

Paper 1 – 40 questions – 1 hour

You will need a Periodic Table.

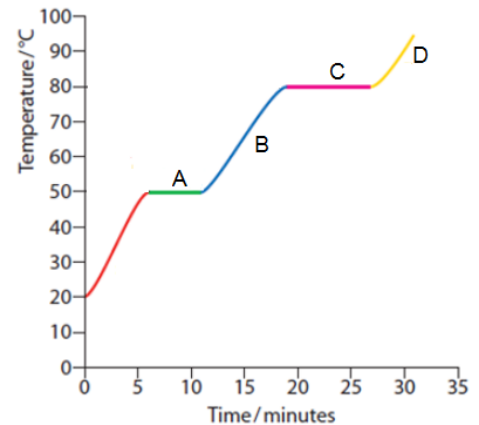
All questions can be done without a calculator.

1. What of the following is a homogeneous mixture?

- A. a mixture of sand and sodium chloride
 B. a sodium chloride solution
 C. a mixture of hexane and water
 D. a mixture of sulfur and iron

2. A substance, X, which is a solid at room temperature, is heated and the temperature monitored. The graph of the temperature against time is shown. At which point are a solid and a liquid present?

- A. B. C. D.

3. A 2.0 dm³ sample of water was found to contain 30 µg of arsenic. The concentration in ppm is

- A. 15 ppm B. 0.015 ppm
 C. 6.7 ppm D. 15000 ppm

4. The condensed electron configuration for ²⁴Cr is

- A. 1s² 2s² 2p⁶ 3s² 3p⁶ 4s² 3d⁴ B. 1s² 2s² 2p⁶ 3s² 3p⁶ 4s¹ 3d⁵
 C. [Ar] 4s² 3d⁴ D. [Ar] 4s¹ 3d⁵

5. In the emission spectrum of deuterium the frequency of the convergence limit in the series where the electron falls down to n=1 is 3.29x10¹⁵ Hz. The value of Planck's constant is 6.63x10⁻³⁴ Js. The ionization energy of deuterium in kJ mol⁻¹ is given by.

- A. $\frac{3.29 \times 10^{15} \times 6.63 \times 10^{-34}}{6.02 \times 10^{23} \times 1000}$
 B. $\frac{3.29 \times 10^{15} \times 6.63 \times 10^{-34} \times 6.02 \times 10^{23}}{1000}$
 C. $\frac{6.63 \times 10^{-34}}{3.29 \times 10^{15} \times 6.02 \times 10^{23} \times 1000}$
 D. $\frac{3.29 \times 10^{15} \times 6.63 \times 10^{-34} \times 1000}{6.02 \times 10^{23}}$

6. Which of the following is an f-block element and a lanthanoid?

- A. Uranium B. Europium
 C. Hafnium D. Rutherfordium

7. Which of the following statements is **not** correct?

- A. metals are found on the left hand side of the periodic table
 B. metallic character decreases down a group
 C. metallic character decreases across a period
 D. metals generally have lower first ionization energies than non-metals

8. Which of the following has the most exothermic electron affinity?
 A. P B. S C. Cl D. Br
9. Which of the following compounds will be diamagnetic??
 A. NiCl₂ B. CuCl₂ C. FeCl₂ D. ZnCl₂
10. Which of the following does not contain a coordinate covalent bond?
 A. O₃ B. CO C. ClO⁻ D. NO₃⁻
11. In the Lewis structure of NO₂⁻ the formal charge on the N atom is?
 A. 0 B. 1- C. 1+ D. 2+
12. What is the shape and electron domain geometry of I₃⁻?

	shape	electron domain geometry
A.	trigonal bipyramidal	trigonal bipyramidal
B.	bent	trigonal planar
C.	linear	trigonal bipyramidal
D.	T-shaped	trigonal bipyramidal

13. Some enthalpy changes are given in the table. The enthalpy change of solution of magnesium chloride is

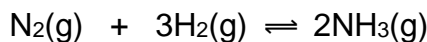
Enthalpy change of hydration of Mg ²⁺ (g)	-1920 kJ mol ⁻¹
Enthalpy change of hydration of Cl ⁻ (g)	-364 kJ mol ⁻¹
Lattice enthalpy of MgCl ₂ (s)	2493 kJ mol ⁻¹

- A. 209 kJ mol⁻¹ B. -155 kJ mol⁻¹
 C. -5141 kJ mol⁻¹ D. 155 kJ mol⁻¹
14. The Arrhenius equation is $k=Ae^{-(E_a/RT)}$. The units of A for a reaction that is second order overall could be
 A. no units B. s⁻¹
 C. mol dm⁻³ s⁻¹ D. mol⁻¹ dm³ s⁻¹
15. The Arrhenius equation can be written in the form $\ln k = -\frac{E_a}{RT} + \ln A$

The gradient of a graph of $\ln k$ (y-axis) against $1/T$ (x-axis) is -2000 K and the value of R is 8.31 J K⁻¹ mol⁻¹. From this it can be deduced that the activation of this reaction in kJ mol⁻¹ is given by

- A. $\frac{2000 \times 8.31}{1000}$
 B. $\frac{-2000 \times 8.31}{6.02 \times 10^{23}}$
 C. 2000 x 8.31
 D. $\frac{2000}{8.31 \times 1000}$

16. What is the expression for the reaction quotient, Q , for the following reaction?



- A. $Q = \frac{[\text{N}_2][\text{H}_2]}{[\text{NH}_3]}$
 B. $Q = [\text{NH}_3]^2 \times [\text{H}_2]^3 \times [\text{N}_2]$
 C. $Q = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$
 D. $Q = \frac{[\text{NH}_3]}{[\text{N}_2][\text{H}_2]}$

17. The equilibrium constant for the reaction $\text{A}(\text{g}) + 2\text{B}(\text{g}) \rightleftharpoons 2\text{C}(\text{g})$ at 300 K is 4.0.

A student measure the following concentrations in a reaction vessel at 300 K

$[\text{A}(\text{g})] / \text{mol dm}^{-3}$	0.20
$[\text{B}(\text{g})] / \text{mol dm}^{-3}$	0.10
$[\text{C}(\text{g})] / \text{mol dm}^{-3}$	0.20

From this it can be deduced that

- A. the system is not at equilibrium and must move to the right towards equilibrium
 B. when the system reaches equilibrium the concentration of C will be greater than 0.20 mol dm^{-3}
 C. the system is at equilibrium
 D. when the system reaches equilibrium the concentration of B will be greater than 0.10 mol dm^{-3}

18. Consider the following system $\text{X}(\text{g}) + 3\text{Z}(\text{g}) \rightleftharpoons 2\text{Y}(\text{g})$ $\Delta G = -200 \text{ kJ mol}^{-1}$.

$\Delta G = -RT \ln K$ and the value of the gas constant is $8.31 \text{ JK}^{-1} \text{ mol}^{-1}$.

The value of the equilibrium constant, K , at 500 K is given by

- A. $e^{\{-200/(8.31 \times 500)\}}$ B. $10^{\{-200000/(8.31 \times 500)\}}$
 C. $e^{\{200000/(8.31 \times 500)\}}$ D. $e^{\{(200 \times 500)/8.31\}}$

19. The table contains the value for the equilibrium constant for a particular reaction at two different temperatures.

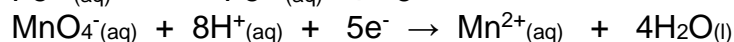
Temperature / K	$\Delta G / \text{kJ mol}^{-1}$
200	+100
400	-500

From this it can be deduced that

- A. the position of equilibrium lies more to the right at 200 K than at 400 K
 B. the value of the equilibrium constant is >1 at 200 K
 C. the value of the equilibrium constant is larger at 400 K than at 200 K
 D. the position of equilibrium lies more to the left at 400 K than at 200 K
20. Which of the following is not amphiprotic?

- A. HCO_3^- B. NO_3^- C. H_2O D. H_2PO_4^-

21. The half equations for the reaction of manganate(VII) with Fe^{2+} ions are

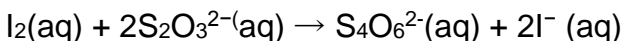
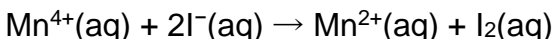
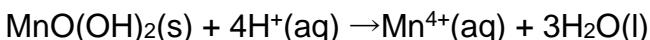
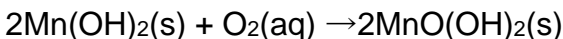


The number of moles of Fe^{2+} that would be oxidised by 50.0 cm^3 of $0.0200 \text{ mol dm}^{-3} \text{ MnO}_4^-$ is

- A. $5.00 \times 10^{-3} \text{ mol}$ B. $1.00 \times 10^{-3} \text{ mol}$
 C. 5.00 mol D. $2.00 \times 10^{-4} \text{ mol}$

22. The Winkler method was used to measure the concentration of dissolved oxygen in a sample of water. Manganese(II) sulfate, sulfuric acid and potassium iodide were added to 50.0 cm³ of the water. The iodine that was formed was titrated against a sodium thiosulfate solution with a concentration of 2.00 × 10⁻³ mol dm⁻³. It was found that 10.00 cm³ of sodium thiosulfate was required for the titration.

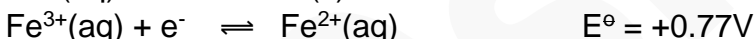
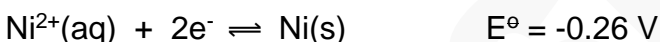
The equations for the reactions are:



The concentration of dissolved oxygen in ppm is given by

- A. $\frac{10.00 \times 32.00 \times 2.00}{4 \times 50.0}$
 B. $\frac{10.00 \times 32.00 \times 2.00}{50.0}$
 C. $\frac{10.00 \times 32.00 \times 2.00 \times 10^6}{1000 \times 4 \times 50.0}$
 D. $\frac{10.00 \times 2.00}{32.00 \times 4 \times 50.0}$

23. Two half equations and standard electrode potentials are shown below.



The standard cell potential and cell notation are

- A. 0.51 V $\text{Ni}^{2+}(\text{aq})|\text{Ni}(\text{s})||\text{Fe}^{3+}(\text{aq})|\text{Fe}^{2+}(\text{aq})$
 B. 1.03 V $\text{Ni}(\text{s})|\text{Ni}^{2+}(\text{aq})||\text{Fe}^{3+}(\text{aq})|\text{Fe}^{2+}(\text{aq})|\text{Pt}(\text{s})$
 C. 1.80 V $\text{Ni}(\text{s})|\text{Ni}^{2+}(\text{aq})||\text{Fe}^{3+}(\text{aq}),\text{Fe}^{2+}(\text{aq})|\text{Pt}(\text{s})$
 D. 1.03 V $\text{Ni}(\text{s})|\text{Ni}^{2+}(\text{aq})||\text{Fe}^{3+}(\text{aq}),\text{Fe}^{2+}(\text{aq})|\text{Pt}(\text{s})$

24. The redox equation for the reaction between dichromate(VI) and bromide ions is:

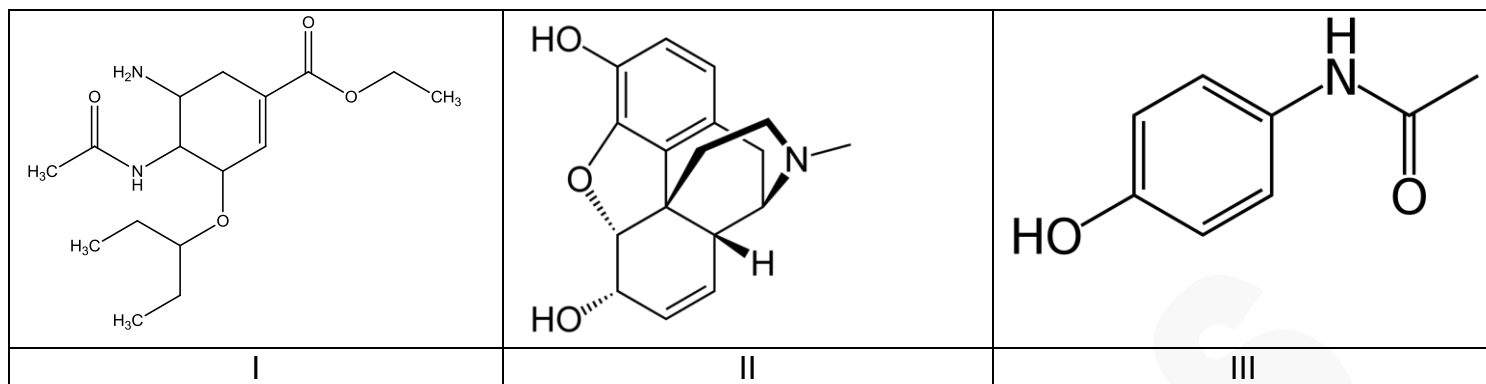


The value of the Faraday constant is 96 500 C mol⁻¹

The value of ΔG° for this reaction is

- A. -156 kJ mol⁻¹ B. -26 kJ mol⁻¹
 C. 59.6 kJ mol⁻¹ D. -357 kJ mol⁻¹

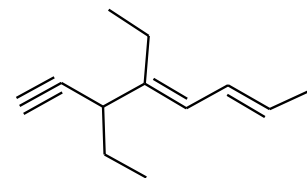
25. Three organic molecules are shown below



Which of the following statements are correct?

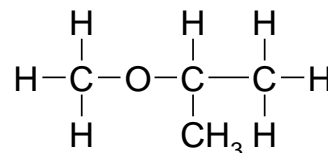
- A. All three molecules contain a tertiary carboxamide group
 B. Only II contains an amine group
 C. I and III contain a carbonyl group
 D. I and II contain an ether group
26. The diagram shows the skeletal formula of an organic molecule. The empirical formula of the compound is

- A. $C_{12}H_{18}$
 B. $CH_{1.5}$
 C. C_6H_{13}
 D. C_2H_3



27. The IUPAC name of the compound shown is

- A. 2-methylmethoxyethane
 B. 2-methoxypropane
 C. 2-methylethoxymethane
 D. 1,1-dimethylmethoxymethane

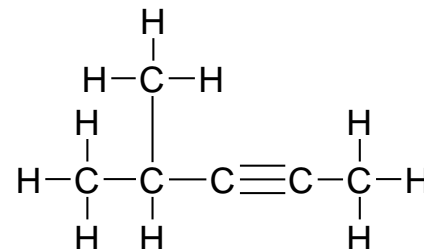


28. The major product when but-1-ene reacts with hydrogen bromide in the dark is?

- A. 1-bromobutane
 B. 1,2-dibromobutane
 C. 2-bromobutane
 D. 2-bromobut-1-ene

29. The IUPAC name of the compound shown is?

- A. 2-methylpent-3-yne
 B. 4-methylpent-2-yne
 C. 2-methylpent-2-yne
 D. 1,1-dimethylbut-2-yne

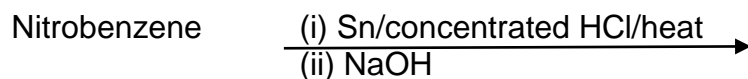


30. The main organic product of the reaction when pentanal is reacted with $NaBH_4$ under suitable conditions is

- A. pentanone
 B. pentanoic acid
 C. pentan-1-ol
 D. pentan-2-ol

31. Benzene reacts with concentrated sulfuric and concentrated nitric acid when heated. In this reaction
- NO_2^+ acts as a nucleophile and Lewis acid
 - NO_2^- acts as a nucleophile and Lewis base
 - NO_2^+ acts as an electrophile and Lewis acid
 - NO_2^+ acts as an electrophile and Lewis base

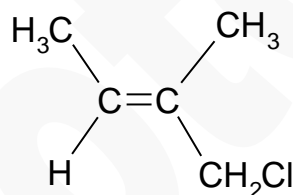
32. Consider the following reaction:



The organic product of this reaction is

- benzene
- phenol
- chlorobenzene
- phenylamine

33. The IUPAC name of the molecule shown is



- (E)-1-chloro-2-methylbut-2-ene
 - (Z)-1-chloro-2-methylbut-2-ene
 - (Z)-1,2-dimethyl-1-(chloromethyl)ethene
 - (E)-1,2-dimethyl-1-(chloromethyl)ethene
34. Which of the following is a protic polar solvent?
- CH_3COCH_3
 - CH_3CN
 - CH_3OH
 - CHCl_3
35. Which of the following compounds has the highest index of hydrogen deficiency (IHD)?
- $\text{C}_6\text{H}_5\text{CH}_3$
 - $\text{CH}_3\text{COOCH}_2\text{CH}_3$
 - $\text{C}_6\text{H}_5\text{COOH}$
 - C_3H_4

36. Which of the following is correct about the nmr spectrum of ethyl ethanoate
- there are 4 peaks in the spectrum corresponding to 4 different hydrogen environments
 - the spectrum includes 2 triplets as there are 2 groups of 3 protons
 - the spectrum contains a singlet with integral 3 as there are 3 protons on the CH_3CO group
 - there are 2 doublets and a singlet in the spectrum as there are 3 different hydrogen environments

37. The nmr spectrum of which of the following molecule(s) contains a triplet?

I	II	III

- I only
- I, II and III
- II and III only
- III only

38. Which of the following statements is not correct about the mass spectrum of ethylbenzene, $C_6H_5CH_2CH_3$
- A. the molecular ion peak occurs at $m/z=106$
 - B. the peak at $m/z=29$ is due to the CH_2CH_3 fragment
 - C. there will be a peak at $m/z=77$ due to the loss of the CH_3CH_2 group
 - D. the mass spectrum will contain a peak at $m/z=15$
39. Which of the following molecules has an IHD of 1 and 3 peaks in the low resolution nmr spectrum
- A. propan-2-ol
 - B. propanone
 - C. butanone
 - D. butanoic acid
40. A student carried out an experiment to measure the enthalpy change of solution of barium nitrate and obtained the value -32 kJ mol^{-1} . The literature value for this quantity is -40 kJ mol^{-1} . The percentage error in the student's experiment was
- A. 8 %
 - B. 20 %
 - C. 25 %
 - D. 80 %