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| 1. Which statements are TRUE?   1. Organic solvents, concentrated acids, and concentrated ammonia should be handled in a fume hood. 2. A respirator should be worn when handling organic solvents. 3. All containers should be labeled to indicate what they contain. 4. Contact lenses are adequate to protect eyes from liquids and gases in the lab.  |  |  |  | | --- | --- | --- | |  | a. | I and II | |  | b. | II and IV | |  | c. | I and III | |  | d. | III and IV | |  | e. | II and III |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 2. Which practices reflect the safe, ethical handling of chemicals and waste in a laboratory?   1. Before working, familiarizing yourself with safety features of your laboratory 2. Cleaning up spills immediately to prevent accidental contact by the next person who comes along 3. Recycling of chemicals rather than disposing of waste 4. Not eating or drinking in the lab  |  |  |  | | --- | --- | --- | |  | a. | I, II, and IV | |  | b. | II and IV | |  | c. | I and II | |  | d. | III and IV | |  | e. | I, II, III, and IV |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ provides a set of principles intended to help sustain a habitable planet.   |  |  |  | | --- | --- | --- | |  | a. | Environmental chemistry | |  | b. | Analytical chemistry | |  | c. | Biological chemistry | |  | d. | Atmospheric chemistry | |  | e. | Green chemistry |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 4. The \_\_\_\_\_\_\_\_\_\_\_\_ fulfills the critical function of reporting what a researcher has done and what she observed, and allows another researcher to repeat the work.   |  |  |  | | --- | --- | --- | |  | a. | lab report | |  | b. | lab notebook | |  | c. | MSDS | |  | d. | project report | |  | e. | technical note |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 5. Which are good practices when keeping a laboratory notebook?   1. Using complete sentences when writing notes 2. Writing a balanced chemical equation for every reaction used 3. Pasting hard copies of important data into the notebook 4. Recording the names of computer files where programs and data are stored  |  |  |  | | --- | --- | --- | |  | a. | I, II, and IV | |  | b. | II and IV | |  | c. | I and II | |  | d. | III and IV | |  | e. | I, II, III, and IV |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 6. The mass of the empty receiving vessel used with an analytical balance is the   |  |  |  | | --- | --- | --- | |  | a. | linearity. | |  | b. | buoyancy. | |  | c. | readability. | |  | d. | tare. | |  | e. | tolerance. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 7. \_\_\_\_\_\_\_\_\_\_\_ is the smallest increment of mass that can be indicated by an electronic balance.   |  |  |  | | --- | --- | --- | |  | a. | Sensitivity | |  | b. | Linearity | |  | c. | Readability | |  | d. | Selectivity | |  | e. | Tare |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 8. Which step(s) is/are NOT required in the practice of weighing by difference?   1. Weigh a capped bottle containing the dry reagent. 2. Quickly pour some of the dry reagent from the weighing bottle into a receiver. 3. Weigh the receiver containing the dry reagent. 4. Recap the bottle that now contains less of the dry reagent. 5. Reweigh the capped bottle that contains less of the dry reagent.  |  |  |  | | --- | --- | --- | |  | a. | III | |  | b. | IV | |  | c. | V | |  | d. | IV and V | |  | e. | I, IV, and V |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 9. \_\_\_\_\_\_\_\_\_\_\_\_\_ is the upward force exerted on an object in a gaseous or liquid fluid. The mass measured by an analytical balance in air is \_\_\_\_\_\_\_\_\_\_\_\_\_ its actual mass.   |  |  |  | | --- | --- | --- | |  | a. | Buoyancy; heavier than | |  | b. | Buoyancy; lighter than | |  | c. | Electromagnetic force; heavier than | |  | d. | Electromagnetic force; lighter than | |  | e. | Tare; equal to |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 10. Which of the following are sources of weighing error?   1. Weighing a sample that is warmer than ambient temperature 2. Cooling a sample in a desiccator prior to weighing 3. Periodically calibrating the balance 4. The temperature of the balance changing over time  |  |  |  | | --- | --- | --- | |  | a. | I and II | |  | b. | I and III | |  | c. | II and IV | |  | d. | II and III | |  | e. | I and IV |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 11. Which scenario has the lowest relative uncertainty?   |  |  |  | | --- | --- | --- | |  | a. | delivering 35.50 mL of titrant with a 50 ± 0.05 mL class A buret | |  | b. | delivering 15.40 mL of titrant with a 50 ± 0.05 mL class A buret | |  | c. | delivering 18.50 mL of titrant with a 25 ± 0.03 mL class A buret | |  | d. | delivering 5.40 mL of titrant with a 25 ± 0.03 mL class A buret | |  | e. | delivering 97.30 mL of titrant with a 100 ± 0.10 mL class A buret |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 12. A small air bubble trapped beneath the stopcock of a buret before a titration was expelled during the titration. Due to the air bubble, the true concentration of the solution that was titrated is \_\_\_\_\_\_\_\_\_\_\_\_ the concentration calculated using the titrant volume.   |  |  |  | | --- | --- | --- | |  | a. | less than | |  | b. | greater than | |  | c. | the same as | |  | d. | unrelated to | |  | e. | impossible to compare to |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 13. A student titrated extracted chloride from a soil sample with 0.1 M silver nitrate. During the titration he performed the following actions while operating the buret.   * Washed the buret with silver nitrate solution * Drained the titrant slowly * Delivered a fraction of a drop near end point * Read the bottom of the concave meniscus * Avoided parallax * Accounted for graduation thickness in the readings   His instructor notes on his lab report that the student forgot to \_\_\_\_\_\_\_\_\_\_\_\_ when operating his buret.   |  |  |  | | --- | --- | --- | |  | a. | eliminate air bubbles | |  | b. | estimate the buret reading to 1/10 of a division | |  | c. | fill the buret to exactly 0.00 mL | |  | d. | eliminate air bubbles and fill the buret to exactly 0.00 mL | |  | e. | eliminate air bubbles and estimate the buret reading to 1/10 of a division |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 14. A student prepares a solution using a 1-L volumetric flask. When he finishes, the meniscus is above the calibration mark on the flask neck. The concentration of the solution is \_\_\_\_\_\_\_\_\_\_ the calculated concentration.   |  |  |  | | --- | --- | --- | |  | a. | less than | |  | b. | greater than | |  | c. | the same as | |  | d. | irrelevant compared to | |  | e. | impossible to compare to |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 15. Which statement regarding volumetric flasks is FALSE?   |  |  |  | | --- | --- | --- | |  | a. | Volumetric flasks are calibrated to obtain a particular volume at 20°C. | |  | b. | Volumetric flasks are calibrated to deliver their indicated volume. | |  | c. | To properly use a volumetric flask, dissolve the reagent in less than final volume of liquid and then dilute to volume. | |  | d. | The volume of the flask changes with temperature because liquid and glass expand when heated. | |  | e. | To obtain the calibrated volume, the bottom of the meniscus is aligned to the center of the mark on the neck of the flask. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 16. Acid washing glassware can replace low concentrations of cations on the surface with H+. Which acids at a concentration of 3–6 M are typically used to clean glassware?   1. acetic acid 2. nitric acid 3. hydrochloric acid 4. phosphoric acid  |  |  |  | | --- | --- | --- | |  | a. | I or II | |  | b. | II or III | |  | c. | III or IV | |  | d. | II or IV | |  | e. | I or III |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 17. Which statement(s) is/are TRUE regarding collecting and storing samples for trace analysis?   1. Trace ionic analytes stored in glass are lost by adsorption or contaminated by metals leaching from the glass surface. 2. Plastic bottles are recommended to collect and store ionic analyte samples. 3. Amber glass bottles are best for collecting and storing aqueous samples of organic materials.  |  |  |  | | --- | --- | --- | |  | a. | I and II | |  | b. | II and III | |  | c. | I and III | |  | d. | I, II, and III | |  | e. | I |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 18. \_\_\_\_\_\_\_\_\_\_\_\_\_ are calibrated to deliver one fixed volume and are \_\_\_\_\_\_\_\_\_\_\_\_ than \_\_\_\_\_\_\_\_\_\_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | Measuring pipets; more accurate; transfer pipets | |  | b. | Transfer pipets; less accurate; measuring pipets | |  | c. | Measuring pipets; less accurate; transfer pipets | |  | d. | Transfer pipets; more accurate; measuring pipets | |  | e. | Measuring pipets; more precise; transfer pipets |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 19. On a lab quiz, a student listed the steps to properly use a pipet. Which step is INCORRECT?   |  |  |  | | --- | --- | --- | |  | a. | Use a rubber bulb to twice pull up a volume of liquid past the calibration mark and discard the contents into a waste container. | |  | b. | Pull up a third volume past the calibration mark and quickly replace the bulb with the index finger. | |  | c. | Touch the tip of the pipet to the side of a beaker and use the index finger to drain the liquid until the meniscus reaches the center of the calibration mark. | |  | d. | Transfer the pipet to the receiving vessel, touch the tip of the pipet to the side of the vessel, and allow the pipet to drain by gravity. | |  | e. | Use the rubber bulb to blow any remaining liquid from the pipet. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 20. \_\_\_\_\_\_\_\_\_\_\_ is the liquid from which a substance precipitates or crystallizes.   |  |  |  | | --- | --- | --- | |  | a. | Filtrate | |  | b. | Eluate | |  | c. | Effluent | |  | d. | Mother liquor | |  | e. | Slurry |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 21. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is used to convert a precipitate to a known, constant composition.   |  |  |  | | --- | --- | --- | |  | a. | Ashless filter paper | |  | b. | A fritted-glass funnel | |  | c. | Ignition | |  | d. | A rubber policeman | |  | e. | A dessicator |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 22. Drying to constant mass is a common gravimetric analysis technique. Which of the following are sources of false weights?   1. A warm crucible 2. Touching the crucible with bare fingers 3. Using a microwave oven to dry reagents and crucibles 4. Using a desiccator  |  |  |  | | --- | --- | --- | |  | a. | I, II, and III | |  | b. | II, III, and IV | |  | c. | I and II | |  | d. | II and IV | |  | e. | III and IV |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 23. A 0.150 0 M HCl solution was prepared on a day when the temperature was 20°C. What is the concentration of the solution when used the next day at 27°C? The density of water is 0.998 207 1 g/mL at 20°C and 0.996 516 2 g/mL at 27°C.   |  |  |  | | --- | --- | --- | |  | a. | 0.150 3 M | |  | b. | 0.149 7 M | |  | c. | 0.150 8 M | |  | d. | 6.653 M | |  | e. | 6.632 M |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 24. A researcher dispenses distilled deionized water from a 20-mL transfer pipet into an empty 8.437 6-g weighting bottle. If the total mass of water and weighting bottle is 28.584 5 g, what is the volume of the water delivered by the 20-mL pipet? The density of water is 0.996 786 7 g/mL.   |  |  |  | | --- | --- | --- | |  | a. | 20.21 mL | |  | b. | 20.08 mL | |  | c. | 28.68 mL | |  | d. | 19.94 mL | |  | e. | 19.90 mL |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 25. Find the true mass of NaCl (density = 2.16 g/mL) if the apparent mass weighed in air is 25.00 g. The density of air is 0.001 2 g/mL at 1 bar and 25ºC, and the density of the calibration weights is 8.0 g/mL.   |  |  | | --- | --- | | *ANSWER:* | 25.01 g; Use the buoyancy equation to calculate the true mass (*m*) from the apparent mass (*m'*). | |

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| 26. What mass of CaCl2 must you measure in air to obtain a true mass of 2.811 2 g? The density of air is 0.001 2 g/mL at 1 bar and 25ºC and the density of the calibration weights is 8.0 g/ mL.   |  |  | | --- | --- | | *ANSWER:* | 2.810 1 g; Use the buoyancy equation to calculate the apparent mass (*m'*) from the true mass (*m*). | |

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| 27. Potassium hydrogen phthalate (KHP) is a primary standard used to determine the concentration of base solutions. The mass of a sample of KHP measured in air is 4.860 7 g. Determine the true mass of KHP (density = 1.636 g/mL). The density of air is 0.001 2 g/mL at 1 bar and 25ºC, and the density of the calibration weights is 8.0 g/ mL.   |  |  | | --- | --- | | *ANSWER:* | 4.863 5 g; Use the buoyancy equation to calculate the true mass (*m*) from the apparent mass (*m'*). | |

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| 28. A total of 39.56 mL of 0.102 8 M HCl were delivered with a 50 ± 0.05 mL class A buret to neutralize an NaOH solution with an unknown concentration. What is the relative uncertainty associated with the volume delivered by the buret?   |  |  | | --- | --- | | *ANSWER:* | 0.13%; Divide the uncertainty of the buret by the delivered volume and multiply by 100 to determine the relative uncertainty. | |

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| 29. An empty 10-mL volumetric flask weighs 10.271 g. After filling to the mark with distilled water at 20°C, the mass is 20.217 g. What is the true volume of the volumetric flask at 20°C? The density of water at 20°C is 0.998 207 1 g/mL.   |  |  | | --- | --- | | *ANSWER:* | 9.975 mL; Subtract the mass of the empty flask from the mass of the filled flask to determine the mass of the water in the flask. Divide the mass of water by the density to determine the volume of the water and the flask. | |

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| 30. A weigh bottle has a mass of 10.272 g. When distilled water from a 25-mL transfer pipet is added to the weigh bottle the mass is 35.162 at 25°C. What is the true volume of the 25-mL pipet at 25°C? The density of water at 25°C is 0.997 947 9 g/mL.   |  |  | | --- | --- | | *ANSWER:* | 24.990 mL; Subtract the mass of the empty bottle from the mass of the filled bottle to determine the mass of the water in the bottle delivered by the pipet. Divide the mass of water by the density to determine the volume of the water and the pipet. | |

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| 31. Describe how to prepare a 20.00-µg/mL iron solution from a 1 000-mg/mL iron standard solution using 10-mL and 50-mL volumetric pipets and 500-mL and 1 000-mL volumetric flasks.   |  |  | | --- | --- | | *ANSWER:* | Dilute 10 mL of the 1 000-mg/mL iron solution to 500 mL to give a 20 000-µg/mL iron solution. Then, dilute 10 mL of the 20 000-µg/mL iron solution to 1 000 mL to give a 200-µg/mL iron solution. Dilute 50 mL of the 200-µg/mL solution to 500 mL to give a 20-µg/mL solution. | |

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| 32. A 0.103 4 M NaOH solution was prepared in the lab at 25°C. By what percentage will the concentration increase if the solution is used in the field at 10°C? The density of water at 10°C is 0.999 702 6 g/mL and the density at 25°C is 0.997 047 9 g/mL.   |  |  | | --- | --- | | *ANSWER:* | 0.266 3%; Calculate the concentration of the solution at 10°C, accounting for thermal expansion. Then find the difference between the concentrations at both temperatures, divide the difference by the concentration at 25°C, and multiply by 100 to determine the percent increase in the concentration. | |

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| 33. An empty 10.00-mL volumetric flask has a mass of 11.175 3 g. When filled to the mark with deionized water, the volumetric flask has a mass of 21.178 0 g. Both weighings were performed at 25°C. What is the deviation of the apparent volume from the true volume of the volumetric flask at 25°C? The density of water at 25°C is 0.997 047 9 g/mL.   |  |  | | --- | --- | | *ANSWER:* | 0.032 3 mL; Subtract the mass of the empty flask from the mass of the flask and the water to determine the mass of the water. Divide the mass of the water by its density to determine the volume of the water and the flask. The difference between this volume and 10.00 mL is the deviation in the volume. | |

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| 34. A solution has a concentration of 0.528 4 M at 13°C. What will its concentration be at 25°C? The density of water at 13°C is 0.999 379 g/mL and the density of water at 25°C is 0.997 047 g/mL.   |  |  | | --- | --- | | *ANSWER:* | 0.527 2 M; Divide the concentration of the solution at 13°C by the density of water at the same temperature and multiply by the density at 25°C. | |