AP Physics C Name: ___________________________________

Unit 7 Test: Oscillations and Gravity Period: ______

Part 1: Multiple Choice. Directions – Only a Sith deals in absolutes, but for the questions below, choose the one, and only one answer that best answers the question posed. If an exact answer is not present, chose the closest available answer. (4 points each)

1. This is where the fun begins! Which of the following is true for a system consisting of an object oscillating on the end of an ideal spring?

A) The kinetic and potential energies are equal at all times.
B) The kinetic and potential energies are both constant.
C) The maximum potential energy is achieved when the object passes through its equilibrium position.
D) The maximum kinetic energy and maximum potential energy are equal, but occur at different times.
E) The maximum kinetic energy occurs at maximum displacement of the object from its equilibrium position.

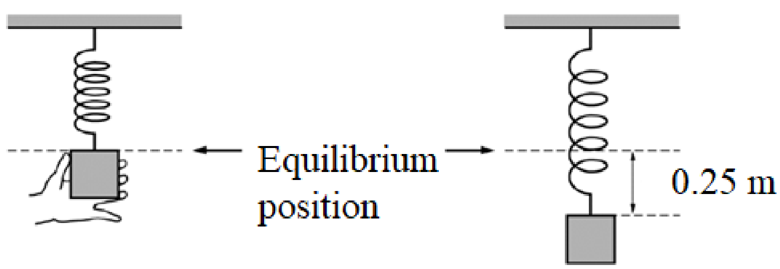
2. A mass of 25.0 kg is attached to a spring. Luke uses the force to apply a 80 N to the spring, compressing it 20 cm from its equilibrium position. He then releases the spring and allows it to oscillate. Which of the following functions could give the position of the mass as a function of time?

A) $x(t) = 20\cos(16t)$
B) $x(t) = .2\sin(0.25t)$
C) $x(t) = 20\sin(4t)$
D) $x(t) = .2\sin(4t)$
E) $x(t) = .2\cos(0.25t)$

3. The acceleration of a mass-spring system is given by $a(t) = -32\cos(4t + 2)$. Find the amplitude of the mass's motion.

A) 2 m B) 4 m C) 8 m D) 32 m E) 512 m

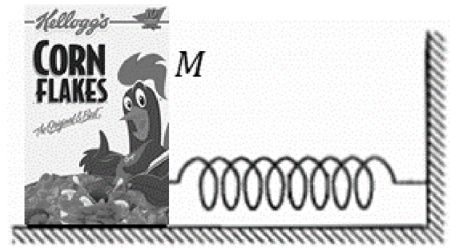
4. A block of mass m = 1.0 kg is attached to a spring of spring constant k = 50 N/m as shown. In the left picture, the spring is at its equilibrium position with the high ground. On the right, the spring is stretch a distance of 0.25 down past equilibrium.



What is the magnitude in the change in total mechanical energy in the earth-spring system between the two positions of the spring?

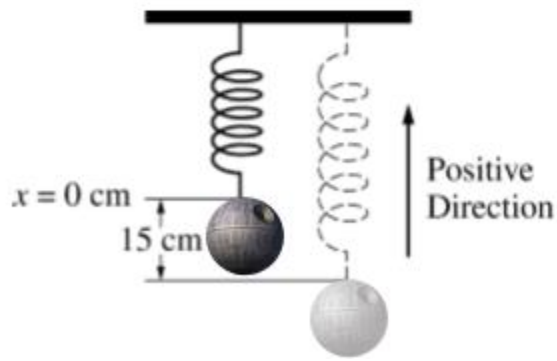
A) 1.6 J B) 0.67 J C) 0.88 J D) 0.50 J E) 1.2 J

5. An ideal massless spring is fixed to the wall at one end, as shown. A box of mass M is attached to the other end of the spring on a frictionless, horizontal surface. The box is displaced and the spring starts moving that corn flakes as the mass oscillates with amplitude A. The maximum speed of the block during its oscillation is v. Which of the following is an expression for the elastic constant of the spring?



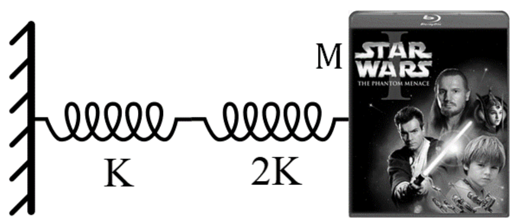
A) $\frac{Mg}{A}$ B) $\frac{Mgv}{2A}$ C) $\frac{Mv^2}{2A}$ D) $\frac{Mv^2}{A}$ E) $\frac{Mv^2}{2A^2}$

6. An object is initially hanging in equilibrium from a vertical spring. The object is pulled down 15 cm from its equilibrium position, as illustrated above, and released at time t = 0. The object then oscillates with a period of 2.0 s. Let x = 0 be the equilibrium position and let the positive direction be upward. Which of the following statements is true of the magnitude of the acceleration of the object at time t = 1.0 s?



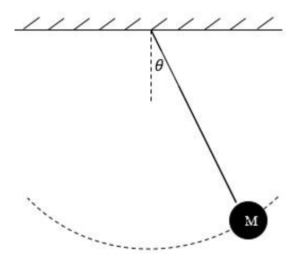
A) It is equal to zero.
B) It is equal to g.
C) It has its minimum value that is not zero.
D) It has its maximum value.
E) It has a value between zero and its maximum value.

7. A copy of The Phantom Menace of mass M is attached to two springs as shown. The two springs are connected end-to-end and have spring constants K and 2K. Determine an expression for the frequency of the motion if the copy of the Phantom Menace is allowed to oscillate.



A) $\frac{1}{2\pi}\sqrt{\frac{3K}{m}}$ B) $\frac{1}{2\pi}\sqrt{\frac{2K}{3m}}$ C) $\frac{1}{2\pi}\sqrt{\frac{3K}{2m}}$ D) $\frac{1}{2\pi}\sqrt{\frac{K}{3m}}$ E) $\frac{1}{2\pi}\sqrt{\frac{K}{m}}$

8. A pendulum bob of mass M is attached to a light string of length L. The bob is pulled back so that it makes an angle of θ with the horizontal as shown. The bob tries spinning since that's good trick but only ends up oscillating as an ideal pendulum. Which of the following gives an expression for the tension in the string when the kinetic energy of the bob is a maximum?



A) Mg
B) $Mg(3 - 2cos\theta)$
C) $Mg(1 - 2cos\theta)$
D) $2Mg(cos\theta - 1)$
E) $Mg(2 - cos\theta)$

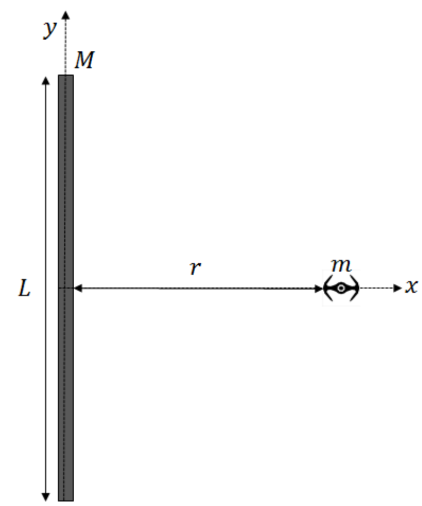
9. Hello, what have we here? Lando, the last Jedi, is from the planet Socorro. Socorro has the same diameter as earth, but is only ¼ as dense. Lando releases a pendulum of small amplitude and length L on Socorro. What is the period of the pendulum?

A) $4\pi\sqrt{\frac{L}{g}}$ B) $2\pi\sqrt{\frac{L}{2g}}$ C) $\pi\sqrt{\frac{L}{g}}$ D) $4\pi\sqrt{\frac{2L}{g}}$ E) $2\pi\sqrt{\frac{2L}{g}}$

10. But what about the droid attack on the Wookiees? The Wookiee home plant is Kashyyk; it's not a system we can afford to lose. Kashyyk is found to have twice the radius and three times the mass of Earth. If the acceleration due to gravity on Earth's surface is g, the acceleration due to gravity at the surface of Kashyyk is:

A) $\frac{2g}{3}$ B) $\frac{3g}{2}$ C) g D) $\frac{4g}{3}$ E) $\frac{3g}{4}$

11. That's no moon. That's a massive rod in space of mass M and length L as shown in the diagram. The rod lies along the y-axis, with its center at the origin. A small point mass of mass m lies along the x-axis a distance of r away. Which of the following expression would, when evaluated give the force of gravity between the two objects?



A) $F = \frac{Mmr}{L}\int_{-L/2}^{L/2}\frac{dy}{y^2+r^2}$

B) $F = \frac{Mmr}{L}\int_{-L/2}^{L/2}\frac{dy}{(y^2+r^2)^{\frac{3}{2}}}$

C) $F = \frac{Mm}{L}\int_{0}^{r}\frac{xdx}{(L^2+x^2)^{\frac{3}{2}}}$

D) $F = \frac{2Mm}{L}\int_{0}^{r}\frac{xdx}{L^2+x^2}$

E) $F = \frac{Mmr}{L}\int_{0}^{L}\frac{dy}{y^2+r^2}$

12. Jar Jar Binks is thrown down to the bottom of a deep mine shaft on a planet of uniform density, which of the following is true?

A) Jar Jar's weight is exactly the same as at the surface.
B) Jar Jar's weight is greater than at the surface.
C) Jar Jar's weight is less than at the surface.
D) Jar Jar's weight may increase or decrease, depending on the density of the planet.
E) The gravitational force on Jar Jar changes in direction but not in magnitude.

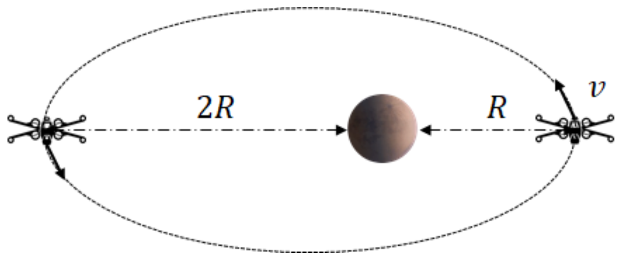
13. An Imperial satellite orbits the ice planet of Hoth. The satellite has a mass m and is in a circular orbit with speed v_0 at a distance r from the center of Hoth. What is the ratio of its escape speed from its current orbit to its orbital speed, $\frac{v_e}{v_0}$?

A) $\sqrt{2}$ B) 2 C) 1/2 D) 1 $\sqrt{2}/2$

14. A bombad projectile is launched from the surface of Naboo (mass = M, radius = R). What minimum launch speed is required if the projectile is to rise to a height 4R above the surface of the planet? Disregard any dissipative effects of the atmosphere.

A) $\sqrt{\frac{4GM}{3R}}$ B) $\sqrt{\frac{8GM}{5R}}$ C) $\sqrt{\frac{3GM}{2R}}$ D) $\sqrt{\frac{5GM}{3R}}$ E) $\sqrt{\frac{4GM}{5R}}$

15. Luke Skywalker has vanished. In his absence, the sinister FIRST ORDER has risen from the ashes of the Empire and will not rest until Skywalker, the last Jedi, has been destroyed. With the support of the REPUBLIC, General Leia Organa leads a brave RESISTANCE. She is desperate to find her brother Luke and gain his help in restoring peace and justice to the galaxy. Leia has sent her most daring pilot on a secret mission to Jakku, where an old ally has discovered a clue to Luke's whereabouts.

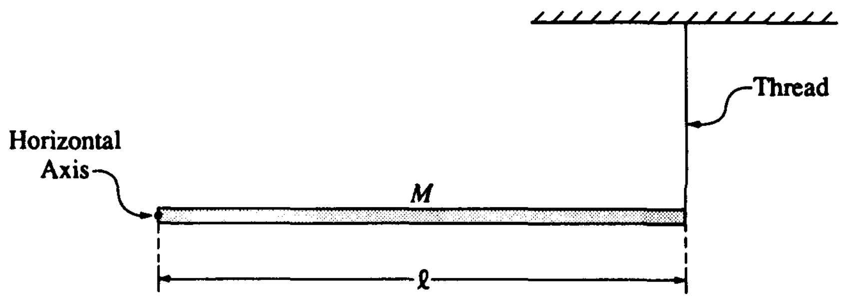


Poe Dameron pilots his X-wing of mass M in an elliptical orbit about Jakku as shown above. At one point in his orbit, he is a distance of R from the center of Jakku and moving at speed v. At another point in his orbit, he is a distance 2R from the center of Jakku. What is his orbital speed at this location?

A) $v/2$ B) $v/4$ C) $v/\sqrt{2}$ D) $\sqrt{2}v$ E) v

Multiple Choice Answers: For ease of grading at the South Florida Fairgrounds, please enter your multiple choice answers below:

1. ______	6. ______	11. ______
2. ______	7. ______	12. ______
3. ______	8. ______	13. ______
4. ______	9. ______	14. ______
5. ______	10. ______	15. ______



1993M3. A long, uniform rod of mass M and length l is supported at the left end by a horizontal axis into the page and perpendicular to the rod, as shown above. The right end is connected to the ceiling by a thin vertical thread so that the rod is horizontal. The moment of inertia of the rod about the axis at the end of the rod is $Ml^2/3$. Express the answers to all parts of this question in terms of M, l, and g.

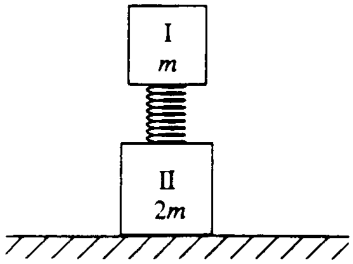
a. Determine the magnitude and direction of the force exerted on the rod by the axis.

The thread is then burned by a match. For the time immediately after the thread breaks, determine each of the following:

b. The angular acceleration of the rod about the axis
c. The translational acceleration of the center of mass of the rod
d. The force exerted on the end of the rod by the axis

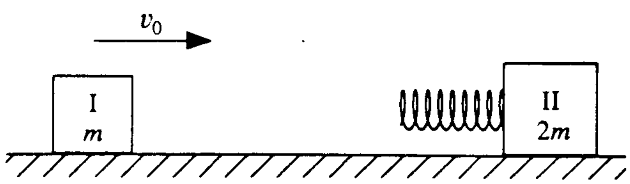
The rod rotates about the axis and swings down from the horizontal position.

e. Determine the angular velocity of the rod as a function of θ, the arbitrary angle through which the rod has swung.



The two blocks I and II shown above have masses m and 2m respectively. Block II has an ideal massless spring attached to one side. When block I is placed on the spring as shown. the spring is compressed a distance D at equilibrium. Express your answer to all parts of the question in terms of the given quantities and physical constants.

a. Determine the spring constant of the spring

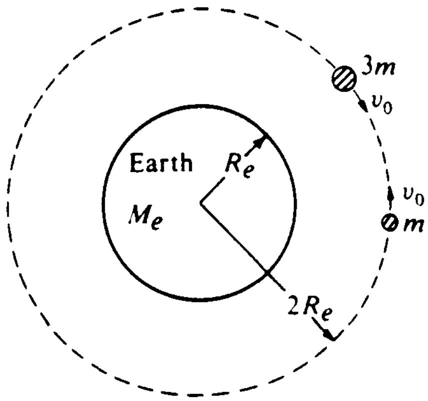


Later the two blocks are on a frictionless, horizontal surface. Block II is stationary and block I approaches with a speed v_o, as shown above.

b. The spring compression is a maximum when the blocks have the same velocity. Briefly explain why this is so.

c. Determine the maximum compression of the spring during the collision.

d. Determine the velocity of block II after the collision when block I has again separated from the spring.



Two satellites, of masses m and 3m, respectively, are in the same circular orbit about the Earth's center, as shown in the diagram above. The Earth has mass M_e and radius R_e. In this orbit, which has a radius of $2R_e$, the satellites initially move with the same orbital speed v_o but in opposite directions.

a. Calculate the orbital speed v_o of the satellites in terms of G, M_e, and R_e.

b. Assume that the satellites collide head-on and stick together. In terms of v_o find the speed v of the combination immediately after the collision.

c. Calculate the total mechanical energy of the system immediately after the collision in terms of G, m, M_e, and R_e. Assume that the gravitational potential energy of an object is defined to be zero at an infinite distance from the Earth.