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Student ID:

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Paper No. 1
Repeat Paper

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- Instructions:**
1. Write your name and student ID on the examination paper.
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 6. Use a HB pencil, or blue or black biro to mark the correct answer like this .
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 10. Marks: 4 marks for each correct answer, -1 for each incorrect answer, 0 for no attempt.

Duration 2 Hours
No. of Pages 13
Department(s) Chemistry
Course Co-ordinator(s) Professor Michael J. Hynes

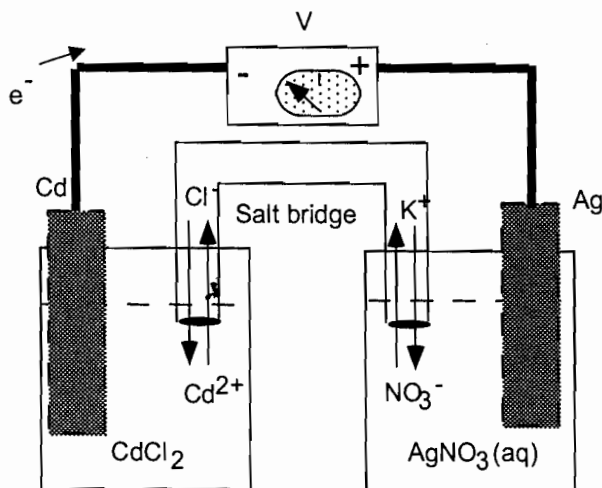
Requirements:

MCQ Yes
Handout
Statistical Tables
Graph Paper
Log Graph Paper
Other Material Log Tables/Atomic masses

¹Relative atomic masses: O, 16; N, 14, P, 31

1. Analytical chemistry seeks to achieve one of the following:
 - (A) Develop methods to yield information on the physical properties of a sample.
 - (B) Analyse the risks associated with chemical poisons.
 - (C) Develop methods to yield information on the composition of matter.
 - (D) Discover new chemicals by analysis of samples.
2. Sampling is a procedure whereby:
 - (A) Part of a substance is taken to provide a true reflection of the whole.
 - (B) Small portions of a large batch are taken to simplify the analyst's work.
 - (C) Part of a substance is taken to provide a representative sample of the whole.
 - (D) Portions of a substance are collected randomly.
3. In simple random sampling one of the following applies:
 - (A) Each sample is truly representative of the whole.
 - (B) The lot is segmented and samples at the top and bottom are selected.
 - (C) Samples are selected by drawing straws.
 - (D) Any sample has an equal chance of being selected.
4. In systematic random sampling one of the following applies:
 - (A) Samples of the system are selected randomly.
 - (B) The first sample is selected randomly and subsequent samples are taken at arranged intervals.
 - (C) The lot is subdivided and a simple random sample selected from each stratus.
 - (D) The lot is segmented and samples at the top and bottom are selected.
5. Subsampling is done to yield one of the following:
 - (A) A simplified sample for the analyst.
 - (B) Subsamples of varying composition for laboratory analysis
 - (C) Subsamples that are alike for laboratory analysis.
 - (D) Portions of a substance that are in proportion to the amount of material they represent.
6. Samples for inorganic analysis should not be stored in one of the following:
 - (A) Polyethylene containers.
 - (B) A refrigerator.
 - (C) Glass containers.
 - (D) Room temperature environments.
7. Grinding of solid samples prior to analysis is advantageous because:
 - (A) All of the following (B), (C) and (D).
 - (B) Finely powdered samples are more homogeneous and can be sub-sampled with greater accuracy and precision.
 - (C) Finely powdered samples are easier to dissolve because they present a large surface area to volume ratio.
 - (D) Samples must be finely powdered before certain solid-state analytical techniques can be applied to analyse them

8. Ashing is used in sample pre-treatment in order to:
- Add carbon soot to the sample.
 - Heat the sample prior to analysis.
 - Remove the inorganic content of the sample.
 - Remove the organic content of the sample.
9. Variance measures one of the following:
- The extent to which the data vary over time.
 - The variety of results in the data.
 - The difference between the data and a standard.
 - The extent to which the data differs in relation to itself.
10. Confidence limits are described by one of the following:
- The confidence we have that the mean lies within the given limits.
 - The confidence we have that the true value of the result lies within the given limits.
 - The limits we place in our confidence of the analyst's abilities.
 - The limits we place on the standard deviation to ensure that all values lie within the given limits
11. Electroanalysis involves one of the following:
- The analysis of chemicals that produce electricity.
 - Analysis of electrodes.
 - Harnessing chemical reactions for the production of electricity.
 - Relating a measured electrical parameter to a chemical parameter.
12. Give the line notation for the cell below:



- $\text{Cd(s)}|\text{Cd}^{2+}(\text{aq.})|\text{Ag}^+(\text{aq.})|\text{Ag(s)}$
- $\text{Ag(s)}|\text{Ag}^+(\text{aq.})||\text{Cd}^{2+}(\text{aq.})|\text{Cd(s)}$
- $\text{Cd(s)}|\text{Cd}^{2+}(\text{aq.})||\text{Ag}^+(\text{aq.})|\text{Ag(s)}$
- $\text{Cd(s)}|\text{Cd}^{2+}(\text{aq.})||\text{Ag}^+(\text{aq.})|\text{AgCl}|\text{Ag(s)}$

13. The more positive the value of the standard reduction potential for a half-reaction:
- (A) The weaker the oxidant.
 - (B) The stronger the reductant.
 - (C) The quicker the reaction.
 - (D) The stronger the oxidant.
14. In potentiometry one of the following is true:
- (A) The potential difference between two electrodes is varied to electrolyse the analyte.
 - (B) The potential difference between two electrodes is related to the analyte concentration.
 - (C) The current flowing between two electrodes is related to the analyte concentration.
 - (D) The conductivity of the solution is related to the analyte concentration.
15. The *average* temperature (in Kelvin) of the Earth is one of the following:
- (A) 228 (B) 288 (C) 258 (D) 318
16. The two principal “greenhouse gases” are one of the following:
- (A) $O_2 + CO_2$
 - (B) $CH_4 + CO$
 - (C) $H_2O + CO_2$
 - (D) $O_2 + CH_4$
17. The average person inhales how many kilograms of air every day?
- (A) 0.13 (B) 13 (C) 1.3 (D) 130
18. The pH of *natural* rainwater is one of the following:
- (A) 4.6 (B) 5.6 (C) 6.6 (D) 7.6
19. The “ozone layer” lies how many km above ground level:
- (A) 25 km (B) 250 km (C) 2,500 km (D) 2.5 km
20. Which one atmospheric gas is primarily responsible for filtering sunlight between 120 and 220 nm?
- (A) CO_2 (B) O_3 (C) Ar (D) O_2
21. How many cubic metres of methane are produced per tonne of decaying waste in a landfill?
- (A) 1,000 (B) 100 (C) 10 (D) 1
22. Which one of the following statements about the incineration of waste is not true?
- (A) It reduces toxic threat
 - (B) It reduces total volume
 - (C) It neutralises acids
 - (D) It recovers energy.
23. The temperature in the upper Stratosphere (50 km above sea-level) is approximately one of the following:
- (A) $-80\text{ }^{\circ}C$ (B) $-40\text{ }^{\circ}C$ (C) $0\text{ }^{\circ}C$ (D) $20\text{ }^{\circ}C$

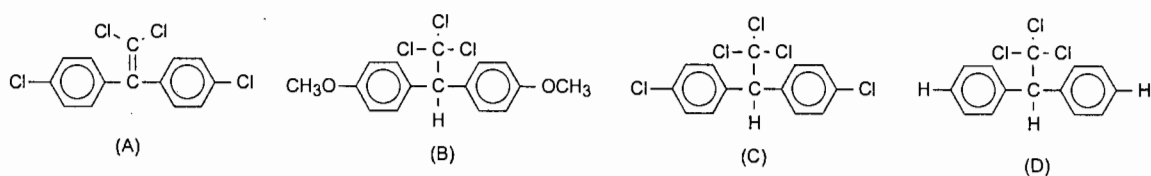
24. The typical concentration of CO in photochemical smog ($\mu\text{g m}^{-3}$) is one of the following.
 (A) 200 (B) 2,000 (C) 20,000 (D) 200,000
25. The brown colour of photochemical smog is mainly due to one of the following:
 (A) O_2 (B) NO_2 (C) CH_2O (D) O_3
26. The greenhouse gas with the biggest warming effect is:
 (A) CO_2 (B) CH_4 (C) N_2O (D) H_2O
27. The number of metric tons of CO_2 added to the atmosphere each year is one of the following:
 (A) 3 million (B) 30 million (C) 300 million (D) 3 billion
28. Ozone filters out radiation from the atmosphere in one of the following wavelength ranges:
 (A) 120–220 nm (B) 220–320 nm (C) 330–430 nm (D) 440–520 nm
29. Mass spectrometry separates components according to:
 (A) Molecular mass.
 (B) Molecular charge.
 (C) Molecular mass to charge ratio.
 (D) Molecular shape to weight ratio.
30. Centrifugation separates components on the basis of one of the following:
 (A) Particle charge.
 (B) Particle melting point.
 (C) Particle size/mass.
 (D) Particle shape.
31. If t_R is the retention time and w is the peak width, the number of theoretical plates (n) is given by:
 (A) $n = (t_R/w)^2$
 (B) $n = 16(w/t_R)^2$
 (C) $n = 16(t_R/w)^3$
 (D) $n = 16(t_R/w)^2$
32. If n is the number of theoretical plates and L is the column length, the height equivalent of a theoretical plate (HETP) is given by:
 (A) L/n
 (B) n/L
 (C) $n + L$
 (D) $(n)(L)$
33. If t_R is the retention time and w is the peak width, the resolution of two chromatographic peaks is defined as one of the following:
 (A) $w/\Delta t_R$
 (B) $16 t_R^2/w$
 (C) $\Delta t_R/w$
 (D) $w/16 t_R^2$

34. To double the resolution of a column it must be:
- (A) Quadrupled in length.
 - (B) Halved in length.
 - (C) Doubled in length.
 - (D) The length is irrelevant to resolution.
35. Paper chromatography is based on which of the following:
- (A) Gas-liquid partitioning.
 - (B) Liquid – liquid partitioning.
 - (C) Solid – solid partitioning.
 - (D) Solid – liquid partitioning.
36. The retention time for a component on a planar chromatography plate is defined as one of the following:
- (A) Distance travelled by sample x distance travelled by mobile phase.
 - (B) Distance travelled by mobile phase x distance travelled by sample.
 - (C) Distance travelled by mobile phase / distance travelled by sample
 - (D) Distance travelled by sample / distance travelled by mobile phase.
37. Normal phase chromatography involves the use of one of the following:
- (A) Polar stationary phase and polar mobile phase.
 - (B) Non-polar stationary phase and non-polar mobile phase.
 - (C) Polar stationary phase and non-polar mobile phase.
 - (D) Non-polar stationary phase and polar mobile phase.
38. Tailing of TLC spots is usually caused by one of the following:
- (A) Sample impurities.
 - (B) Sample overloading.
 - (C) Poor atmospheric saturation.
 - (D) Mobile phase impurities.
39. For separation of Li^+ from Na^+ which of the following stationary phases would be chosen?
- (A) Gel permeation resin.
 - (B) Silica gel.
 - (C) Anion exchange resin.
 - (D) Cation exchange resin.
40. A strong acid ion exchange resin is a cross-linked polystyrene with which one of the following groups present?
- (A) $\text{R}-\text{CO}_2\text{H}$
 - (B) $\text{R}-\text{SO}_3\text{H}$
 - (C) $\text{R}-\text{NH}_2$
 - (D) $\text{R}_4\text{N}^+ \text{HO}^-$

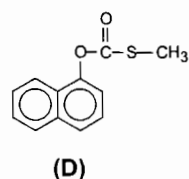
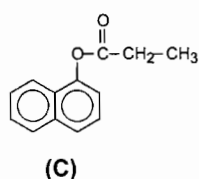
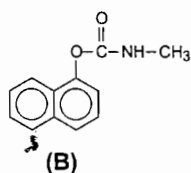
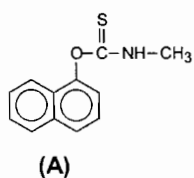
41. Ions are usually detected in ion exchange chromatography by which one of the following?
- (A) Ultra violet light adsorption.
 - (B) Conductivity measurements.
 - (C) Colour change.
 - (D) Iodine staining of a TLC plate.
42. In size exclusion chromatography the order of elution is determined by which one of the following?
- (A) Molecular size and shape, polarity and degree of solvation.
 - (B) Molecular weight.
 - (C) Molecular size and shape.
 - (D) Polarity.
43. In size exclusion chromatography the molecular weight of a molecule that will just permeate the gel and be retarded is known as which one of the following?
- (A) The exchange capacity.
 - (B) The inclusion limit.
 - (C) The exclusion limit.
 - (D) Pore size.
44. Which one of the following statements is true?
- (A) World Health Organisation (WHO) guidelines on drinking water quality are used universally.
 - (B) EU guidelines on drinking water quality are used universally.
 - (C) US guidelines on drinking water quality are used universally.
 - (D) Japanese guidelines on drinking water quality are used universally.
45. Which one of the following causes temporary hardness in water?
- (A) MgSO_4 (B) CaSO_4 (C) CaHCO_3 and MgHCO_3 (D) Na_2SO_4
46. Which one of the following is the major salt in seawater?
- (A) CaCO_3 (B) NaCl (C) CaSO_4 (D) none of these
47. Water covers one of the following percentages of the Earth's surface:
- (A) 70% (B) 75% (C) 85% (D) 90%
48. Which one of the following is the major source of domestic and industrial water in the EU countries of continental Europe?
- (A) Rain-water (B) Surface-water (C) Wetlands (D) Ground-water
49. Which one of the following is the major source of domestic water in Ireland?
- (A) Rain-water (B) Surface-water (C) Wetlands (D) Ground-water
50. The EU Water Framework Directive applies to one of the following:
- (A) Polluted waters in the EU (B) Rives and Lakes (C) All waters in the EU (D) Ground waters

51. According to the Water Framework Directive all water in the EU must meet “good status” by which one of the following years?
 (A) 2008 (B) 2009 (C) 2012 (D) 2015
52. The major method of domestic water supply in Ireland is one of the following:
 (A) Private supplies (B) Group water schemes (C) Public water supplies
 (D) Ground water
53. In Ireland, the Water Framework Directive will be implemented on the basis of which one of the following?
 (A) River basin districts (B) Individual river basins (C) Counties (D) Major lakes
54. Which one of the following is the major source of water pollution in Ireland?
 (A) Industry (B) Agriculture (C) Domestic (D) Fish farming
55. Which one of the following is the primary function of sodium tripolyphosphate in detergents?
 (A) To complex cations that cause hardness.
 (B) To react with sodium ions present.
 (C) To increase the bulk of the detergent.
 (D) To complex the anions present.
56. The EC I value for NO_3^- in drinking water is 50 ppm. Expressed as N this is equal to which one of the following:
 (A) 11.3 ppm (B) 14.2 ppm (C) 25.8 ppm (D) 2.1 ppm
57. An N level of 0.012 mg dm^{-3} when expressed as NO_2^- corresponds to which one of the following:
 (A) 0.030 mg dm^{-3} (B) 0.039 mg dm^{-3} (C) 0.060 mg dm^{-3} (D) 0.026 mg dm^{-3}
58. A concentration of $0.2 \text{ ppm PO}_4^{3-}$ when expressed as P equals which one of the following:
 (A) 0.1 ppm (B) 0.12 ppm (C) 0.08 ppm (D) 0.065 ppm
59. At 25°C the dissolved oxygen content of clean river-water is one of the following:
 (A) 7.0 mg/L (B) 14.7 mg/L (C) 8.7 mg/L; (D) 12.0 mg/L.
60. The EU Nitrate Directive (91/676/EEC) aims to achieve one of the following:
 (A) Eliminate the use of nitrate fertilisers.
 (B) Eliminate the use of farmyard manure as a fertiliser.
 (C) Reduce the use of fertilisers by farmers.
 (D) The reduction of water pollution by nitrates from agricultural sources.
61. The EU Nitrate Directive (91/676/EEC) allows for a maximum spreading level of organic nitrogen of one of the following:
 (A) 150 kg N/ha (B) 210 kg N/ha (C) 170 kg N/ha (D) 260 kg N/ha

62. Water is chlorinated in order to achieve one of the following:
- Oxidise the organic matter present.
 - Reduce the ammonia concentration.
 - Make it taste better.
 - Kill the bacteria present.
63. Acidic lakes have which one of the following characteristics:
- Have higher concentrations of dissolved metals.
 - Have lower concentrations of dissolved metals.
 - Sustain higher concentrations of game-fish.
 - Have high concentrations of bicarbonate.
64. In wastewater analysis, BOD means one of the following:
- Biological Oxygen Digestion.
 - Biochemical Oxygen Demand.
 - Biochemical Organic Demand.
 - Biological Organic Digestion.
65. Which one of the following statements is true?
- BOD is a suitable method for continuous monitoring wastewaters.
 - COD indicates a higher oxygen demand than BOD.
 - COD is a suitable method for continuous monitoring of wastewaters.
 - COD indicates a lower oxygen demand than BOD.
66. The Irish classification system for freshwater lakes is based on which one of the following?
- (A) Hardness (B) pH (C) Heavy metal concentration (D) chlorophyll concentration
67. A river is designated as 'clean' if it has a BOD of one of the following:
- (A) <20 mg/l (B) <50 mg/l (C) <3 mg/l (D) <1,000 mg/l
68. The design criteria for the Mutton Island treatment plant in Galway provide for a final effluent having one of the following levels of BOD:
- 1 mg/dm³
 - 25 mg/dm³
 - 100 mg/dm³
 - 1000 mg/dm³
69. One of the following is the structure of DDT:



70. Which one of the following statements is true?
- (A) Dioxins are the most toxic substances known to man.
 - (B) Dioxins are naturally occurring substances.
 - (C) Dioxins have only entered the environment in the twentieth century.
 - (D) Dioxins are added to phenoxy herbicides to make them more effective.
71. Organophosphorus pesticides are characterised by one of the following properties:
- (A) Less toxic to mammals than DDT.
 - (B) More toxic to mammals than DDT.
 - (C) Less toxic to pests than DDT.
 - (D) Safer to use than DDT.
72. Which of the following classes of pesticides is most likely to be found in *narrow spectrum insecticides*?
- (A) Inorganic compounds
 - (B) Organophosphates
 - (C) Organochlorines
 - (D) Carbamates
73. The US Food Quality Act of 1996 uses one of the following criteria to set tolerance levels for pesticide residues in food:
- (A) The food must be free from chemicals.
 - (B) The lowest level that can be detected using chromatography.
 - (C) A level that will ensure a cheap supply of wholesome food.
 - (D) A reasonable certainty of no harm.
74. In terms of pesticide residues in food, a 'tolerance' is one of the following:
- (A) The maximum concentration legally allowed by the US EPA.
 - (B) The maximum concentration of pesticide tolerated by an infant.
 - (C) The concentration that is safe for humans.
 - (D) The concentration that results in no risk to consumers.
75. One of the following is a carbamate insecticide:



76. Indicate which one of the following is true. Environmental estrogens (endocrine disruptors) act by:
- (A) Destroying hormones.
 - (B) Reacting with chemicals in the cells to produce hormones.
 - (C) Binding to hormone receptors.
 - (D) Increasing hormone production.
77. Environmental estrogens are described by one of the following:
- (A) Synthetic chemicals.
 - (B) A mixture of synthetic and naturally occurring chemicals.
 - (C) Naturally occurring chemicals.
 - (D) All come as a result of leaching from plastics.

78. ISO 14001 is which one of the following?
- (A) A quality management system.
 - (B) A system that enables us to produce better products.
 - (C) A system for monitoring the environment.
 - (D) An environmental management system.
79. The linewidth of the 589 nm sodium line emitted by a hollow cathode lamp is which one of the following:
- (A) Same as the linewidth of a sodium atom in an air/acetylene flame
 - (B) Narrower than the linewidth of a sodium atom in an air/acetylene flame.
 - (C) Broader than the linewidth of a sodium atom in an air/acetylene flame..
 - (D) Is operator dependent.
80. With respect to ionisation interference, nitrous oxide/acetylene flames are:
- (A) More prone to it than air/acetylene flames.
 - (B) Less prone to it than air/acetylene flames.
 - (C) The same as air/acetylene flames.
 - (D) The same as air/hydrogen flames.
81. Atomic absorption spectroscopy depends on one of the following:
- (A) Molecules do not dissociate in a flame.
 - (B) Molecules dissociate into ions in a flame.
 - (C) Molecules dissociate into atoms in a flame.
 - (D) Only metal atoms can be detected.
82. Which one of the following techniques provides the greatest sensitivity for most elements?
- (A) Graphite furnace atomic absorption spectroscopy.
 - (B) Flame atomic absorption spectroscopy.
 - (C) Flame emission spectroscopy.
 - (D) All three techniques give approximately the same sensitivity.
83. *Sensitivity* in atomic absorption spectroscopy is defined as the concentration of an element that will reduce the transmission by which one of the following:
- (A) 0.1% (B) 1.0% (C) 5% (D) 10%
84. A chopper is used in an atomic absorption spectrophotometer in order to achieve which one of the following:
- (A) Improve sensitivity.
 - (B) Improve atomisation.
 - (C) Reduce the requirement to use a hollow cathode lamp.
 - (D) Reduce the effects of flame emissions.
85. A monochromator is used in atomic absorption spectrophotometers in order to achieve which one of the following:
- (A) Produce a source of narrow linewidth.
 - (B) Isolate the wavelength of interest.
 - (C) Enable the use of a continuous source.
 - (D) Because one is used UV/VIS spectrophotometers.

86. Hollow cathode lamps are used in atomic absorption spectrophotometers because:
- (A) A monochromator is not required.
 - (B) They are cheap.
 - (C) They provide a source of narrow lines.
 - (D) The same hollow cathode lamp can be used for all elements.
87. Chemical interferences such as those encountered in the determination of calcium in natural waters by atomic absorption spectroscopy can be eliminated by which one of the following:
- (A) Using a cooler flame
 - (B) Using a hotter flame
 - (C) Using a different line
 - (D) Using flame emission spectroscopy
88. The concentration of nitrate in tap water is best determined by which one of the following methods?
- (A) UV-visible spectroscopy.
 - (B) AAS - atomic absorption spectroscopy.
 - (C) Gas liquid chromatography.
 - (D) Infra-red spectroscopy.
89. One of the following statements is true:
- (A) UV-visible spectra are usually presented in wavenumbers.
 - (B) UV-visible spectra are usually presented in angstroms.
 - (C) UV-visible spectra are usually presented in nanometers.
 - (D) UV-visible spectra are usually presented in microns.
90. One of the following statements is true:
- (A) The intensity of UV-visible spectra is usually expressed in % transmission.
 - (B) The intensity of UV-visible spectra is usually expressed in absorbance.
 - (C) The intensity of UV-visible spectra is usually expressed in moles/dm³.
 - (D) The intensity of UV-visible spectra is usually expressed in % absorbance.
91. One of the following statements is true:
- (A) Sample cells made from glass cover the entire UV-visible spectrum.
 - (B) Plastic cells may be used in the UV region.
 - (C) Stainless steel cells may be used in the visible region
 - (D) Quartz cells may be used in the visible region.
92. One of the following is true:
- (A) 50% transmission corresponds to an absorbance of 0.25
 - (B) 50% transmission corresponds to an absorbance of 0.10
 - (C) 50% transmission corresponds to an absorbance of 0.30.
 - (D) 50% transmission corresponds to an absorbance of 0.50
93. One of the following is true:
- (A) An absorbance of 0.6 corresponds to 25% transmission.
 - (B) An absorbance of 0.6 corresponds to 60% transmission.
 - (C) An absorbance of 0.6 corresponds to 30% transmission.
 - (D) An absorbance of 0.6 corresponds to 10% transmission.

94. One of the following is true:
- (A) UV-visible spectroscopy is excellent for qualitative analysis.
 - (B) IR spectroscopy is excellent for qualitative analysis.
 - (C) IR spectroscopy is useless in qualitative analysis.
 - (D) UV-visible is useless in quantitative analysis.
95. One of the following is true:
- (A) A diode array spectrometer can measure absorbance at only 2 wavelengths.
 - (B) A diode array spectrometer can measure absorbance at a range of wavelengths.
 - (C) A diode array spectrometer can measure absorbance at only 1 wavelength.
 - (D) A diode array spectrometer can measure transmission at only 1 wavelength.
96. One of the following is true:
- (A) Water absorbs in the IR at 1500 cm^{-1} only.
 - (E) Water absorbs in the IR at 3600 cm^{-1} and 1630 cm^{-1} .
 - (F) Water absorbs in the IR at 3000 cm^{-1} only.
 - (G) Water absorbs in the IR at 3100 cm^{-1} and 1500 cm^{-1} .
97. One of the following is true:
- (A) Nujol is used for IR because solids dissolve in it.
 - (B) Nujol is used for IR because it can exclude the air between solid particles.
 - (C) Nujol is used for IR because it has no bands in the IR region.
 - (D) Nujol is used for IR because it sticks the NaCl plates together.
98. One of the following is true:
- (A) Diamond composite ATR has a limited IR spectral range.
 - (B) Diamond composite ATR requires Nujol paste samples.
 - (C) Diamond composite ATR has a very limited IR spectral range.
 - (D) Diamond composite ATR is the method of choice for IR spectroscopy.
99. One of the following is true:
- (A) NIR is transmitted through glass.
 - (B) NIR spectroscopy requires quartz cells.
 - (C) NIR spectroscopy is never used in industry.
 - (D) NIR spectroscopy can not be used for quantitative analysis.
100. The concentration of free chlorine in a sample of tap water can be determined by one of the following methods:
- (A) Infra red spectroscopy.
 - (B) Atomic absorption spectroscopy.
 - (C) By reacting it with N,N-p-phenylenediamine (DPD) to produce a red colour which can be measured spectrophotometrically.
 - (D) Using an ion selective electrode.