Revision Session - Worked Solutions - 17/3/17

1) a) • Arrow gains more energy
• Aiming is more reliable
• Arrow travels further

b) $W = Fd$
= Area under curve

1 Square = 0.05×25
$= 1.25\,J$

# of squares = 64

$E = W = 64 \times 1.25$
$= 80\,J$

c) $E = \frac{1}{2} mv^2$

$v^2 = \frac{2E}{m}$

$v^2 = \frac{2 \times 58}{3.5 \times 10^{-2}}$

$v^2 = 3.3 \times 10^3\,ms^{-1}$
$v = 58\,ms^{-1}$

d) • Air resistance will oppose the motion of the arrow.
• This will slow the arrow down
• Therefore it will travel less far before falling to the ground than in vacuum (time taken for this to occur will be unchanged)

2) $F = k\Delta L$

$\Delta L = \frac{F}{k} = \frac{8}{125}$

$= 0.064m$

3) a) It returns to its original length when the load is removed.

b) $W = Fd$

= Area under curve

# of big Squares = 12

Area of 1 big square = 10×0.05

$= 0.5J$

$W = 12 \times 0.5 = 6.0J$

c) $E = \frac{\sigma}{\epsilon}$ $\epsilon = \frac{\Delta l}{l}$ $\sigma = F/A$

$E = \frac{Fl}{A\Delta L}$

from graph read off at $\Delta l = 0.040m$, $F = 10N$

$E = \frac{10 \times 0.5}{5 \times 10^{-6} \times 0.04}$

$= 2.5 \times 10^7 Pa$

d) i) Straight line through origin

Finishes at same point as rubber (where Curve A meets Curve B at $\Delta l = 0.60m$)

ii) The point at which force is no longer proportional to the extension.

4a) i) $\omega = 15 \text{ revs}^{-1} = 30\pi \text{ rads}^{-1}$

$F = m\omega^2 r$

$= 1.5 \times (30\pi)^2 \times 0.55$

$= 7.3 \text{kN}$

ii) Towards the centre of the rotor

iii) $\sigma = \frac{F}{A} = \frac{7.3 \times 10^3}{3.5 \times 10^{-4}}$

$= 2.1 \times 10^7 \text{ Pa}$

$= 21 \text{MPa}$

iv) $E = \frac{\sigma}{\epsilon} = \frac{\sigma l}{\Delta l}$

$\Delta l = \frac{\sigma l}{E}$

$= \frac{2.1 \times 10^7 \times 0.55}{6.0 \times 10^{10}}$

$= 1.9 \times 10^{-4} \text{m}$

$= 0.19 \text{mm}$

~~v) $F = k\Delta l$~~

~~$k = F/\Delta l$~~

~~$= \frac{7.3 \times 10^3}{1.9 \times 10^{-4}}$~~

v) $E = \frac{1}{2} F\Delta L$

$= \frac{1}{2} \times 7.3 \times 10^3 \times 1.9 \times 10^{-4}$

$= 0.69 \text{J}$

b) i) Volume pushed down per second $V = Av$

$m = \rho V$

so Change in mass per second $\Delta m = \rho A v$

momentum ~~eqn~~, $p = mv$

so Change in momentum $\Delta p = \Delta m v$

$\Delta p = \rho A v^2$

ii) Force is rate of change of momentum

ie $F = \Delta p = \rho A v^2$ (as shown in b i)

so $v^2 = \frac{F}{\rho A}$

$A = \pi r^2 = \pi \times 0.55^2$

$v = \sqrt{\frac{900}{1.3 \times \pi \times 0.55^2}}$

$v = 27 ms^{-1}$