State Examinations Commission – Physics Higher Level, 2003.

Question 2.

In an experiment to measure the specific latent heat of vaporisation of water, cold water was placed in a copper calorimeter. Steam was passed into the cold water until a suitable rise in temperature was achieved. The following results were obtained.

Mass of calorimeter ………………………………… = 73.4 g
Mass of cold water ………………………………… = 67.5 g
Initial temperature of water ……………………… = 10 ^{0}C
Temperature of steam ……………………………… = 100 ^{0}C
Mass of steam added ……………………………… = 1.1 g
Final temperature of water ………………………… = 19 ^{0}C

Describe how the mass of the steam was found.

Using the data, calculate a value for the specific latent heat of vaporisation of water. The specific heat capacity of copper is 390 J kg^{-1} K^{-1} and the specific heat capacity of water is 4180 J kg^{-1} K^{-1}

Why is the rise in temperature the least accurate value? Give two ways of improving the accuracy of this value.

Describe how the mass of the steam was found

It was found by subtracting the mass of the calorimeter and the cold water from the mass of the calorimeter, cold water and added steam.

Using the data, calculate a value for the specific latent heat of vaporisation of water. The specific heat capacity of copper is 390 J kg^{-1} K^{-1} and the specific heat capacity of water is 4180 J kg^{-1} K^{-1}

		Heat Gained	=	Heat Lost		
Heat gained by calorimeter	+	Heat gained by cold water	=	Heat lost by steam condensing	+	Heat lost by resulting condensed water cooling to final temp
$(mc\Delta\theta)_{cal}$	+	$(mc\Delta\theta)_{water}$	=	$(ml_v)_{steam}$	+	$(mc\Delta\theta)_{steam}$
0.0734 x 390 x 9	+	0.0675 x 4180 x 9	=	0.0011 x l_v	+	0.0011 x 4180 x 81

Solving for l_v gives l_v = 2.2 x 10^6 J kg^{-1}

Why is the rise in temperature the least accurate value? Give two ways of improving the accuracy of this value.

The rise in temperature is 9^{0}C. This means the true value lies between 8 and 10^{0}C, i.e. the rise in temp is 9 ± 1^{0}C. There is a possible percentage error of 11% here, which is the largest possible percentage error in any of the readings used. The accuracy of this value could have been improved by i) using a more sensitive thermometer that measured to an accuracy of, say, 0.1^{0}C or ii) by allowing more steam to bubble into the calorimeter, thereby giving a greater rise in temperature and hence a reduced possible percentage error.