Name_____

PHY 1033 HIS 3931 IDH 331
Final exam
December 17, 2015

"On my honor, I have neither given nor received unauthorized aid in doing this assignment."
_____ (sign)

Part I (3 points each, 30 points total) Choose the best selection

1. Suppose "F" is the gravitational force between two identical spaceships of mass m, far from any other masses. Now consider two planets the same distance apart, but of mass 3m. The gravitational force would then become

a) 3F
b) F/3
c) cannot be determined from information given
d) F
e) 9F

2. In the 13^{th} and 14^{th} centuries, the Catholic church endorsed the concept that there *could* be intelligent life on other worlds because

a) Canals were observed on Mars
b) Aristotle's writings proposing life on other worlds were discovered
c) Classical ideas confining life to the Earth were felt to restrict the omnipotence of God
d) Accounts of visits of Christ to Jupiter were discovered in the Dead Sea scrolls.
e) It was thought that human influence must be providing the motive force driving the planets in their orbits

3. A cannonball dropped from the top of the leaning tower of Gainesville, height h, hits the ground with a velocity (neglecting air resistance)

a) $\sqrt{(gh/2)}$
b) hg^2
c) h/2
d) gh^2
e) $\sqrt{(2gh)}$

4. A pond on a hot summer day never freezes by giving up its heat to the air. This is an example of

(a) momentum conservation
(b) 2nd law of thermodynamics
(c) energy conservation
(d) 1st law of thermodynamics
(e) heat death of the universe

5. Who first noticed that an electric current could deflect a compass needle?

a) Faraday
b) Maxwell
c) Franklin
d) Oersted
e) Galileo

6. Which of these measurement is Hipparchus known for?

a) Distance of Earth to moon and sun
b) Weight of the moon
c) Circumference of the Earth
d) None of the above
e) Distance from Marathon to Athens

7. From ancient to medieval times, one of the most persuasive arguments against the motion of the Earth was that if one threw a stone straight up on a moving Earth, it would not fall at the point from which it had been thrown, but somewhere behind it. Using the example of activities on a moving ship, Galileo argued that the stone landed in the same place because

a. the stone was pushed sideways by the air carried by the Earth
b. a magnetic force kept it moving with the Earth after it had been thrown upwards
c. the stone moved with the Earth because it was always attached to an invisible crystalline sphere
d. the stone's tendency is to return to its natural place of rest at the center of the Earth
e. the stone has a sideways component of its velocity equal to that of the rotating Earth

8. When Kepler arrived in Prague to become Tycho's assistant, Tycho assigned him to work on the problem of one planet whose motion fit his model *worst*. Which planet was it? (Hint: this planet has the largest ellipticity of the known planets at the time).

a) Venus
b) Jupiter
c) Saturn
d) Mars
e) Mercury

9. Maxwell's equations had solutions that could be interpreted as light because

a) they reduced in a charge-free region to Faraday's equations for a moving light pulse
b) they proved the existence of the ether
c) they had exactly the right frequency corresponding to visible light
d) he demonstrated that they could exhibit interference phenomena
e) the speed of a wave in these solutions was equal to the speed of light measured by astronomical means

10. Bohr's Planck's theory of energy quanta

a) Allowed for a perfect explanation of blackbody radiation
b) Enabled Clausius to prove the 2^{nd} law of thermodynamics
c) Allowed Einstein to explain the photoelectric effect
d) a) and c)
e) a) and b)

Part II (2 pts each, total 40 points) Answer the following briefly:

1. Newton's laws of motion

(a) State Newton's laws of motion. Discuss how they differ from Aristotle's "laws of motion", considering both horizontal and vertical motions.

(b) If you are just standing still, what forces are acting on you? What are the Newtonian reaction forces to those forces?

2. A drag racer at Gator Nationals has a mass of 800 kg, and the engines provide a maximum force of 32000 N. Give the peak acceleration of the drag racer in units of g=10 m/s^2, the acceleration due to gravity.

3. Centripetal acceleration. A space station is designed as a ring of radius 20 m.

   a) How fast must it rotate if it is to simulate Earth's gravity at the edge (speed at the outer rim v)?

   b) What is the corresponding angular velocity ω?

4. Discuss Galileo's trial, its origin, context, and outcome.

5. Describe Tycho Brahe's solar system model, and compare with Copernicus. Draw sketches for both systems.

6. Identify and explain briefly Einstein's 3 discoveries from his *Annus Mirabilis* 1905.

7. Interference

a) Young showed that light exhibited interference phenomena like water waves. Explain this with a diagram of a Young's 2-slit experiment.

b) Explain why modern quantum mechanics suggests that electrons behave like waves in some circumstances, and as discrete particles in some others, using the 2-slit experiment.

8. Who said, “I feign no hypotheses”, and in what context? Why was this important for the modern scientific method?

9. Name two of Galileo’s great discoveries with his telescope, and explain why they were important.

10. Explain why we have seasons, using a diagram. What days mark the beginning of each season in the northern hemisphere? Show where the Earth is on your diagram at the beginning of each season.

11. How did Newton and Descartes differ regarding their notion of what a force was, and how it could act on an object?

12. Describe the Bohr model of the atom, and explain why it was successful.

13. Explain what 19th century physicists thought the "ether" was. Why did they think it *must* exist? What proved it didn't?

14. Copernicus was proudest of having found a solar system model that "eliminated the equant" Explain the definition of the equant, its history, and what Copernicus did to "eliminate" it.

15. The 20th century conclusion that the universe was expanding depended on knowing the distance to faraway stars and galaxies. Describe one method of measuring such distances, and identify who discovered it.

Part III. (30 pts) Essay. Choose **one** of A, B or C (Do not do more than one).

A. Describe the development of the modern scientific method, starting from the ancient Greeks until the modern era until the modern era, with specific examples from important scientists. Refer to at least three of the following

Aristotle
Galileo
Descartes
Huygens
Newton
Michelson

B. From the following list of major figures in the development of our understanding of the motion of earthly bodies (not the Earth!), identify the contributions of any four of them and explain how each arrived at his results. When appropriate, identify aspects of the individual's ideas which were incorrect as viewed from the modern perspective.

Aristotle
Buridan
Galileo
Newton
Einstein

C. Using ideas from the Bronowski film "Knowledge and Certainty", discuss the notion of certainty, tolerance and determinism, first contrasting the ideas of Laplace with those of the theorists who developed the kinetic theory of gasses, and with those of Heisenberg and modern quantum theory. Describe in your discussion how the role of the observer has evolved. How does Bronowski connect the act of observation or measurement with the notion of scientific tolerance or openness?