MATHS N PHYSICS
IIT BOMBAY

BAZINGA!

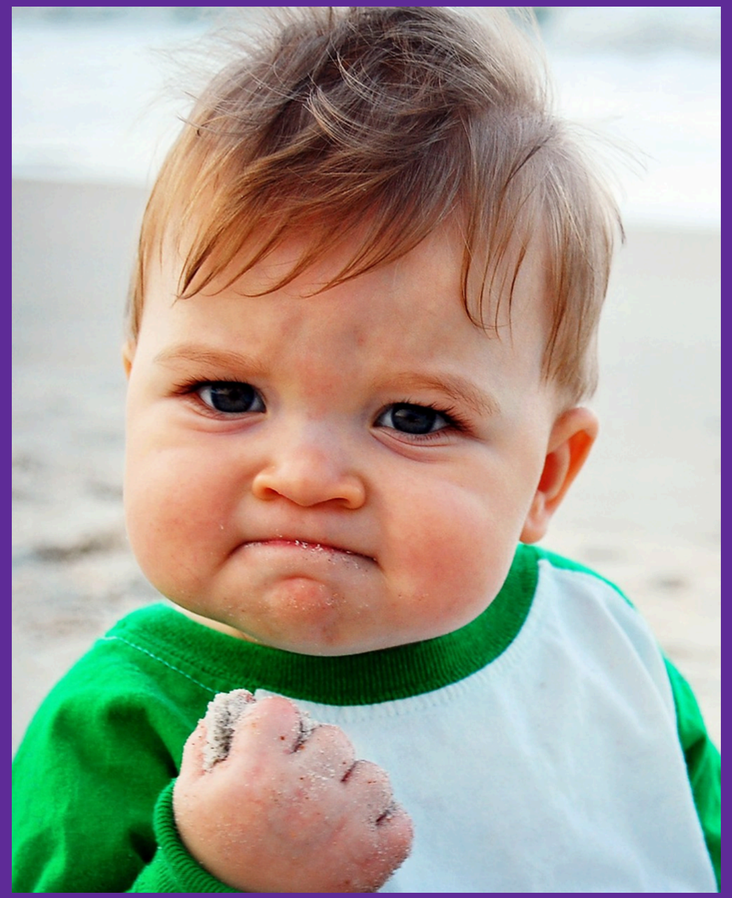
THE ULTIMATE PHYSICS SHOWDOWN

PRELIMS ROUND

Rules

- 13 Questions, one by one, will be shown on the screen for one minute each.
- After all Questions have been shown once, they will be shown again in the same order, for 30 seconds each.
- Write all answers neatly in the sheet provided (with your name and roll number on top)
- For multiple choice questions, just write the option, like Q1. a)
- In the event of a tie, the person who solves more star-marked questions will qualify
- Best of Luck to Everyone!

Let the game begin!



Question 1 ★

Consider a small underwater bubble. A light beam shines through it. After passing through the bubble the light beam

a) converges

b) diverges

c) remains unaffected

Question 2

In 2016 a trend popped up by the name of bottle flip challenge. Now Mr. X is trying to flip a symmetrical bottle that is half filled with water (consider the bottle weightless). The length of the bottle is L and radius is very small.

Mr. X flips it from the top applying an impulse of F perpendicular to the axis of bottle while the bottle is horizontal. The total mass of bottle is m and the bottle is at a height of h initially. Find the condition for which the bottle lands perfectly upright and Mr. X gains a little aura .

Question 3

This phenomenon, named after the Roman Goddess of the Dawn, occurs in the Earth's upper atmosphere due to its interaction with solar winds. At altitudes above 80 km, ionised nitrogen atoms regain an electron, and oxygen and nitrogen atoms transition from an excited state to their ground state, releasing excitation energy through the emission of photons.

What is this captivating natural light display, commonly seen near the poles?

Question 4 ★

A projectile is launched from the origin and can move only in one plane. What is the locus of the highest point of its trajectory, as the angle of projection changes, keeping the speed of projection constant?

Question 5 ★

The word cinematic is derived from the French word ‘cinematique’ which in turn is derived from the Greek for ‘to move’. ‘Cinematique’ was also used by Andre-Marie Ampere and a variation of it went on to be a part of Physics vocabulary. ID the word.

Question 6

Three sources of sound are switched on together . Their respective frequencies are *400 Hz*, *402 Hz* and *405 Hz*. How many beats are produced per second?

Question 7 ★

After the core of an ageing massive star stops generating energy through nuclear fusion, it may collapse into a neutron star or black hole, releasing gravitational potential energy and expelling the star's outer layers. Alternatively, a white dwarf star that accumulates material from a companion can reach a critical core temperature and undergo runaway nuclear fusion. Stellar cores collapse when their masses exceed the Chandrasekhar limit, while accreting white dwarfs ignite as they approach this limit, approximately 1.38 times the mass of the Sun. What interesting astronomical phenomenon is being described here?

Question 8

A rectangular rod of length *L*, vertical thickness *h*, width *w*, Young's modulus *E*, density *d*, is fixed horizontally from one of its ends along the length on a vertical wall. What is the distance by which the front end descends?

A

$$he^{\frac{dgL}{E}}$$

B

$$\frac{2dgh^2}{2E}$$

C

$$\sqrt{2Lh}$$

D

$$\frac{3gdL^4}{2Eh^2}$$

E

$$\frac{\sqrt{3}EL}{dgh}$$

Question 9 ★

The dependence of the index of refraction of air on temperature and pressure is well approximated by $n(P,T) = 1 + 0.000293\left(\frac{P}{P_0}\right)\left(\frac{T_0}{T}\right)$, where T_0 = *300K* and P_0 = *1 atm*. Consider the image shown. This is an image taken of a large ship on Powai Lake. The correct explanation for this phenomena is-

a) There is turbulent air between the observer and the ship, leading to an inversion of the image.
b) There is a layer of warm air above a layer of cool air near the surface of the water.
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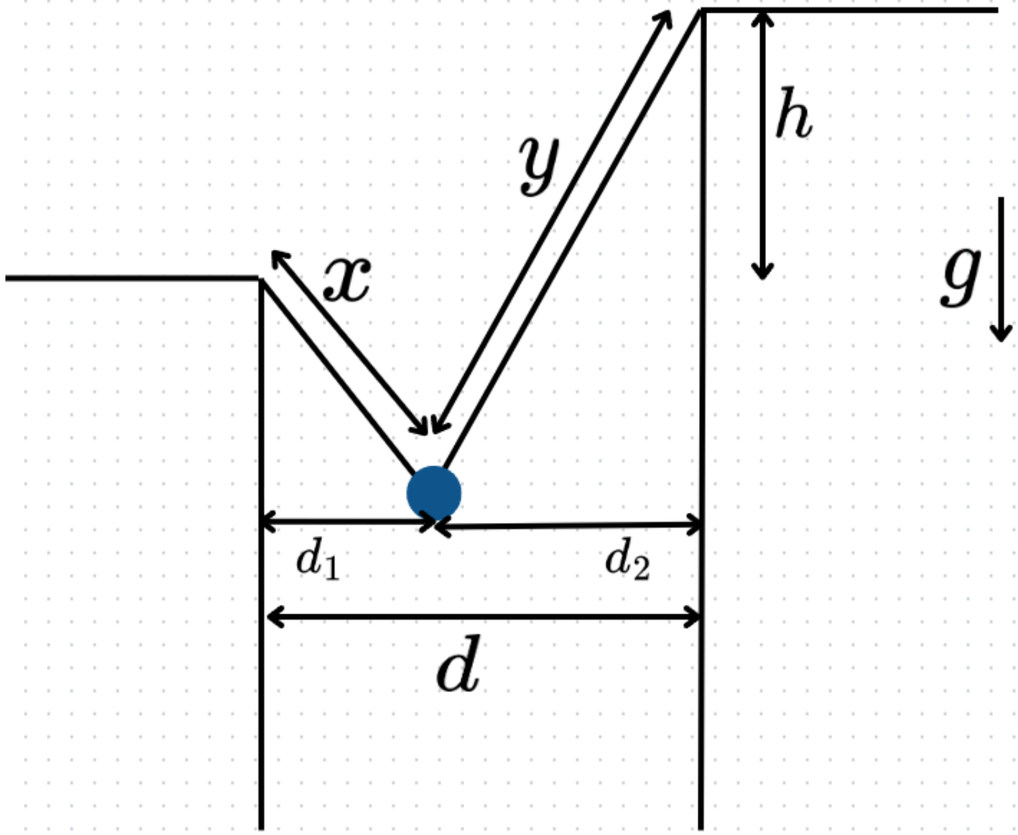
Question 10

There are two cliffs, one higher than the other by a distance *h = 27.5m*, the distance between them is *d = 48m*. On the edge of each cliff, we have tied the end of a rope of length *l = 73m*. On the rope, there is a heavy bead. The rope is massless and inextensible. In equilibrium, find the distance of the bead from each cliff.



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Let a plane contain a set of *n* electric point charges (of equal magnitude and sign), all placed at the vertices of a regular polygon. We define an equilibrium point for a set of coplanar charges as any point on that plane which:

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Question 12 ★

Imagine a future where humanity discovers a mysterious phenomenon causing the Earth to slowly expand. No one knows exactly how or why this is happening, but what's certain is that the planet is growing larger, day by day. The oceans spread out, swallowing coastlines, and mountains rise as the crust stretches. Cities scramble to adjust to the shifting landscape, and scientists race to understand the implications of this bizarre event. Amidst the chaos, one question stands out: how will this expansion affect the length of a day?

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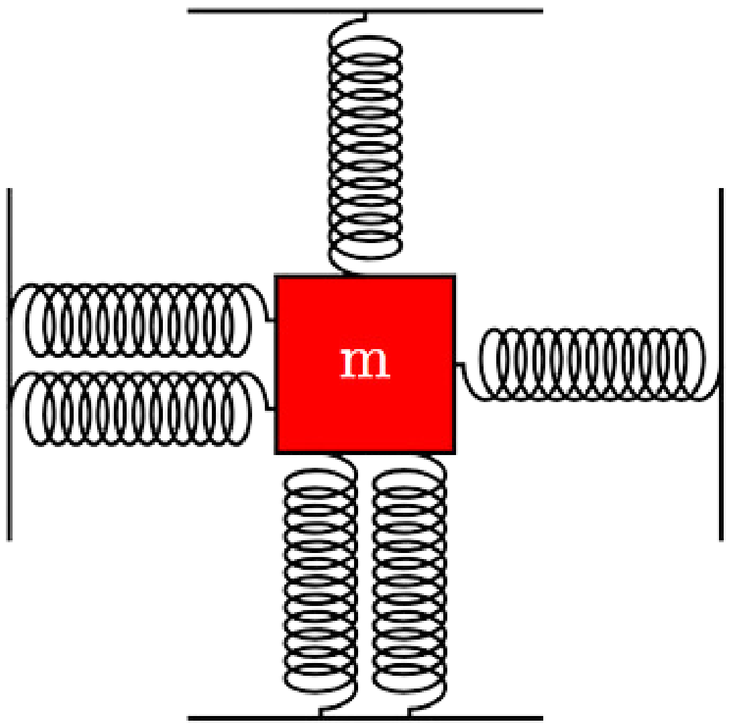
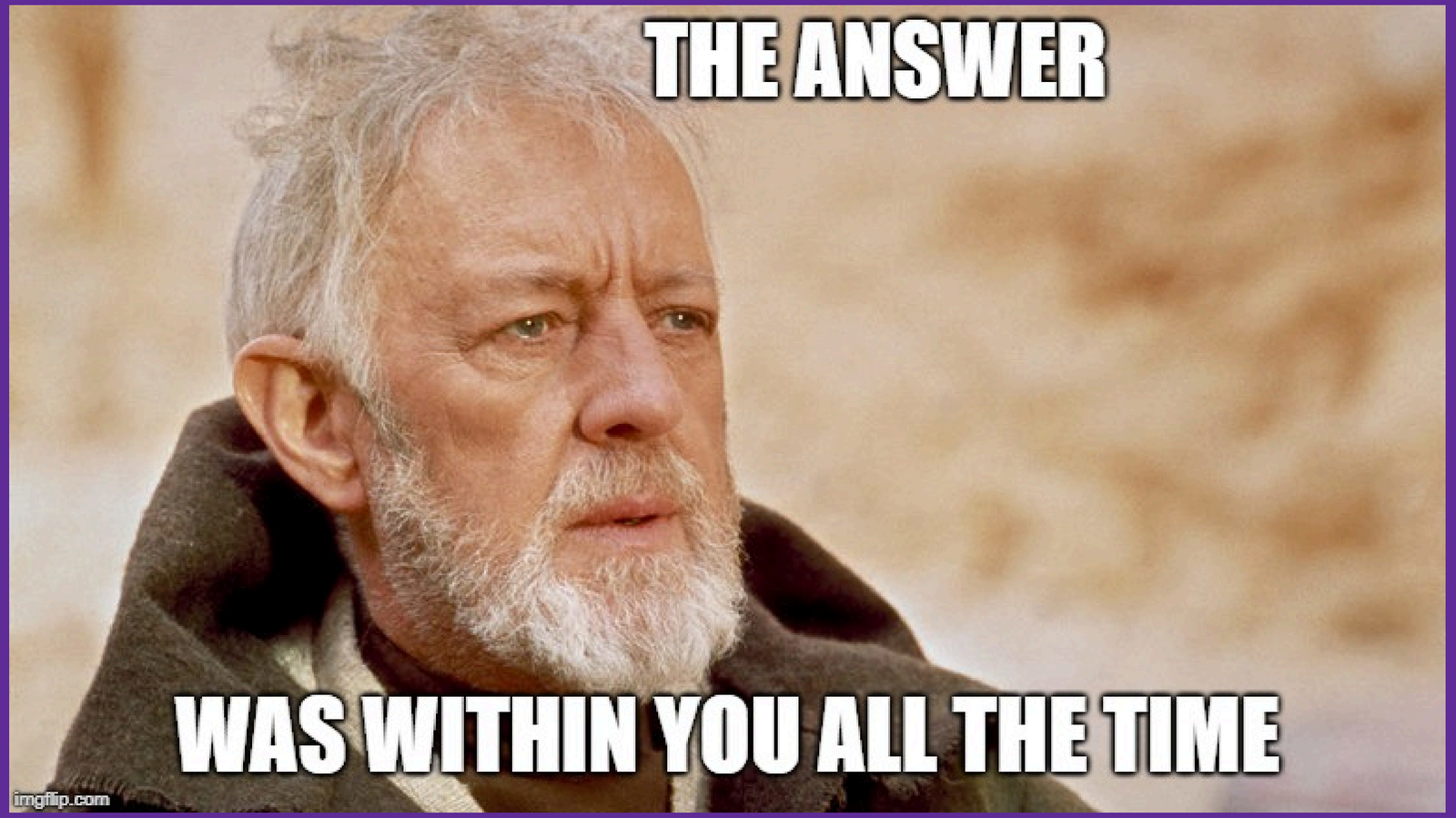


SAFETY SLIDE


itc
Institute
Technical
Council

Time to crack the code



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$$\frac{3I}{\pi mL}\sqrt{\frac{2h}{g}} \in \mathbb{N}$$

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Aurora Australis/Borealis

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Ellipse

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Kinematics

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Supernova

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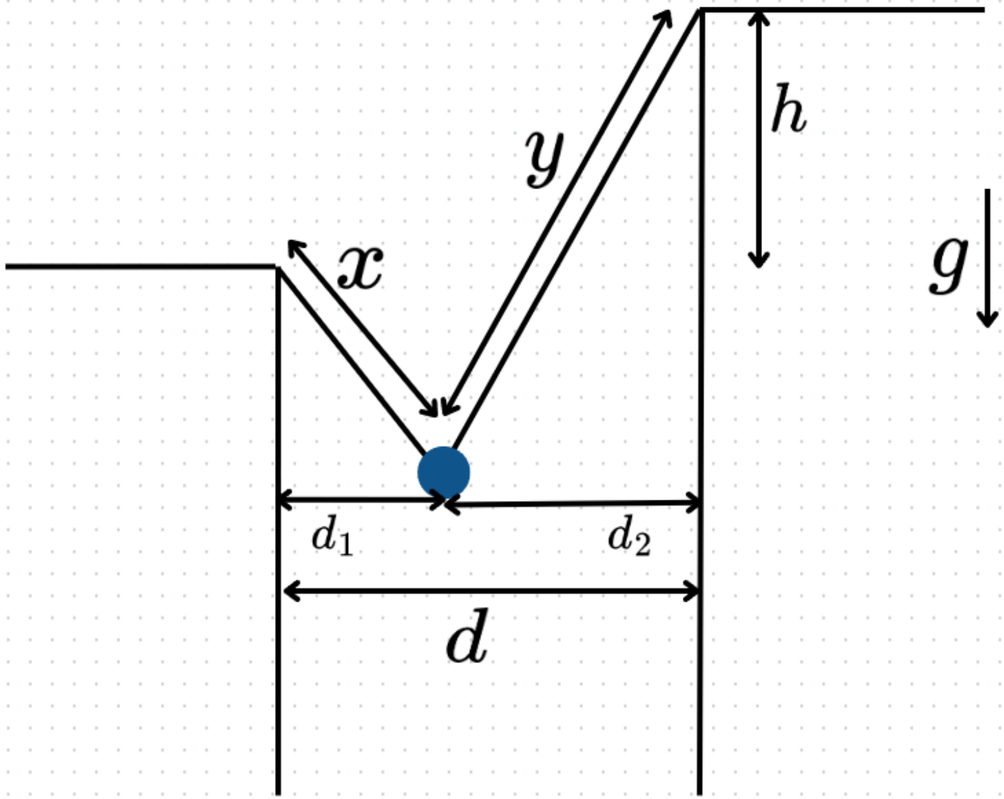

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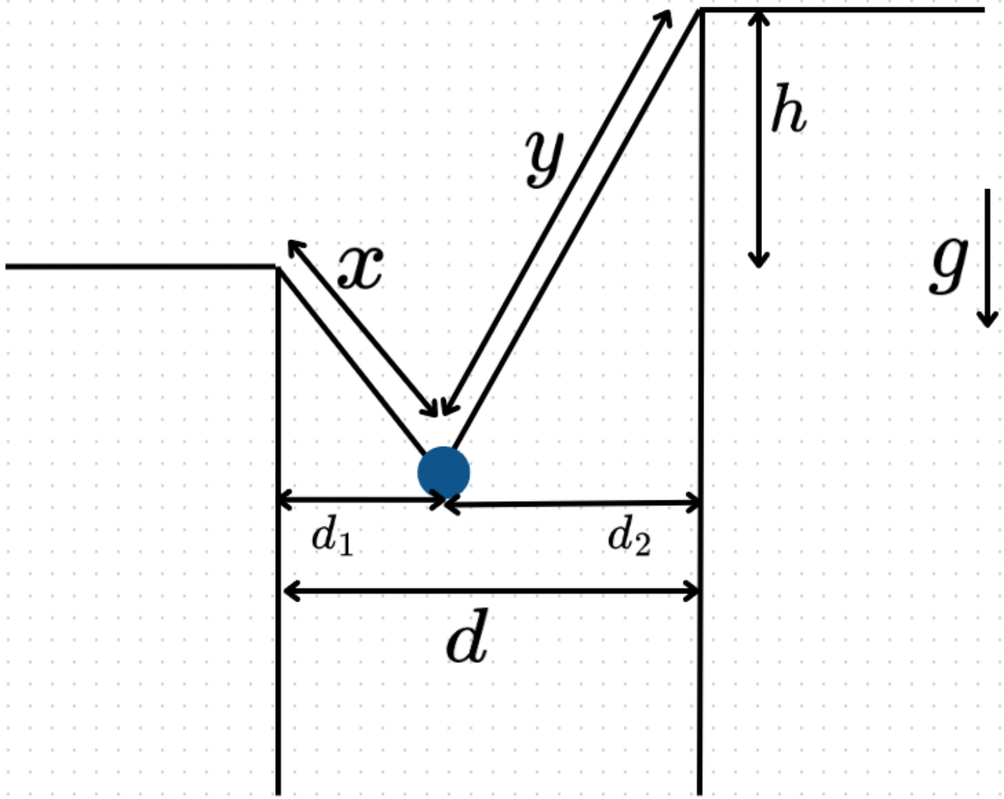

d1 = 12

d2 = 36

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n + 1

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The length of a day increases

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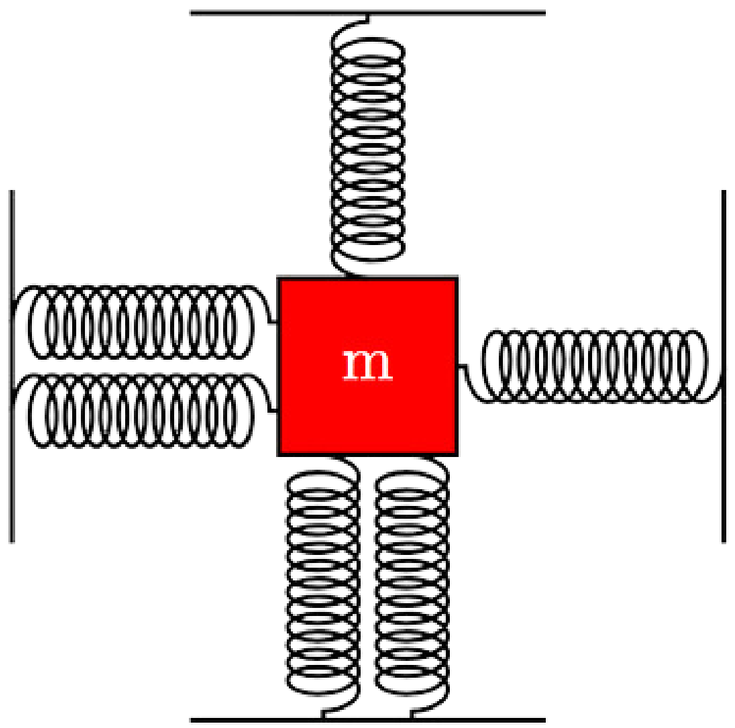

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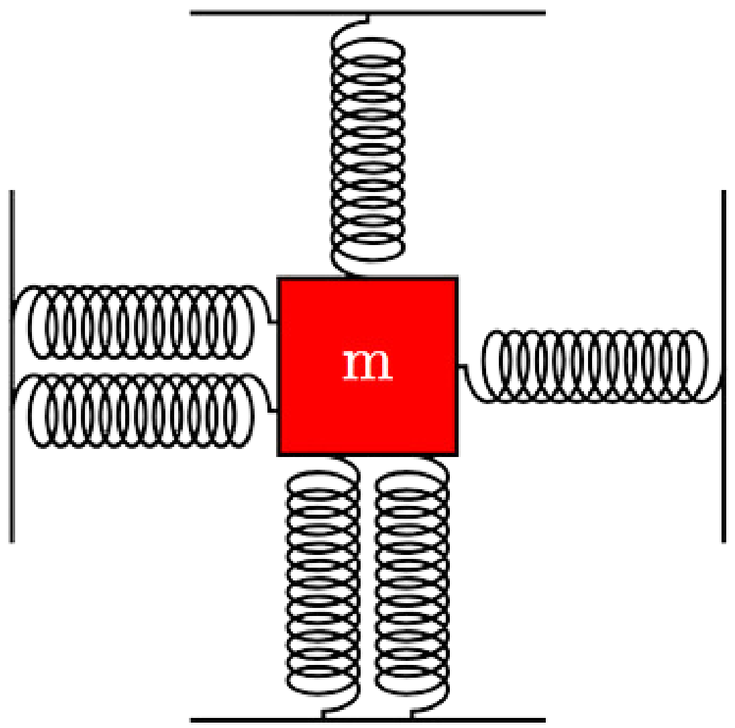

$$\sqrt{\frac{3k}{m}}$$