

MY SO PRACTICE TEST

DIVISION B - MIDDLE SCHOOL, GRADES 6-9

PRACTICE TEST

Instructions

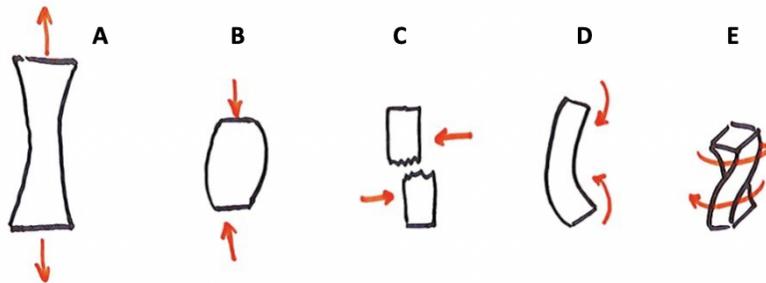
- You have 20 minutes to complete this test.
- You may write your answers directly in the test.
- You may use any notes or resources you have created or collected.
- You may use a calculator and scratch paper if necessary.
- Good Luck!

Test Questions

1. Carbon fiber is an example of an...
 - a. Isotropic material, where the strength is the same in every direction
 - b. Isotropic material, where the strength depends on the direction
 - c. Anisotropic material, where the strength depends on the direction
 - d. Anisotropic material, where the strength depends on the direction
2. Which of the following is NOT true about historical structural innovations?
 - a. The ancient Greeks created pillars by stacking shorter sections on top of each other to form a taller pillar
 - b. Ancient Greek pillars have high tensile strength
 - c. A keystone is set last in an arch and plays an important role in the structural integrity of the arch
 - d. Ancient Roman arches are strong under compression
3. Why is rebar generally made with an uneven surface?
 - a. To help adhere better to the concrete
 - b. To withstand corrosion in areas with high humidity
 - c. To keep the manufacturing process simpler and cheaper
 - d. To prevent bending in areas prone to earthquakes
4. Crushing a long cardboard piece from two ends is an example of...
 - a. Tension
 - b. Torsion
 - c. Bending
 - d. Buckling

5. Calculate the cross sectional area of a rope with radius 2 cm.
- $A = \pi \text{ cm}^2$
 - $A = 2\pi \text{ cm}^2$
 - $A = 4\pi \text{ cm}^2$
 - $A = 8\pi \text{ cm}^2$
6. How much weight does 6 kilograms of mass exert, where $g = 9.81 \text{ m/s}^2$?
- $\frac{1}{6} * g$ Newtons
 - 6 Newtons
 - $6 * g$ Newtons
 - 36 Newtons
7. How many Pascals does a force of 8 Newtons exert on an area of 4 square meters?
- $\frac{1}{2}$ Pascal
 - 2 Pascals
 - 8 Pascals
 - 32 Pascals

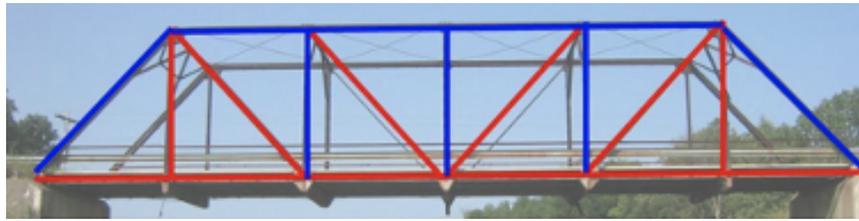
For questions 8-9, consider the loading scenarios pictured below.



(source: [StructurePlanet](#) - Internal Forces)

8. Which image depicts tension?
- A
 - B
 - C
 - D
 - E
9. Which image depicts torsion?
- A
 - B
 - C
 - D
 - E

10. In the following image of a truss bridge, which color depicts members that primarily experience tension?



- a. Blue
- b. Red
- c. There is no correlation between the colors at all

Questions 11 and 12 will reference the below diagram of a compression bridge:

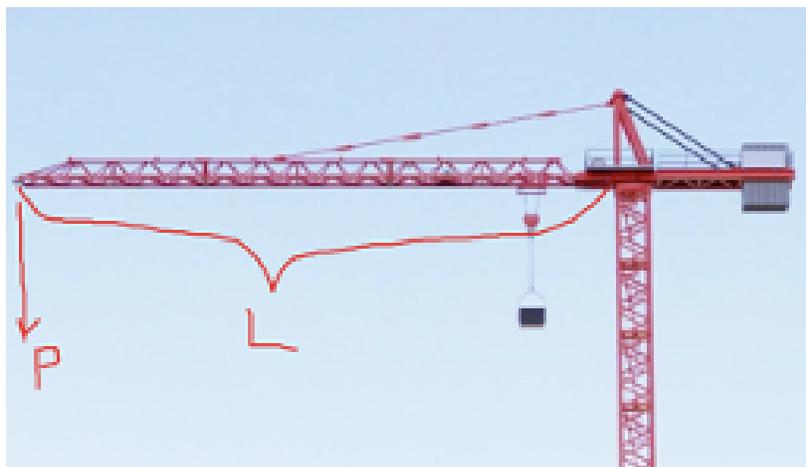


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- 11. What force do the cables of a compression bridge primarily experience?
 - a. Compression
 - b. Tension
 - c. Torsion
 - d. Shear

- 12. What about the towers of the bridge?
 - a. Compression
 - b. Tension
 - c. Torsion
 - d. Shear

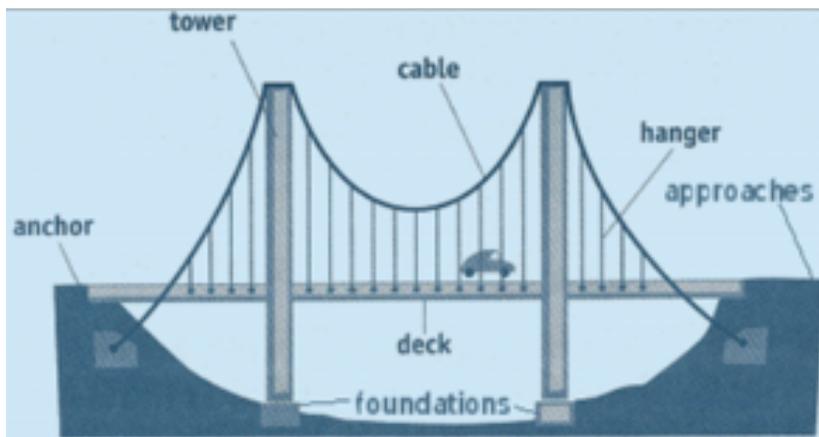
Consider the arm of the construction tower shown below for questions 13-16.



13. Let's say the arm supports a load P at a distance L away from the central tower. Which part of the arm is under the most stress?
- The part of the arm closest to the tower.
 - The halfway point between the weight and the tower
 - The part of the arm closest to the load P
 - All parts of the arm of the crane are under equal stress
14. If we said that the tower could support a maximal load of $P = 120,000$ lbs (at a distance L) before it collapses, but in real life, the most it would ever be loaded with would be $P = 80,000$ lbs at a (distance L), what is the safety factor of the arm?
- 0.66
 - 1.2
 - 1.33
 - 1.6
 - 2.2
15. At the right hand side of this image, there are many concrete slabs on the backside of the arm. These are known as counterweights. What is the purpose of these counter weights?
- To increase the moment of inertia of the crane so it does not spin too fast
 - To keep the tower equally loaded on both sides, to prevent it from toppling over when the load P is large.
 - To serve as catapult projectiles if the tower falls over to one side
 - To keep the arm equally loaded in torsion whenever it needs to withstand torsion
16. Let's say that a certain engineer wants to double the maximal theoretically supportable load of this crane. What could the engineer do to the dimension L to support a load of $P = 180,000$ lbs or more?
- Let L be twice as long as its original length
 - Let L be 0.5 of its original length (half)
 - Let L be 0.75 of its original length (three fourths)
 - Keep L the same dimension. The built in safety factor is sufficient.
17. What is a drawback to having too much water in a concrete mix?
- Increased workability of the concrete
 - The risk of having gaps in the concrete, leading to weaknesses in the structure.
 - Different amounts of water leads to concrete with different uses, and thus there is no drawback.
 - Longer drying time for the concrete, which may lead to delays in the construction.
18. Which of the following are loads that need to be accounted for when designing a structure?
- Wind load
 - Structure self weight
 - Precipitation
 - Seismic load
 - Human
- Only I and II
 - Only I, II and IV
 - Only I, II, IV, and V
 - All of them

19. Why is steel used to help reinforce concrete over other metals?
- Steel has a thermal expansion coefficient similar to that of concrete.
 - Steel is strongest when acting as reinforcement for concrete.
 - Steel is relatively cheaper compared to other metals of similar strength.
- a. Only I and II
 b. Only I and III
 c. I, III, and III
 d. Only I

20. Which of the following part(s) of the suspension bridge is in tension?



- a. The deck and the foundation
 b. The tower and the deck
 c. The hanger and the deck
 d. The hanger and the cable

21. Steel has a thermal expansion coefficient $\alpha = 12 \times 10^{-6}$. If a bridge made of steel is 1000m long when it is 10°C outside, how long will it be when it is 20°C outside? Remember that

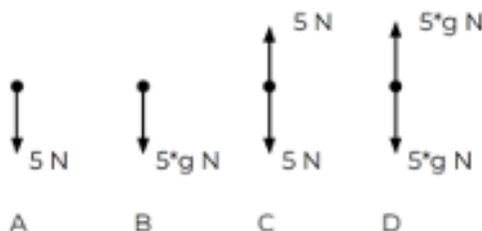
$$\alpha = \frac{1}{\text{length}} * \frac{\text{change in length}}{\text{change in temperature}}$$

- a. 1000.012m
 b. 1000.12m
 c. 1001.2m
 d. 1012m

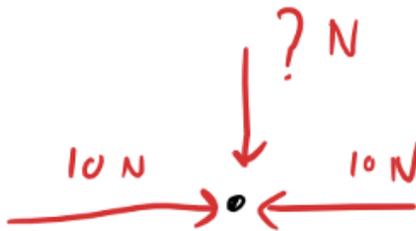
22. Which type of annealing would be useful to make hardened steel with 1% carbon workable again?
- a. Spheroidize
 b. Normalize
 c. Process Anneal
 d. Full Anneal

23. A box sitting on the ground weighs 5kg. Which free body diagram correctly shows the forces acting on the box?

- a. A
 b. B
 c. C
 d. D

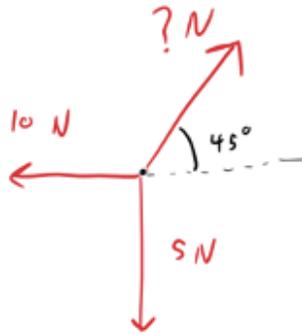


24. When cutting a piece of paper with a pair of scissors, what force is being applied to the paper?
- Compression
 - Tension
 - Shear
 - Bending
25. A rope suspends a box from the ceiling that weighs 300 N and is experiencing a force directed 400 N to the right. What is the magnitude of the tension in the rope? (the rope will not hang straight down)
- 300 N
 - 400 N
 - 500 N
 - 600 N
26. A 10 ft long steel beam has a safety factor of 3. If the designed load is 5,000 N then what is the maximum load this steel beam can withstand?
- 15,000 N
 - 20,000 N
 - 1666.67 N
 - 5,000 N
27. What is steel?
- An alloy of aluminum
 - An alloy of iron
 - An mixture of silver and aluminum
 - Pure iron that has been heat treated
28. Solve for the force needed to place the particle in equilibrium.



- 0 N
- 10 N
- 20 N
- 40 N
- No equilibrium possible

29. Solve for the force needed to place the particle in equilibrium.



- a. 7.07 N
- b. 14.1 N
- c. 15 N
- d. 20 N
- e. No equilibrium possible

30. A bicycle chain delivers power to the rear wheel by withstanding what kind of stress?

- a. Torsion
- b. Tension
- c. Compression
- d. Bending

ANSWER KEY

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



Practice Test Developed with Science Olympiad at Cornell



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