PHYSICS 1090: MIDTERM II PROBLEM FILE

The Midterm will be eight of these.

*It will be pledged: you must not use any source of information during the exam. You will not need calculators, as you can see.   When asked for approximate times, the right century is enough. Numbers labeled * could change!*

1. When did Copernicus live, approximately? What was his main contribution to science? What reasons did he give for introducing a new model? Why did Galileo's discovery of Jupiter's moons make Copernicus's picture more plausible?

2. How did Galileo estimate the height of mountains on the Moon? Draw a diagram and explain. Approximately, how high were they? How could the Moon still look so round?

3. What physical justification was there for Aristotle's belief that things fell at a uniform speed? What everyday experience did Galileo invoke to suggest that in fact everyone knew better?

Galileo also argued against Aristotle's assertion that something twice as heavy would fall twice as fast by asking how fast a heavy ball tied to a light ball would fall. (See Two New Sciences, second selection.) Recount the argument.

4. Reconstruct Galileo's argument that a ball rolling down a ramp would pick up the same speed in losing a given vertical height as a ball simply falling. Explain how timing the ball's motion for certain distances led him to believe it accelerated at a uniform rate.

5. Venus is called the evening star sometimes. Does that mean you can never see Venus in the early morning (before sunrise, of course)? Could you ever see Venus at midnight? Explain your answer with a diagram.

At the north pole, the Pole Star, Polaris, is always directly overhead. Is there anywhere where it is always on the horizon? (At night, of course!) If there is such a place, does it move around the horizon, or stay in the same spot?

6. If you lived on the Moon and watched the Earth, would you see phases? Would you ever see the Earth eclipse the Sun? Would you ever see the Earth set?

Draw a diagram making clear how an eclipse of the Moon happens, and explain why there isn't one every month.

7. Why didn't Galileo believe in giants? Why can a cat fall through a greater distance safely than a horse can, even though the cat is a lot smaller? Explain your answer.

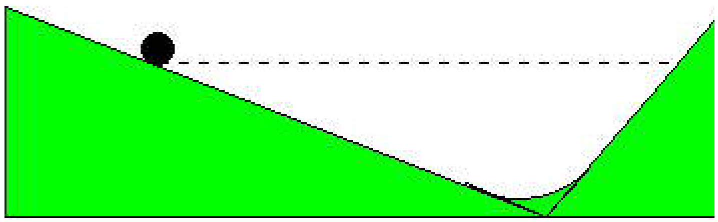
Why are ants several feet long, as seen in movies like "Them" never going to bother us?   Why are there no mice in the arctic? Why are lungs so complicated, instead of being like the inside of a balloon, for example?

8. In the movie "Honey I shrunk the kids" the shrunken wife is trapped in her kitchen sink. Galileo would have spotted a mistake in this scenario. What is it?

If a grasshopper could be scaled up to one hundred times its natural length, keeping the same proportions, and it's still able to jump, how high very approximately can it jump?

9. If something falls from rest for two seconds, what is its speed at the end of the two seconds? What was its average speed during the two seconds? How far did it fall? (Note: this question could appear with a different time interval.)

10.   A cannonball is shot horizontally from a cliff top at 100* meters per second. Show on a diagram vectors representing the *velocity* of the cannonball after 1*, 2*, and 3* seconds. Explain with a drawing how these vectors relate to each other and to the acceleration.



11. Draw vectors for the velocity and acceleration of Galileo's two ramp ball at the high point and halfway down each ramp, and at its lowest point. Assume friction is negligible.

12 Draw vectors for the velocity and acceleration of a swinging pendulum at the far point of the swing, at the midpoint, and at a point halfway between the far point and the midpoint.

13. If Newton's cannon were on a mountaintop 7,000 km from the center of the Earth, and we take it that something dropped from rest there falls 5 m in one second, use Pythagoras' theorem to find how fast the cannon must shoot the ball for it to stay in orbit.

14. What three laws of planetary motion did Kepler discover when he analyzed the data?

Suppose Saturn takes 27 years to make one circuit of the Sun, and the earth is about 100,000,000 miles from the Sun, roughly how far from the Sun is Saturn? (Use Kepler's Third Law!)

(*Note: Actually Saturn's period is a little different, but taking 27 years means you don't need a calculator, if you do it right.*)

15 State Kepler's three laws. If an asteroid's orbit is such that its furthest distance from the Sun is twice its nearest distance, how does its speed at the furthest point compare with its speed at the nearest point? Explain how this can be deduced using one of Kepler's laws.

16. State Newton's Laws of Motion. Discuss how they differ from Aristotle's "Laws of Motion", considering both horizontal and vertical motions. How did Newton tie Galileo's two types of motion together?

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

17. What is Newton's Law of Gravitational Attraction? Explain how relating a falling apple to the Moon in orbit gave him the clue about how gravity between two objects varies with their distance apart.

Show how Newton's Law of Gravitational Attraction explains Kepler's Third Law of planetary motion, assuming the orbits are circles. (It's still true if they're not, but harder to prove.)

18. A car is going around a circular track of radius 100* meters at a speed of 10* meters per second, and at the same time is picking up speed at a rate of 1* meter per second per second. Show on a diagram the magnitude and direction of its acceleration.

19.   It's 40,000 km all the way round the equator—so what is the approximate speed (say within 20%) in meters per second of a town on the equator from the Earth's rotation?

This town is going in a circle! So, what's its acceleration? Does gravity provide enough force to keep it firmly on the ground? (A historical objection to a rotating earth was that things would be thrown off.)

20. Describe how the mass of the Earth was first found. Given that, how much more needs to be done to find the mass of the Sun?