PHYS 1001 - PHYSICS 1 (REGULAR)
Sample Laboratory Skills Test
SOLUTIONS

Question 1

Estimate the length of the Sydney Harbour Bridge that lies between the pylons. Give your answer in metres and a justification for your answer.

To answer this type of question you need to consider extreme values and then "zoom in" to an appropriate answer.

1 mm < distance < 100 km
1m < distance < 10 km
10 m < distance < 5 km
100 m < distance < 1 km
200 m < distance < 1 km

(1 mark for above argument)

Estimate of distance between pylons of Sydney Harbour Bridge is 600 m.

(1 mark for numerical answer)

Comment:

The awe-inspiring **Sydney Harbour Bridge** has spanned the water dividing north and south Sydney since 1932. It's hard to imagine the view of the harbour without the castle-like sandstone pylons anchoring the bridge to the shore and the crisscross of steel arch against the sky. At 503 m, it was the longest single span arch bridge in the world when it was built. As the NSW Premier, J.T. Lang, of the Labor party, prepared to cut the ribbon, further excitement was provided by the dashing horseman and Royalist fanatic, Francis de Groot, who galloped up like a cavalryman and cut the opening ribbon with a saber declaring "I open this bridge in the name of the Majesty the King and all the decent citizens of NSW" in protest at Lang's Socialist leanings.

Residents of the north of England might find the bridge familiar: the much tinier Tyne Bridge in Newcastle-upon-Tyne, built in 1929, was the model for Sydney Harbour Bridge. Construction costs for the altogether hugher Sydney project weren't paid off until 1988, and there's still a $2 toll to drive across, though, payable only when heading south; you can walk or cycle it for free. Pedestrians should head up the steps to the bridge from Cumberland Street, reached from The Rocks via the Argyle Steps off Argyle Street, and walk on the eastern side (the western side is the preserve of cyclists).

The bridge demands full-time maintenance, protected from rust by continuous painting in trademark steel-grey. One of Australia's best-known comedians, Paul Hogan of *Crocodile Dundee* fame, worked as a rigger on "the coathanger" before being rescued by a New Faces talent quest in the 1970s. To check out Hoge's vista, you can now follow a rigger's route and climb the bridge without getting arrested - once the favoured illegal occupation of drunken uni students. If you can't stomach (or afford) the climb, there's a lookout point actually inside the bridge's southern pylon where, as well as gazing out across the harbour, you can study a photo exhibition on the bridge's history.

Question 2

The weight of a box was recorded as 1200 N. How many significant figures are in this value?

$W = 1.200 \times 10^3$ N (4 sf)
$W = 1.20 \times 10^3$ N (3 sf)
$W = 1.2 \times 10^3$ N (2 sf)
The correct answer is 2, 3 or 4 significant figures - the way the number is expressed is ambiguous.

(2 marks)

Question 3

The dimensions of A4 paper are 2.10×10^2 mm by 2.97×10^2 mm.
The paper was quoted by the manufacturer to be 8.0×10^1 g.m^{-2}.
What is the mass of a single page of the A4 paper?
Your answer has to be expressed in grams and to the correct number of significant figures.

1 mm = 10^{-3} m
Area, $A = (2.10\times10^{-1})((2.97\times10^{-1})$ m^2
$A = 6.237\times10^{-2}$ m^2

Surface density (mass/area)
$m / A = 8.0\times10^1$ g.m^{-1}
$m = (8.0\times10^1)(6.237\times10^{-2})$ g = 4.9895 g
***m* = 5.0 g (2 sf)**

(2 marks)

Question 4

Pat, whose weight is (650 ± 35) N, is lying on Bondi beach with (0.3 ± 0.1) m^2 of Pat's body in contact with the beach. How much pressure does Pat exert on the sand? The uncertainties shown are standard errors of the mean (SEM). Your answer needs to include the value of the pressure and the SEM.

$W = 650$ N
$E(W) = 35$ N
$A = 0.3$ m^2
$E(A) = 0.1$ m^2

Pressure = force / area
$P = W / A$
$P = 650 / 0.3$
$P = 2166.667$ Pa

Uncertainties are SEMs.
$E(P) / P = \{ [E(W)/W]^2 + [E(A)/A]^2 \}^{0.5}$
$E(P) = P \{ [E(W)/W]^2 + [E(A)/A]^2 \}^{0.5}$
$E(P) = 2166.667 \{ [35/650]^2 + [0.1/0.3]^2 \}^{0.5} = 731$ Pa

$P = (2.2 \pm 0.7) \times 10^3$ Pa

The uncertainty is generally expressed to one significant figure. The uncertainty then determines the number of decimal places in the value of the quantity.

(2 marks)

Question 5

In the lab, your want to measure the density of a liquid. The volume measurement is 2.43×10^{-4} m^3 and the uncertainty is estimated to be ± 5%. The mass of the liquid is 3.10×10^{-4} kg and its uncertainty is estimated to be ±1%. What is the density of the liquid and its uncertainty expressed as a percentage and value?

$V = 2.43\times10^{-4}$ m^3
E(V) = (5/100)
$m = 3.10\times10^{-4}$ kg
E(m) = (1/100)

Density = mass / volume
$\rho = m / V$
$\rho = (3.10\times10^{-4}) / (2.43\times10^{-4}) = 1.2757$ kg.m-^{3}

Since the uncertainties quoted are percentages
$E(\rho) / \rho = E(m)/m + E(V)/V$
$E(\rho)= \rho \{ E(m)/m + E(V)/V \} = (1.2757)(5/100 + 1/100) = 0.0765$

$\rho = (1.28 \pm 0.08)$ kg.m-^{3}

Note: uncertainty usually quoted as a single digit.
Note: Value and its uncertainty are expressed to the same number of decimal places.

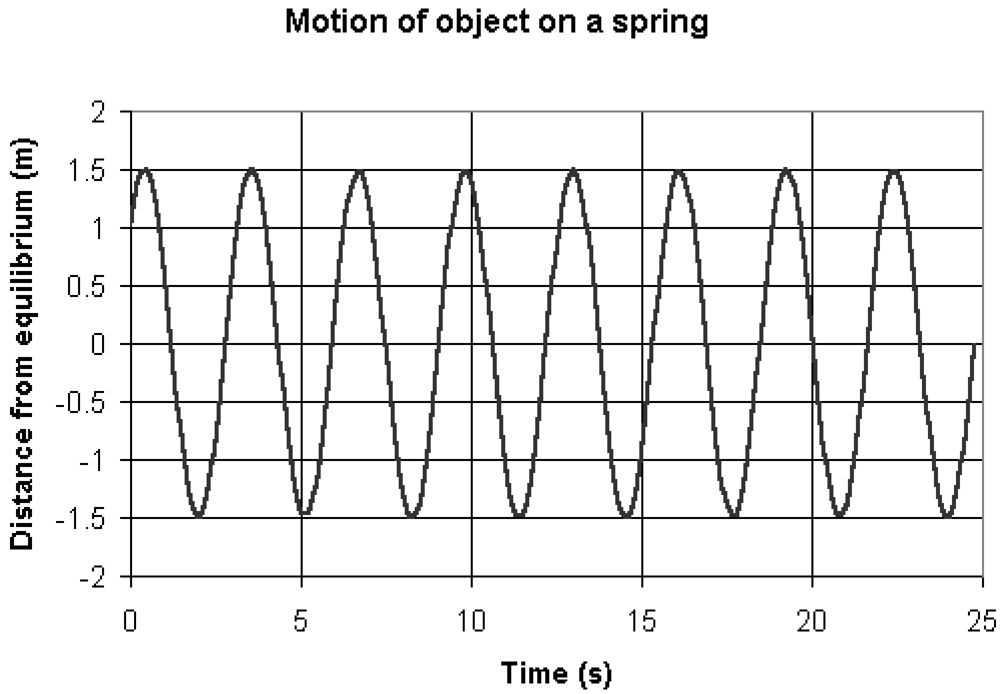
(2 marks)

Question 6

An object is placed at one end of a spring, the other end being fixed. When the system is set into motion, the distance of the object from equilibrium varies with time as shown below.

a) What is the period of oscillation of the system?
b) What is its frequency?
c) What is the amplitude of oscillation?

You don't need to give uncertainties.



Period T is the time for one complete oscillation. When you measure the period from the graph as shown above (or on a CRO screen), you should measure the time interval for the max number of periods.

$7\,T = (23 - 1) = 22$ s
$T = 22 / 7$

T = 3.1 s

Frequency, $f = 1 / T$
f = 1 / 3.1

f = 0.32 Hz

To measure the amplitude in often best to measure the peak to peak value first.
Peak to peak distance = 1.5 – (1.5) = 3.0 m

Distance amplitude, A = 3.0 / 2 = 1.5 m

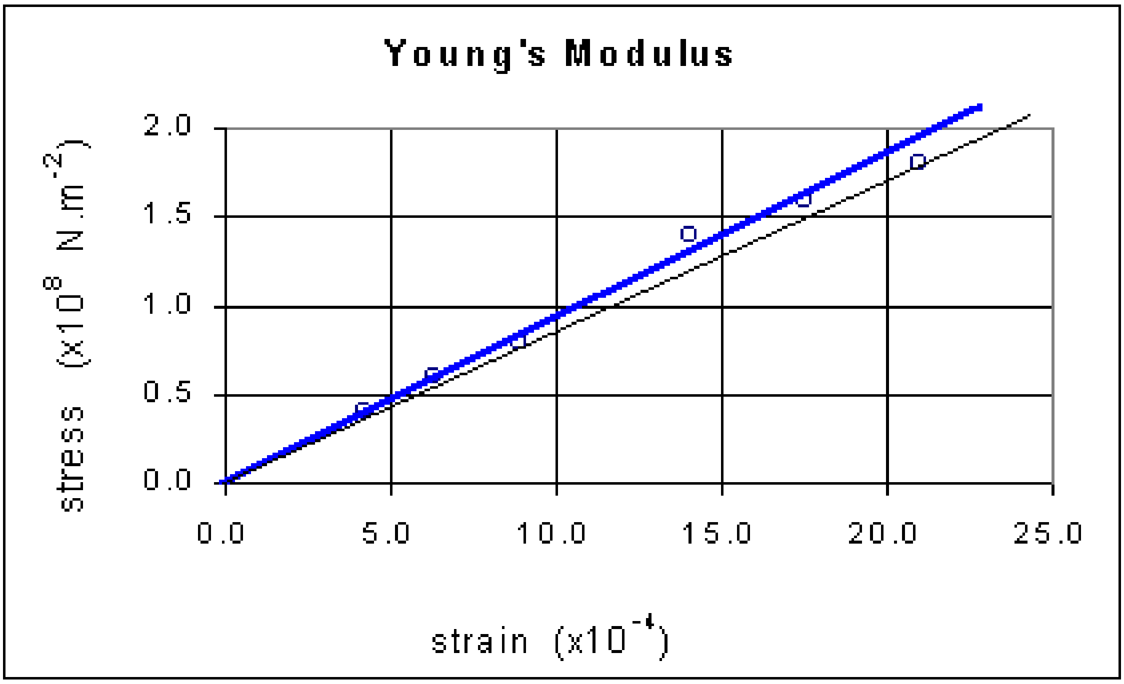
(3 marks)

Question 7

All materials have some inherent "elasticity" i.e. when subject to a force (or stress) they experience deformation (or strain), but recover their shape when the stress is removed, unless the stress is too great. The relationship between stress and strain for a brass wire can be studied by plotting the data given in the table below. The slope of this relationship, i.e. Δstress/Δstrain, is called Young's modulus.

Graph the data.
For the brass wire, what is the Young's modulus and its uncertainty?

Stress (N m^{-2})	Strain (no units)
0.4×10^8	4.2×10^{-4}
0.6×10^8	6.3×10^{-4}
0.8×10^8	8.9×10^{-4}
1.4×10^8	1.4×10^{-3}
1.6×10^8	1.75×10^{-3}
1.8×10^8	2.1×10^{-3}



(3 marks)

The blue line represents the “line of best fit - lbf”, the other line is the “line of worst fit - lwf”. The slope of the straight line gives the value of Young’s Modulus, *E*

$m = E = \Delta\text{stress} / \Delta\text{strain}$

(1 mark)

Line of best fit
$m = (18.5 – 0)\times10^{8} / (20.0 – 0)\times10^{-4} = 9.25\times10^{10}$ N.m^{-2}

(1 mark)

Line of worst fit
$m = (17.0 – 0)\times10^{8} / (20.0 – 0)\times10^{-4} = 8.50\times10^{10}$ N.m^{-2}

(1 mark)

Young’s modulus, ***E*** **= (9.3 ± 0.8) ¥ 10^{10} N.m^{-2}**

(1 mark)