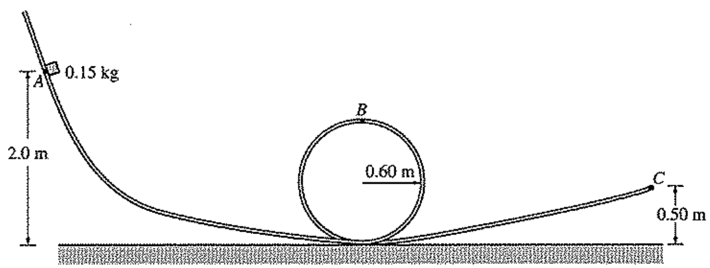
USED $g = 10\,m/s^2$

PHYSICS B
SECTION II
Time—90 minutes
7 Questions

Directions: Answer all seven questions, which are weighted according to the points indicated. The suggested times are about 11 minutes for answering each of Questions 1 and 4-7 and about 17 minutes for answering each of Questions 2-3. The parts within a question may not have equal weight. Show all your work in the goldenrod booklet in the spaces provided after each part, NOT in this lavender insert.



1. (10 points)

A small block of mass 0.15 kg is placed at point A at a height 2.0 m above the bottom of a track, as shown in the figure above, and is released from rest. It slides with negligible friction down the track, around the inside of the loop of radius 0.60 m, and leaves the track at point C at a height 0.50 m above the bottom of the track.

(a) Calculate the speed of the block when it leaves the track at point C.

(b) On the figure below, draw and label the forces (not components) that act on the block when it is at the top of the loop at point B.

F_N F_g

(c) Calculate the minimum speed the block can have at point B without losing contact with the track.

(d) Calculate the minimum height h_{min} above the bottom of the track at which the block can be released and still go around the loop without losing contact with the track.

A) $mgh_A = mgh_c + \frac{1}{2}mv_c^2$
$(10\,m/s^2)(2m) = (10\,m/s^2)(.5m) + \frac{1}{2}v^2$
$15 = \frac{1}{2}v^2$
$5.48\,m/s = v$

C) $\Sigma F = ma_c$
$F_N + F_g = m\left(\frac{v^2}{r}\right)$
$0 + mg = \frac{mv^2}{r}$
$g = \frac{v^2}{r} \rightarrow 10\,m/s^2 = \frac{v^2}{0.6}$
$2.45\,m/s = v$

D) $mgh_{start} = mgh_{loop} + \frac{1}{2}mv_{loop}^2$
$gh = gh_L + \frac{1}{2}v_L^2$
$(10)h = (10)(1.2) + \frac{1}{2}(2.45)^2$
$h = 1.5\,m$

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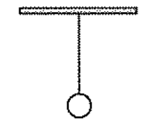

2. (15 points)

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
X 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.

(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.

(d) After swinging for a long time, the pendulum eventually comes to rest. Assume that the room is perfectly thermally insulated. How will the temperature of the room change while the pendulum comes to rest?

X It would slightly increase. ____ It would slightly decrease.

____ No effect. It would remain the same.

Justify your answer. Lose Mech. energy to thermal Energy.

(e) Another pendulum using a thin, light, metal rod instead of a string is used in a clock to keep time. If the temperature of the room was to increase significantly, what effect, if any, would this have on the period of the pendulum?

X It would increase. ____ It would decrease. ____ No effect. It would remain the same.

Justify your answer. Metal expands when heated. longer Pendulums have greater frequencies.

B) Time 10 swings & Divide the time by 10. This is the period. $f = \frac{1}{T}$

C) Length . . . (Explain)

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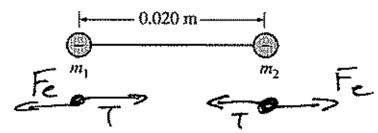
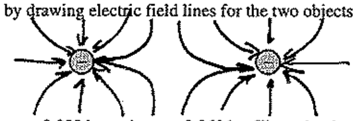


3. (15 points)

Two small objects, each with a charge of −4.0 nC, are held together by a 0.020 m length of insulating string as shown in the diagram above. The objects are initially at rest on a horizontal, nonconducting frictionless surface. The effect of gravity on each object due to the other is negligible.

(a) Calculate the tension in the string.

(b) Illustrate the electric field by drawing electric field lines for the two objects on the following diagram.

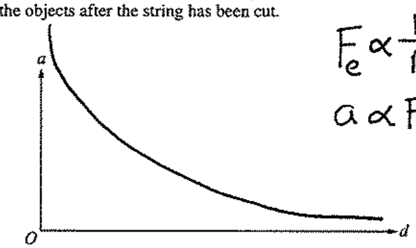


The masses of the objects are $m_1 = 0.030$ kg and $m_2 = 0.060$ kg. The string is now cut.

(c) Calculate the magnitude of the initial acceleration of each object.

(d) On the axes below, qualitatively sketch a graph of the acceleration a of the object of mass m_2 versus the distance d between the objects after the string has been cut.

(Try points if you have extra time)



$F_e \propto \frac{1}{r^2}$

$a \propto F$ so $a \propto \frac{1}{r^2}$

$\frac{1}{x^2}$ graphs look like

(e) Describe qualitatively what happens to the speeds of the objects as time increases, assuming that the objects remain on the horizontal, nonconducting frictionless surface.

A) $\Sigma F = 0$

$F_e - T = 0$

$F_e = T$

$F_e = \frac{kQ_1Q_2}{r^2}$

$= \frac{(9\times10^9)(-4.0\times10^{-9})^2}{(0.02)^2}$

$T = 3.6\times10^{-4}\ N$

C) $m_1 \rightarrow a = \frac{F}{M}$

$a_1 = \frac{3.6\times10^{-4}}{0.03}$

$= 0.012\ m/s^2$

$a_2 = \frac{3.6\times10^{-4}}{0.06}$

$= 0.006\ m/s^2$

E) They increase, b/c they are accelerating. The speeds increase by smaller amounts as distance increases.

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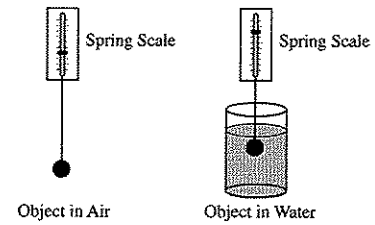

6. (10 points)

An object is suspended from a spring scale first in air, then in water, as shown in the figure above. The spring scale reading in air is 17.8 N, and the spring scale reading when the object is completely submerged in water is 16.2 N. The density of water is 1000 kg/m³.

(a) Calculate the buoyant force on the object when it is in the water. $17.8 - 16.2 = 1.6N$

(b) Calculate the volume of the object.

(c) Calculate the density of the object.

(d) How would the absolute pressure at the bottom of the water change if the object was removed?

__ It would increase. X It would decrease __ It would remain the same.

Justify your answer.

B) $F_B = \rho_{H_2O}\, g\, V_{obj}$

$1.6 = 1000(10)(V)$

$V = 1.6\times10^{-4}\ m^3$

C) $\rho_{ob} = \frac{M}{V} = \frac{1.78\ kg}{1.6\times10^{-4}\ m^3} = 11{,}125\ \frac{kg}{m^3}$

$F_g = 17.8$ N (from scale)

$mg = 17.8$

$m = 1.78$ kg

D) P_{abs} depends on depth. without the object the water level goes down.

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