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Student *Class*

Section 2 – External and Internal Forces Act on Structures

2.1 Measuring Forces

1. A force is a push or a pull that tends to cause an object to change its …
   - **A. height or length**
   - **B. movement or shape**
   - **C. colour or texture**
   - **D. direction or strength**

2. The actual effect of a force depends on three things: the magnitude, or size of the force; the direction of the force; and …
   - **A. how the force is applied**
   - **B. where the force is applied**
   - **C. why the force is applied**
   - **D. how long the force is applied**

3. In structural drawings, arrows represent forces. A force that is being applied to a heavy box to lift it off the ground would be shown by the following arrow …

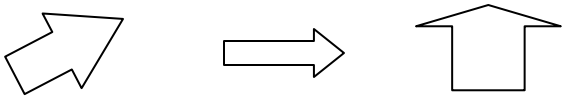
   A. 

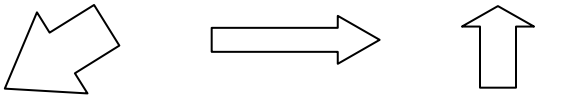
   B. 

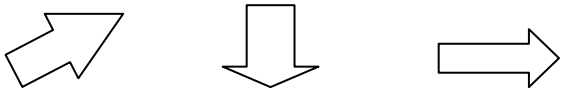
   C. 

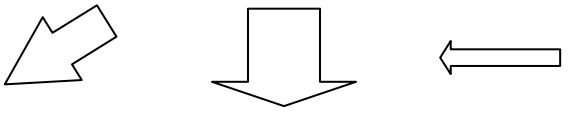
   D. 

4. A large force is applied to a freezer to move it up a ramp to the second floor, where a smaller force is used to push it to the window, and a very large force is needed to lift it up, to put it off balance, so it falls out the window and is demolished on the sidewalk below.

   A. 

   B. 

   C. 

   D. 

5. The standard unit of measuring force is named after a famous English scientist, who the first one to describe the *'law of gravitation'*, getting the idea for the law as he sat under an apple tree. This unit of measuring force is similar to the amount of force needed to hold an apple in your hand and is called a …
   - **A. joule**
   - **B. kilogram**
   - **C. Newton**
   - **D. gram**

2.2 External Forces Acting on Structures

1. An external force is a force applied to a structure by …
   - **A. its own mass**
   - **B. something else**
   - **C. an internal force**
   - **D. Newtons**

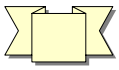
2. Identify which structure would have the greatest stability, because of its centre of gravity.
   - **A. High centre of gravity and a narrow base**
   - **B. High centre of gravity and a wide base**
   - **C. Low centre of gravity and a narrow base**
   - **D. Low centre of gravity and a wide base**

3. The Leaning Tower of Pisa is an example of a mass structure. The Tower was built with a lean originally and it had been getting worse, because of the foundation on which it was built. The structure has not fallen over yet, because its center of gravity still keeps it relatively stable. Once it started to lean more, engineers knew that the center of gravity shifted. The reason that the Tower is moving is because ...
   - **A. it is very windy in Pisa**
   - **B. Pisa has many earthquakes**
   - **C. the thrust line is inside the foundation**
   - **D. the thrust line is outside the foundation**

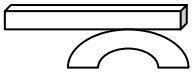
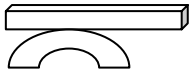
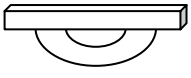
4. A student compared his mass and weight in two different places (Vancouver and Banff). Which statement is correct?
   - **A. His mass and weight were unchanged.**
   - **B. His mass and weight were both the same.**
   - **C. His mass was the same, but his weight was different**
   - **D. His mass was different, but his weight was the same.**

5. Weight is a force that is measured by the gravitational pull on the object. It is usually measured in ...
   - **A. Newtons**
   - **B. kilograms**
   - **C. grams**
   - **D. pounds**

6. *Symmetry* is a balanced arrangement of mass that occurs on opposite sides of a line or plane, or around a centre or axis. The force of gravity acting on each side is the same. Which of the following illustrations is symmetrical?

A.  **B.**  **C.**  **D.** 

7. Which of the following structures would have the greatest stablility?
   - **A.**

A.  **B.**  **C.**  **D.** 

8. An external force on a structure is called a …
   - **A. force**
   - **B. load**
   - **C. mass**
   - **D. weight**

9  This bridge cannot perform its function any longer because it has collapsed. One of the probable causes of the failure of this structure was the actual weight of the bridge, which could not be supported by its suspension cables. This type of load is called …

A. gravitational
B. supporting
C. static
D. dynamic

10.  A dynamic load on this train bridge is the …

A. tracks
B. train
C. cement pillars
D. wood beams

11.  The dynamic load that makes this device work is …

A. wind
B. tsunami
C. earthquake
D. landslide

12. Designers generally use three key methods to help structures withstand forces. They include all of the methods below, EXCEPT for ...

A. distribute the load evenly
B. direct the forces along angled components
C. shape the parts for the forces they are likely to face
D. place lighter materials above heavier materials

13. When engineers build bridges, they take two conditions into account: what the bridge is crossing and what kinds of loads it will support, to decide which type of bridge will best suit the situation. Which type of bridge would engineers suggest to withstand very heavy loads?

A. Beam Bridge
B. Truss Bridge
C. Arch Bridge
D. Suspension Bridge

14. How well a structure will hold up under a load is important for cost, efficiency and …

A. aesthetics
B. appearance
C. safety
D. materials

15. Performance requirements are the guiding principles that engineers use to design structures. Maximum weight that the structure can support is expressed as …

A. weight capacity
B. load performance
C. static load mass
D. dynamic load mass

2.3 Internal Forces Within Structures

1. Internal forces are classified by the direction in which they act within an object. A force that acts to push parts of the object in contact with each other in opposite directions is this kind of internal force …
   - **A. bend**
   - **B. buckle**
   - **C. shear**
   - **D. twist**

2. When a solid material is compressed, small microscopic cracks in the material can enlarge or break apart. This can cause one section of the material to break away from the other part. This action is called ...
   - **A. bend**
   - **B. buckle**
   - **C. shear**
   - **D. twist**

3. Structures fail for a number of reasons. Engineers, study failed structures so they can design stronger, more durable structures. A flagpole that has been blown over in a strong wind happens because of the increased force that is applied to the ...
   - **A. entire structure**
   - **B. entire base**
   - **C. opposite side of the flagpole's base**
   - **D. same side of the flagpole's base**

4. Metal fatigue happens because metal is ...
   - **A. too old to be used any more**
   - **B. not made properly**
   - **C. bent or twisted over and over again**
   - **D. exposed to extreme conditions**

5. Complementary forces happen when different kinds of forces act on a structure at the same time. An example of a complementary force is …
   - **A. bend**
   - **B. buckle**
   - **C. shear**
   - **D. twist**

6. When you put your hands on your desk and put all your weight on them - then try to move them forward your hand (much like a structure) resists movement forward because of ...
   - **A. static forces**
   - **B. kinetic forces**
   - **C. external forces**
   - **D. frictional forces**

2.4 Designing Structures

1. The 7 wonders of the Ancient World took may years to complete, but they lasted a very long time. Why do you think that the Statue of Zeus at Olympia lasted so long?
   - **A. It was sheltered in a valley.**
   - **B. It was protected by the Greek Gods.**
   - **C. It was made of gold and ivory, which resists corrosion.**
   - **D. It was made of reinforced concrete and sealed with epoxy.**

2. The strongest structural shape is a …
   - **A. square**
   - **B. circle**
   - **C. triangle**
   - **D. rectangle**

3. When a structure has a single horizontal load-bearing beam, supported by two columns - one at each end, the beam will likely bend in the middle (A box and girder bridge spanning a river is a good example). This bending exerts pressure outward on the vertical supporting beams. To strengthen this bridge, so that heavy vehicle can cross it, you should ...
   - **A. reinforce the columns at both ends with braces**
   - **B. place additional columns in the middle**
   - **C. use a double cantilever design**
   - **D. utilize flying buttresses**

4. An arch, which is a common shape in bridges, can support large loads. This is possible because the force of the load is carried down through the arch to the foundation, from this point in the arch …
   - **A. loadstone**
   - **B. keystone**
   - **C. column**
   - **D. cantilever**

5. Beams are common components in a wide range of structures. The advantage of I beams is that they have a lot of strength but have less of this compared to simple beams …
   - **A. shape**
   - **B. mass**
   - **C. tension**
   - **D. girder**

6. Structural stability requires that a variety of materials should to be utilized to avoid deformation and structural failure. In a hang-glider the way that helps to reduce internal forces, such as tension, compression and shear, on the component parts is to …
   - **A. distribute the load evenly**
   - **B. direct the forces along angled components**
   - **C. shape the parts for the forces they are likely to face**
   - **D. place lighter materials above heavier materials**

7. Auto safety designers and inspectors to identify impact points when material fails in a collision use crash test dummies. When the car is rammed into a solid wall, the front end buckles. This happens to better protect the Crash test dummies (us) in a real accident. The metal deforms because of the energy it absorbs in the impact. Designers ...
   - **A. do this on purpose to ensure the material buckles.**
   - **B. identify the weaknesses and try to fix them.**
   - **C. determine what materials buckle the least.**
   - **D. identify where the front end needs more reinforcement.**