

Physics 221

Midterm Exam, Form: A

Name: _____

Date: _____

These questions are written to test your understanding of the principles and your ability to apply the principles you have learned. For full credit, you must show all work.

1. In the lab you observe a 0.74-kg object oscillating up and down at the end of a spring. You time the oscillations and record that the mass makes 15 round trips in 4.50 seconds. You remove the mass and measure the length of the spring, which is 0.430 m. Next you hang the mass from the spring, so that the mass hangs motionless. Now what is the length of the spring?

2. If you switch springs to one that has half the spring constant, what will be the period of oscillation?

Questions 3–5: A load of 190 kg is supported motionless above the ground by two ropes. Rope 1 exerts a force of $\langle -300, 500, 0 \rangle$ N on the load.

3. What is the momentum principle, stated in words?

4. What is the force exerted by rope 2? Explain carefully and completely, starting from a fundamental principle.

5. Draw a diagram showing all the forces acting on the load. All vectors should be drawn to the same scale, so that longer arrows correspond to larger magnitudes. Clearly label each force to identify it.

Questions 6–8: You write a VPython program to model the motion of a 2000-kg satellite around the Earth. The Earth is at the origin and the satellite is at $\langle 0, 1.00 \times 10^7, 0 \rangle$ m with a velocity of $\langle -6.326 \times 10^3, 0, 0 \rangle$ m/s. The net force on the satellite is equal to the gravitational force of the Earth on the satellite, and the satellite's speed is just the right speed for circular motion. In your program, you use a time interval of $dt = 3600$ s for calculating the momentum and position during each iteration of the while loop.

6. What is the net force on the satellite when it is at its initial position? (Express this as a vector!)

7. What is the momentum of the satellite after the first time step of 3600 s? (Express this as a vector!)

8. What is the position of the satellite after the first time step of 3600 s? (Express this as a vector!)

Questions 9– 10: A comet's orbit is shown in Figure 1. Treat the comet as a particle. Assume that the only force on the comet is the gravitational force of the Sun.

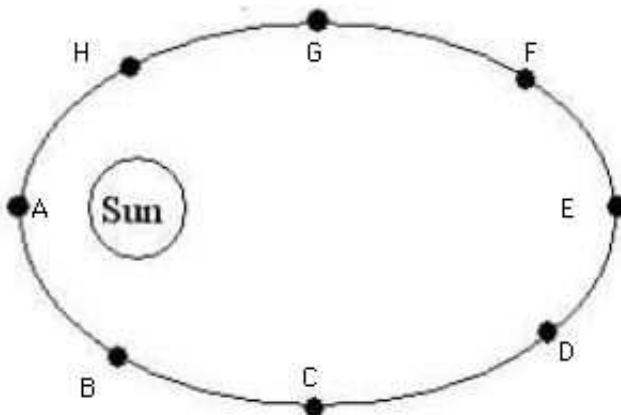


Figure 1: Orbit of a comet.

9. As the comet travels from A to E, is the work done by the gravitational force of the Sun positive, negative, or zero? Explain your answer.

10. As the comet travels from E to A, is the work done by the gravitational force of the Sun positive, negative, or zero? Explain your answer.

11. What is the total work done on the comet as it makes one complete revolutions (from A back to A for instance). Explain your answer.

12. What is the energy principle for a particle?

13. Suppose that the comet's speed at point A is 2.4×10^4 m/s. If the total work done on the comet as it travels from A to E is -9.69×10^{29} J and if its mass is 6×10^{20} kg, what will be its speed at point E? Treat the comet as a particle.

Answer Key for Exam A

1. See key
2. See key
3. See key
4. See key
5. See key
6. See key
7. See key
8. See key
9. See key.
10. See key.
11. See key.
12. See key.
13. See key.