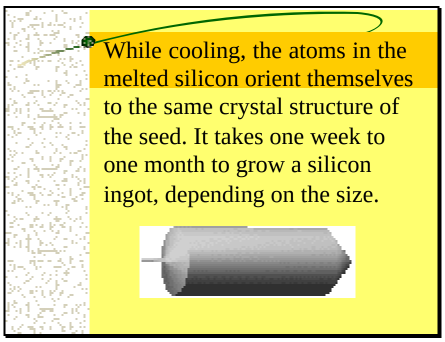


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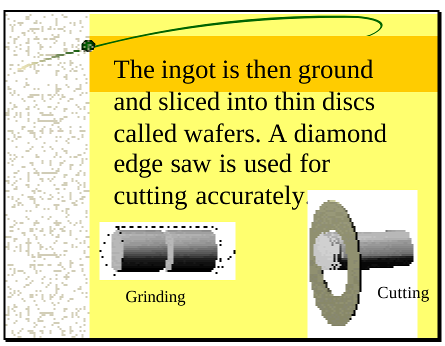
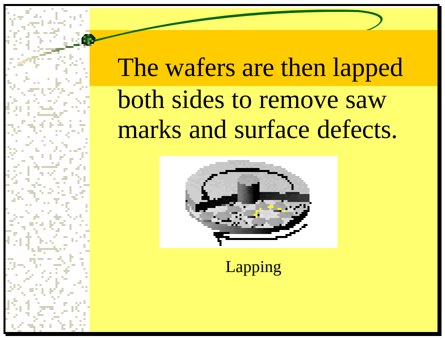
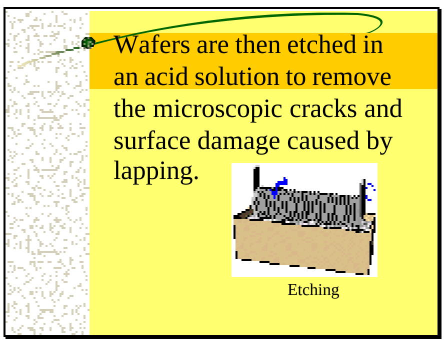


Slide 9




Slide 10

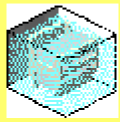



Slide 11


polishing

Slide 12

The wafers are finally cleaned using ultra-pure water and chemicals.

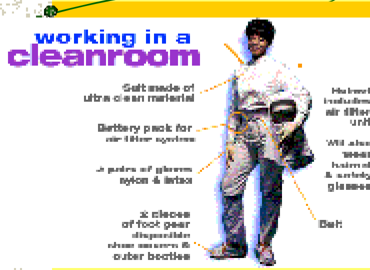


Cleaning

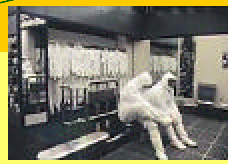
Slide 13

The polishing and cleaning processes have to be done in a very clean room. Workers must wear cleanroom suits that are designed to not collect any dust particles.

Slide 14



Slide 15



Putting on a cleanroom suit can take 30 to 40 minutes. A pro can do it in 5 minutes.

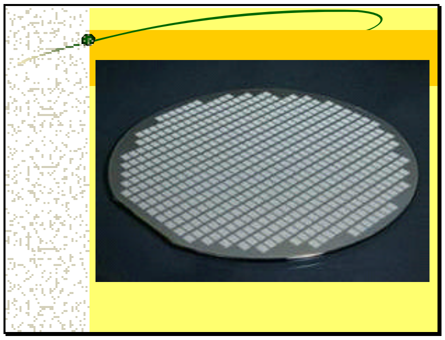
Slide 16

The wafer is now ready for making computer chips.

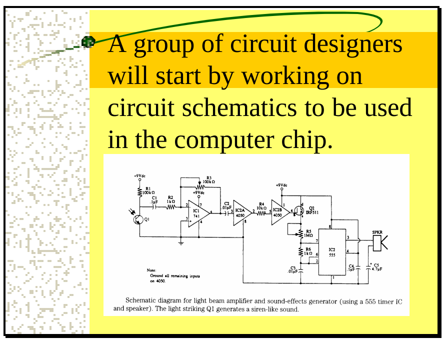
Slide 17

The silicon wafer will be etched with millions of tiny transistors hundred times smaller than a human hair.

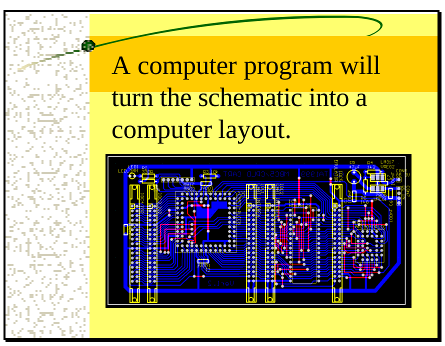
Slide 18



Slide 19




Slide 20



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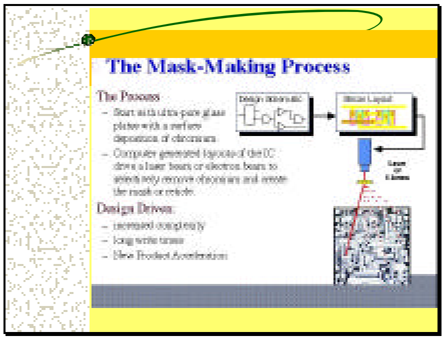


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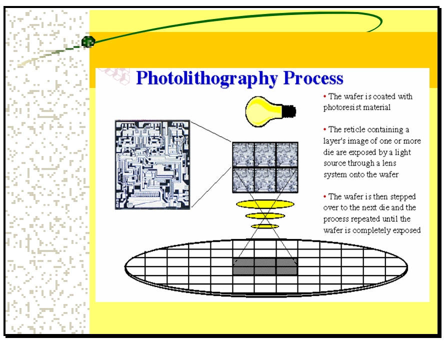


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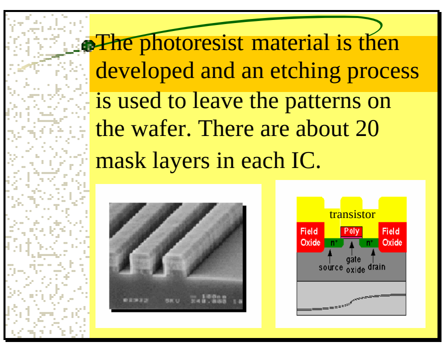

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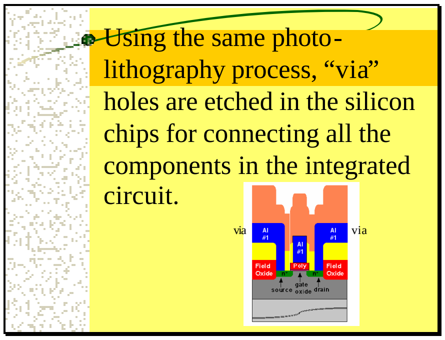


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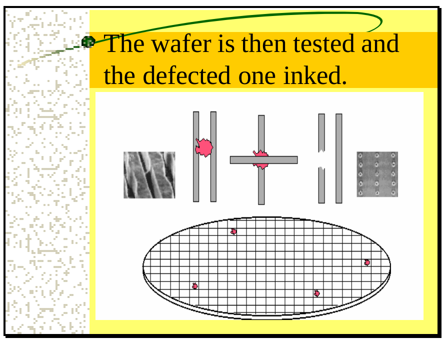


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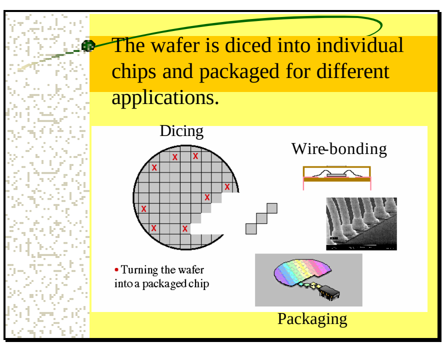

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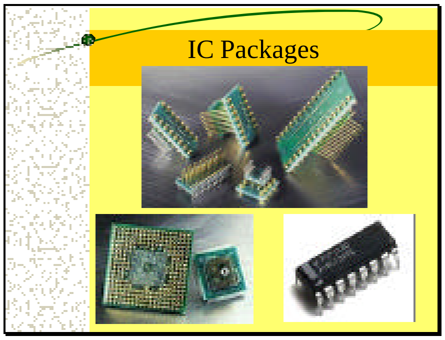


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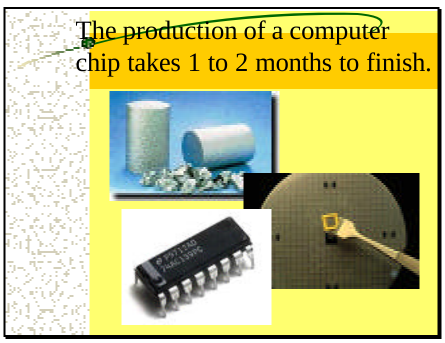

Appendix 7

A microprocessor (IC) about the size of a dime, contains millions of microscopic transistors. The tiniest speck of dust to a chip would be like a Godzilla-sized footprint to us, and it could ruin thousands of transistors. So the production of microprocessors has to be in a cleanroom.

A class 1 cleanroom has less than 1 particle and a class 10 cleanroom has less than 10 particles >0.5µm in size per $ft^3$ of air respectively. In a classroom, there could be 5 million particles per cubic foot.

Example:

In a class 10 cleanroom, how many particles are there in one cubic yard of air?

1 yd = 3 ft

$1yd^3 = (3\ ft)^3$

$= 3 \times 3 \times 3\ ft^3$

$= 27\ ft^3$

$$\frac{10 \text{ particles}}{1\ ft^3} = \frac{x \text{ particles}}{1\ yd^3}$$

becomes

$$\frac{10 \text{ particles}}{1\ ft^3} = \frac{x \text{ particles}}{27\ ft^3}$$

or

$$\frac{10}{1} = \frac{x}{27}.$$

Cross-multiplying,

$x(1) = 10(27)$

$x = 270$

Exercise 1:

In a class 10 cleanroom, how many particles are there in one cubic meter of air?

1 m = 3.3 ft

Exercise 2:

If our classroom is a class 10 cleanroom, how many dust particles would there be?

Appendix 8

# Some Measurements of Silicon Wafers

| Diameter (mm) | Thickness (μm) | Weight (g) | Area ($cm^2$) | Volume ($cm^3$) | Density ($g/cm^3$) |
|---|---|---|---|---|---|
| 100 | 525 | 9.6 | | | |
| 125 | 625 | 17.9 | | | |
| 150 | 675 | 27.8 | | | |
| 200 | 725 | 53.0 | | | |
| 300 | 775 | 128.0 | | | |

Appendix 9

# Portfolio

The portfolio you are going to work on is a meaningful collection of your work that tells the effort you have put in, your learning progress, and your achievement over the course of this math and science unit

The portfolio should include

- Journal entries
- Web research
- Math work
- Graphs & Charts
- Reflections

All items from the above list should be accompanied by explanations on the significance of the work.

On top of the Portfolio Rubrics, the following list of question could be helpful for you to prepare your portfolio:

- What are the reasons for including this work in your portfolio?
- What problems did you encounter? How did you solve them?
- What goal did you set for yourself? How well did you accomplish them?
- If you could work further on this piece, what would you do?
- How does this relate to what you have learned before?
- Of the work you have done recently, what do you feel most confident about?
- Of the work you have done recently, what do you feel not too clear and want to find out more?

Appendix 10

# Portfolio Rubrics

| CATEGORY | Proficient (4) | Advanced (3) | Basic (2) | Beginning (1) |
|---|---|---|---|---|
| **Organization** | Content is well organized using a table of contents, headings or bulleted lists to group related material. | Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed. | Content is logically organized for the most part. | There was no clear or logical organizational structure, just lots of facts. |
| **Math Content** | All problems are completed. 90-100% of the steps and solutions have no mathematical errors. | Almost all of the problems are completed. Almost all (80-89%) of the steps and solutions have no mathematical errors. | More than half of the problems are completed. Most (70-79%) of the steps and solutions have no mathematical errors. | None or a few of the problems are completed. Less than 70% of the steps and solutions have no mathematical errors. |
| **Graphs** | A creative title is clearly printed at the top of the graph. The axes are clearly labeled and units are included. A graph is accurately produced. | Title is clearly printed at the top of the graph. The axes are clearly labeled. A graph is accurately produced. | A title is present at the top of the graph. The axes are labeled. A graph is there. | A title is not present. The axes are not labeled. A graph is there. |
| **Science Content** | Covers topic in-depth with details and examples. Subject knowledge is excellent. | Includes essential knowledge about the topic. Subject knowledge appears to be good. | Includes essential information about the topic but there are 1-2 factual errors. | Content is minimal OR there are several factual errors. |
| **Information Gathering** | Accurate information taken from several sources in a systematic manner. All sources are referenced. | Accurate information taken from a couple of sources in a systematic manner. Most sources are referenced. | Accurate information taken from a couple of sources but not systematically. A few sources are referenced. | Information taken from only one source and/or information not accurate. Source is not referenced. |
| **Journal** | All entries are made and all are dated and neatly entered. | Most entries are made and most of the entries are dated and neatly entered. | Several entries are made and most of the entries are dated and legible. | Few entries are made AND/OR many entries are not dated or very difficult to read. |