Solutions to Sample Progressive Test
Language of Physics

PHYSICS 1002 FUNDAMENTALS

Question 1

(a) The 450-BC has zero velocity at time 0 seconds. It accelerates uniformly at 0.32 $m.s^{-2}$ for the next 100 seconds. (Or average acceleration of 0.32 $m.s^{-2}$.)
The XR-3000 also has zero velocity at time 0 seconds. But it remains stationary for at least another 10 seconds before taking off. It accelerates non-uniformly for the next 90 seconds. The instantaneous acceleration at time t=100 s is approximately 1 $m.s^{-2}$.

(b) The car which has the greater displacement has crossed the finish line.
Displacement is given by area under the curve and the graph representing the 450-BC has a greater area under the curve.

(c) The XR-3000 remains stationary for at least 10 seconds before taking off. This is much greater than the time for a person to respond to the start signal.

Question 2

A ball falls directly to earth because it experiences a net downward force which is caused by the gravitational force.

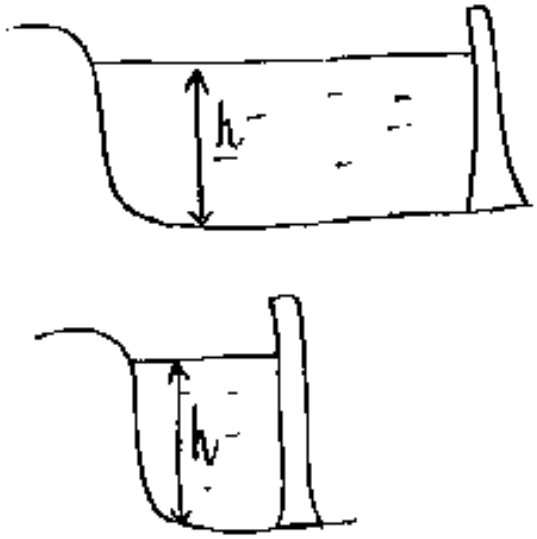
Similarly, a satellite experiences a net downward force caused by the gravitational force and thus is continuously falling downward.

In the case of the ball we can assume a flat earth while in the case of the satellite we can't. We can’t make this assumption for the satellite because it has a large orbital (sideways) speed and it is much further from earth.

For the satellite ,taking the curvature of the earth into account, the direction of the acceleration down keeps changing and is always towards the centre of the earth. The net downward gravitational force is towards the centre of the earth. The satellite is falling but doesn't reach the earth’s surface. Instead it traces a circular orbit around the earth.

Question 3

(a)



When designing a dam one should conside
the vertical depth of the water. This i
because the pressure at a point is determine
by the depth of water above that point. Du
to pressure there is a force perpendicular t
the surface in contact with the water.

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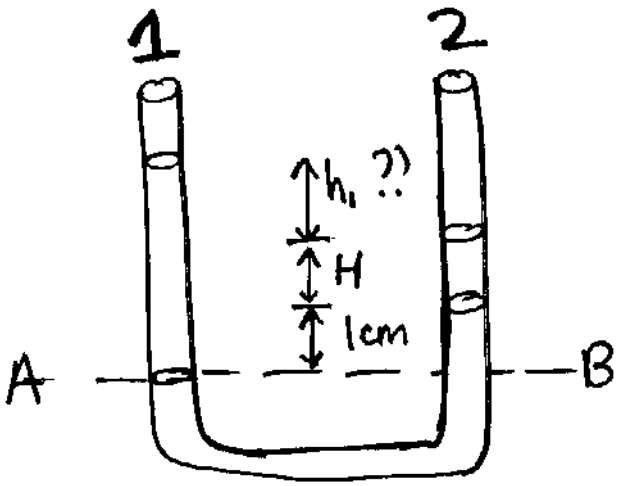
(b)



For static equilibrium
the pressure in arm 1 at the interface is equa
to the pressure in arm 2 at the same heigh
(shown by the dashed line AB).

The pressure in arm 1 at the interface is
$P_0 + \rho_w g(h_1 + H + h_2)$
The pressure in arm 2 at the same height is
$P_0 + \rho_w gH + \rho_m gh_2$
Equating these
$P_0 + \rho_w g(h_1 + H + h_2) = P_0 + \rho_w gH + \rho_m gh_2$

$\rho_w g(h_1 + h_2) = \rho_m gh_2$

$h_1 = (\rho_m gh_2 - \rho_w gh_2) / \rho_w g$

$$h_1 = \frac{(13.6\times10^3\ \text{kg.m}^{-3} \times 9.8\ \text{m.s}^{-2} \times 0.0100\ \text{m}) - (1.00\times10^3\ \text{kg.m}^{-3} \times 9.8\ \text{m.s}^{-2} \times 0.0100\ \text{m})}{1.00\times10^3\ \text{kg.m}^{-3} \times 9.8\ \text{m.s}^{-2}}$$

$= 0.126\ \text{m} = 12.6\ \text{cm}$

Question 4

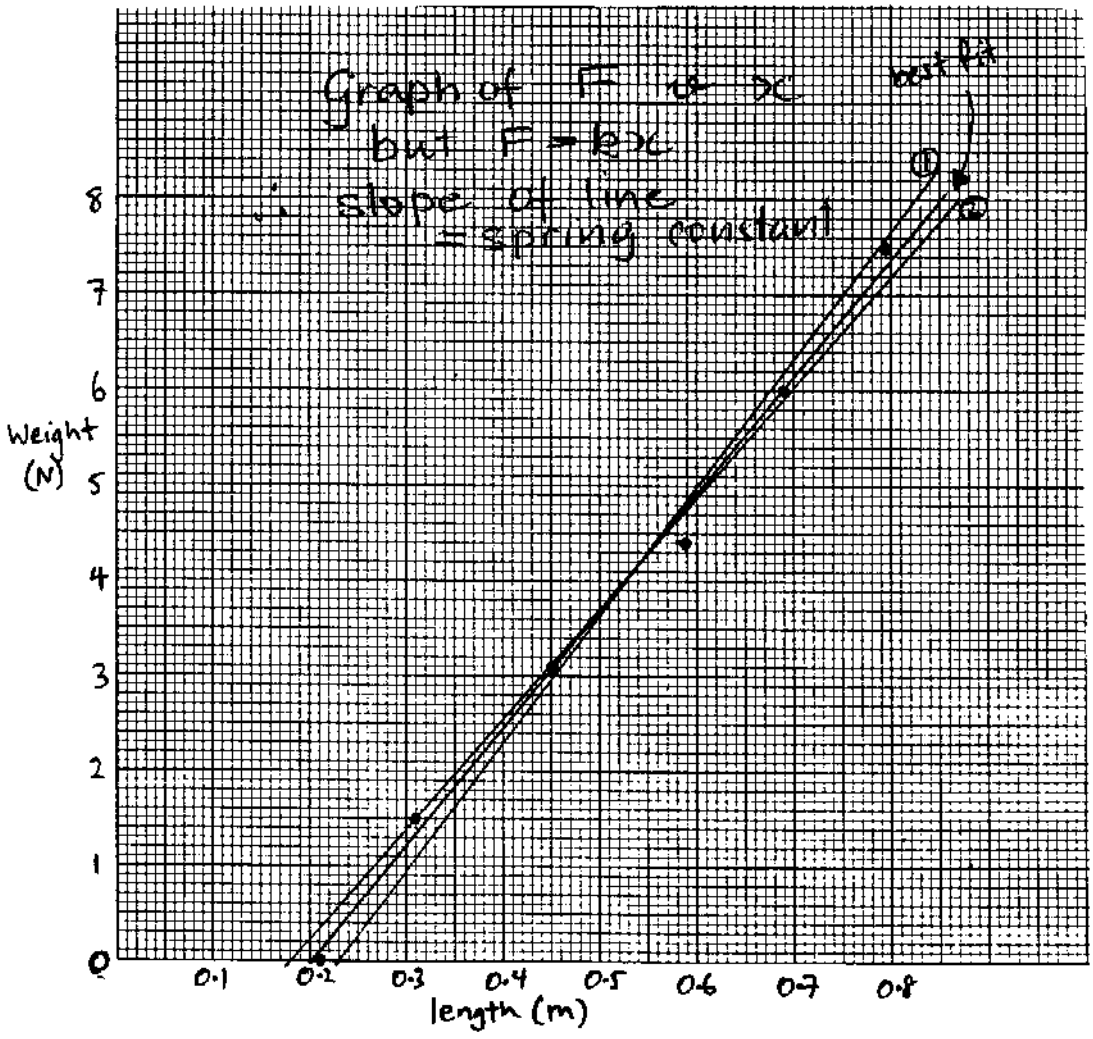
The relationship between load(weight) F and extension x of a spring is given by the following equation $F = kx$, where F is in Newtons and x in metres..
A student measured the total length of a spring when various weights were suspended from it, as follows

Length (cm)	21.1	30.9	45.2	54.8	69.0	79.4
Weight (N)	0	1.50	3.10	4.40	6.02	7.48

Graph these points and determine the spring constant, k , in units of N / m.
Include an estimate of uncertainty of your answer.

(10 marks)

ANSWER



m = slope of best fit line = (8.0-0.0) N / (0.85-0.20) m = 12.31N / m

m_1 = slope of line 1 = (8.0- 0.0) N / (0.825 - 0.23) m = 13.45N / m

m_2 = slope of line 2 = (8.0- 0.0) N / (0.87 - 0.18) m = 11.59N / m

Uncertainty = $|m_1 - m_2| / 2$ = 1.86 N / m / 2 = 0.93 N / m

Therefore, spring constant k = (12.3 ± 0.9) N / m