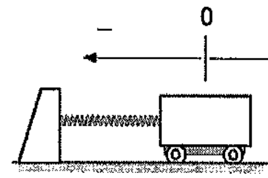
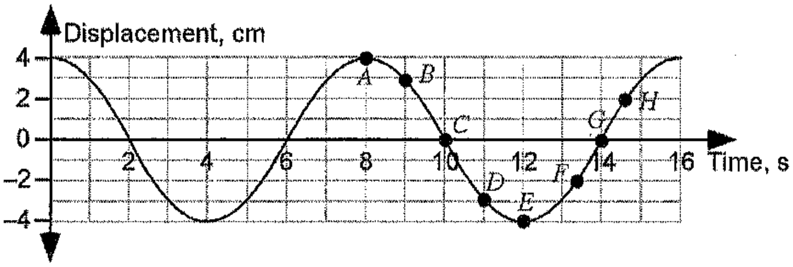
SHM Practice problems

Name: ______________

Period: _____



1. A cart attached to a spring is displaced from equilibrium and then released. A graph of displacement as a function of time for the cart is shown below. There is no friction. Eight points are labeled *A* – *H* in the graph.



For each question below, choose from the labeled points above or state "none."

1. **At which point or points is the acceleration positive?**
Explain.

D, E, F
opposite sign of position

2. **At which point or points does the cart have zero velocity but nonzero net force?**
Explain.

A, E. → Spring is stretched, but cart is switching directions
$a \neq 0$ $v = 0$

3. **At which point or points is the net force on the cart equal to zero?**
Explain.

C, G
Spring is not stretched

4. **At which point or points are the acceleration, velocity, and displacement all positive?**
Explain.

None.
accel is always opposite sign of displacement.

5. **At which point or points is the acceleration nonzero and opposite in sign to the position?**
Explain.

All but C + G. (a=0)
See #4.

6. **At which point or points is the velocity nonzero and opposite in sign to the acceleration?**
Explain.

If a + V have opp. signs, the cart is slowing down.
C + D are slowing down
H is slowing down

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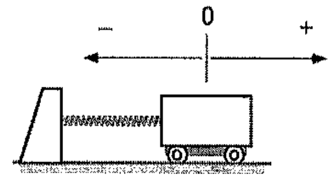
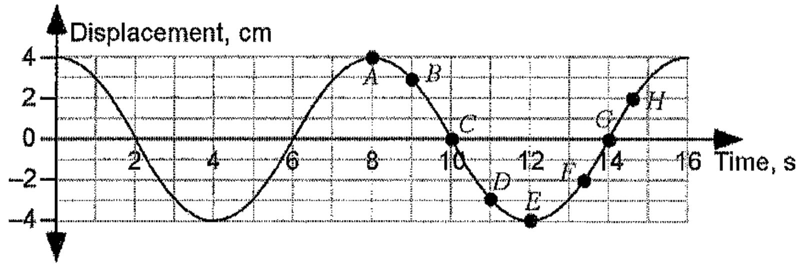
2. A cart attached to a spring is displaced from equilibrium and then released. A graph of displacement as a function of time for the cart is shown. There is no friction. Points are labeled *A* – *H* in the graph.

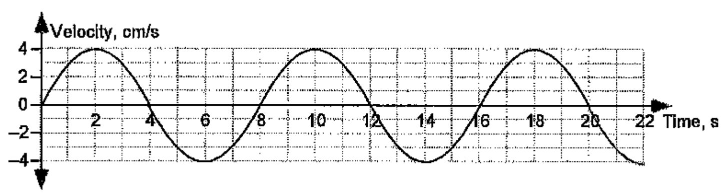


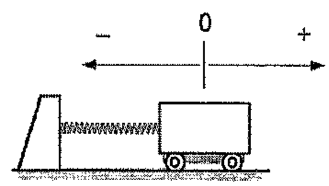


For each labeled point above, identify if the vector quantity listed below is in the positive (+) direction, negative (–) direction, or is zero (0) for no direction.

Point	Acceleration	Velocity	Displacement	Net Force
A	–	0	+	–
B	–	–	+	–
C	0	–	0	0
D	+	–	–	+
E	+	0	–	+
F	+	+	–	+
G	0	+	0	0
H	–	+	+	–

3. A cart attached to a spring is displaced from equilibrium and then released. A graph of velocity as a function of time for the cart is shown below. There is no friction.





(a) What is the period of the motion for this cart? 8 sec

(b) What is the frequency of the motion for this cart? $f = \frac{1}{8\,sec} = 0.125\ Hz$

(c) In which direction was the cart displaced from equilibrium before it was released? Explain.

Negative direction: It started moving in the positive direction after time = 0.

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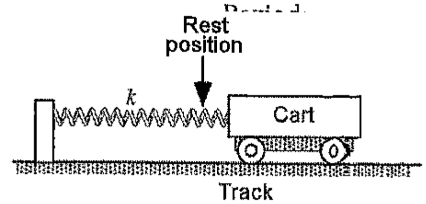
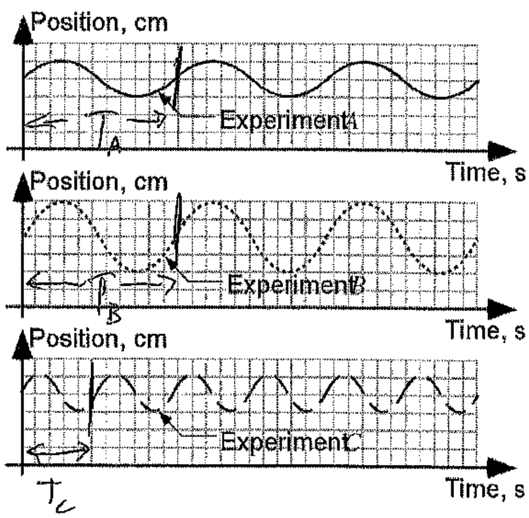
2. A frictionless cart of mass m is attached to a spring with spring constant k. When the cart is displaced from its rest position and released, it oscillates with a period T that is given by

$$T = 2\pi\sqrt{m/k}.$$



The graph of the position of the cart as a function of time is shown below for Experiment *A*. Graphs for two other experiments are shown below this. The same spring is used in all three experiments.



(1) Compared to Experiment *A*, in Experiment *B* the cart has

a) ~~*more*~~ mass.

b) *equal* mass.

c) *less* mass.

Explain.

Same k, same T, m must be the same. They have different Amplitudes because they were stretched different amounts.

(2) Compared to Experiment *A*, in Experiment *C* the cart has

a) *more* mass.

b) *equal* mass.

c) *less* mass.

Explain.

T is smaller, so m must be less.

(3) Suppose that for a fourth experiment (Experiment D), the mass used in Experiment A was doubled and the spring was replaced with a spring with double the spring constant. The period in Experiment D would be

a) *the same* as the period in Experiment A.

b) *double* the period in Experiment A.

c) *four times* the period in Experiment A.

d) *one-half* the period in Experiment A.

e) *one-fourth* the period in Experiment A.

Explain.

$$T_A = 2\pi\sqrt{\frac{m_A}{k_A}}$$

$$T_D = 2\pi\sqrt{\frac{m_D}{k_D}} = 2\pi\sqrt{\frac{2m_A}{2k_A}}$$

$$= 2\pi\sqrt{\frac{m_A}{k_A}} = T_A$$

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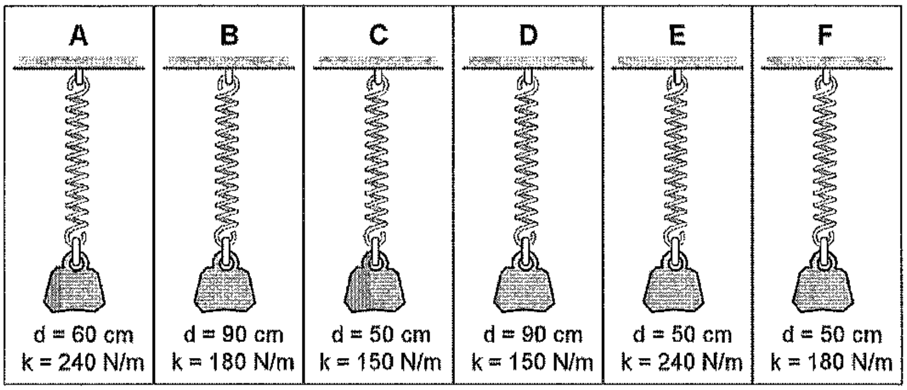
Period:_____

1. The figures below show six identical masses attached to springs and hung vertically. The masses are pulled down various distances and then released. The spring constant (k), which measures the stiffness of the spring, and the distance (d) that the mass is pulled down are given for each case in the figures.



Rank these situations on the basis of the time for the mass to get from the maximum distance below the equilibrium point to the maximum distance above the equilibrium point. → Period/2

Greatest 1 C = 2 D 3 F = 4 B 5 A 6 E Least

OR, The times are the same for all these cases. ___

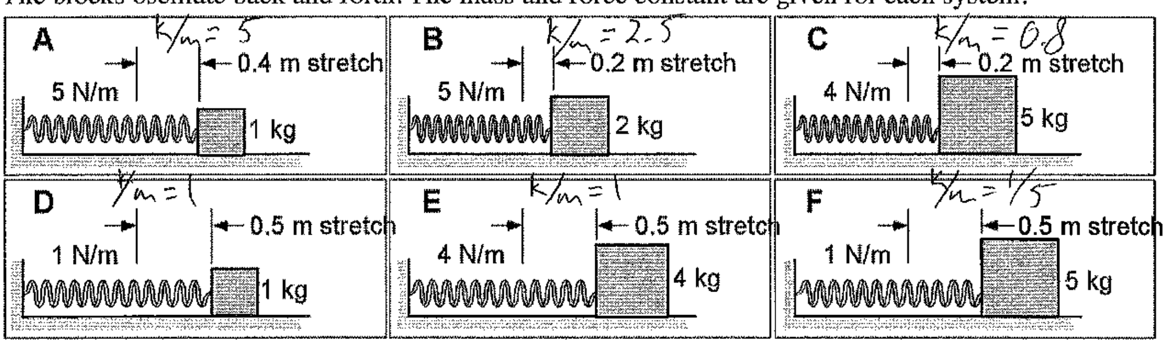
OR, The times are zero for all these cases. ___

OR, We cannot determine the ranking for the times of these cases. ___

Please explain your reasoning. k↑, T↓

$T = 2\pi\sqrt{\frac{m}{k}}$

2. The figures below show systems containing a block resting on a frictionless surface and attached to the end of a spring. The springs are stretched to the right by a distance given in each figure and then released from rest. The blocks oscillate back and forth. The mass and force constant are given for each system.



Rank the systems on the basis of the frequency of the vibratory motion.

Greatest 1 A 2 B 3 D = 4 E 5 C 6 F Least

OR, All of the frequencies will be the same for each system. ___

OR, We cannot determine the ranking for the frequencies of these oscillations. ___

Please explain your reasoning. $f = \frac{1}{T}$ $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

k/m is what matters