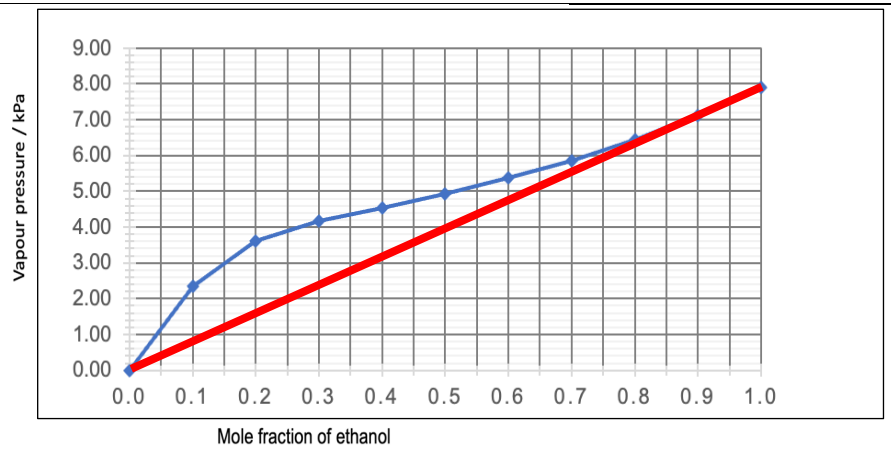
2023 Prelim Chemistry HL Paper 3 Mark Scheme

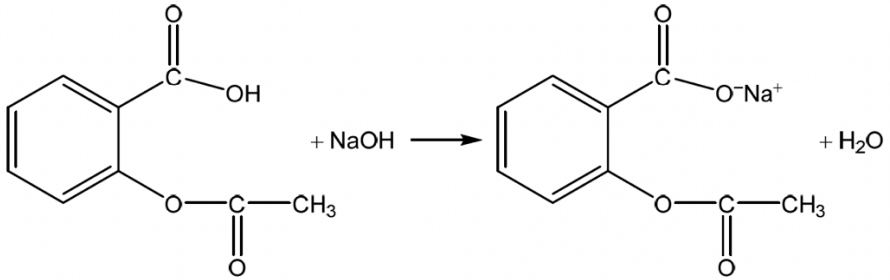
Section A

1a	$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ Correct products and balancing✓ Correct state symbols✓
bi	Oxidising agent ; ✓
ii	To provide an acidic medium /H^+ ions needed for the redox reaction ; ✓ Do not accept catalyst
ci	(5.20 + 5.30) / 2 = 5.25 cm^3 ✓ Reject other values
ii	% uncertainty = 0.10 / 5.25 x 100% = 1.9% ; ✓ ECF from c(i)
iii	Dilute/lower the concentration of sodium thiosulfate solution OR Increase the mass of fish OR Increase volume of iodine solution used OR more repeats✓ Reject: “bigger” or “larger” sample
2a	P°_{water} = 3.2 kPa ✓ *Accept any answer from 3.1 kPa to 3.3 kPa.*
b	The vapour pressure will increase with temperature. ✓
c	7 kPa ✓ *Accept any answer from 6.8 kPa to 7.2 kPa.*
d	Pure ethanol has a higher vapour pressure than water. ✓
e(i)	*Award [2 max] for the following:* There is strong intermolecular forces of attraction/hydrogen bonding between the ethanol molecules. ✓ The ethanol molecules has a significant size and occupies space. ✓ The collisions between ethanol molecules are not elastic. ✓

e(ii)	 *Award [2 max] for each of the following:* Starting point at origin (P = 0 kPa) Ending point at P = 8.0 kPa A straight line from these two points.

Section B

3a	TD50 is the amount / dose that negatively affects / produce toxic effects in 50% of the population. ✓ LD50 is the amount / dose that kills 50% of the population. ✓ Award 1 mark max: TD50 is used in human studies but LD50 is used in animal studies.
b	The risk of overdose is high because of the low therapeutic index. ✓ Accept: The drug must be used with caution.
c	intravenous / IV <<injection>> OR injection into the bloodstream ✓
d	Any one of: • «negative» side-effects of medication on patient / volunteers ✓ • effects on environment «from all materials used and produced» ✓ • potential for abuse ✓ • drugs may be developed that are contrary to some religious doctrines ✓ • animal testing ✓ • risk to benefit ratio ✓ • appropriate consent of patient volunteers ✓

4a	ethanoic anhydride / $(CH_3CO)_2O$ OR ethanoyl chloride / CH_3COCl ✓ Accept: ethanoic acid / CH_3COOH
b	It has a <<large>> benzene ring / arene ring which is non-polar / hydrophobic / cannot form hydrogen bonds with water. ✓ It has carboxyl / COOH / hydroxyl / OH <<and ester group>> which is polar / hydrophilic / can form hydrogen bonds with water. ✓
c	 OR $C_6H_4(COOCH_3)COOH + NaOH \rightarrow C_6H_4(COOCH_3)COONa + H_2O$ ✓ Accept: ionic equation, any other strong base Charges (O^- and Na^+) are not necessary to score the mark.
d	Similarities: Award 2 marks max • Both have <> absorption from 1700-1750 cm^{-1} for C=O <<in carboxylic acid>>. ✓ • Both have <<strong and very broad>> absorption from 2500-3000 cm^{-1} for O–H <<in carboxylic acid>>. ✓ • Both have <> absorption from 1050-1410 cm^{-1} for C–O <<in alcohol/phenol>>. ✓ • Both have <<<> absorption from 2850-3090 cm^{-1} for C–H. ✓ Difference: Award 1 mark max • Salicylic acid has a <<strong and broad>> absorption from 3200-3600 cm^{-1} for O–H <<in alcohol/phenol>> but not aspirin. ✓ Accept: Aspirin has 2 absorptions in 1700-1750 cm^{-1} due to 2 different C=O, but salicylic acid only has 1 absorption.

5	They <<temporarily>> bind / bond to <<opioid>> receptors in the brain / CNS. ✓ This prevents / block the transmission of pain impulses. ✓

6a	It blocks histamine from binding to the <<H2>> receptor. OR it binds to the same <<H2>> receptors <<as histamine>>. OR it competes with histamine for binding. ✓
b	proton pump OR H^+/K^+ ATPase enzyme ✓ Accept: <<secretary surface of>> parietal cells Do not accept: "stomach/stomach wall"

7	Any two of: • It prevents the virus from attaching to host cell/ binding to cellular receptors targeted by viruses. ✓ • It alters the cell's genetic material / DNA <<so that virus cannot use it to multiply>>. ✓ • It blocks enzyme activity in the host cell <<so that virus cannot use it to multiply>>. ✓ • It prevents the release of <<replicated>> viruses from host cell. ✓ • It prevents the removal of protein coat / capsid. ✓ • It prevents the injection of viral DNA / RNA into cell. ✓ Accept: "prevents synthesis of virus by host cell", "alters genetic material / DNA / RNA of virus"

8a	It gives off small / low amounts of radiation for a short time. ✓ Accept: “weakly ionizing radiation” instead of “small amounts of radiation”, “short half-lives” instead of “for a short time”.
b	It is stored in shielded containers until radiation drops <<to a safe level>>. OR shipped to central/specific site for specialized disposal. OR Incineration/burn. OR Buried underground. ✓

9a	It contains many stereoisomers / optical isomers / chiral carbons / chiral centres. ✓ Do not accept just “chiral”.
b	Any one of: • use of a chiral auxiliary to form the desired enantiomer ✓ • asymmetric synthesis ✓ • biosynthesis / using genetically modified bacteria / microorganisms ✓
c	Any two of: • use of immiscible solvents ✓ • partitioning of Taxol between the two solvents ✓ • Taxol is more soluble in one solvent. ✓ • The extraction is carried out multiple times «to improve extraction». ✓ • shaking / stirring the mixture ✓ • separating the two layers ✓ • The solvent is evaporated from the final solution «to obtain pure Taxol». ✓

10 a	Any two of: Advantages: • It can be readily “tagged” to a variety of biologically active carriers «which will deliver it to specific locations for imaging uses». ✓ • The frequency of radiation is compatible with existing X-ray detection apparatus. ✓ • The product of decay has low radioactivity / relatively short half-life / low total exposure to patient. ✓ • It produces only low-level waste / LLW. ✓ • It is a transition metal which forms compounds in a variety of oxidation states. ✓ • Gamma-radiation «can escape the body and» be detected by external sensors. ✓ Limitations: • There is a «small» increased risk of cancer to patient. ✓ • It must be made on site. ✓ • Activity decreases quickly, so dose must be calculated prior to each injection. ✓
b	$N(t) = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$ $= 100 \times 0.5^{15.0/6.0}$ ✓ = 18 % ✓ Award 1 mark: Correct substitution of values Award 2 marks: Correct final answer

11 a	gas chromatography / GC OR high-performance liquid chromatography / HPLC ✓ Accept: chromatography / thin-layer chromatography / paper chromatography / extraction Do not accept just “mass spectrometry / MS”, but do not penalize combined techniques such as GC-MS or HPLC-MS.
b	Water contains O-H bonds <<and is found in the breath>>. ✓