CH106 December 2023

University of Strathclyde Science

Department of Pure and Applied Chemistry

CH106 Chemistry: Principles & Practice 1

**Answer each Multiple Choice Question on the
EDPAC sheet provided. See overleaf for instructions.**

Each of the 50 questions is worth 1 mark

Date: 7th December 2023   **Time: 10am**   **Duration: 2 hours**

Periodic Table of Elements

1 H 1																	2 He 4
3 Li 6.94	4 Be 9.01											5 B 10.8	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20.2
11 Na 23	12 Mg 24.3											13 Al 27	14 Si 28.1	15 P 31	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45	22 Ti 47.9	23 V 50.9	24 Cr 52	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 122	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197	80 Hg 200.6	81 Tl 204.4	82 Pb 207	83 Bi 209	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226	89 Ac# 227															

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173	71 Lu 175
90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Dr. Alan Kennedy (ARK):	Inorganic
Dr. Barry Moore (BM):	Physical
Dr. Donna Ramsay (DR):	Structure & Bonding
Dr. Patrick Thomson (PT):	Organic

Physical chemistry equations and constants found on last page of paper.

CH106 December 2023

Multiple Choice Examination Answer Sheet Guide

You have been issued with an "EDPAC" answer sheet, which must be filled out with your answers as follows:

1. **PRINT** your surname and initials as shown on the sample sheet below. Use black pen or pencil.

2. **MARK OFF YOUR SURNAME AND INITIALS**. If you have a hyphenated name, do not leave a space between names. If your name is too long, only fill in as many characters as fit on the sheet.

3. **MARK OFF YOUR REGISTRATION NUMBER IN THE CANDIDATE NUMBER BOX.**

4. **PRINT** the module code of CH106 in both **SUBJECT** boxes, and mark off the subject code.

5. Cross out the appropriate letters to indicate the answer to the question. **USE A THICK HORIZONTAL LINE.** You may use **BLACK INK** or an **HB PENCIL**. Ensure that you mark off the letter completely and accurately, including the brackets and no more.

6. Make as few changes to the EDPAC answer sheet as possible. It is best to write your answers on the examination paper until you are satisfied with them then transcribe them on to the special pink sheet.

7. If you must alter an answer in ink, use white tipp-ex. This can be requested from an invigilator.

8. **WRITE AN ANSWER FOR EVERY QUESTION**. There is no penalty for guessing incorrectly.

CANDIDATE NAME: **B L O G G S** INIT. **F D**

SUBJECT: **CH106**

Use HB Pencil to complete this form

1	A	B	C	D	E
2	A	B	C	D	E
3	A	B	C	D	E
4	A	B	C	D	E
5	A	B	C	D	E
6	A	B	C	D	E
7	A	B	C	D	E
8	A	B	C	D	E
9	A	B	C	D	E
10	A	B	C	D	E
31	A	B	C	D	E
32	A	B	C	D	E
33	A	B	C	D	E
34	A	B	C	D	E
35	A	B	C	D	E
36	A	B	C	D	E
37	A	B	C	D	E
38	A	B	C	D	E
39	A	B	C	D	E
40	A	B	C	D	E
61	A	B	C	D	E
62-70	A	B	C	D	E
91-100	A	B	C	D	E

DG (6) – Analytical (Written by PT)

1. If 10.0 mL of a 0.333 mol dm^{-3} solution of sulfuric acid is titrated with a 0.314 mol dm^{-3} solution of sodium hydroxide, what volume of sodium hydroxide is required to reach the equivalence point?

    (a)   5.3 mL
    (b)   10.6 mL
    (c)   21.2 mL
    (d)   22.1 mL
    (e)   42.4 mL

2. Silver nitrate is used as a primary standard for which of the following?

    a)   potassium permanganate
    b)   hydrochloric acid
    c)   silver nitrate
    d)   sodium chloride
    e)   sodium thiosulfate

3. What indicator could you use for a titration between hydrochloric acid and sodium hydroxide?

    (a)   phenolphthalein
    (b)   methyl orange
    (c)   potassium permanganate
    (d)   bromothymol blue
    (e)   potassium chromate

PLEASE TURN OVER

4. Balance the following redox half-equations and combine them to give the chemical equation. Which of the following values is the total of the stoichiometric coefficients (**a** to **h**) after cancelling common species? (Remember to count the coefficient if it is one.)

$$\textbf{a } Cr_2O_7^{2-} + \textbf{b } e^- + \textbf{c } H^+ \rightarrow \textbf{d } Cr^{3+} + \textbf{e } H_2O$$
$$\textbf{f } Pb^{2+} \rightarrow \textbf{g } Pb^{4+} + \textbf{h } e^-$$
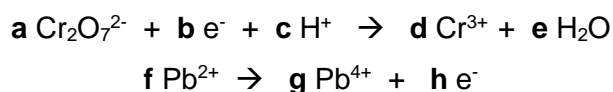
(a) 26
(b) 28
(c) 29
(d) 30
(e) 42

5. Which of the following is the correct half equation for the reaction of permanganate in basic solution?

(a) $MnO_4^- + 8 H^+ + 5 e^- \rightarrow Mn^{2+} + 4 H_2O$
(b) $MnO_4^- + e^- \rightarrow MnO_4^{2-}$
(c) $MnO_4^- + 8 H^+ + e^- \rightarrow Mn^{2+} + 4 H_2O$
(d) $MnO_4^- + 4 H^+ + 3 e^- \rightarrow MnO_2 + 2 H_2O$
(e) $MnO_4^- + 8 H^+ + 4 e^- \rightarrow Mn^{3+} + 4 H_2O$

6. A student collects the following set of titration data, where the true value of concentration is 0.100 mol dm^{-3}. Which statement best describes whether this data is precise and/or accurate?

0.92 mol dm^{-3}, 0.91 mol dm^{-3}, 0.93 mol dm^{-3}, 0.93 mol dm^{-3}

(a) The data is not precise, but it is accurate
(b) The data is precise, but not accurate
(c) The data is both precise and accurate
(d) The data is neither precise nor accurate
(e) It is impossible to tell from the given data

PLEASE TURN OVER

ARK (11) – Inorganic

7. Which of the following describes Ionisation Energy?
   (a) The change in energy on removing an electron from a positive ion in the gaseous state to form a neutral atom.
   (b) The change in energy on removing an electron from a neutral atom in the gaseous state to form a positive ion.
   (c) The change in energy on adding an electron to a positive ion in the gaseous state to form a neutral atom.
   (d) The change in energy on adding an electron to a negative ion in the gaseous state to form a cation.
   (e) The change in energy on adding an electron to a neutral atom in the gaseous state to form a negative ion.

8. From trends in the periodic table, which of the following statements is true?
   (a) Mg has a larger atomic radius than Na, and Mg is more electronegative than Na.
   (b) Mg has a larger atomic radius than Ca, and Mg is less electronegative than Ca.
   (c) Mg has a larger atomic radius than Na, and Mg is less electronegative than Si.
   (d) K has a larger atomic radius than Na, and K is more electronegative than Na.
   (e) Mg has a smaller atomic radius than Na, and K is less electronegative than Na.

9. Which one of the following statements is **INCORRECT**?
   (a) As you move down group 1 from Li to Cs, the ionisation energy decreases.
   (b) Hydrogen and helium are the most abundant elements in the universe.
   (c) KF is an ionic solid.
   (d) Atomic radii decreases across the periodic table from left to right (e.g. from Na to Cl).
   (e) Effective nuclear charge decreases across the periodic table from left to right (e.g. from Na to Cl).

PLEASE TURN OVER

10. What are the oxidation states of Ca, Se and O in $CaSeO_4$?

    (a) +1, -1, -4

    (b) +2, +6, -2

    (c) +2, +4, -8

    (d) +2, +6, +2

    (e) +2, +2, -2

11. Which of the following contains an element in the +3 oxidation state?

    (a) PCl_3O

    (b) Li_3N

    (c) Ga_2O_3

    (d) H_2SO_4

    (e) HNO_3

12. Which of the following is **NOT** normally an ion with a stable oxidation state ?

    (a) Al +3

    (b) S +2

    (c) K +1

    (d) Br -1

    (e) Se -2

13. What shape does Valence Shell Electron Pair Repulsion (VSEPR) theory predict for

    the anion ClO_4^- ?

    (a) tetrahedral

    (b) square planar

    (c) disphenoidal (see-saw shaped)

    (d) square pyramid

    (e) bent

PLEASE TURN OVER

14. Which species does VSEPR theory predict will have 2 lone pairs of electrons on the central atom?

    (a) NH_4^+

    (b) OH_3^+

    (c) NF_3

    (d) PH_3

    (e) XeF_4

15. Which species is **NOT** a correct prediction according to VSEPR theory ?

    (a) CH_4 is tetrahedral.

    (b) SiH_4 is tetrahedral.

    (c) NH_3 is trigonal pyramidal.

    (d) BH_3 is trigonal pyramidal.

    (e) SbH_3 is trigonal pyramidal.

16. Which of the following statements is **TRUE** ?

    (a) In $NaMnO_4$, the oxidation state of Mn is +7.

    (b) Na_2O is a covalent compound.

    (c) In H_3PO_4, the oxidation state of P is +3.

    (d) PF_5 has a square pyramidal shape.

    (e) The elements B, Al, Si and Tl are all semi-metals.

17. Which of the following statements is **TRUE** ?

    (a) A Lewis base is an electron acceptor.

    (b) A Bronsted base is an electron acceptor.

    (c) Alcohols (ROH) are stronger hydrogen bond donors than thiols (RSH).

    (d) In the periodic table, the diagonal relationship between Be and Si means that they have similar characteristics.

    (e) Butyl lithium is more reactive than butyl potassium.

PLEASE TURN OVER

BM (11) – Physical

18.   The following reaction has reached chemical equilibrium at 900 K.

SnO_2 (s) + 2 H_2 (g) $\rightleftharpoons$ Sn (l) + 2 H_2O (g)
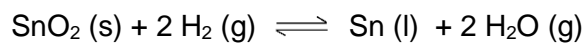
Which of the following is the correct expression to calculate K for this reaction?

(a) $\dfrac{[Sn].[H_2O]^2}{[SnO_2].[H_2]^2}$

(b) $\dfrac{[Sn].[H_2O]^2}{[H_2]^2}$

(c) $\dfrac{[H_2O]^2}{[H_2]^2}$

(d) $\dfrac{[H_2O]}{[H_2]}$

(e) $\dfrac{1}{[H_2]^2}$

PLEASE TURN OVER

19. In the following reaction sequence, the nitric oxide produced in reaction 1 reacts further to produce nitrogen dioxide in reaction 2 which may associate to N_2O_4 by reaction 3. What is the equilibrium constant for the overall reaction 4?

    1: $4 NH_3 (g) + 5 O_2 (g) \rightleftharpoons 4 NO (g) + 6 H_2O (g)$ K_1

    2: $2 NO (g) + O_2 (g) \rightleftharpoons 2 NO_2 (g)$ K_2

    3: $N_2O_4 (g) \rightleftharpoons 2 NO_2 (g)$ K_3

    4: $4 NH_3 (g) + 7 O_2 (g) \rightleftharpoons 2 N_2O_4 (g) + 6H_2O (g)$ K_4
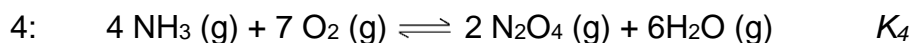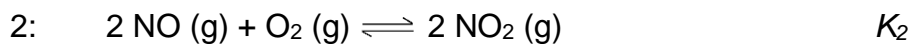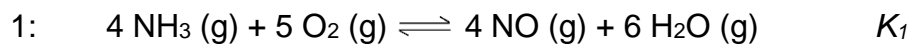
    (a) $K_4 = K_1 \times K_2 / K_3$

    (b) $K_4 = K_1 \times K_2^2 / K_3^2$

    (c) $K_4 = K_1 \times K_2 \times K_3$

    (d) $K_4 = K_1 \times K_2^2 / K_3$

    (e) $K_4 = K_1 \times K_2^2 \times K_3^2$

20. The reaction

    $$2 SO_2 (g) + O_2 (g) \rightleftharpoons 2 SO_3 (g)$$
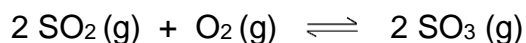
    has an equilibrium constant of 30 at 900 K. An equilibrium mixture is sampled and found to contain $[SO_3] = 0.078$ mol dm^{-3} and $[O_2] = 0.045$ mol dm^{-3}. What is $[SO_2]$?

    (a) 0.0045 mol dm^{-3}
    (b) 0.058 mol dm^{-3}
    (c) 0.090 mol dm^{-3}
    (d) 0.078 mol dm^{-3}
    (e) 0.067 mol dm^{-3}

PLEASE TURN OVER

21. Gaseous chlorine and bromine (0.300 mol each) are mixed in a 3.00 dm³ container and the following reaction allowed to come to equilibrium:

$$Br_2 \text{ (g)} + Cl_2 \text{ (g)} \rightleftharpoons 2\text{ BrCl (g)} \qquad K = 3$$
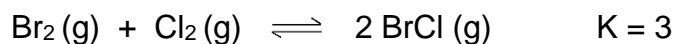
The following ICE table was prepared:

	Cl_2	Br_2	BrCl
Initial	0.1	0.1	0
Change	–x	–x	+2x
Equilibrium	0.1 – x	0.1 – x	2x

These values were substituted into an expression for the equilibrium constant. What will be the equilibrium concentration of BrCl?

(a) 0.0928 mol dm⁻³

(b) 0.0234 mol dm⁻

(c) 0.0634 mol dm⁻³

(d) 0.0195 mol dm⁻³

(e) 0.173 mol dm⁻³

PLEASE TURN OVER

22. Consider the following reactions at equilibrium and determine which of the indicated changes will cause the reaction to proceed to the left.

 (i) $CO(g) + 3 H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ (remove CO)

 (ii) $CO_2(g) + C(s) \rightleftharpoons 2 CO(g)$ (add CO_2)

 (iii) $N_2(g) + 3 H_2(g) \rightleftharpoons 2 NH_3(g)$ (add nitrogen)

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

 (v) $CO(g) + 2 H_2(g) \rightleftharpoons CH_3OH(g)$ (add methanol)
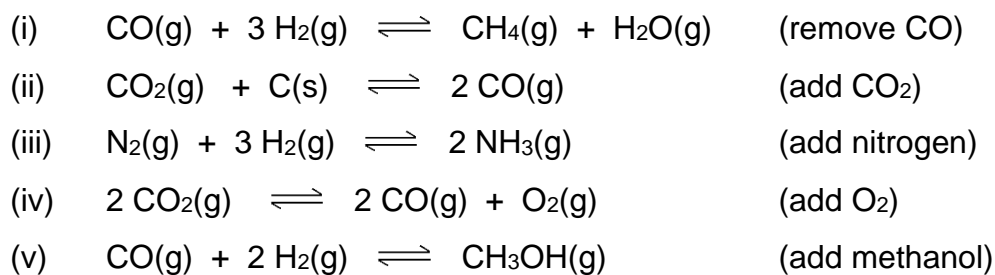
 (a) i, ii and v

 (b) iii and iv

 (c) ii, iii and v

 (d) i, iv and v

 (e) ii and v

23. For the exothermic reaction:

 $$4 HCl(g) + O_2(g) \rightleftharpoons 2 H_2O(g) + 2 Cl_2(g)$$
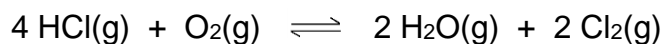
 which of the following conditions will shift the equilibrium to the left?

 (a) increasing the temperature

 (b) adding more oxygen

 (c) adding a catalyst

 (d) increasing the pressure

 (e) removing chlorine

PLEASE TURN OVER

24. The pK_a values of five substances are given below. Which of these will give the highest pH value when dissolved in water at a concentration of 0.01 M?

    a) benzoic acid, pK_a = 4.19
    b) 2,4-dinitrophenol, pK_a = 3.96
    c) hypobromous acid, pK_a = 8.69
    d) hypochlorous acid, pK_a = 7.53
    e) hydrocyanic acid, pK_a = 9.31

25. In the reaction

    $$H_2PO_4^- + NH_2.CH_2.CH_2.NH_3^+ \rightleftharpoons HPO_4^{2-} + NH_3^+.CH_2.CH_2.NH_3^+$$
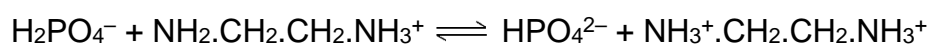
    which two species are acting as bases?

    (a) HPO_4^{2-} and $H_2PO_4^-$
    (b) HPO_4^{2-} and $NH_3^+.CH_2.CH_2.NH_3^+$
    (c) HPO_4^{2-} and $NH_2.CH_2.CH_2.NH_3^+$
    (d) $H_2PO_4^-$ and $NH_3^+.CH_2.CH_2.NH_3^+$
    (e) $NH_3^+.CH_2.CH_2.NH_3^+$ and $NH_2.CH_2.CH_2.NH_3^+$

26. Here are some chemical species that might be present in a buffer solution. Which of them are essential if the buffer is to control pH?

    1. A strong acid able to produce H^+
    2. A weak acid or conjugate acid able to produce H^+
    3. A strong base able to produce OH^-
    4. A weak base or conjugate base able to produce OH^-

    a) 1 and 2
    b) 1 and 3
    c) 2 and 4
    d) 3 and 4
    e) All of them

PLEASE TURN OVER

27. For which of the following is the enthalpy of formation NOT zero?

    a) C (s)
    b) N_2 (g)
    c) H_2 (g)
    d) Na (s)
    e) ZnO (s)

28. The reaction

    $$H_2 (g) + CuO (s) \rightleftharpoons H_2O (g) + Cu (s)$$
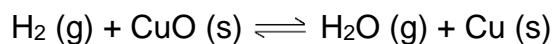
    has a ΔH^o value of −86 kJ mol^{-1}. The standard enthalpy of formation of CuO (s) is known to be −155.8 kJ mol^{-1}. What is the enthalpy of formation of H_2O (g)?

    a) −327.8 kJ mol^{-1}
    b) −241.8 kJ mol^{-1}
    c) +86 kJ mol^{-1}
    d) +155.8 kJ mol^{-1}
    e) +327.8 kJ mol^{-1}

PLEASE TURN OVER

DR (11) – Structure & Bonding

29.   Which one of the following statements about Rutherford's model of the atom is **CORRECT**?

(a)   The electrons emit radiation as they orbit the nucleus.

(b)   The electron orbits are described by quantum numbers.

(c)   The protons are in the nucleus whilst the neutrons and electrons occupy the remaining space.

(d)   The mass is highly concentrated at the centre of the atom.

(e)   The particles are evenly distributed in a plum pudding model.

30.   Which of the following states Hund's Rule?

(a)   A subatomic particle has a wavelength that is related to its mass.

(b)   Electrons are added to an atom starting with the lowest orbital first.

(c)   An electron can have either particle character or wave character.

(d)   Both the position of an electron and its momentum cannot simultaneously be known very accurately.

(e)   Electrons will occupy different degenerate orbitals and have parallel spins if allowed by the exclusion principle.

31.   Which of the following statements about the quantum numbers in a hydrogen atom is **INCORRECT**?

(a) n has integer values from 1 upwards

(b) ℓ has values from zero up to n

(c) m has values of $+\ell$ to $-\ell$ including zero

(d) m has $2\ell + 1$ possible values

(e) s has the values of $+\frac{1}{2}$ and $-\frac{1}{2}$

PLEASE TURN OVER

32. Which of the following statements about angular functions and quantum numbers is **CORRECT**?

    (a)   If $n = 2$ and $m_l = 0$, l must be 1
    (b)   The combination $n = 4$, $l = 4$, $m_l = -2$, $m_s = -1/2$ is not permitted.
    (c)   If $n = 3$, there are five d orbitals: two of them lie between the axes (x, y, z), and the other three are directed along the axes.
    (d)   The quantum numbers n and m_l define the shape of atomic orbitals.
    (e)   The s angular function is a dumbbell shape centred on the nucleus.

33. Select a valid combination of sets of quantum numbers for the two 3p electrons of Si.

    (a) $n = 3$, $l = 0$, $m_l = 0$, $m_s = +1/2$
            $n = 3$, $l = 0$, $m_l = 0$, $m_s = -1/2$
    (b) $n = 2$, $l = 1$, $m_l = +1$, $m_s = -1/2$
            $n = 2$, $l = 1$, $m_l = 0$, $m_s = -1/2$
    (c) $n = 3$, $l = 1$, $m_l = -1$, $m_s = +1/2$
            $n = 3$, $l = 1$, $m_l = +1$, $m_s = +1/2$
    (d) $n = 3$, $l = 1$, $m_l = +1$, $m_s = +1/2$
            $n = 3$, $l = 1$, $m_l = 0$, $m_s = -1/2$
    (e) $n = 3$, $l = 1$, $m_l = 0$, $m_s = -1/2$
            $n = 3$, $l = 0$, $m_l = +1$, $m_s = -1/2$

34. Which of the following ground state electronic structures is **CORRECT**?

    (a)   B (Z = 5) $1s^2\ 2s^2\ 3p^1$
    (b)   P (Z = 15) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2\ 3d^1$
    (c)   Ca (Z = 20) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$
    (d)   Cu (Z = 29) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$
    (e)   Ga (Z = 31) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9\ 4p^2$

PLEASE TURN OVER

35. Which one of the following statements regarding the periodic table is **INCORRECT**?

    (a) The ionisation energy of an element generally decreases as we progress from left to right along the rows of the periodic table.

    (b) The electronegativity of an element generally increases as we progress from left to right along the rows of the periodic table.

    (c) The main group elements are those present in the columns where the outer s and p orbitals are being filled.

    (d) The elements are arranged in order of increasing atomic number.

    (e) The elements in each column have the same outer electronic configuration.

36. The valence bond description states that sp^2 hybridisation is found in which one of the following?

    (a) NH_3

    (b) SF_6

    (c) H_2S

    (d) BeH_2

    (e) C_6H_6

37. The valence bond description of the hybridisation of the atomic orbitals of C present in the ground state of C_2H_2 is which one of the following?

    (a) one sp hybrid orbital and three p orbitals

    (b) two sp hybrid orbitals and two p orbitals

    (c) two sp^2 hybrid orbitals and two p orbitals

    (d) three sp^2 hybrid orbitals and one p orbital

    (e) four sp^3 hybrid orbitals

PLEASE TURN OVER

38. Which of the following statements concerning the molecular orbital approach to bonding is **INCORRECT**?

    (a) A bond is always formed by a pair of electrons.
    (b) The atomic orbitals interact to form bonding and antibonding orbitals.
    (c) Atomic orbitals that are in-phase form a bonding molecular orbital.
    (d) The bonding and antibonding orbitals are delocalised over the whole molecule.
    (e) Completely new molecular orbitals of different shapes are formed from the atomic orbitals.

39. The molecular orbital energy diagram of N_2 shows that N_2 has which one of the following?

    (a) 2 bonding $2p\pi$ electrons
    (b) 2 antibonding $2p\sigma^*$ electrons
    (c) 3 unpaired electrons in $2p\pi$ and $2p\sigma$ orbitals
    (d) 3 unpaired electrons in $2p\pi^*$ and $2p\sigma^*$ orbitals
    (e) no unpaired electrons in $2p\pi^*$ and $2p\sigma^*$ orbitals

PT (11) – Organic Chemistry

40. How many hydrogen atoms are in the formula of the molecule shown below?
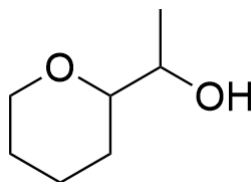
    (a) 11
    (b) 12
    (c) 13
    (d) 14
    (e) 15

PLEASE TURN OVER

41. How many stereogenic (chiral) centres are in the same molecule?
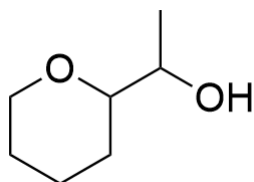
(a)   0

(b)   1

(c)   2

(d)   3

(e)   4

PLEASE TURN OVER

42. Which one of the following expanded (line) formula corresponds to the structure shown below?

(a)

(b)

(c)

(d)

(e)
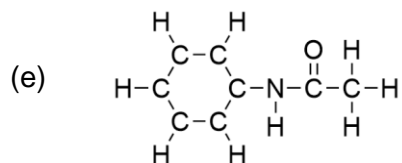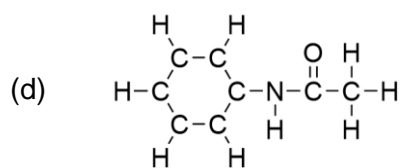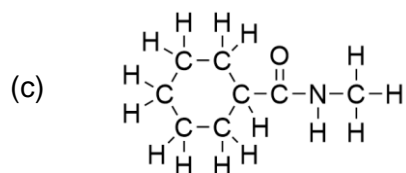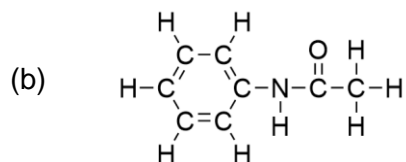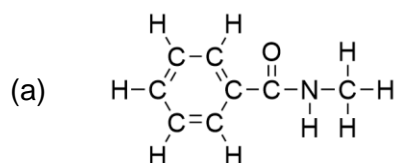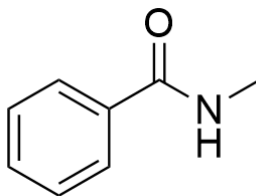
PLEASE TURN OVER

43. Assign the absolute configuration of the two stereogenic centres indicated below. This question only has four options.

stereogenic
centre 1

stereogenic
centre 2
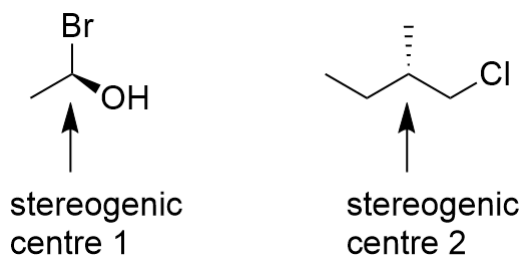
 (a) Stereogenic centre 1 = (*R*), stereogenic centre 2 = (*R*)
 (b) Stereogenic centre 1 = (*R*), stereogenic centre 2 = (*S*)
 (c) Stereogenic centre 1 = (*S*), stereogenic centre 2 = (*R*)
 (d) Stereogenic centre 1 = (*S*), stereogenic centre 2 = (*S*)

44. Which of the options best corresponds to the name of the compound shown below?
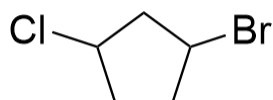
 (a) 1-bromo-3-chlorocyclopentane
 (b) 1-chloro-3-bromocyclopentane
 (c) 3-chloro-1-bromocyclopentane
 (d) 3-bromo-1-chlorocyclopentane
 (e) 2-bromo-5-chlorocyclopentane

PLEASE TURN OVER

45.   Which of the following molecules is the strongest acid?

(a)

(b)

(c)

(d)

(e)
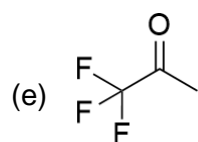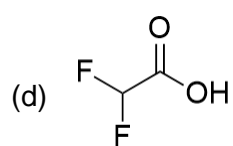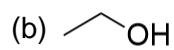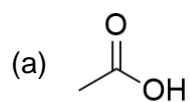
PLEASE TURN OVER

46.   Which statement best describes the mechanism shown below?
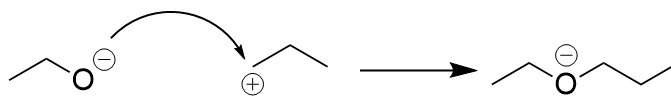
(a)   The mechanism is drawn correctly.

(b)   The mechanism is drawn incorrectly, because the atom at the **source** of the curly arrow has **lost too many** electrons.

(c)   The mechanism is drawn incorrectly, because the atom at the **source** of the curly arrow has **not lost enough** electrons.

(d)   The mechanism is drawn incorrectly, because the atom at the **destination** of the curly arrow has **gained too many** electrons.

(e)   The mechanism is drawn incorrectly, because the atom at the **destination** of the curly arrow has **gained too few** electrons.

47.   Which of the following statements best describes the most likely mechanism of the following reaction scheme? This question only has four options.
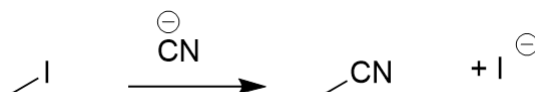
a)   The reaction definitely only proceeds by an S_N1 mechanism

b)   The reaction definitely only proceeds by an S_N2 mechanism

c)   The reaction could proceed either by an S_N1 or an S_N2 mechanism

d)   The reaction could not proceed by either S_N1 or an S_N2 mechanism
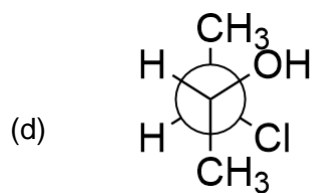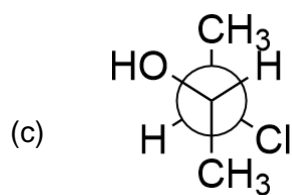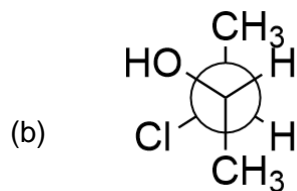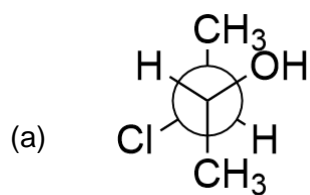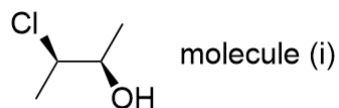
PLEASE TURN OVER

48.   Which one of the following molecules would be the expected final product of the reaction scheme shown?

(a)   Br⌀⤵

(b)   ⤵ Br

(c)   Br⌀⤵ Br

(d)   ⤵ Br

(e)   ⤵ Br
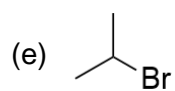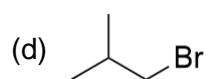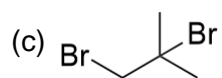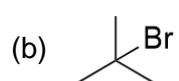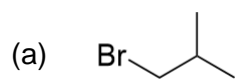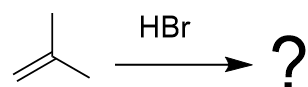
PLEASE TURN OVER

49.   Which of the below options is the same stereoisomer as molecule (i), when viewed from a different angle and with 0 or more bonds rotated? This question only has four options.
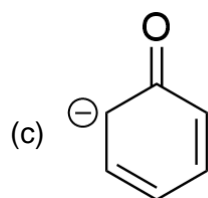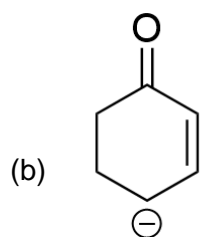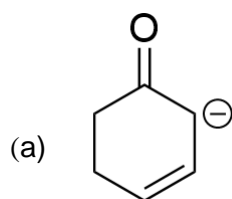

molecule (i)

(a)

(b)

(c)

(d)

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50.   Molecule (ii) has several valid resonance forms. Which one of the molecules shown below, if any, is **<u>NOT</u>** a valid resonance form of molecule (ii)? This question only has four options.

molecule (ii)

(a)

(b)

(c)
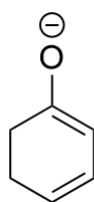
(d)   All three of the other options shown are valid resonance forms.

PLEASE TURN OVER

Appendix: Physical Chemistry Formulae

Kinetic Energy (KE) = ½ $m\,v^2$ Potential Energy (PE) = $m\,g\,h$

$P\,V\ =\ n\,R\,T$ $P_2 - P_1 = \rho\,g\,h$

$$y_A = \frac{P_A}{P_{total}} = \frac{x_A P_A^o}{x_B\left(P_B^o - P_A^o\right) + P_A^o}$$ $$\sqrt{\overline{u^2}} = \sqrt{\frac{3RT}{MW}}$$

$(P + n^2 a/V^2)(V - nb)\ =\ nRT$ $V_{STP}\ =\ \alpha_T P$

$P_A\ =\ P_A^o\ x_A$ $P_A\ =\ K\,x_A$

$\Delta T\ =\ K_{1000}$ x $1000/m_A$ x m_B/MW_B $w\ =\ -\,P\,dV$

$\Pi = (n/V)\,RT\ =\ A_1 c\ +\ A_2 c^2\ +\ A_3 c^3\ +\ \ .....$

$\Delta U\ =\ w\ +\ q$ $\Delta H\ =\ \Delta U\ +\ \Delta(PV)$

$\Delta S\ =\ q/T$ $\Delta G\ =\ \Delta H\ -\ T\Delta S$

$dG/d\xi\ =\ 0$ Rate = $1/A$ $(d[X]/dt)$

$\ln\{a/(a\text{-}x)\} = kt$ $k\ =\ A\,e^{-(Ea/RT)}$

_____

End of Appendix