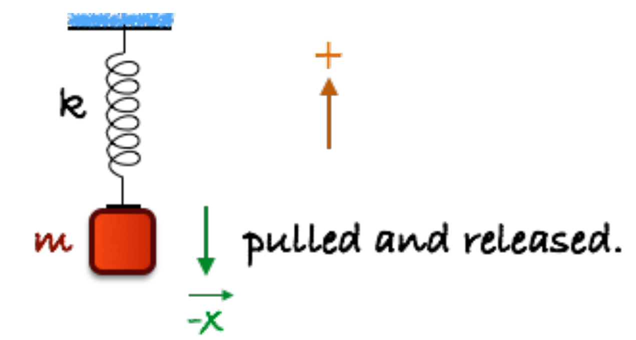
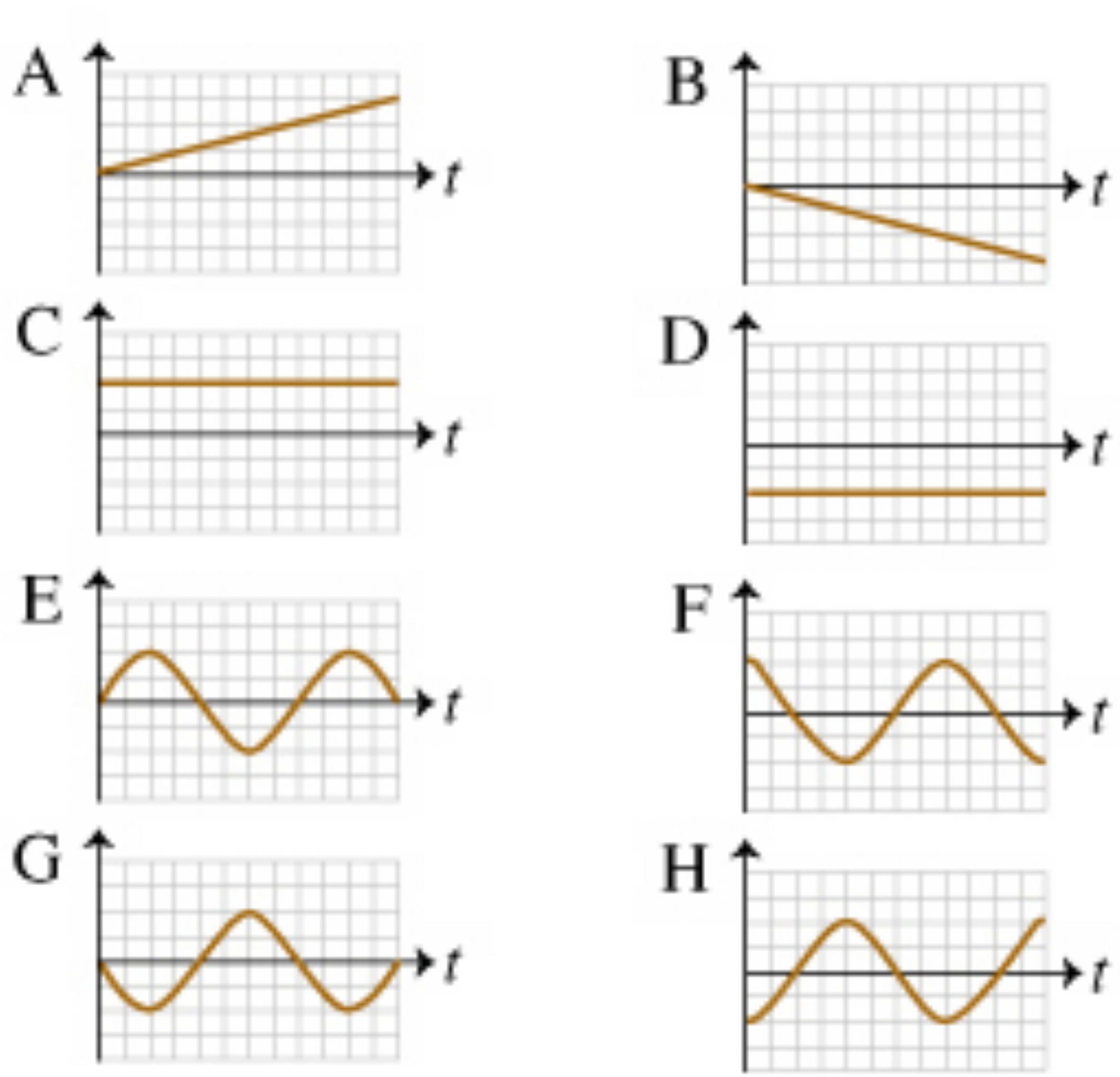
1.

An object is attached to a vertically oriented spring. The object is pulled a short distance below its equilibrium position and released from rest. Set the origin of the coordinate system at the equilibrium position of the object and choose upward as the positive direction. Assume air resistance is so small that it can be ignored.





a) Beginning the instant the object is released; select the graph that best matches the position vs. time graph for the object.

Position -time graph must start from -x position. It is given in graph "H".

b) Beginning the instant the object is released; select the graph that best matches the velocity vs. time graph for the object.

When the object is at "-x" its velocity is zero. So velocity-time graph is "E".

c) Beginning the instant the object is released; select the graph that best matches the acceleration vs. time graph for the object.

Displacement and acceleration are in opposite directions. So, acceleration-time graph is "F".

2.

The force that acts on a oscillating object is usually called as “restoring force. Which of the following statements is correct?

A) The restoring force is constant.
B) The restoring force is directly proportional to the displacement of the object.
C) The restoring force is proportional to the mass of the block.
D) The magnitude of the restoring force is maximum when the object is in the equilibrium position.
E) The restoring force is opposite to the direction of motion.

The restoring force is always toward the position $x=0$ and its magnitude is calculated by “k.x” where “k” is the spring constant and “x” is the magnitude of the displacement.

So, restoring force and displacement are directly proportional quantities.

Answer is “B”.

3.

The motion of a particle connected to a spring is described by **$x=10\sin(\pi t)$**; x is in centimeters.

I. The amplitude of the motion is 10 cm.
II. The period of the motion is 2 s.
III. The maximum speed of the particle is 20 cm/s.

Which of the given statement(s) is/are wrong? *($\pi=3$)*

$x=R.\sin(\omega t)$ and $x=10.\sin(\pi t)$

$R=10$ cm and $\omega=\pi$

$\omega=\pi=2\pi/T$ then $T=2$ s

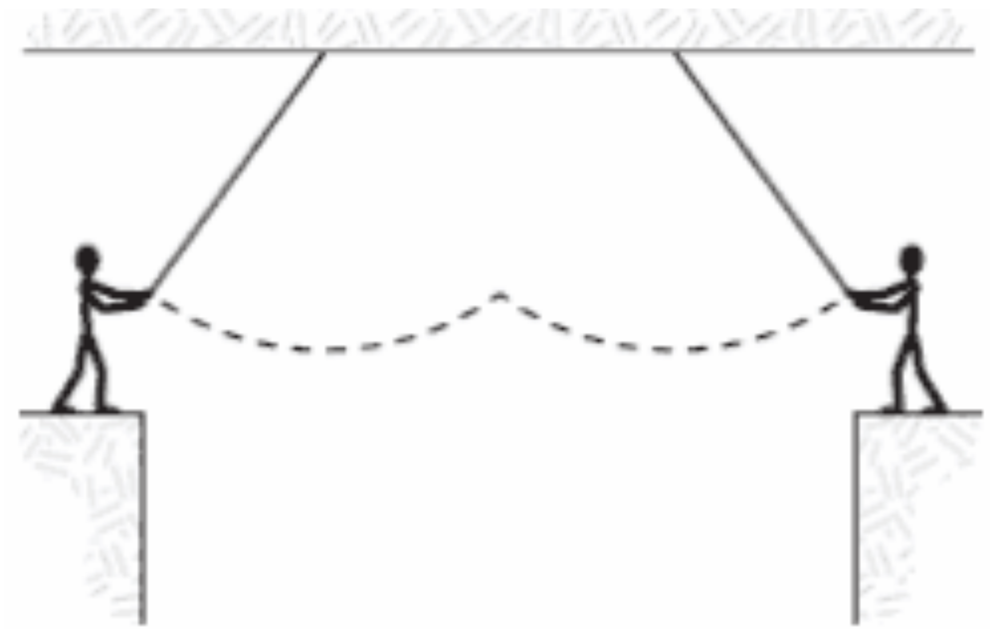
$V_{max}=\omega.R=3.10=30$ cm/s

So, statements I and II are correct.

Only III is wrong.

4.

Two circus clowns (each having a mass of 50 kg) swing on two flying trapezes (negligible mass, length 25 m) shown in the figure. At the peak of the swing, one grabs the other, and the two swing back to one platform.



What is the time for the forward and return motion?

$(\sqrt{10} = \pi)$

$T = 2\pi.\sqrt{L/g}$ → $T = 2\pi.\sqrt{25/10}$

$T = 2.5 = 10$ s

5.

The motion of a particle connected to a spring is described by x = 10 sin (πt), "x" is in meters.

At what time (in seconds) is the potential energy equal to the kinetic energy?

$x = R.\sin(\omega t)$ and $x = 10.\sin(\pi t)$

$PE_{max} = (kR^2)/2$

At the instant when KE=PE

$PE = (PE_{max}/2) = (kR^2)/4 = (kx^2)/2$

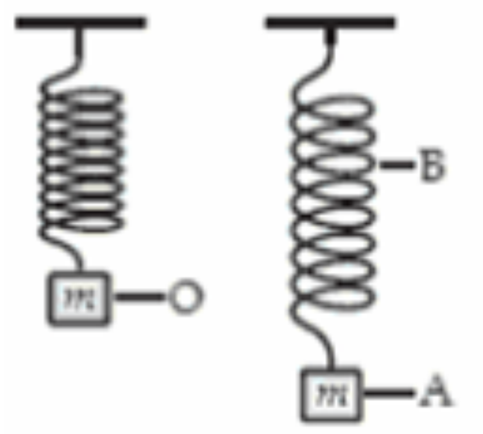
Then $x = R/\sqrt{2}$

$(R/\sqrt{2}) = R.\sin(\pi t)$ then $\pi t = \pi/4$

$t = 0{,}25$ s

6.

A weight of mass m is at rest at O when suspended from a spring, as shown. When it is pulled down and released, it oscillates between positions A and B.



Which statement about the system consisting of the spring and the mass is correct?

A) The gravitational potential energy of the system is greatest at A.
B) The elastic potential energy of the system is greatest at O.
C) The rate of change of momentum has its greatest magnitude at A and B.
D) The rate of change of gravitational potential energy is smallest at O.
E) The rate of change of gravitational potential energy has its greatest magnitude at A and B.

$m.\Delta V = F.\Delta t$ then

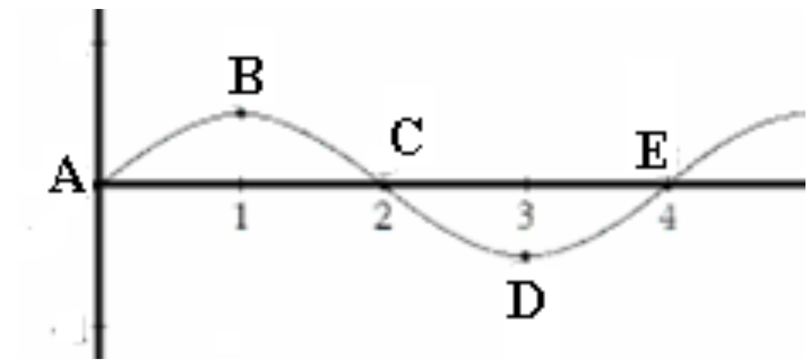
$F = m.(\Delta v/\Delta t) = \Delta P/\Delta t$

Force is max when x is max

Answer is "C".

7.

A graph of position versus time for an object oscillating at the free end of a horizontal spring is shown below.



a)
A point or points at which the object has positive velocity and zero acceleration is (are)

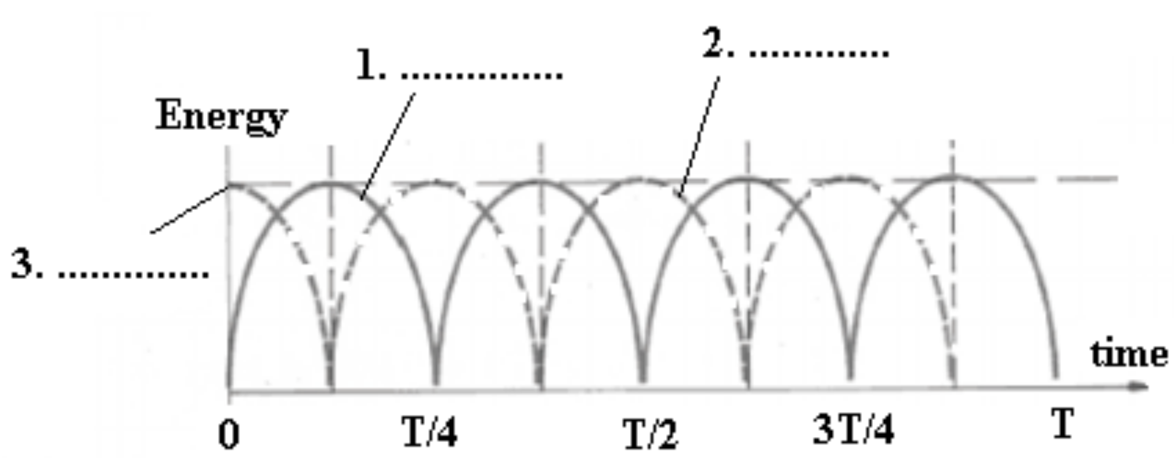
at points A and E where x=0

b)
The point at which the object has zero velocity and positive acceleration is

at points D

8.

Energy-time graph of a mass – spring system is given.



Which of the following best completes the blanks numbered 1, 2 and 3?
(The amplitude of the motion is "A" and the maximum speed is "V")

	Blank-1	Blank-2	Blank-3
A)	Potential energy	Kinetic energy	$mv^2/2$
B)	Kinetic energy	Potential energy	$mv^2/4$
C)	Potential energy	Kinetic energy	$kA^2/2$
D)	Kinetic energy	Potential energy	$kA^2/2$
E)	Potential energy	Kinetic energy	$kA^2/4$

$x_0 = A$ this means it starts with an initial PE.

Answer is "C".

9.

An object is tied at the end of a spring and the object is displaced by a distance "R" and released. The object's maximum speed is "V" and its maximum acceleration is "a".
If the object's initial displacement were "2R", how would "V" and "a" change?

A) "V" increases, "a" does not change.
B) Both of them increase.
C) "V" increases, "a" decreases.
D) Both of them do not change.
E) "V" does not change, "a" increases.

When the displacement is increased, "V" and "a" increase. Because they are directly proportional to the displacement.

Answer is "B".

10.

A child swings at the end of rope. Assume that the child is near equator and the swing is almost SHM.

I. If the length of the swing's rope were longer, the time for one complete cycle would increase.
II. If the mass of the child were greater, the child would make fewer oscillations in a given time.
III. If the child were at a place near the arctic region, the maximum speed of the child would decrease.

Which of the above statement(s) is/are correct?

When the length of the swing is increasedPeriod will increase. Statement I is correct.

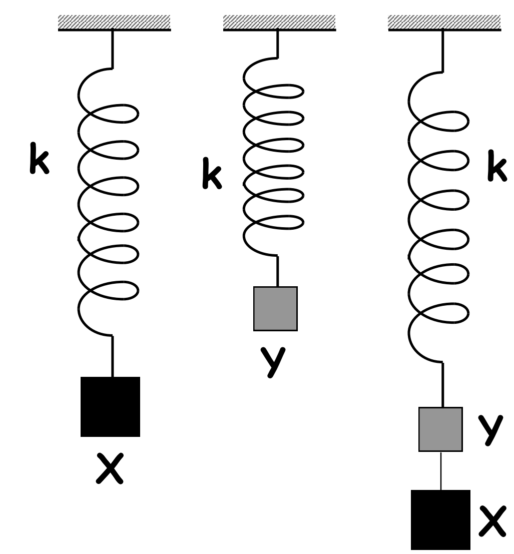
When the mass of the swing is increased, period will not change. Statement II is not correct.

When the swing is at a place near the arctic region (more "g"), period will decrease. Statement III is correct.

Answer is I and III

11.

The period of the motion in the first figure (X only) is 4 s. The period of the motion in the second figure (Y only) is 3 s.



What is the period of the motion in the third figure (X and Y together)?

$4 = 2\pi . \sqrt{(m_X/k)}$

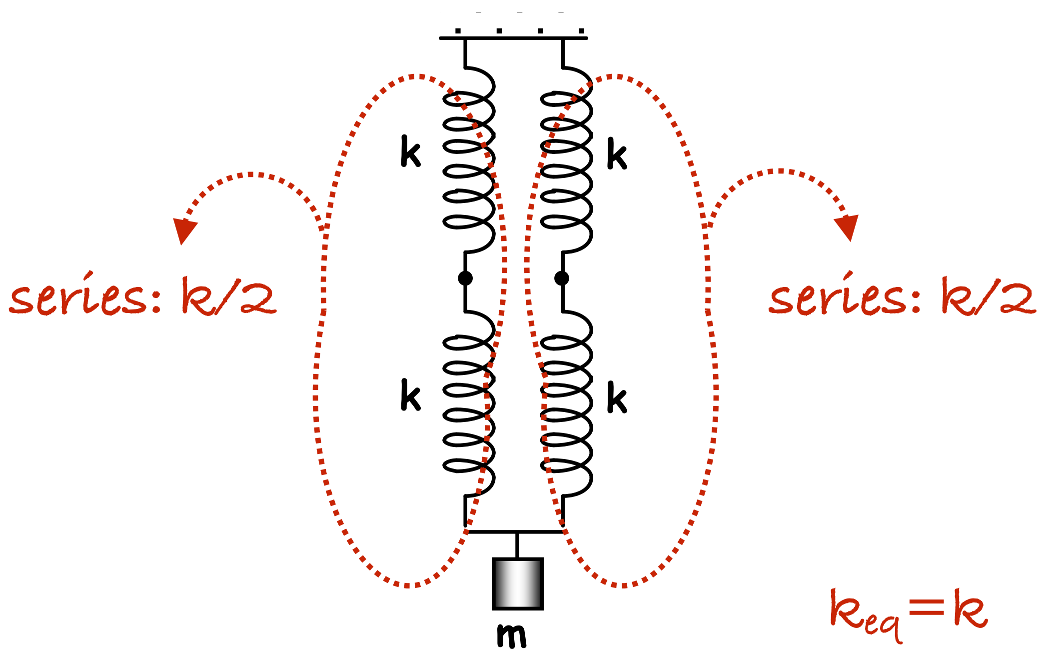
$3 = 2\pi . \sqrt{(m_Y/k)}$

then $m_X / m_Y = 16/9$

So, the period of combined mass system is "5 s".

12.

In the figure all the springs are identical (k=1000 N/m) and the oscillating mass is m=25 kg.



What is the number of oscillations is one second?

$(\sqrt{10} = \pi)$

$f = (1/2\pi).\sqrt{(k/m)}$

$f = (1/2\pi).\sqrt{(1000/25)}$

$f = (1/2\pi).\ 2\sqrt{10}$

$f = 1$ Hz

13.

A box moves of mass "m" and speed "V" hits an elastic spring whose spring constant is "k". The box sticks to the spring and makes SHM.

I. The object will have its maximum acceleration at the instant of impact.

II. If only the mass of the object were greater, the amplitude of the SHM would increase.

III. If only the speed of the object were greater, the period of SHM would increase.

IV. If only the spring constant were greater, the maximum acceleration of the SHM would increase.

Which of the above statement(s) is/are correct?

Statement I is wrong. At the instant of impact, speed is maximum and acceleration is zero.

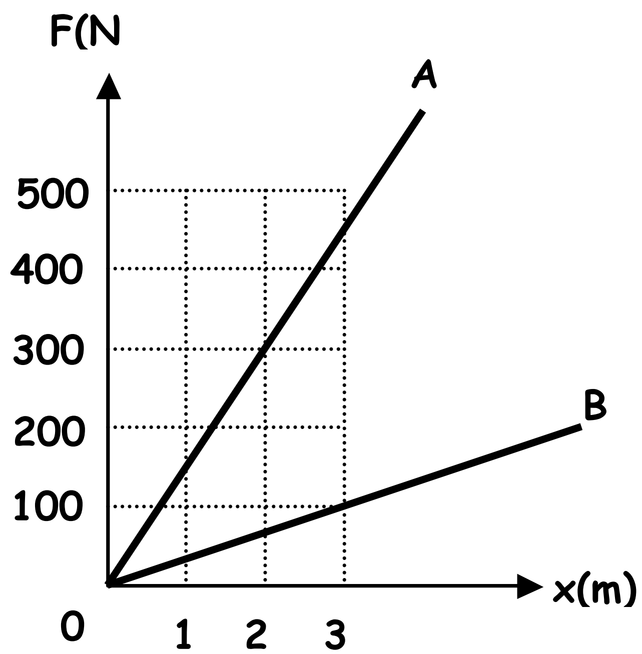
Statement II is correct. When the mass is increased, the max. KE of the object will be more. This means max PE will be more.

Statement III is wrong. Speed is not related to the period of motion. Only mass and spring constant are effective.

Statement IV is correct. Acceleration and sğring constant are directly proportional.

14.

Force-Displacement graphs of two springs A and B are given as in the figure. The identical objects are hung to the springs and they start to oscillate.



What is the ratio of the period of oscillation of spring A to spring B?

From the graph;

Slope=spring constant

$k_A = 300/2 = 150$ N/m

$k_B = 100/3$ N/m

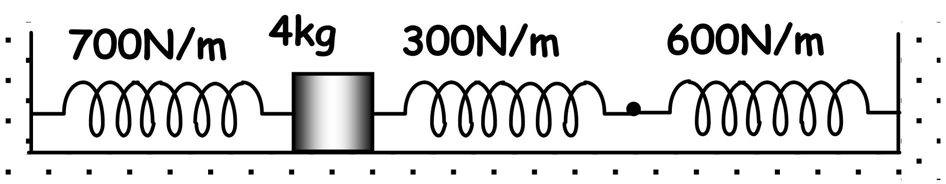
$T_A = 2\pi.\sqrt{(m/150)}$

$T_B = 2\pi.\sqrt{(3m/100)}$

$T_A / T_B = \sqrt{2}/3$

15.

Consider three springs with spring constants of 300 N/m, 600 N/m and 700 N/m. A 4kg mass on a horizontal frictionless surface is connected to the springs as in figure.



What is the period of the simple harmonic motion in seconds?

(π= 3)

Two springs having 300 N/m

And 600 N/m are series.

$k_1 = (300.600)/(300+600) = 200$ N/m

200 N/m and 700 N/m springs are

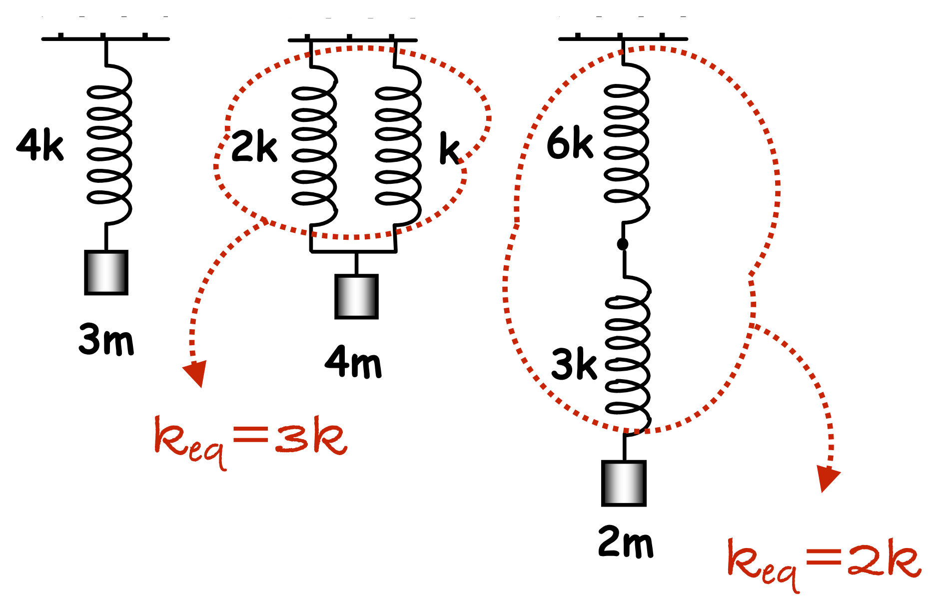
connected in parallel.

$k_e = 200+700 = 900$ N/m

$T_A = 2\pi.\sqrt{(4/900)} = 0{,}4$ s

16.

The periods of oscillations of the systems given in the figure are T_1, T_2 and T_3 respectively.



What is the relation among the period of oscillations of the systems?

$$T_1=2\pi.\sqrt{(3m/4k)}$$

$$T_2=2\pi.\sqrt{(4m/3k)}$$

$$T_3=2\pi.\sqrt{(2m/2k)}$$

then $T_2 > T_3 > T_1$

17.

A pendulum of length 1 m is suspended from the ceiling of an elevator.
If the elevator accelerates downward at a rate of 1 m/s^2, what will be the period of the pendulum in seconds?
(g=10 N/kg)

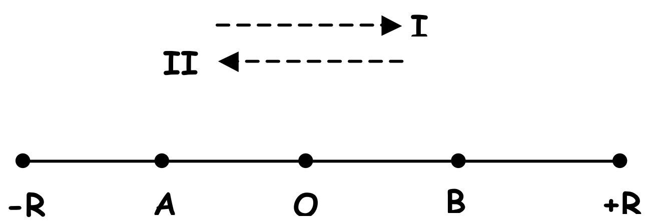
$$T=2\pi.\sqrt{(L/g-a)}$$

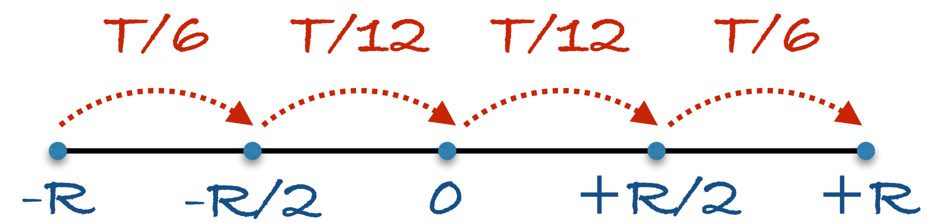
$$T=2.3.\sqrt{(1/10-1)}$$

$$T=2\ s$$

18.

An object makes simple harmonic motion between points –R and +R with a period of 6 seconds. (Points are equally spaced)





Answer the following questions in accordance with the above description.

a) The time to travel from point O to B is 0,5 seconds.

b) The time to travel from point B to +R is 1 seconds.

c) The direction of force when the object is at point B is II. **(“I” or “II”)**

d) The direction of acceleration when the object is at point A is I. **(“I” or “II”)**

e) The magnitude of acceleration while traveling from O to –R is increasing **(“decreasing”, “increasing”, or “constant”)**

f) The direction of acceleration while traveling from O to –R does not change **(“changes” or “does not change”)**

g) The magnitude of acceleration is maximum at point(s) -R and +R

h) The acceleration is zero at point(s) O.

19.

depends on displacement

W a) The restoring force of SHM is constant.

W b) The amplitude of SHM is the distance between two end points. equilibrium position and max displacement

C c) The acceleration of the simple pendulum at the lowest position is zero.

W d) The acceleration of the simple pendulum at the highest point is zero. maximum

W e) The pendulum makes SHM for any starting angle. angles smaller than 12°

C f) The period of a simple pendulum is independent of the mass.

W g) The period of mass-spring system depends on the orientation of the spring. If the spring is vertical, its period is the greatest. the mass and the spring constant

W h) The restoring force of a vertically oriented mass spring system is given by F = kx + mg. F=kx

C i) Suppose you drill a hole through the center of the Earth and then drop a stone into it. The stone makes SHM.

acceleration

W j) The velocity of the SHM is always directed toward the equilibrium position.

20.

The piston of a diesel car motor moves 8cm up and down with a period of 2 seconds. Suppose that at t=0 the piston is at the origin.

a) The equation of displacement: x = $4.\sin(\pi t)$ cm

b) The equation of velocity: V = $4\pi.\cos(\pi t)$ cm/s

c) The equation of acceleration: a = $-4\pi^2.\sin(\pi t)$ cm/s^2

d) The position at t = 1/3 s is $2\sqrt{3}$ cm

e) The velocity at t = 1/3 s is 2π cm/s

f) The acceleration at t = 1/3 s is $-2\sqrt{3}\,\pi^2$ cm/s^2