

PHY 201: Space, Time and Motion
Spring 2019, Test 1 on Galileo's *Dialogues*
EXAM TIME: 50 min.
NO CALCULATORS
Exam, Form: A

Name: _____

Student Number: _____

TA: _____

Date: _____

Section 1. Matching of scientific terms and concepts (4 pts.)

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| _____ suffice | (a) relating to a ratio of 3:2 |
| _____ transcend | (b) a drum |
| _____ consonance | (c) little known; abstruse |
| _____ augment | (d) be enough or adequate |
| _____ tympanum | (e) an ancient measure of length, approximately equal to the length of a forearm: about 18 inches |
| _____ inherent | (f) lacking in interest, excitement, or meaning |
| _____ arid | (g) entirely lacking or free from |
| _____ indignation | (h) existing in something as a permanent, essential, or characteristic attribute |
| _____ devoid | (i) make (something) greater by adding to it; increase |
| _____ circumspect | (j) the quality or fact of being able to grip something firmly |
| _____ implicit | (k) surpass, exceed |
| _____ recondite | (l) implied though not plainly expressed |
| _____ sibilant | (m) making or characterized by a hissing sound |
| _____ sesquialteral | (n) anger or annoyance provoked by what is perceived as unfair treatment |
| _____ cubit | (o) the combination of notes that are in harmony with each other due to the relationship between their frequencies |
| _____ tenacity | (p) wary and unwilling to take risks |

Section 2. Multiple choice (10 pts.)

- How might you sharpen the pitch (increase the frequency) of a guitar string by one octave?
 - double the tension of the string
 - double the density of the string
 - double the diameter of the string
 - halve the length of the string
 - all of the above would work
- According to Kleiber's law, the *specific* metabolic rate, r , of an animal scales as the $-\frac{1}{4}$ power of the animal's mass, M . This implies that if the mass of a lion is twice the mass of a dog, then the *metabolic rate*, R , of the lion is
 - 2 times that of the dog
 - $4\sqrt{2}$ times that of the dog
 - $\sqrt[4]{8}$ times that of the dog
 - $1/\sqrt[4]{8}$ times that of the dog
 - none of the above
- Two identical gold balls are suspended by strings from the ceiling. String A is four times as long as string B . Pendulum A and B are both pulled back by 10 degrees and simultaneously released. Which of the following statements are true?
 - The two pendulums will swing back and forth with the same period.
 - Pendulum B has twice the frequency of pendulum A .
 - Pendulum B has a longer period than pendulum A .
 - At the bottom of their swings, pendulum A is moving more slowly than B .
 - none of the above
- Which of the following reasons did Sagredo and Simplicio initially bring forward—in Day One of the *Dialogues*—to argue that ships should be able to be built on an enormous scale without otherwise changing their appearance?
 - the laws of geometry are the same for large and small shapes, such as triangles and circles
 - both large and small animals can survive falls that are many times their body size
 - both small and big clocks can be built with equal precision
 - all of the above
 - none of the above
- A 50 lb. lead weight is suspended from the ceiling by a thin copper wire. The wire is on the verge of snapping. If you want to suspend a 200 lb weight from the wire, you could
 - double the cross-sectional area of the wire
 - double the diameter of the wire
 - double the length of the wire
 - half the length of the wire
 - any of the above would work

6. A prism of diameter D and length L extends horizontally from a wall. A transverse force of 10 pounds (when applied to the end) just barely snaps the prism. If you were to triple both the diameter and the length of the prism, approximately how much force (again, applied to the end) would be necessary to snap the prism?
- (a) $3\frac{1}{3}$ pounds
 - (b) 10 pounds
 - (c) 33 pounds
 - (d) 90 pounds
 - (e) none of the above
7. Which of the following did Galileo provide as evidence that air exerts drag on the surface of a moving body?
- (a) spinning objects emit a whirring noise
 - (b) submerged objects float
 - (c) the period of a swinging pendulum is independent of its amplitude
 - (d) large clocks are more precise than small clocks
 - (e) all of the above
8. A spherical crystal of magnetite (specific gravity 3) is dropped into a pool of liquid mercury (specific gravity of 14). The sphere will
- (a) quickly sink to the bottom.
 - (b) float at first, but eventually sink to the bottom.
 - (c) float; more than half will be submerged
 - (d) float; about half of it will be submerged
 - (e) float; less than half will be submerged
9. A scuba diver holds two rocks he found on the bottom of the sea. They are identical in size and shape, but rock A has a specific gravity of 3 and rock B has a specific gravity of 4. Just after dropping them underwater, the acceleration of rock B is
- (a) $\frac{3}{4}$ that of rock A
 - (b) $\frac{9}{8}$ that of rock A
 - (c) $\frac{4}{3}$ that of rock A
 - (d) $\frac{9}{7}$ that of rock A
 - (e) twice that of rock A
10. In a fifth the frequencies of the notes are related by
- (a) 2:3
 - (b) 3:4
 - (c) 4:5
 - (d) 5:6
 - (e) none of the above

Section 3. Underwater architecture (4 pts.)

Suppose that Nemo, Captain of the *Nautilus*,¹ is planning to build a fabulous underwater city. According to his plans, a stone beam is to project 100 cm horizontally out from a vertical wall. He reads that such a beam can just barely support its own weight (when out of water) if the diameter of the beam is 1 cm. The specific gravity of the stone is 2.

1. First, what is the weight of the beam *out of water*? Let's assume the beam has a square cross section. You may express its weight in grams for now. Also, you may neglect any buoyant force that air exerts on the beam.

2. What is the breaking moment (torque) caused by the weight of the horizontal beam *out of water*? Please express the moment in Newton-meters.

¹The *Nautilus* is the submarine French author Jules Verne's 1870 book Twenty Thousand Leagues Under the Sea.

3. Now, what is the breaking moment caused by the (effective) weight of the horizontal beam when it is submerged underwater? Again, express this in Newton-meters. Is the breaking moment for the underwater beam less than or greater than the beam when out of water?

4. How much additional downward (transverse) force can be applied to the end of the submerged beam before it breaks? Explain your answer.

Section 4. Music and harmony essay (2 pts.)

Answer the following essay prompt using neat handwriting, logical and relevant argumentation, and correct grammar, spelling and punctuation.

1. What do you think: is there an objective standard for good music? Defend your position. (In other words, you will receive no credit for merely stating your opinion. Be sure to explain clearly how your view is similar to, or different from, Galileo's.)