2026 6092 Sec 4 Pure Chemistry Prelim P1 Answers

1	2	3	4	5	6	7	8	9	10
D	**C**	**C**	**A**	**C**	**C**	**B**	**C**	**D**	**D**
11	12	13	14	15	16	17	18	19	20
D	**C**	**D**	**C**	**C**	**B**	**C**	**B**	**C**	**C**
21	22	23	24	25	26	27	28	29	30
B	**D**	**D**	**C**	**C**	**D**	**A**	**D**	**B**	**D**
31	32	33	34	35	36	37	38	39	40
A	**C**	**C**	**C**	**A**	**B**	**C**	**C**	**A**	**B**

2026 6092 Sec 4 Pure Chemistry Prelim P2 Answers

1 **(a)** Al^{3+}

(b) H^-

(c) H^+ and CO_3^{2-}

(d) Ag^+ and I^-

(e) Ca^{2+} and OH^-

[1] each total [5]

2 **(a)** Similarities: Both diamond and graphene

(1) have giant covalent structures (R: that extends 3-dimensionally since graphene has 2-dimensional structure)
(2) have **large number** of carbon atoms held together by covalent bonds.

Differences:
(1) Atoms in diamond are arranged in a rigid, tetrahedral 3-dimensional structure but graphene is made up of a single layer of atoms arranged in hexagonal rings in a 2-dimensional structure.
Accept: 3-dim vs 2-dim or tetrahedral arrangement of atoms that extends throughout structure vs a single layer of carbon atoms arranged in hexagonal rings)

(2) In diamond, each carbon atom is covalently bonded to four other carbon atoms. In graphene, each carbon atom is bonded to three other carbon atoms.

(3) In diamond, each carbon atom uses all four valence electrons in bonding but in graphene, each carbon atom uses three valence electrons for bonding, leaving one free/delocalised electron per atom.

3 points [1] each, max [3]

(b) A large number of strong covalent bonds exist between atoms in a layer of graphene and throughout diamond. A lot of energy is required to overcome these bonds hence inability to dissolve in water. [1]
Carbon dioxide has simple molecular structure. Weak intermolecular forces between molecules are easily overcome as it forms attractive forces with water molecules. [1]
Partial ionisation of molecules as they dissolve in water to form low concentration of hydrogen ions, hence the acidic solution. [1]

3 points [1] each, max [3] [Total: 6]

3 **(a)** Potassium sulfate and water are formed at neutralisation. Potassium sulfate is a soluble salt and dissolves in water forming mobile ions which can move to carry charges. [1]

Barium sulfate is an insoluble solid with ions held in fixed positions in the ionic crystal lattice and water exists as neutral molecules hence no mobile charge carriers to conduct electricity. [1]

(b) At both cathodes, 4 moles of hydrogen ions, the only positive ions present, are discharged, forming 2 moles of hydrogen gas. [1]

$4H^+(aq) + 4e^- \rightarrow 2H_2(g)$

At both anodes, 4 moles of hydroxide ions are preferentially discharged instead of chloride or sulfate ions, forming 1 mole of oxygen gas. [1]

$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$

Mole ratio of gases is directly proportional to volume ratio, hence 2:1 ratio for hydrogen at cathode and oxygen at anode

[Total: 4]

4 (a) precipitation [1]

(b) Same number of moles of each salt formed but the mass of lead(II) chloride is smaller because of its lower relative molecular mass. [1]

(c) (i) Excess aqueous lead(II) nitrate (excess reactant) present contaminates the solution of potassium nitrate. [1]

(ii) Titration using aqueous potassium hydroxide/carbonate and dilute nitric acid. [1]

[Total: 4]

5 (a) (i) 90 cm^3

(ii) 0 cm^3

(iii) 45 cm^3 [1] each

(b) The volume of hydrogen formed decreases as the volume of copper(II) sulfate added increases. [1]

As more copper(II) sulfate is available, more zinc will react with it to displace copper hence, there will be less zinc present for reaction with acid to form hydrogen. [1]

(c) Increasing the temperature of the acid (warm up the acid)./ Using the same mass of finely powdered zinc./ Increasing the concentration of acid used.

any 2 [1] each.

(d) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

No. of mol, H_2 gas = 180/24000 = 0.0075 mol [1]

H_2 : Zn

1 mol : 1 mol

No of mol, Zn = 0.0075 mol

Mass of Zn = 0.0075 x 65 g

= 0.4875 g = 0.488 g (3 sf) [1]

[Total: 9]

6 (a) Copper is more reactive than silver/loses electrons more readily forming copper(II) ions [1] which dissolve into the electrolyte, causing a decrease in mass. [1]

(b) No. of mol of Cu that dissolved

= 0.5/64 = 0.007813 mol [1]

$Cu \rightarrow Cu^{2+} + 2e^-$

No of mol e- transferred in reaction

= 2 x 0.007813 mol [1] OR give ratio comparison of electrons at each electrode

$2Ag^+ + 2e- \rightarrow 2Ag$

No. of mol Ag formed

= 2 x 0.007813 x 108 = 1.69 g (3sf)

New mass of Ag electrode

= 5.0 + 1.69 = 6.69 g [1]

(c) The blue copper(II) sulfate solution becomes more blue/ darkens. [1]

[Total: 6]

7 **(a)** The energy released in the forming of 16 C=O bonds (in carbon dioxide) and 20 O-H (in water) bonds is greater than [1] the energy absorbed in the breaking of 6 C-C, 20 C-H (in butane) and 13 O=O bonds (in oxygen)[1]

b **(i)** No of mol butane = 3.65/ 4(12) + 10(1)

= 3.65/58 = 0.06293 mol [1]

0.06293 mol butane releases 160 kJ heat

1 mol butane releases 160 kJ/ 0.06293

= 2540 kJ (3sf) or 2542.5 kJ heat

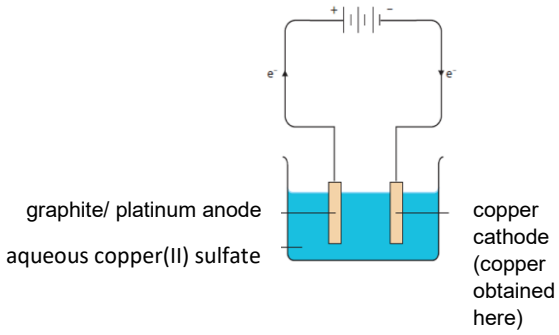
ΔH = -2540 kJ/mol or -2543 kJ/mol [1] must have negative sign

(ii) There could be heat loss to the surroundings hence less heat available to heat up the water. [1]
The combustion of butane could be incomplete or the butane gas could escape before it is combusted. [1]

[Total: 6]

8 **(a)** **(i)** $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$ [1]

(ii) .



[1] correct labels (R – copper anode)
[1] copper cathode connected to negative terminal of battery

(b) **(i)**

Cl_2 (g) + 2Br-(aq) → Br_2(aq) + 2Cl^- (aq) [1]
Colourless seawater turned reddish brown/orange. [1]

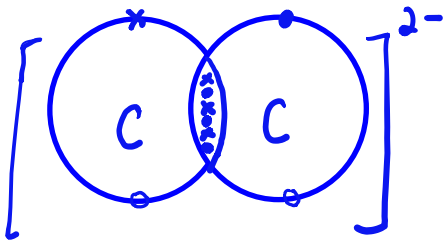
(ii) The concentration of bromide ions in seawater is low and would have to be concentrated before bromide ions can be discharged preferentially over hydroxide ions. [1]

(c) **(i)** Iron loses electrons forming iron(II) ions hence is oxidized. [1]
Copper(II) ions gain electrons to form copper hence reduced. [1]

(ii) Chlorine is the oxidising agent [1] as it oxidises bromide ions causing them to increase in oxidation state from -1 in bromide ions to 0 as bromine molecules are formed. [1]

[Total: 10]

9 **(a)**



[1] for correct sharing and total number of e
[1] for correct charge and gain of 2 e
accept either paired or lone electrons in shell

(b) Aluminium is more reactive than carbon/ Carbon is less reactive than aluminium hence carbon is unable to displace aluminium from aluminium oxide.[1]

(c) **(i)** $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$ [1]

(ii) Similarity: Both reactions result in formation of calcium hydroxide. [1]
Difference: Hydrogen gas is produced when calcium reacts with water but acetylene or ethyne is produced for calcium carbide. [1]

(d) Carbon monoxide.[1]

(e) **(i)** C_4H_6 [1]

(ii) It has a carbon to carbon triple bond/ C≡C hence can have more atoms added into the molecule. [1]

(f) **(i)** A much lower temperature would mean less fuel needed hence saving resources/ lower fuel cost hence saving costs.

(ii) $2O^{2-}(l) \rightarrow O_2(g) + 4e^-$ [1]
or $6O^{2-}(l) \rightarrow 3O_2(g) + 12e^-$ [1]

(iii) At high temperatures, the hot oxygen produced at the anode reacts with the carbon anodes which burn off forming carbon dioxide. [1]

[Total: 12]

10 **(a)** The rate of a reaction is affected by temperature hence important to monitor the temperature for effective comparison. [1]

(b) A catalyst allows a reaction to proceed by an alternative pathway with lower activation energy. [1] Hence a larger proportion of particles will have sufficient energy to overcome the activation energy resulting in higher frequency of effective collisions. [1]

(c) The time taken for the reaction to complete when magnesium compounds catalysts were used is much longer (45s) than when transition compound catalysts were used. (<30s) [1]

(d) Fe^{3+}/ Iron (III) ion.[0] The time taken for reaction to complete with iron(III) nitrate was 4 s shorter (17s) than for iron(II) nitrate (21s) [1] (despite the lower temperature of 25°C used).

(e) The type of anion in the catalyst compound has no effect on the rate of reaction. [1]
The reaction is completed in the same length of time when the same metal ion compound with different anions are used e.g. $CoCl_2$ and $Co(NO_3)_2$ both take 28s / $FeCl_2$ and $Fe(NO_3)_2$ both take 21s. [1]
(at least 1 example must be given)

(f) $FeCl_3$ or $Fe_2(SO_4)_3$ [1] (soluble iron(III) salt)

[Total: 8]

11 **(a)** Substitution [1]

(b) It has 7 electrons in its valence/outermost electron shell hence unstable. It needs to react and gain one more electron to have a full valence shell and achieve stability/ to achieve noble gas electronic configuration.

(c) $CH_3 + CH_3 \rightarrow C_2H_6$ [1]

(di) Particles are in constant random motion./ Collision of particles takes place randomly. [1]
Chlorine atoms can combine not only with methane but also the chloromethane formed to replace more hydrogen atoms [1] forming a mixture of organic molecules with different number of chlorine atoms in each molecule.

(ii) methane

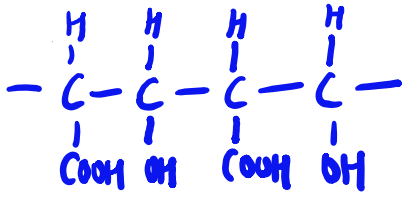
(e) Chloromethane has a simple molecular structure. Weak intermolecular forces between molecules require little energy to overcome during a change of state. Strong covalent bonds between chlorine, carbon and hydrogen atoms are not broken.
2 pts [1], 3 pts [2]

(f) Molecules change from being very closely packed and orderly to closely packed and disorderly arranged. [1]
Molecules change from vibrating and rotating about fixed positions to moving freely and exchanging positions within the liquid. [1]

[Total: 10]

12 **(a)** Add purple acidified aqueous potassium manganate(VII) to X and warm. [1]
Purple solution will turn colourless. [1]

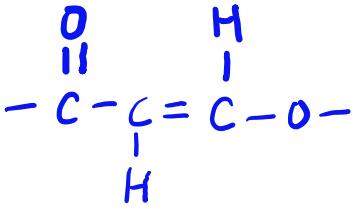
(b) **(i)**



[1] for correct joining of C atom with single bonds
[1] for correct joining of carboxyl and hydroxyl group and bonds at the two ends of molecule

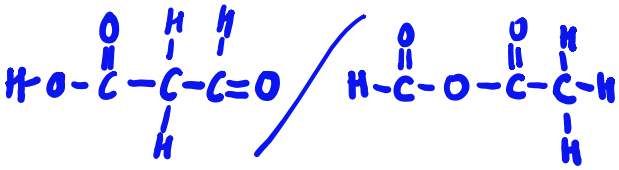
(ii) Add aqueous bromine/ bromine water to the resulting substance and mix well. [1]
If reddish brown aqueous bromine remains unchanged, it means that all X has been converted. If reddish brown colour turns colourless, it means some X remains unconverted. [1]

(c) **(i)**



(ii) By hydrolysis reaction with water using acid as a catalyst [1]

(d)



any formula with correct number of atoms and bonds around each atom [1]

(e) Y has a lower solubility in organic solvent than X./ Y has a higher density or viscosity than X. [1]

[Total: 10]