AP Physics Study Guide Chapters 5, 11 Gravitation & Oscillations Name_____

Circle the vector quantities below and underline the scalar quantities below

gravitational force gravitational acceleration restoring force potential energy in spring

kinetic energy orbital speed centripetal force

Write the equation that defines each quantity, **INCLUDE UNITS FOR ALL QUANTITIES**
specify these 4 formulas as a function of radial distance r
gravitational force gravitational acceleration orbital speed centripetal force

potential energy in spring period of a mass in SHM on a spring pendulum period

Chapter 5 Gravitation & Satellites
Write Newton's law of universal gravitation using words.

For two uniform spheres what does the distance r represent?

Explain in detail the phenomenon of "apparent weightlessness" that astronauts experience in orbiting space vehicles.

Chapter 11 Simple Harmonic Motion (SHM)

Define the following for an object in SHM

Amplitude position

Equilibrium position

What is the basic relationship for restoring force? Explain both criteria in this relationship.

At what position is the object's speed maximum?_____ zero?_____

At what position is the object's acceleration maximum?_____ zero?_____

At what position is the restoring force on the object maximum?_____ zero?_____

SHM displacement, velocity and acceleration functions are _____ functions with respect to time.

Explain what the UCM reference circle is and how it is related to SHM.

For the displacement function $x = A\cos(\omega t)$ explain what A is and what the angular frequency ω is.

For any object in SHM explain why the period of oscillation is independent of the amplitude of the motion.

What are the two quantities that the period of oscillation of a mass on a spring depends on?

What are the two quantities that the period of oscillation of a simple pendulum depends on?

In addition to amplitude, what is the period of a simple pendulum independent of?

No process is required for multiple choice questions.

1)If the mass of a simple pendulum is doubled but its length remains constant, its period is multiplied by a factor of

(A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$ (C) 1 (D) $\sqrt{2}$ (E) 2 1)_____

2. Which of the following is true for a system consisting of a mass oscillating on the end of an ideal spring?

(A) The kinetic and potential energies are equal to each other at all times. 2)_____

(B) The kinetic and potential energies are both constant.

(C) The maximum potential energy is achieved when the mass 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 mass from its equilibrium position

3. When a mass is attached to a spring, the period of oscillation is approximately 2.0 seconds. When the mass attached to the spring is doubled, the period of oscillation is most nearly

(A) 0.5 s (B) 1.0 s (C) 1.4 s (D) 2.0 s (E) 2.8 s 3)_____

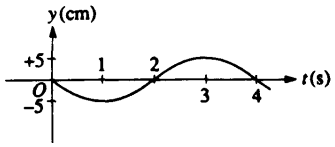
4. When an object oscillating in simple harmonic motion is at its maximum displacement from the equilibrium position. which of the following is true of the values of its speed and the magnitude of the restoring force?

	Speed	Restoring Force
(A)	Zero	Maximum
(B)	Zero	Zero
(C)	½ maximum	½ maximum
(D)	Maximum	½ maximum
(E)	Maximum	Zero

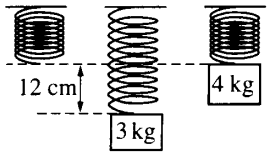
4)_____

5) The planet Mars has mass = $M_{earth}/10$ and radius = $R_{earth}/2$. The acceleration of an object in free-fall near the surface of Mars is most nearly

(A) zero (B) 1.0 m/s^2 (C) 1.9 m/s^2 (D) 3.7 m/s^2 (E) 9.8 m/s^2



6. A particle oscillates up and down in simple harmonic motion. Its height y as a function of time t is shown in the diagram above. At what time t does the particle achieve its maximum positive acceleration?
   (A) 1 s (B) 2 s (C) 3 s (D) 4 s
   (E) None of the above, because the acceleration is constant 6)_____



7. A block of mass 3.0 kg is hung from a spring, causing it to stretch 12 cm at equilibrium, as shown above. The 3.0 kg block is then replaced by a 4.0 kg block, and the new block is released from the position shown above, at which the spring is unstretched. How far will the 4.0 kg block fall before its direction is reversed?
   a. 9 cm b. 18 cm c. 24 cm d. 32 cm e. 48 cm 7)_____

8. An object has a weight *W* when it is on the surface of a planet of radius *R*. What will be the gravitational force on the object after it has been moved to a distance of *4R* from the center of the planet?
   A) 16W B) 4W C) W D) W/4 E) (1/16) W
   8)_____

9) 9)_____

An artificial satellite orbits Earth at a speed of 7800 m/s and a height of 200 km above Earth's surface. The satellite experiences an acceleration due to gravity of

(A) 39 m/s^2

(B) less than 39 m/s^2 but greater than 9.8 m/s^2

(C) 9.8 m/s^2

(D) less than 9.8 m/s^2 but greater than zero

(E) zero

10) 10)_____

A simple pendulum is used to determine the acceleration due to gravity at the surface of a planet. The pendulum has a length of 2 m and its period is measured to be 2 s. The value of g obtained in this investigation is most nearly

(A) 1 m/s^2
(B) 2 m/s^2
(C) 5 m/s^2
(D) 10 m/s^2
(E) 20 m/s^2

11) 11)_____

. The displacement x with respect to time t of a particle moving in simple harmonic motion is given by $x = 5\cos(16\pi t)$, where x is in millimeters and t is in seconds. If the particle starts at $x = 5$ mm and $t = 0$ s, at what time t does it first pass through its equilibrium position?

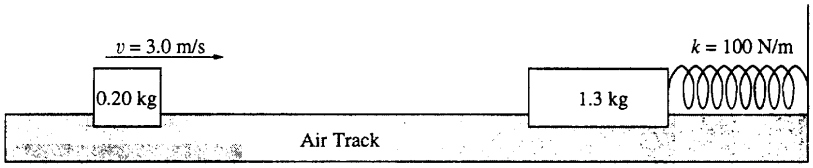
(A) $\frac{1}{32}$s

(B) $\frac{1}{16}$s

(C) $\frac{1}{5}$s

(D) 4 s

(E) 8 s



1) As shown above, a 0.20-kilogram mass is sliding on a horizontal, frictionless air track with a speed of 3.0 meters per second when it instantaneously hits and sticks to a 1.3-kilogram mass initially at rest on the track. The 1.3-kilogram mass is connected to one end of a massless spring, which has a spring constant of 100 newtons per meter. The other end of the spring is fixed.

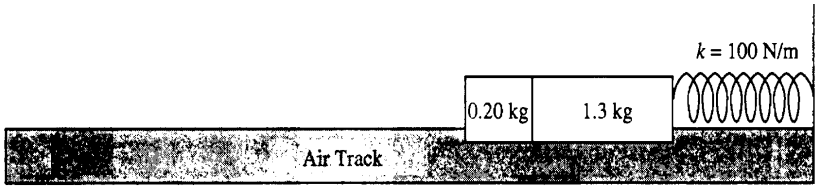
a. Determine the following for the 0.20-kilogram mass immediately before the impact.

i. Its linear momentum i)_____

ii. Its kinetic energy ii)_____

b. Determine the following for the combined masses immediately after the impact.

i. The linear momentum i)_____

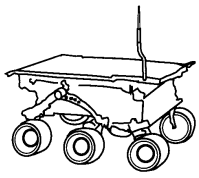


ii. The kinetic energy ii)_____

After the collision, the two masses undergo simple harmonic motion about their position at impact.

c. Determine the amplitude of the harmonic motion. c)_____

d. Determine the period of the harmonic motion. d)_____



2) The Sojourner rover vehicle shown in the sketch above was used to explore the surface of Mars as part of the Pathfinder mission in 1997. Use the data in the tables below to answer the questions that follow.

Mars Data	Sojourner Data	
Radius: 0.53 x Earth's radius	Mass of Sojourner vehicle:	11.5 kg
Mass: 0.11 x Earth's mass	Wheel diameter:	0.13 m
	Stored energy available:	5.4×10^5 J
	Power required for driving under average conditions:	10 W
	Land speed:	6.7×10^{-3} m/s

a. Determine the acceleration due to gravity at the surface of Mars in terms of g, the acceleration due to gravity at the surface of Earth.

a)_____

b. Calculate Sojourner's weight on the surface of Mars.

b)_____

c. Assume that when leaving the Pathfinder spacecraft Sojourner rolls down a ramp inclined at 20° to the horizontal. The ramp must be lightweight but strong enough to support Sojourner. Calculate the minimum normal force that must be supplied by the ramp.

c)_____

d. What is the net force on Sojourner as it travels across the Martian surface at constant velocity? Justify your answer.

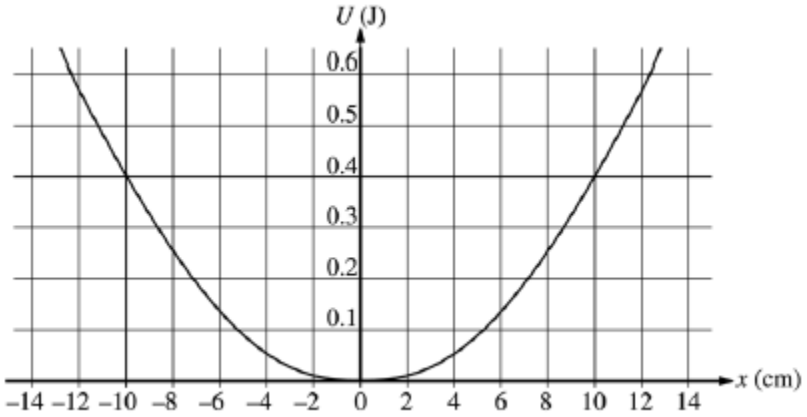
d)_____

e. Determine the maximum distance that Sojourner can travel on a horizontal Martian surface using its stored energy.

e)_____

f. Suppose that 0.010% of the power for driving is expended against atmospheric drag as Sojourner travels on the Martian surface. Calculate the magnitude of the drag force.

f)_____



3) A 3.0 kg object subject to a restoring force F is undergoing simple harmonic motion with a small amplitude. The potential energy U of the object as a function of distance x from its equilibrium position is shown above. This particular object has a total energy E = 0.4 J.

a) what is the object's potential energy when its displacement is +4 cm from its equilibrium position?

a)_____

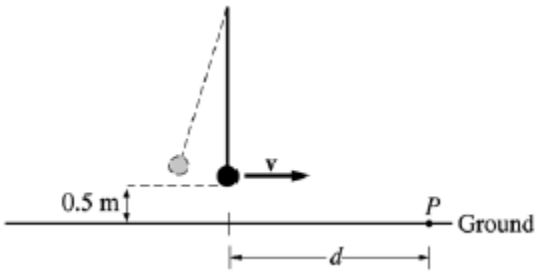
b) What is the farthest the object moves along the x-axis in the positive direction? Explain your reasoning.

b)_____

c) determine the object's kinetic energy when its displacement is –7 cm.

c)_____

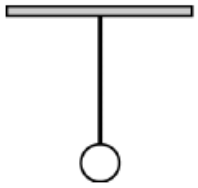
d) what is the object's speed at x = 0? d)_____



e) suppose the object undergoes this motion because it is the bob of a simple pendulum as shown above. If the object breaks loose from the string at the instant the pendulum reaches its lowest point and hits the ground at point P shown, what is the horizontal distance d that it travels?

e)_____

4)



The simple pendulum above consists of a bob hanging from a light string. You wish to experimentally determine the frequency of the swinging pendulum.

(a) By checking the line next to each appropriate item on the list below, select the equipment that you would need to do the experiment.

____ Meterstick	____ Protractor	____ Additional string
____ Stopwatch	____ Photogate	____ Additional masses

(b) Describe the experimental procedure that you would use. In your description, state the measurements you would make, how you would use the equipment to make them, and how you would determine the frequency from those measurements.

over for more

(c) You next wish to discover which parameters of a pendulum affect its frequency. State one parameter that could be varied, describe how you would conduct the experiment, and indicate how you would analyze the data to show whether there is a dependence.