Model 1   Primitive Types

Keyword	Size	Min Value	Max Value	Example
byte	1 byte	-128	127	(byte) 123
short	2 bytes	$-32,768$	$32,767$	(short) 12345
int	4 bytes	-2^{31}	$2^{31} - 1$	1234567890
long	8 bytes	-2^{63}	$2^{63} - 1$	123456789012345L
float	4 bytes	-3.4×10^{38}	3.4×10^{38}	3.14159F
double	8 bytes	-1.8×10^{308}	1.8×10^{308}	3.141592653589793
boolean	1 byte	N/A	N/A	true
char	2 bytes	0	65,535	'A'

Note that 1 byte is 8 bits, i.e., eight "ones and zeros" in computer memory. Since there are only two possible values for each bit, you can represent $2^8 = 256$ possible values with 1 byte.

Questions (15 min)   Start time:

1. Which of the primitive types are integers? Which are floating-point?

Integers: byte, short, int, long. Floating-point: float, double.

2. Why do primitive types have ranges of values? What determines the range of the data type?

The range of values depends on the size, i.e., how many bytes are used to store the value.

3. Why can't computers represent every possible number in mathematics? Will they ever be able to do so?

Computers have finite memory, but there are an infinite number of numbers. There will always be a number larger than what computers can store.

4. Since a byte can represent 256 different numbers, why is its max value 127 and not 128?

One of the 256 values is the number zero. So 128 negatives, plus 1 zero, plus 127 positives equals 256 values.

5. What is the data type for each of the following values?

1.14159	double	7.2E-4	double	-128	int
0	int	0.0	double	'0'	char
-1.0F	float	-13L	long	false	boolean
123	int	'H'	char	true	boolean

6. Based on the examples below, when does Java allow you to assign one type of primitive variable to another?

```java
int int_ = 3;                                  float_ = int_;
long long_ = 3L;                               float_ = long_;
float float_ = 3.0F;                           float_ = float_;
double double_ = 3.0;                          float_ = double_;   // illegal

int_ = int_;                                   double_ = int_;
int_ = long_;        // illegal               double_ = long_;
int_ = float_;       // illegal               double_ = float_;
int_ = double_;      // illegal               double_ = double_;

long_ = int_;                                  int_ = '0';
long_ = long_;                                 int_ = false;       // illegal
long_ = float_;      // illegal               double_ = '0';
long_ = double_;     // illegal               double_ = false;    // illegal
```

The types have to be compatible (e.g., you can't assign numeric to boolean), and you can only assign from smaller to larger (e.g., from float to double, or int to double).

7. Given the following variable declarations, which of the assignments are not allowed?

```java
byte miles;              checking = 56000;
short minutes;           total = 0;
int checking;            sum = total;
long days;               total = sum;
float total;             checking = miles;
double sum;              sum = checking;
boolean flag;            flag = minutes;
char letter;             days = '0';
```

All are okay except:
  total = sum;
  flag = minutes;

Note that assigning '0' to days is legal, but the value is actually stored as 48L (Unicode for the digit zero character).