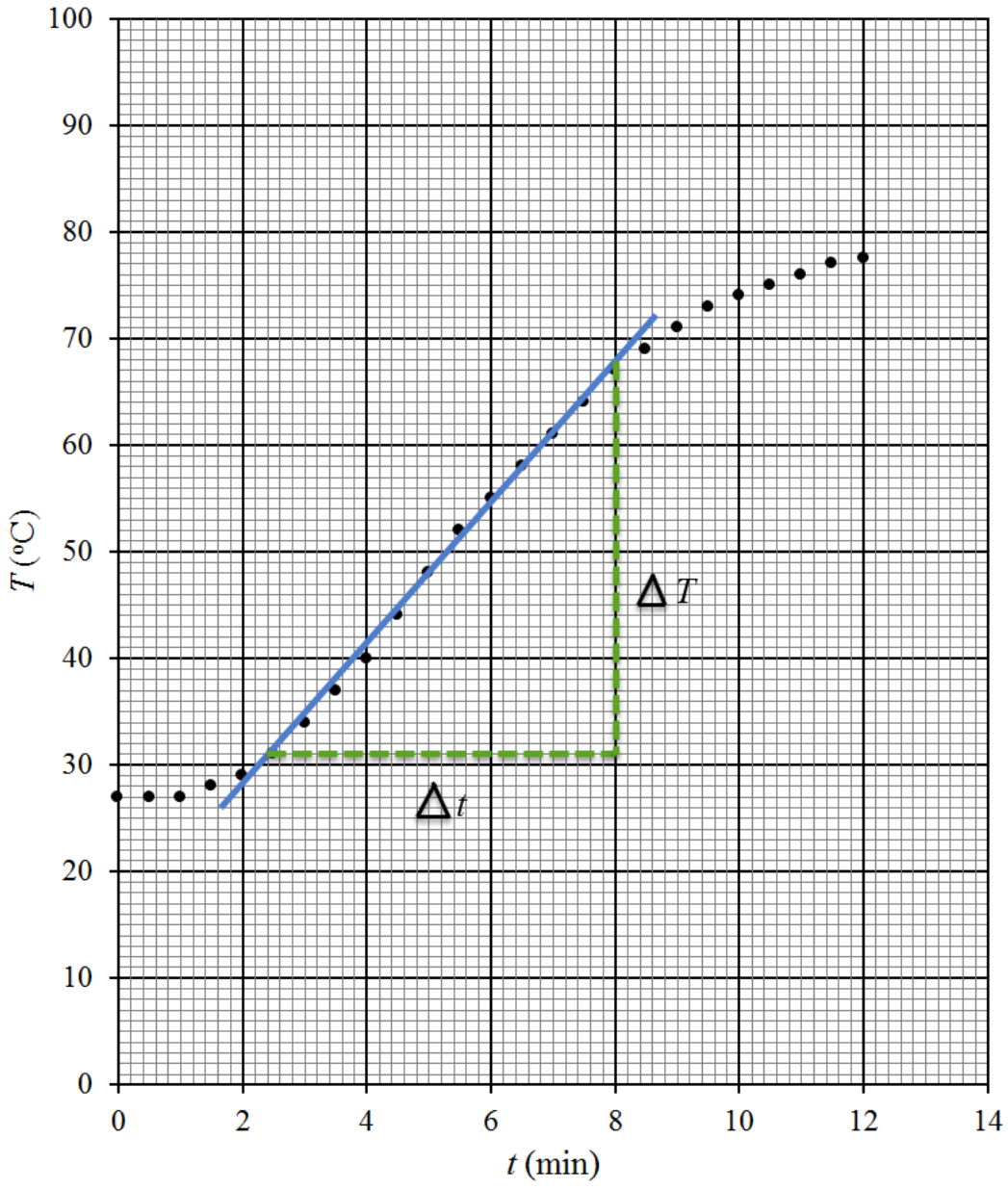
PART ONE: Physics, The effectiveness of energy absorption by water [13.0 points]										
Experimental Data										
	t(min)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	T (°C)	27	27	27	28	29	31	34	37	40
	t(min)	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5
	T (°C)	44	48	52	55	58	61	64	67	69
	t(min)	9.0	9.5	10.0	10.5	11.0	11.5	12.0		
	T (°C)	71	73	74	75	76	77	77.5		

Question (Points)	Graph
Ph-1 (3.0)	

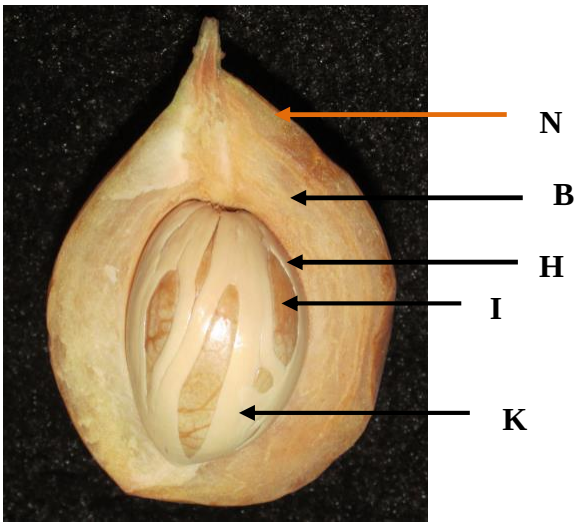
Question	Make a graph of the temperature of water as a function of time!	**Points**	**Max**
Ph-1			
	Name of both axis	0.5	3.0
	Unit of axis	0.5	
	Accuracy point positions of data (correctness of the data plotting)	2.0	
Question	Determine the linear range of water temperature change (ΔT) and time change (Δt)!	**Points**	**Max**
Ph-2 (1.5)	ΔT in the linear part	0.75	1.5
	Δt in the linear part	0.75	
	No answer or any other value	0.0	0.0
Question	Calculate the rate of water temperature change (in °C /s) with respect to time by using the linear part of the graph(which means linear process in water)!	**Points**	**Max**
Ph-3 (2.0)	Slope = (depending on the linear part of the graph)		2
	No answer or any other value		0.0
Question	Calculate how much electrical energy (in joule) is used within the linear part of the graph (electric power used by the stove is 600W)!	**Points**	**Max**
Ph-4 (2.0)	Electric energy = $E_E = P \times \Delta t$		
	E_E = (600W) x (Δt [in minute])x (60s), (Δt depends on student's linear part of graph) Correct formula = 1.0 point	1	2.0
	Correct calculation (in joule) = 1.0 point (units may not be stated)	1	
	E_E = (600W)x (Δt[in minute]), (Δt depends on student's linear part of graph) Correct calculation	0.5	1.0
	Correct formula	0.5	
	(units may not be stated)		

Question	Calculate how much heat (in joule) is received by water within the linear part of the graph! (Note that $c_{water} = 4180\,\text{J/kg.°C}$).	Points	Max
Ph-5 (1.5)	$\rho_{\text{water}} = 1\,\text{g/cm}^3$ $c_{\text{water}} = 4180\,\text{J/kg.°C}$ $V_{\text{water}} = 400\ \text{mL}$ $m_{\text{water}} = \rho_{\text{water}} \times V_{\text{water}} = (1)\times(400) = 400\text{g} = 0.4\text{kg}$ $Q_{water} = m_{water} \times c_{water} \times \Delta T$		
	Correct formula	0.5	1.5
	Correct calculation (in joule)	1.0	
	Correct calculation (units may not be stated)	0.5	1.0
	Correct formula	0.5	
	No answer or any other value	0.0	0.0
Question	Calculate how much heat (injoule) is released into the environment during thelinear partof the graph!	**Points**	**Max**
Ph-6 (1.5)	$\Delta Q = E_E - Q_{water}$		
	Correct formula	0.75	1.5
	Correct calculation (in joule)	0.75	
	Correct calculation (units may not be stated)	0.5	1.0
	Correct formula	0.5	
	No answer or any other value	0.0	0.0

Question	Calculate the percentage of energy absorbed by water with respect to the total energy of the stovewithin the linear part of the graph!	Points	Max
Ph-7 (1.5)	$\eta = (mc\Delta T) \div (P\Delta t) \times 100\%$		
	Correct formula	0.5	1.5
	Correct calculation (in joule)	1.0	
	Correct calculation (units may not be stated)	0.5	1
	Correct formula	0.5	
	No answer or any other value	0.0	0.0

PART TWO: Biology, Characteristics of Nutmeg [13.0 points]

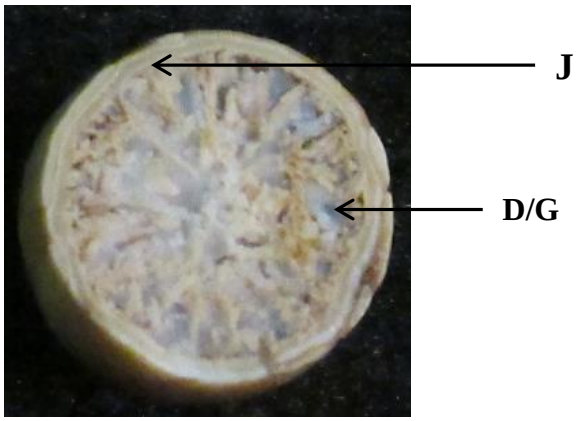
A. Nutmeg Fruit

Question	**Bi-1.** Draw the longitudinal section of the fruit with the seed intact! **Bi-2.** Label parts of the fruit with reference provided on the answers box. Show the fruit parts by arrows. Choose the corresponding parts from the answers box and write down the answer by writing the letter only (for example A, B, C etc.).	Points	Max
			
Bi-1	Drawing the correct longitudinal section of the fruit	0.25	2.0
	Drawing the cross section of the fruit	0.0	
	Size of the drawing is appropriate to the original fruit = 0.5 and correct proportion of the different parts = 0.5	1.0	
	Drawing the correct and complete 3 parts of the fruit (fruit, seed and arillus @ 0.25).	0.75	
	No drawing	0.0	
Bi-2	Correct labelling B = 0.6 point H = 0.6 point N = 0.6 point I = 0.6 point K = 0.6 point	3.0	3.0

Notes:

Pericarp	:	the walls of a ripen ovary or fruits (fruit coat: exocarp/epicarp, mesocarp and endocarp)
Seed	:	the fertilized mature ovule of flowering plant containing an embryo, the germ of propagative source, offspring or progeny)
Arillus/Aril/Mace	:	specialized outgrowth of a seed that partly or completely covered the seed

B. Nutmeg Seed

Question	**Bi-3. Draw the cross section of the seed!** **Bi-4.** Label parts of the seed with reference provided on the answers box. Show the seed parts by arrows. Choose the corresponding parts from the answers box and write down the answer by writing the letter only (for example A, B, C etc)	Points	Max
			
Bi-3	Drawing the correct cross section of the seed	0.5	3.0
	Drawing the longitudinal section of the seed	0.0	
	Size of the drawing is appropriate to the original seed	0.5	
	Correct drawing of the internal seed parts (testa/seed coat (J)= 1.0 point, endospem/perisperm (D/G))= 1.0 point Drawing the incomplete internal parts of the seed (without testa (J) or endosperm/perisperm (D/G) = 1.0 point	2.0	
	No drawing	0.0	
Bi-4	Correct labelling : testa/seed coat (J)= 1.0 point, endosperm/perisperm (D/G) = 1.0 point. Only one correct labeling: testa/seed coat (J) or endosperm/perisperm (D/G) = 1.0 point	2.0	2.0
	No label	0.0	

Notes:

Seed coat/Testa : the outer protective covering of a seed
Endosperm : a tissue produced inside the seeds of most flowering plants it surrounds the embryo and provide nutrition in the form of starch, it can also contain oils and protein

C. Nutmeg Fruit and Seed Characteristics

Question (Points)	Fruit and Seed Classification Tick (√) one correct answer on each classification categories (A-F) in the box provided below! (0.5 point for each correct answer)				
Bi-5 (3.0)	A. Fruit origin:	√	Simple fruit		Compound fruit
	B. Fruit composition:	√	True fruit		Accessory fruit
	C. Fruit description:	√	Fleshy fruit		Dry fruit
	D. Fruit type:		Pome	√	Drupe
	E. Seed cotyledon:		Monocotyledon	√	Dicotyledon
	F. Seed shape:		Round	√	Ovoid

PART THREE: Chemistry, Nutmeg Oil Distillation [14.0 points]

After conducting experiment by using 120 g of ground nutmeg seed, you have obtained certain amount of nutmeg oil.			
Question	How much is the volume of nutmeg oil you have obtained?	**Points**	**Max**
Ch-1	Sample collected by students is free of water	2.00	4.50
	Volume of Nutmeg Oil (mL):		
	> 4.00	2.50	
	2.50 – 3.99	2.00	
	1.00 – 2.49	1.50	
	0.00 – 0.99	0.50	
	If wrong fraction (only water) is collected	0.00	
Question	It is known that the mass of exactly 1.00 mL of nutmeg oil is 0.862 g at 25 ^{o}C. What is the percentage by mass of nutmeg oil in nutmeg seed according to your experiment if it is measured at 25 ^{o}C?	**Points**	**Max**
Ch-2	Mass of nutmeg oil = volume (mL) x density (g/mL) =..... mL x 0.862 (g/mL) = ... g	0.75	1.50
	Percentage of nutmeg oil in nutmeg seed: = {mass of nutmeg oil (~~g~~)/mass of nutmeg seed (~~g~~)} x 100 % = ... %	0.75	
Question	It is known that the main component of nutmeg oil is myristicin. Assume that your sample of nutmeg oil contains 65% of myristicin ($C_{11}H_{12}O_3$) by mass. **(a) [1.5 point]** Calculate the number of myristicin molecules in your sample. **(b) [1.5 point]** Calculate the mass of the carbon in grams in the myristicin in your sample. (atomic mass of C = 12, H = 1, and O = 16)	**Points**	**Max**
Ch-3	Molecular mass of myristicin = (12 x 11) + (1 x 12) + (16 x 3) = 192	0.50	3.00
	Mass of myristicin in nutmeg oil: = volume of nutmeg oil (~~mL~~) x density (g/~~mL~~) x 0.65 **= ..... x 0.862 x 0.65 g**	0.50	
	Number of moles of myristicin: = (gram of myristicin)/192 = ... moles	0.50	
	Number of molecules of myristicin: = number of mole of myristicin × Avogadro number = number of mole of myristicin × 6.02x10^{23} molecule = ... ×10^{23} molecules	0.50	

	Mass of carbon in the myristicin of your nutmeg oil: = 132/192 x gram of myristicin = ... grams	1.00	
Question	Based on the result of your experiment, calculate how many kilograms of nutmeg seed powder are required to produce 100 grams of nutmeg oil?	**Points**	**Max**
Ch-4	Assume that the percentage of nutmeg oil in nutmeg seed obtained from question Ch-3 = a % The mass of nutmeg seed powder required to produce 100 grams (0.1 kg) of nutmeg oil: = (0.1 x 100)/a kg = ...kg	1.00	1.00
Question	What is the function of boiling stones added in your experiment? (a) to accelerate the heating of water (b) to speed up the separation of nutmeg oil from water (c) to assist the distribution of heat inside the cylindrical flask content.	**Points**	**Max**
Ch-5	Answer: (c) to assist the distribution of heat inside the cylindrical flask content.	0.50	0.50
Question	What is the main aim of using nutmeg seed powder rather than nutmeg seed granules in your experiment? (a) to increase the solubility of nutmeg seed in water (b) to increase the contact surface of nutmeg seed and water (c) to speed up the evaporation of water in the flask.	**Points**	**Max**
Ch-6	Answer: (b) to increase the contact surface of nutmeg seed and water	0.50	0.50
Question	The separation of water and nutmeg oil in the Dean-Stark apparatus reflects the principle of ..... (a) like dissolves like (b) vapor pressure difference (c) chemical equilibrium.	**Points**	**Max**
Ch-7	Answer: (a) like dissolves like	0.75	0.75
Question	If the flow of cooling water in your experiment is changed from upper to lower part of the condensor, the condensation of the steam and nutmeg oil will be ..... (a) more effective (b) less effective (c) no effect.	**Points**	**Max**
Ch-8	Answer (b) less effective	0.75	0.75

Question	Which of these following alternative separation techniques can be used to obtain nutmeg oil from the seed of nutmeg (a) Centrifugation (b) Solvent extraction (c) Paper chromatography	**Points**	**Max**
Ch-9	Answer: (b) Solvent extraction	0.75	0.75
Question	What kind of changes in the experimental design would not reduce the yield of nutmeg oil (a) Heating too rapidly (b) Using more boiling stones (c) Using too short water condensor	**Points**	**Max**
Ch-10	Answer: (b) Using more boiling stones	0.75	0.75

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