Jurong Pioneer Junior College 2024 H2 Chemistry Paper 1 Worked Solutions

1	D	The definition for atomic mass is the ratio of the average mass of one atom of an element to one-twelfth the mass of one atom of 12 C. In option D , the mass of one mole of atoms of an element has already considered all the isotopes and their relative abundances.
2	С	★A Al ²⁺ ions 1s ² 2s ² 2p ⁶ 3s ¹ ; F ⁺ ions. 1s ² 2s ² 2p ⁴
		Incorrect as Al^{3+} has 1 outer shell electron vs F ⁺ 6 outer shell electron. 2nd IE of F is greater than the 3rd IE of Al as 3s electron is Al^{2+} is higher in energy and further away from the nucleus (hence lower nuclear attraction) then the 2p electron in F ⁺ .
		*B Incorrect as the 3 rd IE involves the removal of 3 rd electron from Al is from 3 rd principal quantum shell as compared to the removal of 3 rd electrons from the 2 nd PQM for the remaining 4 species.
		✓C Na ³⁺ 1s ² 2s ² 2p ⁴⁺ ∨s Ne ²⁺ 1s ² 2s ² 2p ⁴⁺
		Same no of electrons but as Na ³⁺ has more protons than Ne, hence higher nuclear charge, thus nuclear attraction of outermost electrons in Na ³⁺ is higher, thus higher 4 th IE for Na compared to 3 rd IE for Ne .
		* D Incorrect as the removal of electrons are removed from different PQM.
3		$\begin{array}{c} C \\ H \\ \times \\ \bullet \\ \bullet$
		Due to the no of bond pairs and lone pairs of electrons in each molecule –
		The shape of BC I_3 and PH ₃ are trigonal planar and trigonal pyramidal respectively
4	П	(1.2 and 3)
		 ✓1: Only id–id attraction can be formed between hydrocarbon molecules and H₂O molecules which is weaker than the hydrogen bonds between H₂O molecules. Hence, the energy released upon forming the less favourable interaction is not sufficient to compensate the energy required to break the stronger hydrogen bonds. Hence, hydrocarbon molecules are not solvated by water and hence the two layers are immiscible.
		✓2 : See (1).
		✓3: The stronger hydrogen bonds between H₂O molecules pulls the molecules closer to each other and hence, the volume of water is smaller. Given similar mass, the density of water is higher and hence, it will be below the hydrocarbon layer.

5	В	Under constant n and T,
		the ideal gas equation is simplified to $pV = k$ (where k is a constant and $k = nRT$).
		*A Rearranging $pV = k$ such that $y = \frac{1}{p}$ and $x = V$ (<i>i.e.</i> $\frac{1}{p} = k^{N}$), a graph of $y = mx$ is obtained (<i>i.e.</i> straight line passing through origin).
		✓B Since pV is a constant and $x = pV$, a graph of $x = c$ is obtained (<i>i.e.</i> vertical line)
		* C Rearranging pV = nRT such that y = p and x = ρ (<i>i.e.</i> p = $\frac{\rho RT}{M_r}$), a graph of y = mx is
		obtained (<i>i.e.</i> straight line passing through origin).
		* D Rearranging pV = nRT such that $y = \frac{pV}{T}$ and $x = p$ (<i>i.e.</i> $\frac{pV}{T} = nR = constant$), a
		graph of y = c is obtained (<i>i.e.</i> <u>horizontal line</u>)
6	С	Mol ratio of $O_2 = \frac{150}{500} = 0.3$
		Hence amt of $O_2 = 0.3 \times 1.2 = 0.36$ mol
		Amt of $N_2 = \frac{5.76}{24} = 0.24$ mol
		Hence amt of Ar = 1.2 - 0.36 - 0.24 = 0.6 mol
		Thus $p_{Ar} = \frac{0.6}{1.2} \times 500 = 250 \text{ kPa}$
7	А	1 only
		When aqueous ammonia is added to a solution containing hexaaquairon(III) ions, $[Fe(H_2O)_6]^{3+}$, a red-brown precipitate is formed.
		$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
		where NH ₃ is Brønsted-Lowry base where it accepts proton to release OH ⁻ which will then ppt with Fe ³⁺ to form red-brown ppt, Fe(OH) _{3.}
		Fe^{3+} + $3OH^- \rightarrow Fe(OH)_3$
		Ppt does not dissolve when excess ammonia is added, indicates that there is no further reaction or no ligand exchange to form a soluble complex.
8	А	$Cr_2O_7^{2-}$ + 14H ⁺ + 6e ⁻ \rightarrow 2Cr ³⁺ + 7H ₂ O
		$n(\mathbf{M}^{n+}) \text{ used} = 0.100 \times \frac{15.00}{1000} = 0.0015 \text{ mol}$
		$n(Cr_2O_7^{2-})$ used = $0.0250 \times \frac{20.00}{1000} = 0.0005$ mol
		ratio <u>Cr₂O₇²⁻ : e⁻ : M</u> ⁿ⁺
		$\begin{array}{cccc} 0.0005 & 6(0.0005) = 0.003 \\ & 0.003 & 0.0015 \\ & 2 & & 1 \end{array}$
		Hence, 1 Mⁿ⁺ loses 2 electrons and the oxidation state of M changes by 2 .

9	A	$C_{6}H_{12} + 9O_{2} \rightarrow 6CO_{2} + 6H_{2}O$ Since $6CO_{2} \equiv 6H_{2}O \equiv 1C_{6}H_{12}$, $n(CO_{2})$ formed = $n(H_{2}O)$ formed = x mol $\frac{M_{p}}{M_{Q}} = \frac{\text{mass of } H_{2}O}{\text{mass of } CO_{2}} = \frac{(x) \times 18.0}{(x) \times 44.0} = 0.41$
10	С	Energy absorbed by water = $250 \times 4.18 \times (100 - 12) \times 10^{-3}$
		Energy evolved by combustion of butane = 91.96 × $\frac{100}{47}$ = 195.6 kJ
		$195.6 = 2877 \times \frac{m(butane)}{58}$
		m(butane) = $3.944 \approx 3.94$ g
11	D	$H_2O(g) + C(s) \rightarrow H_2(g) + CO(g)$
		$\Delta S > 0$ as there is an increase in disorderliness from 1 to 2 mol of gas particles.
		$\Delta G = \Delta H - T \Delta S$ $-ve \underbrace{+ve}_{-ve}$ If $\Delta H < 0, \Delta G < 0$ at all temperatures.
		However, ΔG_1 becomes more negative as temperature increases; hence
		$\Delta G = \Delta H - T \Delta S$ +ve +ve -ve
		When temperature increases, $-T\Delta S$ becomes more negative.
		At high enough temperatures, $\Delta G < 0$ since $ -T\Delta S > \Delta H $.
		Reaction is spontaneous at high enough temperatures .when temperature increases
12	В	With the addition of another mole of gas, the area under the graph increases. When the temperature increased, the Maxwell Boltzmann graph peak will be shifted to the right.
13	А	Graph 1:
		The melting point increases from Na to A/ as the metallic bonding is stronger. Si has the highest melting point as it is a giant covalent lattice which requires the largest amount of energy to overcome the strong network of Si-Si bond. S_8 and P_4 are simple covalent molecule. As the number of electrons for S_8 increases, the id-id increases, hence, the melting point increases.
		Graph 2:
		Across the period, nuclear charge increases while the increase in shielding effect is insignificant as electrons are added to the same shell. The effective nuclear charge increases, hence, the 1 st ionisation energy increases. However, the first ionisation energy for A <i>I</i> is lower than expected because less energy is needed to remove the 3p electron which is further away from nucleus and experience additional shielding from 3s electrons.

14	А	1 only
		When a system is at a state of dynamic equilibrium,
		 the concentration of all reactants and products remains constant and an equilibrium mixture is obtained.
		 the rate of forward reaction = the rate of the backward reaction.
		• Equilibrium can only be achieved in a closed system , where there is no loss or gain of substances to and from the surroundings.
15	В	When [maltose] is very low as compared to [enyzme], many empty active sites of the enzyme molecules available for binding so the reaction is approximately <u>1st order w.r.t.</u> maltose.
		As [maltose] increases, more active sites of enzymes are occupied by maltose molecules so reaction is no longer 1st order w.r.t maltose
		At high enough [maltose], all active sites are occupied by maltose molecules (<i>i.e.</i> saturated) so any further increase in [CO ₂] will not increase the rate. Hence, the reaction becomes zero order w.r.t maltose.
16	А	$Ca(OH)_2 (s) \rightleftharpoons Ca^{2+} (aq) + 2OH^{-}(aq) \dots (1)$
		*A INCORRECT. When common ion Ca ²⁺ is added, [Ca ²⁺] increases, hence POE in (1) shifts to the left, [OH] decreases, hence pH increases
		✓B CORRECT. Increasing temperature increases solubility of solids
		✓C CORRECT. When Na₂O is added into the solution, NaOH is formed. When common ion OH is added, [OH] increases, hence POE in (1) shifts to the left, solubility of Ca(OH)₂ decreases.
		\checkmark D CORRECT. [OH ⁻]= 10 ^{-1.7} = 0.0200 mol dm ⁻³
		$[Ca^{2+}] = 0.0100 \text{ mol } dm^{-3}$
		Ksp = $[Ca^{2+}][OH^{-}]^2 = 0.01 \times 0.02^2 = 4 \times 10^{-6} \text{ mol}^3 \text{ dm}^{-9}$
17	D	$O_2 + 4H^+ + 4e \rightleftharpoons 2H_2O$ $E^e = +1.23V$
		$O_2 + 2H_2O + 4e \rightleftharpoons 4OH$ - $E^{\circ} = +0.40V$
		$Sn^{4+} + 2e \Rightarrow Sn^{2+}$ $E^{e} = +0.15V$
		$Co^{3+} + e \rightleftharpoons CO^{2+}$ $E^{e} = +1.89V$
		$MnO_{4}^{-} + 8H^{+} + 5e \rightleftharpoons Mn^{2+} + 4H_2O$ $E^{e} = +1.52V$
		$V^{3+} + e \rightleftharpoons V^{2+}$ $E^{e} = -0.26V$
		★A INCORRECT. Sn will not show any colour change even though there is a reaction between $2Sn^{2+} + O_2 + 4H^+ \rightarrow 2H_2O + 2Sn^{4+}$ ($E^{\circ}_{cell} = +1.08V > 0$) as Sn ions have no colour
		* B INCORRECT. $E^{\circ}_{cell} = +1.23 - 1.89 < 0$; not energetically feasible
		*C INCORRECT. No reaction as both will undergo reduction reactions.
		✓D CORRECT E°_{cell} = +1.23 – (-0.26) > 0; energetically feasible $4V^{2+} + O_2 + 4H^+ \rightarrow 2H_2O + V^{3+}$







