CHEM1901/1903 Example Multiple Choice Questions

The following multiple choice questions are provided to *illustrate* the type of questions used in this section of the paper and to provide you with extra practice.

It is *not* a sample quiz. The questions in the paper will be in the style of these questions but may well cover different topics.

In the exam, the answer should be indicated by clearly circling the letter next to the choice you make **and** by filling in the corresponding box on the computer-marked sheet provided. The marks for each correct answer are given beside each question.

Instructions for use of the computer sheet. Draw a **thick** line through the **centre** and crossing both edges of each box selected, as in this example.

Use a **dark** lead pencil so that you can use an eraser if you make an error. Errors made in ink cannot be corrected – you will need to ask the examination supervisor for another sheet. Boxes with faint or incomplete lines or not completed in the prescribed manner may not be read. Be sure to complete the SID and name sections of the sheet.

Your answer as recorded on the sheet will be used in the event of any ambiguity.

There is only one correct choice for each question.

Negative marks will not be awarded for any question.

		Marks
1.	Which one of the following sets of quantum numbers is valid?	1

	n	l	m_l	m_s
A	4	3	4	–½
B	3	1	0	+½
C	1	–1	1	+½
D	2	1	2	–½
E	2	3	–3	+½

2. How many protons (p), neutrons (n) and electrons (e) are present in the barium isotope $^{123}_{56}$Ba ? **1**

A	56 p	67 n	56 e
B	56 p	123 n	67 e
C	123 p	56 n	56 e
D	67 p	56 n	67 e
E	67 p	123 n	56 e

3. What is the ground state electronic configuration of the bromine atom? **1**

A $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{15}$

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^6$

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9\ 4p^6$

E $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^5$

4. ^{222}Rn is unstable and decays by emits two alpha and two beta particles. What is the final decay product? **1**

A ^{218}Bi

B ^{216}Bi

C ^{216}Pb

D ^{214}Po

E ^{212}Tl

		Marks
5.	For which one of the following species is it possible to solve the wave equation analytically and obtain an equation for its electronic energy levels? **A** He **B** Li^{2+} **C** H_2 **D** H^- **E** He^-	**1**
6.	Which of the following atoms has the highest first ionisation energy? **A** Rb **B** Na **C** K **D** Cs **E** Si	**1**
7.	Which of the following quantities is proportional to the electron density at a point? **A** the wavefunction **B** the square of the wave function **C** the de Broglie wavelength **D** the reciprocal of the de Broglie wavelength **E** the Rydberg constant	**1**
8.	How many valence electrons are there in the P^{3-} ion? **A** 3 **B** 5 **C** 8 **D** 15 **E** 18	**1**
9.	The ^{14}C activity of a sample of wood is 0.250 of a modern standard. What is the radiocarbon age of the sample (to 3 significant figures)? **A** 2780 years **B** 5570 years **C** 11,100 years **D** 16,100 years **E** 22,300 years	**1**

Marks

10. Which one of the following best describes a 3*p* orbital? **1**

A A function with 2 spherical nodes and 1 planar node.

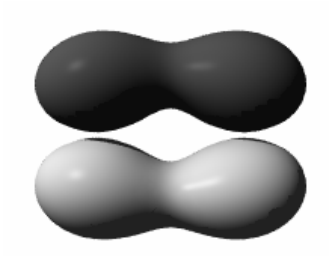
B A function with 1 spherical node and 0 planar nodes.

C A function with 2 spherical nodes and 2 planar nodes.

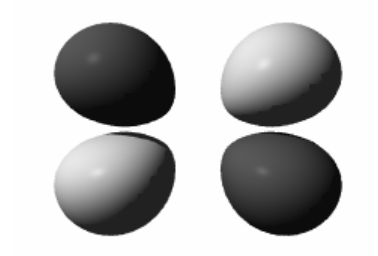
D A function with 1 spherical node and 1 planar node.

E A function with 0 spherical nodes and 1 planar node.

11. Which one of the following is a lobe representation for a σ bonding molecular orbital? **1**



A



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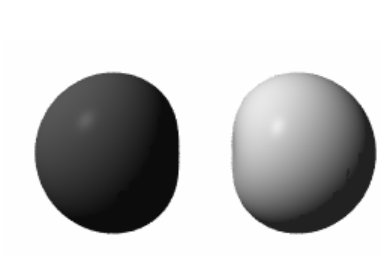

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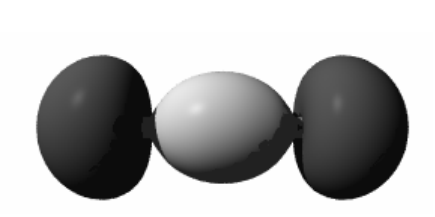

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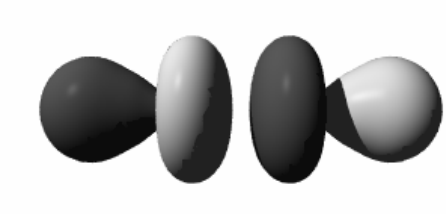
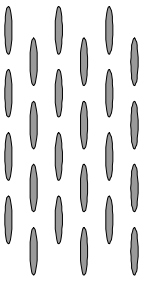
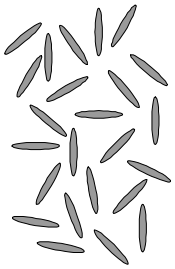


E

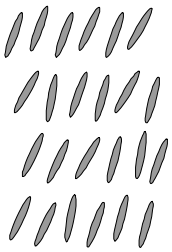
12. Which one of the following diagrams best represents a smectic A liquid crystal phase? (Each ellipse represents a molecule.) **1**



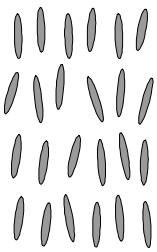
A



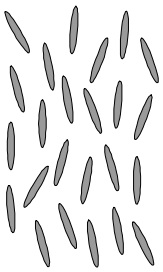
B



C

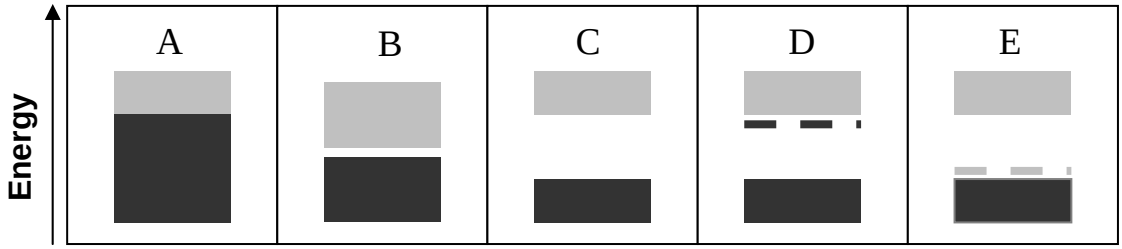


D

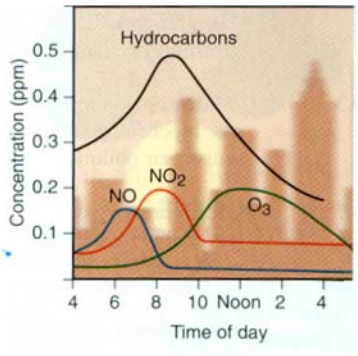


E

13. Which one of the following diagrams best represents an n-type semi-conductor? (Dark grey denotes filled electron energy levels, light grey denotes unfilled levels.) **1**



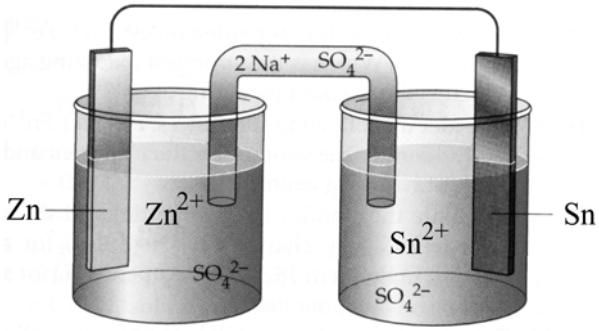
		Marks
14.	LiF and NaBr are ionic salts that both form a simple cubic lattice. The ionic radii of Li^+, F^-, Na^+ and Br^- are 0.76, 1.33, 1.02 and 1.96 Å respectively. Which one of the following statements is *true*? **A** The atomic radius of Na is smaller than 1.0 Å. **B** The atomic radius of F is larger than 1.4 Å. **C** Each Li^+ ion in LiF has 8 F^- ions as nearest neighbours. **D** The lattice energy of LiF is greater in magnitude than the lattice energy of NaBr. **E** The boiling point of NaBr is higher than the boiling point of LiF.	**1**
15.	How would the concentration of $Pb^{2+}(aq)$ ions in equilibrium with $PbI_2(s)$ be affected if the concentration of $I^-(aq)$ ions were doubled? **A** no change **B** increased by a factor of 2 **C** decreased by a factor of 2 **D** decreased by a factor of 4 **E** decreased by a factor of 16	**1**
16.	List the following "ideal" gases in order of increasing density at 25 °C and 1 atm. Cl_2 H_2 N_2 NO_2 O_2 **A** $H_2 < N_2 < O_2 < NO_2 < Cl_2$ **B** $Cl_2 < NO_2 < O_2 < N_2 < H_2$ **C** $H_2 < N_2 < O_2 < Cl_2 < NO_2$ **D** $NO_2 < Cl_2 < O_2 < N_2 < H_2$ **E** All ideal gases have the same density	**1**
17.	What is the oxidation number of the oxygen atoms in O_3? **A** – 3 **B** $-\,^1/_3$ **C** 0 **D** $+\,^1/_3$ **E** +3	**1**

		Marks
18.	Which type of rocket fuel is chosen for a space engine that needs to be turned on and off frequently? **A** solid fuel **B** hypergolic fuel **C** petroleum fuel **D** cryogenic fuel **E** any of the above	**1**
19.	Consider the idealised graph of various pollutants shown. Which one of the following statements concerning these species is *false*?  **A** NO and hydrocarbons are primary pollutants. **B** NO_2 and O_3 are secondary pollutants. **C** NO_2 decomposes to form NO via: $NO_2 + h\nu \rightarrow NO + O$ **D** When the concentrations of NO_2 and O_3 are very high, the nitrate radical, NO_3 can form, leading to acid rain. **E** The production of NO_2 and O_3 is considered to be bad for the atmosphere because they are both greenhouse gases.	**1**
20.	Consider the following reaction, for which the equilibrium constant, $K_c = 100$. $N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$ What is K_c for the reaction below? $NO_2(g) \rightleftharpoons O_2(g) + \frac{1}{2}N_2(g)$ **A** 0.0100 **B** 0.100 **C** 1.00 **D** 10.0 **E** 100	**1**

		Marks
21.	Which intermolecular force is most important in allowing Xe gas to liquefy? **A** dipole-dipole **B** hydrogen-bonding **C** ionic **D** instantaneous dipole-induced dipole **E** ion-dipole	**1**
22.	Which type of rocket fuel provides the best efficiency in terms of energy per mass of reactants. **A** solid fuel **B** hypergolic fuel **C** petroleum fuel **D** cryogenic fuel	**1**
23.	The reaction below has reached equilibrium. $Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Ag(s) + Fe^{3+}(aq) \qquad \Delta H < 0$ Which one of the following would cause precipitation of more silver? **A** warming **B** removing some of the solid silver **C** increasing the concentration of $Fe^{2+}(aq)$ ions **D** increasing the concentration of $Fe^{3+}(aq)$ ions **E** decreasing the concentration of $Fe^{2+}(aq)$ ions	**1**
24.	Consider the following information: $A + B \rightarrow C + D \qquad \Delta H° = -10.0$ kJ $C + D \rightarrow E \qquad \Delta H° = 15.0$ kJ Which one of the following reactions would have $\Delta H° = -10$ kJ? **A** $C + D \rightarrow A + B$ **B** $2C + 2D \rightarrow 2A + 2B$ **C** $A + B \rightarrow E$ **D** $\frac{1}{2}E \rightarrow \frac{1}{2}C + \frac{1}{2}D$ **E** $2E \rightarrow 2A + 2B$	**1**

		Marks
25.	The enthalpy change for which of the following processes represents the standard enthalpy of formation of AgCl? **A** $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ **B** $Ag(s) + Cl(g) \rightarrow AgCl(s)$ **C** $AgCl(s) \rightarrow Ag(s) + \frac{1}{2}Cl_2(g)$ **D** $Ag(s) + AuCl(s) \rightarrow Au(s) + AgCl(s)$ **E** $Ag(s) + \frac{1}{2}Cl_2(g) \rightarrow AgCl(s)$	**1**
26.	Consider the following reaction and its equilibrium constant. $A + 3B \rightleftharpoons 2C \qquad K = \frac{1}{[A][B]^3}$ What reaction conditions could give rise to the observed equilibrium expression? **A** A, B and C are in aqueous solution. **B** A, B and C are liquids. **C** A and B are liquids, C is a gas. **D** C is a gas, A and B are solids. **E** C is a solid, A and B are in aqueous solution.	**1**
Questions 27 and 28 relate to the smelting of iron from iron oxide. The overall reaction for this process is: $Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(l) + 3CO_2(g)$		
27.	What is the role of the CO(g) in this reaction? **A** A catalyst **B** An oxidant **C** A reductant **D** A fuel **E** A solvent	**1**
28.	What would happen to the equilibrium position if the total pressure were increased? **A** The reaction would move to the left. **B** The reaction would move to the right. **C** The equilibrium would not change. **D** Not sufficient information to decide.	**1**

29. The figure below shows a $Zn^{2+}|Zn$ and $Sn^{2+}|Sn$ voltaic cell. Relevant electrode potentials are on the separate data sheet. **Marks 2**



Which one of the following best describes the chemical operation of the cell?

A The Zn electrode is the cathode; Zn is being oxidised; electrons travel from right to left.

B The Zn electrode is the anode; Zn is being oxidised; electrons travel from left to right.

C The Sn electrode is the anode; Zn^{2+} is being reduced; electrons travel from left to right.

D The Sn electrode is the cathode; Sn is being oxidised; electrons travel from right to left.

E The Zn electrode is the anode; Sn^{2+} is being reduced; electrons travel from right to left.

30. Consider the following reaction. **1**

$$2Fe^{3+}(aq) + Sn^{2+}(aq) \rightleftharpoons 2Fe^{2+}(aq) + Sn^{4+}(aq)$$

Which one of the following is the correct expression for the Nernst equation for this reaction?

A $E = E^\circ - \frac{RT}{2F} \times 2.303 \log \frac{[Fe^{2+}]^2[Sn^{4+}]}{[Fe^{3+}]^2[Sn^{2+}]}$

B $E = E^\circ - \frac{RT}{2F} \times 2.303 \log \frac{[Fe^{3+}]^2[Sn^{2+}]}{[Fe^{2+}]^2[Sn^{4+}]}$

C $E = E^\circ - \frac{RT}{F} \times 2.303 \log \frac{[Fe^{2+}]^2[Sn^{4+}]}{[Fe^{3+}]^2[Sn^{2+}]}$

D $E = E^\circ - \frac{RT}{F} \times 2.303 \log \frac{[Fe^{3+}]^2[Sn^{2+}]}{[Fe^{2+}]^2[Sn^{4+}]}$

E $E = E^\circ - \frac{RT}{F} \times 2.303 \log \frac{[Fe^{2+}][Sn^{4+}]}{[Fe^{3+}][Sn^{2+}]}$

		Marks
31.	Why do lead-acid batteries maintain an approximately constant voltage?	1
	A They never run down.	
	B No aqueous species appear in the equation for the overall cell reaction.	
	C Their $E°$ values are very high.	
	D They are primary batteries.	
	E The concentrations of reagents in the half cell reactions remain approximately constant.	
32.	Which one of the following statements is correct?	1
	A In anodic inhibition, corrosion of a metal is minimised by forming an impermeable barrier at its surface.	
	B In cathodic protection, corrosion of a metal is minimised by forming a contact to another metal with a higher reduction potential.	
	C In fuel cells oxidation and reduction occur at the same electrode.	
	D Iron corrodes in oxygen-free water.	
	E Iron corrodes more rapidly in salty water because the electrochemical potential is higher.	
33.	Why do mercury batteries and silver batteries maintain a constant voltage?	1
	A They never run down.	
	B No aqueous species appear in the equation for the overall cell reaction.	
	C Their $E°$ values are very high.	
	D They are primary batteries.	
	E The concentrations of reagents in the half cell reactions remain approximately constant.	
34.	Using the relevant half cell reduction potentials calculate the standard electrode potential for the hydrogen fuel cell.	1
	A 0.83 V	
	B 1.77 V	
	C 0.68 V	
	D 2.07 V	
	E 1.23 V	

Questions 35 and 36 refer to the following reaction. **Marks**

$$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$$

35. What is the equilibrium constant expression, K_c, for this reaction? **1**

A $K_c = k[CO]^2[O_2]$

B $K_c = \dfrac{[CO]^2[O_2]}{[CO_2]}$

C $K_c = \dfrac{[CO_2]}{[CO][O_2]}$

D $K_c = \dfrac{[CO_2]^2}{[CO]^2[O_2]}$

E $K_c = \dfrac{[CO]^2[O_2]}{[CO_2]^2}$

36. Suppose the equation is rewritten as $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$ with an equilibrium constant K_c'. What is the relationship between K_c and K_c'? **1**

A $K_c' = K_c$ (*i.e.* no change)

B $K_c' = (K_c)^{\frac{1}{2}}$

C $K_c' = \frac{1}{2}(K_c)$

D $K_c' = (K_c)^2$

E $K_c' = (K_c)^{-1}$

37. The following reaction is at equilibrium. **1**

$$CF_2Br_2(g) \rightleftharpoons CF_2(g) + 2Br(g) \qquad \Delta H = 424 \text{ kJ mol}^{-1}$$

How will the system respond if the temperature is decreased?

A The reaction will shift to the **left**.

B The reaction will shift to the **right**.

C There will be **no change** to the equilibrium position.

38. The following reaction is at equilibrium. **1**

$$Cl_2(g) + 3F_2(g) \rightleftharpoons 2ClF_3(g)$$

How will the system respond if the volume is increased at constant temperature?

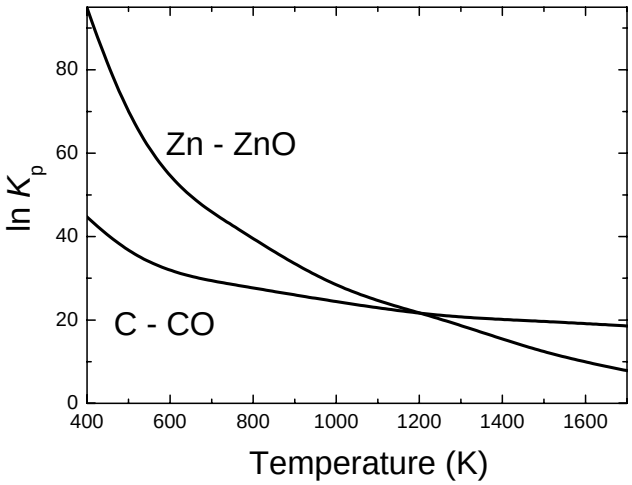
A The reaction will shift to the **left**.

B The reaction will shift to the **right**.

C There will be **no change** to the equilibrium position.

39. Consider the following Ellingham diagram, representing the temperature dependence of the following reactions. **Marks 1**

$Zn(s) + ½O_2(g) \rightleftharpoons ZnO(s)$ and $C(s) + ½O_2(g) \rightleftharpoons CO(g)$



Which one of the following statements is FALSE?

A At $T > 1200$ K, carbon will reduce ZnO(s) to Zn(s).

B At $T < 1200$ K, the reaction $ZnO(s) + C(s) \rightleftharpoons Zn(s) + CO(g)$ favours the reactants.

C At $T < 1200$ K, the reaction $C(s) + ½O_2(g) \rightleftharpoons CO(g)$ favours the reactants.

D The reaction $Zn(s) + ½O_2(g) \rightleftharpoons ZnO(s)$ favours the products at all temperatures shown.

E The reaction $C(s) + ½O_2(g) \rightleftharpoons CO(g)$ favours the products at all temperatures shown.

40. Which one of the following processes is endothermic? **1**

A When concentrated sulfuric acid is added to water, the water gets hot.

B Natural gas (CH_4) is burned in a Bunsen burner.

C Water is frozen in a freezer.

D Glucose is metabolised to warm the body.

E Water is boiled in a kettle.

Answers

Question	1	2	3	4	5	6	7	8	9	10
Answer	B	A	B	D	B	E	B	C	C	D

Question	11	12	13	14	15	16	17	18	19	20
Answer	D	D	D	D	D	A	C	B	E	B

Question	21	22	23	24	25	26	27	28	29	30
Answer	D	D	C	E	E	E	C	C	B	A

Question	31	32	33	34	35	36	37	38	39	40
Answer	E	A	B	E	D	B	A	A	C	E