MY SO PRACTICE TEST
## DIVISION C - HIGH SCHOOL, GRADES 9-12

PRACTICE TEST

Instructions

- You have 20 minutes to complete this test.
- You may write your answers directly in the test.
- You may use any notes or resources you have created or collected.
- You may use a calculator and scratch paper if necessary.
- Good Luck!

Test Questions

1. Imagine you weigh 4 pieces of balsa wood that have been confirmed to weigh about 5 g each, and find that your scale says they are 6.05 g, 6.02 g, 5.99 g, and 6.03 g. Which of the following is most likely to be true?
   a. Your measurements are precise but not accurate, and your scale should be recalibrated
   b. Your measurements are accurate but not precise, and your scale should be recalibrated
   c. Your measurements are neither accurate nor precise, and you should buy a new scale
   d. Your measurements are both accurate and precise, and there is no problem

2. Which of the following is NOT true about motors?
   a. They produce the most torque at 0 RPM
   b. They draw the most current at 0 RPM
   c. As the speed increases, they draw more current
   d. As the speed increases, they produce less torque

3. Which of the following will increase torque and decrease speed?
   a. A 20 teeth gear driving an 20 teeth gear
   b. A 20 teeth gear driving an 70 teeth gear
   c. A 70 teeth gear driving an 70 teeth gear
   d. A 70 teeth gear driving an 20 teeth gear

3. Consider a seesaw that has 2 people sitting on it and is currently in equilibrium, as shown below.
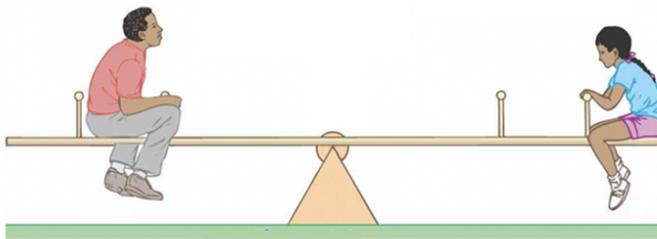

4. If the lighter person is sitting on the right and the heavier person is sitting on the left, which of the following would cause the seesaw to rotate counterclockwise?
   A. The lighter person moving farther from the center of the seesaw
   B. The heavier person moving farther from the center of the seesaw
   C. The lighter person moving closer to the center of the seesaw
   D. The heavier person moving closer to the center of the seesaw

   a. All of the above
   b. Only (a) and (d)
   c. Only (b) and (c)
   d. None of the above

5. A ball is dropped, without throwing (no initial velocity), from the top of the Statue of Liberty (approx 90 meters high). Using acceleration of gravity g = 9.8 m/s^2, how long does it take for the ball to hit the ground, neglecting air resistance? How much longer would it take if it was dropped from the top of the Empire State Building, which is approximately 4x taller than the Statue of Liberty?
   a. Approximately 3.0 seconds; twice as long
   b. Approximately 4.3 seconds; twice as long
   c. Approximately 3.0 seconds, 4x as long
   d. Approximately 4.3 seconds, 4x as long

6. I forgot to bring my Ping Pong Parachute build to regionals, including the launcher, so I will have to throw it myself. If I know I can throw a ping pong ball at 100 mph (I'm a pro baseball pitcher), what angle from the ground should I throw to maximize the time that the ball spends in the air?
   a. 0°
   b. 45°
   c. 60°
   d. 90°

7. Air resistance, and drag forces in general, always act opposite to the direction of motion. Usually the magnitude of drag force will be proportional to velocity or the square of velocity. Suppose two cannons fire identical cannonballs; cannon A fires ball A at 100 m/s while cannon B fires ball B at 50 m/s. Which of the following is true for the balls as they fly through the air? Assume both balls are fired at a 45 degree angle.
   a. Ball A experiences more drag force and has a higher magnitude of acceleration
   b. Ball A experiences less drag force and has a higher magnitude of acceleration
   c. Ball B experiences more drag force and has a higher magnitude of acceleration
   d. Ball B experiences less drag force and has a higher magnitude of acceleration

8. An ice puck lays at rest in an ice rink. A hockey player comes along, and pushes the ice puck with a constant force of 5 N for ten seconds. Immediately after the hockey player stops pushing the puck, the puck is traveling at a velocity of 10 m/s. What is the mass of the puck? Assume that friction is negligible.
   a. 1 kg
   b. 2 kg
   c. 5 kg
   d. 10 kg

9. Suppose a traveler bungee jumps off the Macau Tower in China, the highest verified bungee jumping destination. Prior to pulling the traveler back upwards, the rope reaches full extension. At this brief moment in time, we know that the force of gravity (Fgravity) and the force of tension (Ftension) are acting on the traveler along the vertical axis. If you were to make a free body diagram for this situation, which directions would the Fgravity and Ftension arrows point, and how do the magnitudes of the arrows for Fgravity and Ftension compare?
   a. Fgravity points up and Ftension points down; Fgravity > Ftension
   b. Fgravity points up and Ftension points down; Fgravity < Ftension
   c. Fgravity points down and Ftension points up; Fgravity > Ftension
   d. Fgravity points down and Ftension points up; Fgravity < Ftension

10. If I am pushing a box of Forensics supplies towards the right, which of the following is true?
   a. If I'm pushing at constant speed, my pushing force is the same magnitude as the force of friction
   b. If I'm pushing at constant speed, and my friend pushes her Mission Possible supply box, which is heavier than the Forensics supplies box, at constant speed, then the Mission Possible box feels a larger force of friction
   c. If I'm accelerating towards the right, my pushing force is greater than the force of friction
   d. All of the above

11. When a gravity vehicle is rolling towards the right, which of the following is true?
   I.   The torque on the wheel from the friction points out of the page
   I.   The torque on the wheel from the friction points into the page
   III. The force of friction on the wheel points to the right
   IV. The force of friction on the wheel points to the left
   a. Only (a) and (c)
   b. Only (a) and (d)
   c. Only (b) and (c)
   d. Only (b) and (d)

12. A 70 cm long cylindrical table leg is under so much load that it is compressed to 68 cm long. Another rectangular prism shaped table leg that is 105 cm long is under so much load that it is compressed to 102 cm long. Compare the normal strain for the two table legs.
   a. The cylindrical table leg has a greater normal strain
   b. The rectangular prism shaped table leg has a greater normal strain
   c. The two table legs have the same normal strains
   d. The normal strains are not comparable without knowing the cylinder radius and rectangular prism dimensions

13. If a 20 V battery is powering a circuit with 2 equivalent resistors and the current flowing through is 10 A, what is the resistance of each resistor if they are in series?
   a. 1 ohm
   b. 2 ohms
   c. 4 ohms
   d. 8 ohms

14. In the previous scenario, what is the resistance of each resistor if they are in parallel instead?
     a. 1 ohm
     b. 2 ohms
     c. 4 ohms
     d. 8 ohms

**Use the following circuit for questions 15 and 16.**
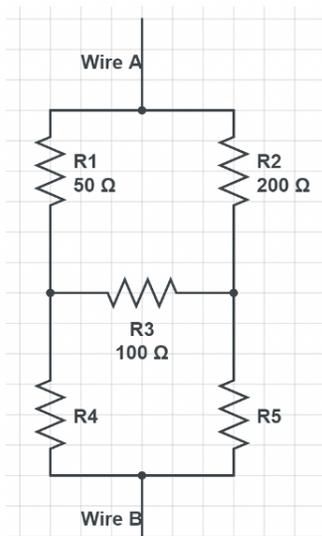
15. If the current through R1 is 30 mA and the current through R2 is 10 mA, what is the voltage drop across R3 and what is the direction of the voltage drop?
     a. 3.5 V left to right
     b. 3.5 V right to left
     c. 0.5 V left to right
     d. 0.5 V right to left

16. If the current through R1 is 30 mA and the current through R2 is 10 mA, what is the current through R4, R5, and Wire B?
     a. 25 mA through R4, 15 mA through R5, and 40 mA through Wire B
     b. 35 mA through R4, 5 mA through R5, and 40 mA through Wire B
     c. 25 mA through R4, 5 mA through R5, and 20 mA through Wire B
     d. 35 mA through R4, 15 mA through R5, and 20 mA through Wire B

17. There are three types of levers: first class where the fulcrum is between the input force and output force, second class where the output force is between the fulcrum and input force, and third class where the input force is between the fulcrum and output force. What class does a pair of scissors belong to?
     a. First class
     b. Second class
     c. Third class
     d. All of the above

18. My dog is running in circles around a tree at a constant speed. What is true about his acceleration?
     a. It is zero because he is running at a constant speed
     b. It is zero because he is running at a constant velocity
     c. It depends on his mass and the force he is exerting on the ground
     d. It is non-zero because he is changing direction

19. You want to create a circuit using an Arduino microcontroller that checks whether a button is pressed and turns on an LED if it is pressed. What would you plug the button into to be able to read whether it is pressed?
   a. Digital pin
   b. Analog pin
   c. USB port
   d. Ground pin

20. Consider the circuit below, which is called a voltage divider. If Vin = 20 V, R1 = 4 ohms, and R2 = 1 ohm, then what is Vout?
   a. 4 V
   b. 5 V
   c. 10 V
   d. 20 V
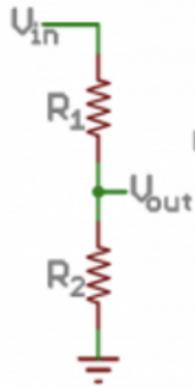
21. What is the maximum number that can be represented with 3 bits?
   a. 3
   b. 6
   c. 7
   d. 8

22. Which of the following expressions is equivalent to A XOR B?
   a. (A OR B) AND (B OR A)
   b. (A OR (NOT B)) AND (A OR B)
   c. (A AND (NOT B)) OR ((NOT A) AND B)
   d. (A OR (NOT B)) AND ((NOT A) OR B)

23. If I need to create a 2D profile from a thin sheet of metal, which manufacturing process would likely be the best choice?
   a. Waterjet
   b. Sheet metal
   c. 3D printing
   d. All of the above; these would all be equally valid processes to use

24. Which of the following is NOT an important consideration to take into account when designing a part to be 3D printed?
   a. Avoid complex geometry
   b. Avoid overhanging features
   c. Consider the orientation of the layers
   d. None of the above; they are all important considerations

25. Which of the following correctly implements the following task (in Python code): Prompt the user for a number and print a countdown from that number down to 0, then stop. Example: inputting the number "5" should countdown 5 4 3 2 1 0.

a.
```
1  #print displays the message, or string, to the screen
2  print("What number would you like to count down from?")
3  #Reads a number input from the user
4  n = int(input())
5
6  #range(0,n) returns the sequence of numbers 0,1,2,...,n-1
7  for i in range(0,n):
8      print(n-i)
```

b.
```
1  #print displays the message, or string, to the screen
2  print("What number would you like to count down from?")
3  #Reads a number input from the user
4  n = int(input())
5
6  #range(0,n) returns the sequence of numbers 0,1,2,...,n-1
7  for i in range(0,n+1):
8      print(n-i)
```

c.
```
1  #print displays the message, or string, to the screen
2  print("What number would you like to count down from?")
3  #Reads a number input from the user
4  n = int(input())
5
6  i = 0
7
8  while(i < n+1):
9      print(n-i)
```

d.
```
1   #print displays the message, or string, to the screen
2   print("What number would you like to count down from?")
3   #Reads a number input from the user
4   n = int(input())
5
6   i = 0
7
8   while(i < n+1):
9       print(i)
10      i = i + 1
```

26. In programming, we follow the Don't Repeat Yourself (DRY) principle, part of which means that we don't want to have duplicated data. For example, say we have a Person object, who has a firstName, lastName, and fullName property. Then if we want to change firstName, we'd have to change both firstName and fullName, which isn't ideal. Instead, we could have just a firstName and lastName property, and turn fullName into a function that returns firstName + a space + lastName. This is better because when we call fullName, it just checks what firstName and lastName are currently. Which of the following is another example of violating the DRY principle?

 a. An object Rectangle with properties length, width, and perimeter
 b. An object Circle with properties radius and diameter
 c. An object RightTriangle with properties base, height, and area
 d. None of the above
 e. All of the above

27. In computer science, there is a field of study focused on sorting algorithms. How "good" a sorting algorithm is can be measured by different metrics, one of which is called time complexity -- or how long the algorithm takes to execute based on the number of items to sort. For example, an algorithm with time complexity proportional to n, the number of items, takes twice as long with twice as many items, four times as long with four times as many items, and so on. One such sorting algorithm is called bubble sort, which works like this to sort items from small to large: Compare the first two items, and put the smaller one first. Then compare the second and third item, and swap them so the smaller one comes first. Now compare the first two items again and perform the necessary swap. Continue this so that for the mth item, you keep comparing the the first m-1 items until no swaps are needed. What is the time complexity of bubble sort?
    a. Proportional to log(n)
    b. Proportional to n
    c. Proportional to n*log(n)
    d. Proportional to n2

28. If you are designing a flexible ruler, which pair of properties are desirable?
    a. Low yield strength, low Young's modulus
    b. High yield strength, low Young's modulus
    c. Low yield strength, high Young's modulus
    d. High yield strength, high Young's modulus

Questions 29-30 concern the following setup.
A 10 kg block hangs from a cable system as shown in the diagram. The cable arrangement is symmetric about the y axis.
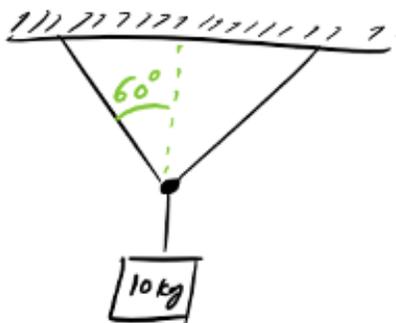
29. What is the tension in each of the two diagonal cables? (use g=10)
    a. 100N
    b. 70.7N
    c. 141.4N
    d. 50N

30. If the angle between the cable and the y axis (the angle given in green) was increased, you should expect the tension in the cable to...
    a. Increase
    b. Decrease
    c. Stay the same

ANSWER KEY

1.	**A**	15.	**D**	29.	**A**
2.	**C**	16.	**B**	30.	**A**
3.	**B**	17.	**A**		
4.	**C**	18.	**D**		
5.	**B**	19.	**A**		
6.	**D**	20.	**A**		
7.	**A**	21.	**C**		
8.	**C**	22.	**C**		
9.	**D**	23.	**A**		
10.	**D**	24.	**A**		
11.	**D**	25.	**B**		
12.	**C**	26.	**E**		
13.	**A**	27.	**D**		
14.	**C**	28.	**B**		

Practice Test Developed with Science Olympiad at Cornell