Sample Interview Questions
Physics and Maths for Natural Sciences

1 hour
No calculators
*You are **not** expected to answer all of these questions in the allocated hour.
    They are difficult and you should concentrate on getting fewer, complete
    questions out rather than many fragments.*

SECTION Mathematics

M1 Find $\sqrt{101}$ to 4 significant figures.

M2 If $x + y = xy = 3$, find $x^3 + y^3$.

M3 Sketch the curves y against x
(a)
$$y = \frac{x}{(x-1)^2}$$
for $-\infty < x < \infty$.
(b)
$$y^2 = \frac{x}{(x-1)^2}.$$
for $x \geq 0$.

M4 Differentiate x^x and $x^{\frac{1}{x}}$.

M5 A Generalized Fibonacci Sequence has first two terms $x_0 = 1$, $x_1 = a$. Subsequent
terms are calculated by $x_n = x_{n-1} + x_{n-2}$. For what values of a is a Generalized
Fibonacci Sequence also a geometric sequence? Calculate the sum to infinity of any such
sequence if it converges.

M6 Sketch the curve $y = \tan x$ and $y = \tan^{-1} x$ on the same graph for $0 \leq x < \frac{\pi}{2}$.
Hence or otherwise find the integral

$$\int_0^1 \tan^{-1} x \ dx.$$

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SECTION Physics

P7   Sketch curves of the acceleration and velocity versus time of a parachutist as he leaves a plane, opens his parachute and eventually lands safely on the ground.

P8   A closed container of volume V is filled by water at temperature T. Imagine that the interaction between the molecules suddenly disappeared. What would be the pressure?

P9   Consider the arrangement of masses and inextensible string on a smooth horizontal surface shown in the diagram. A constant force F is applied to the midpoint of the light string which joins two particles of mass m. Find an expression for the acceleration component a of one of the particles when it is a perpendicular distance x from the line of action of F. Sketch a graph to show the variation of a with x.
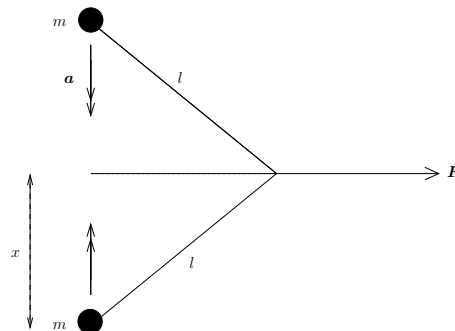
P10   Consider the following five blocks resting on a smooth horizontal table. Suppose there is a force F applied to the leftmost block. All the blocks remain in contact during the application of the force and accelerate similarly. Mark on all the forces on the middle block. (Direction and magnitude) What is the resultant force?
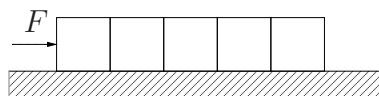
P11   The radius of Earth is 4 times the radius of the moon. Estimate the acceleration due to gravity on the surface of the moon.

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