Friday Worksheet **Name: ……**
UV-visible spectroscopy3

1) In order to help prevent tooth decay, fluoride ions at a level of 0.790 mg L^{-1} of F^- are added to Melbourne's public water supplies. The fluoride ions are obtained by adding sodium fluoride (NaF) to the water.

i. Calculate the mass of sodium fluoride in mg that must be present in one litre of water to produce a concentration of fluoride ions of 0.790 mg L^{-1}.

n(NaF) = n(F-) = 0.790x10^{-3} / 19.0
= (4.16 x10^{-5} mol)
m(NaF) = (4.16x10^{-5}) x 42.0
= 1.75 x10^{-3} g
= 1.75 mg

ii. What mass of sodium fluoride, in kilogram, must be added to a 800.0 ML reservoir (1 ML = 10^6 L) to produce a concentration of fluoride ions of 0.790 mg L^{-1}?

m(NaF) = 1.75 mg L^{-1} x 800 x 10^6 L
= 1.40 x10^9 mg = 1.40 x10^6 g
*= **1.40 x10^3 kg***

iii. Calculate the number of fluoride ions swallowed by a person who drank one litre of water from the reservoir.

n(F^-) in 1 L = 4.16 x 10^{-5} mol ….. from (i) above
N(F^-) in 1 L = 4.16 x 10^{-5} x 6.02 x 10^{23}
*= **2.50 x10^{19}***

2) One method of determining the concentration of fluoride ions in water uses a red-coloured indicator, In , that reacts with fluoride ions in solution to give a colourless product. The reaction can be represented as

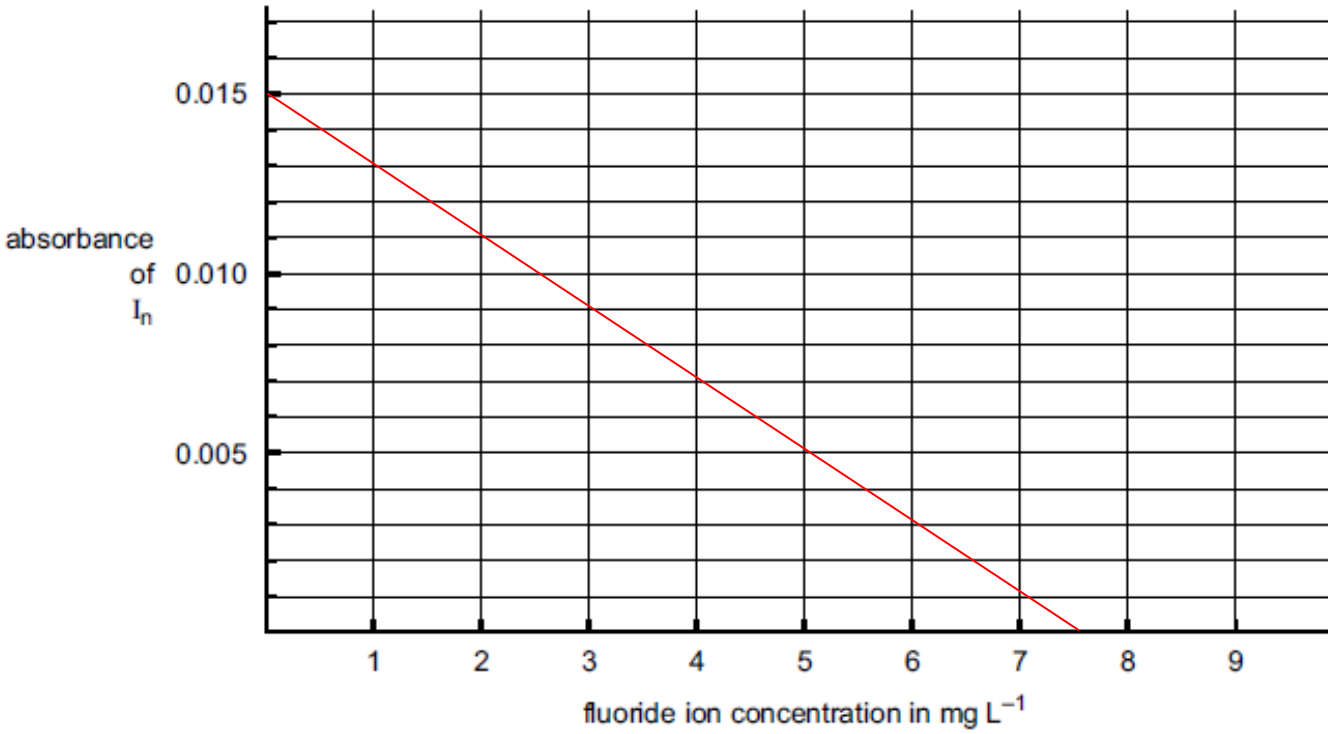
$In(aq)$	+	$F^-(aq)$ →	$FIn^-(aq)$	
red-coloured indicator		colourless	colourless	

A calibration curve was prepared using five different aqueous solutions of sodium fluoride, each of known ion concentration. *Q* mole of In is then added to 25.00 mL of each of five NaF solutions and an NaF solution of unknown concentration. The intensity of the red In colour of each of the mixtures is then determined using a UV-visible spectrophotometer.

The measured absorbances are given in the following table on the right.

Fluoride ion concentration in mg L^{-1}	Absorbance of I_n
1.00	0.0130
2.00	0.0110
3.00	0.0090
4.00	0.0070
5.00	0.0050
unknown NaF sample	0.0120

a) Draw a calibration curve on the set of axis on the following page.



b) Why does the absorbance fall with increasing fluoride ion concentration?

As the [F⁻] increases more I_n (absorbing species) reacts or [I_n] decreases

c) Use your calibration curve to determine the fluoride ion concentration of the unknown NaF sample in mg L^{-1}.

1.5 mg L^{-1} *(accept 1.4-1.6 mg L^{-1})*

d) What was the value of *Q*?

Students should recognise that the n(I_n) present (which is the same as Q) would be equal to the n(F^-) needed to react with all the indicator and hence register zero absorbance
Q mol I_n was used up at the point the absorbance reached zero.
Q = n(I_n) = n(F^-) at zero absorbance
c(F^-) at zero absorbance = ***7.5 mg L^{-1}***
m(F^-) = (25 / 1000) x 7.5
= 0.1875 mg
n(F^-) = 0.1875x10^{-3} / 19
= 9.9 x10^{-6} mol
Q = 9.9x10^{-6}