Practice Test 3

1. Consider the following three arrangements of battery, bulb and wire(s). Circle the arrangement(s) where you predict the bulb would glow. In the space below the pictures, explain why you think so. If you do not think any of the bulbs would glow, explain why not.

A.
The tip of the bulb touches the positive end of the battery, on the knob. A wire touches the negative end of the battery and the flat part of the positive end of the battery.

B.
The screwy side of the bulb touches the negative end of the battery. A wire touches the bottom tip of the bulb and the flat part of the positive end of the battery.

C.
The bottom tip of the bulb touches the negative end of the battery. There are two wires. One wire touches the screwy side of the bulb and the negative end of the battery. The other wire touches the negative end of the battery and the knob on the positive end of the battery.

In order for the bulb to light both its metal tip and the metal side need to be connected, one to each end of the battery. When this is done a complete circuit is established from one end of the battery, through the bulb, and then to the other end of the battery. Then electric current can flow round the circuit, through the bulb, thus making it light.

A WILL NOT LIGHT. The tip of the bulb is connected to the + end of the battery, but the side of bulb is not connected to anything. Electric current cannot flow through the bulb.

B WILL LIGHT. The metal tip of the bulb is connected to the + end of the battery by the wire (Note: the wire does not need to touch the 'knob' on the end.) and the side
of the bulb is connected to the - end of the battery by touching it directly. Thus current can flow through the bulb and it will light.

C WILL NOT LIGHT. Both the tip and the side of the bulb are connected to the - end of the battery, the tip by touching it directly and the side by the wire. Neither part of the bulb is connected to the + end of the battery. Thus current cannot flow through the bulb and it will not light. (Note: the extra wire is actually a short circuit that connects the + and - ends of the battery directly - a high current will flow through this wire and it will get hot.)

2. Students in a class were trying to decide which was a better model for how electric current flowed in a circuit: the two flow model, in which current flows out of both the positive and negative ends of the battery and meets at the bulb; or the one flow model, in which current flows out of one end of the battery and travels all around the circuit, through the bulb, and into the other end of the battery. Below are representations of the two models.

![Two Flow Model](image1.png) ![One Flow Model](image2.png)

a) Describe one good example of evidence from an experiment you did in class that would support either the two flow or the one flow model, but not both.

<table>
<thead>
<tr>
<th>Evidence Description</th>
<th>Diagram</th>
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<tbody>
<tr>
<td>In a regular circuit connected like this, with the two sides of the bulb holder connected to the + and - ends of the same battery, the bulb lights</td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
We did an experiment in class where we connected the two sides of a bulb holder to the + and - ends of two separate batteries, like this:

In this set-up the bulb did not light!

b) State which model, the two flow or the one flow, is supported by your evidence.

This evidence supports the one flow model.

c) Carefully explain why your evidence supports the model you chose and not the other model. (In so doing it would be best to also describe what would have happened if the other model were a better model.)

This evidence supports the one flow model because in the regular circuit the electric charges can flow out of one end of the battery, through the bulb, and back to the battery, through battery, and then back out into the circuit again. This could not happen in the second circuit since the charges flowing into the battery could not flow through it and back out into the circuit.

The evidence does not support the two-flow model because it says electricity flow out from both ends of the battery and meets in the bulb, making it light. If this were the case the second circuit should still work since there are connections that would still allow this to happen from the two ends of the different batteries.

3. Italian salad dressing is a mixture of vinegar (density = 1.00 g/ml) and oil (density = 0.92 g/mL). When the mixture stands undisturbed for a period of time, the vinegar and oil separate into distinct layers according to their densities.

- Label the diagram depicting the layering of vinegar and oil. In the space to the right of the picture, explain your reasoning.
Objects with a smaller density will float on top of objects with a greater density, thus the oil floats on top of the vinegar.

• Predict what would happen if each of the following were dropped into the separated salad dressing (that is, describe where would each object would settle). Briefly explain your reasoning for each:

**steel nut (density = 7.75 g/mL)**

The steel nut will sink to the bottom of the bottle since oil density < vinegar density < steel density, and the object with less density float on top of objects with greater density.

**chunk of candle wax (density = 0.95 g/mL)**

The candle wax will float at the interface of the oil and vinegar (i.e. sink in the oil, but float on the vinegar) since oil density < wax density < vinegar density.

**cork stopper (density = 0.32 g/mL)**

The cork will float on top of both liquids, since cork density < oil density < vinegar density.

• Which would have more mass—a bottle filled with oil only or the same bottle filled with vinegar only? Explain your reasoning.

4. How did the “blowing-through-straws” analogy help you understand the idea that thinner bulb filaments have more resistance to the flow of electricity than thicker bulb filaments (of the same length)? In answering this question,
make sure you refer specifically to what was done in the experiments you did in class and how that helped you change or enhance your own model or idea.

Note: Acceptable student responses to this question will vary depending on what model or ideas they had before being introduced to the blowing-through-straws analogy, and how they interpreted the analogy itself. Given below is an example of students using the analogy to move from an idea of the independence of resistance to variations in thickness, to a definite dependence.

When thinking about resistance of bulb filaments we first thought that they would all be the same, since we thought that the battery supplied the same current to all bulbs and so the resistance to current flow in all circuits would be the same.

We then blew through a thin straw and a thicker straw of the same length and made two observations:
   i. It was easier to blow through the thicker straw
   ii. For the same strength blow, more air flowed through the thicker straw than the thinner straw

This meant the thinner straw had more resistance to air flow through it than the thicker straw.

This made us think that perhaps in a bulb it is easier to push the charges through a thicker filament than a thinner filament. Therefore, for the same push from a battery, there would be more current flowing through a thicker filament than a thinner filament. This would then also mean that the thicker filament must have less resistance to the flow of electricity than the thinner filament. Since more current also means a brighter bulb, this would mean that when connected to the same battery (or other power source) a bulb with a thicker filament would glow brighter than a bulb with a thinner filament of the same length.

5. Below is a circuit with three batteries, an ammeter and three bulbs. The ammeter reads 337.3 mA, and all three bulbs glow equally bright.

Imagine that the bulb on the left is removed from its socket; everything else remains the same—nothing else is changed. (In the picture below, the ammeter and bulbs are covered so you cannot tell what happens.)
d) Would the ammeter reading be higher, lower or remain at 337.3 mA? Briefly explain in terms of electric circuit ideas.

This is a PARALLEL circuit. In a parallel circuit each loop is an independent circuit and the current flowing through each loop is determined only by the bulb(s) in it. The battery will supply whatever total amount of current is needed. In the circuit above the ammeter is measuring the total current flowing out of the battery, before it splits and goes into the separate loops.

Removing the left bulb means that loop is now open and no current will flow through it. However, this has no affect whatsoever on the current flowing through the other two loops. Since the battery only now needs to supply current to two loops instead of three, the total current it has to supply will decrease. Therefore the reading on the ammeter will DECREASE.

e) After the left bulb is removed, would the bulb on the far right get brighter, get dimmer or remain just as it is now? Briefly explain in terms of electric circuit ideas.

As stated above, in a parallel circuit all of the loops are independent of each other. Therefore, removing the left bulb will not affect the current flowing through the other loops and the bulb on the right will REMAIN JUST AS BRIGHT IT IS.

1. Why are mass and volume not considered characteristic physical properties, but density (which is calculated from mass and volume) is?
2. How you can explain someone why the weight of a person appears lighter in a liquid than in air.

3. Do you have evidence for particle motion in liquids? Explain.

4. Do you have evidence for space between particles of liquids? Think about the experiment that may provide such an evidence. Explain Why are mass and volume not considered characteristic physical properties, but density (which is calculated from mass and volume) is?

5. Consider the conversation between two students about why the water level rises when a person sits down in a bathtub filled with water. Why are mass and volume not considered characteristic physical properties, but density (which is calculated from mass and volume) does?
6. Do you have evidence for particle motion in liquids? Explain.

7. Do you have evidence for space between particles of liquids? Think about the experiment that may provide such evidence. Explain.

8. On average, are liquid particles closer together or further apart than particles of gases, relative to the size of the particles?
9. How does the ratio of mass/volume compare for different objects of the same material?

10. Are these ratios the same? How close do the values need to be for you to consider them as the same value? Why might the values be different?

11. What do the appearances of the liquid droplets indicate about the strength of forces between particles? (In other words, which liquid has the strongest forces, which has the weakest forces?) Explain your reasoning.

Multiple Choice Questions

1) When atom A loses an electron to atom B,
   A) atom A becomes more negative than atom B.
   B) atom A acquires more neutrons than atom B.
   C) atom A becomes a positive ion and atom B becomes a negative ion.
   D) atom A becomes a negative ion and atom B becomes a positive ion.
   Answer: C

2) When the distance between two charges is reduced by a factor of 2 the force between these charges is
   A) doubled.
   B) quadrupled.
   C) reduced by a factor of 3.
   D) reduced by a factor of 4.
   Answer: B

3) A light bulb operating at a voltage of 120 V has a resistance of 200 Ω. What is the power?
   A) 100 W
   B) 72 W
   C) $14 \times 10^{-3}$ W
D) 7.2 W  
Answer: B

4) Four unequal resistors are connected in a parallel circuit. Which one of the following statements is correct about this circuit?
   A) The total resistance is less than the smallest resistor.
   B) The total resistance is equal to the average of the resistance of all the resistors.
   C) The total resistance is more than the largest resistor.
   D) None of the other answers is correct.
   Answer: A

5) A 100 V DC signal is applied to four resistors as shown in Figure. The values of the resistors are 20 \(\Omega\), 40 \(\Omega\), 60 \(\Omega\), and 80 \(\Omega\). What is the voltage across the 40 \(\Omega\) resistor?

   A) 20 V  
   B) 40 V  
   C) 60 V  
   D) 80 V  
   Answer: A

6) A light bulb operating at a voltage of 120 V has a resistance of 200 \(\Omega\). What is the power?
   A) 100 W  
   B) 72 W  
   C) 14 \times 10^{-3} W  
   D) 7.2 W  
   Answer: B

7) Which one of the following is a correct statement for a number of resistors connected in series or parallel?
   A) The total resistance in a series circuit decreases as more resistors are added.
   B) The flow of current is difficult through resistors connected in a series circuit.
   C) The voltage is different across resistors connected in a parallel circuit.
   D) The total resistance in a parallel circuit decreases as more resistors are added.
   Answer: D

8) Three resistors of values 2 \(\Omega\), 6 \(\Omega\) and 12 \(\Omega\) are connected across a DC voltage source as shown in Figure. If the total current through the circuit is 2.0 A, what is the applied voltage?
9) Look at the four “circuits” shown in Figure and select those that will light the bulb.

Answer: (c), (d)

10) What is the equivalent resistance between points a and b when $R = 12 \, \text{W}$?

Answer: C) 24 W
11) The number of protons in the nucleus of an electrically neutral atom is equal to
A) the number of neutrons in the nucleus.
B) the number of electrons surrounding the nucleus.
C) the number of electrons in the nucleus.
D) None of the other choices is correct.
Answer: B

12) Electrical and gravitational forces follow similar equations with one main difference:
A) Electrical forces obey the inverse square law and gravitational forces do not.
B) Gravitational forces obey the inverse square law and electrical forces do not.
C) Electrical forces attract and gravitational forces repel.
D) Gravitational forces are always attractive but electrical forces can be attractive or repulsive.
Answer: D

13) The circuit below contains three 100 watt light bulbs. The emf \( E = 110 \text{ V} \). Which light bulb(s) is(are) the brightest?

![Circuit Diagram]

A) A 
B) B 
C) C 
D) B and C 
E) All three are equally bright.
Answer: (A)

14) Which two circuits are exactly equivalent?
15) The circuit below contains 5 light bulbs. The emf is 110 V. Which light bulb(s) is(are) brightest?

A) A: The one closest to the positive terminal of the battery.
B) A and C: The bulbs closest to the positive terminal of the battery.
C) A and B: Because they are closest to the terminals of the battery.
D) C and D: Because they receive current from A and B and from E.
E) E: Because the potential difference across E is that of the battery.

Answer: (E)

16) Blood pressure is normally measured with the cuff of the sphygmomanometer around the arm. Suppose that the blood pressure is measured with the cuff around the calf of the leg of a standing person. Would the reading of the blood pressure be (a) the same here as it is for the arm? (b) greater than it is for the arm? or (c) less than it is for the arm?

Answer: (b)

17) Two charges, \( Q_1 \) and \( Q_2 \), are separated by a certain distance \( R \). If the magnitude of their charges is halved, and their separation is doubled, then what happens to the electrical forces between these charges?
A) It decreases by a factor of 4.
B) It decreases by a factor of 8.
C) It decreases by a factor of 16.
D) It remains the same.  
Answer: C

18) An object that completes 100 vibrations in 5 seconds has a period of  
A) 0.5 second.  
B) 1 second.  
C) 2 seconds.  
D) None of the above choices are correct.  
Answer: D

19) A weight suspended from a spring bobs up and down over a distance of 1 meter in two seconds. Its frequency is  
A) 0.5 hertz.  
B) 1 hertz.  
C) 2 hertz.  
D) None of the above choices are correct.  
Answer: A

20) When a block of ice at zero degrees Celsius melts, the ice  
A) absorbs energy from its environment.  
B) releases energy to its environment.  
C) absorbs energy and gets warmer.  
D) releases energy and gets warmer.  
E) absorbs energy but does not change its temperature.  
Answer: E

21) A good reflector of radiation is  
A) good absorber of radiation.  
B) good emitter of radiation.  
C) poor absorber of radiation.  
D) none of these  
Answer: C

22) Ice cubes submerged at the bottom of a liquid indicate that the liquid  
A) produces no buoyant force on the ice.  
B) has dissolved air.  
C) is warmer than the ice.  
D) is not displaced by the submerged ice.  
E) is less dense than ice.  
Answer: E

23) Two equal sized buckets are filled to the top with water. One of the buckets has a piece of wood floating in it, making its total weight  
A) less than the weight of the other bucket.
B) equal to the weight of the other bucket.
C) more than the weight of the other bucket.
Answer: B

24) If a battleship sinks in a canal lock, the water level in the lock will
A) rise.
B) fall.
C) remain unchanged.
Answer: B

25) When a boat sails from fresh water to salt water, the boat will float
A) lower in the water.
B) higher in the water.
C) at the same water level.
Answer: B

26) A boat loaded with wood floats in a swimming pool. When the wood is thrown overboard, the pool level will
A) rise.
B) fall.
C) remain unchanged.
Answer: C

27) Two small objects are suspended from threads. When the objects are moved close together, they attract one another. Which of the following could produce this result?
A) One object is positively charged and the other is negatively charge.
B) One object is positively charged and the other is uncharged.
C) One object is negatively charged and the other is uncharged.
D) All of the above could result in such attraction.
Answer: D

28) Two point charges are 4 cm apart. They are moved to a new separation of 2 cm. By what factor does the resulting mutual force between them change?
A) 1/2
B) 2
C) 1/4
D) 4
Answer: D

29) Two identical blocks of iron, one at 10 degrees C and the other at 20 degrees C, are put in contact. Suppose the cooler block cools to 5 degrees C and the warmer block warms to 25 degrees C. This would violate the
A) 1st law of thermodynamics.
B) 2nd law of thermodynamics.
C) both of these
D) neither of these
Answer: B

30) Wind blowing over the top of a hill
A) increases atmospheric pressure there.
B) decreases atmospheric pressure there.
C) does not affect atmospheric pressure there.
Answer: B

31) The Bernoulli effect causes passing ships to be drawn together when the ships are close and moving in
A) the same direction.
B) opposite directions.
C) either the same or opposite directions.
Answer: C