UNIVERSITI KUALA LUMPUR
INSTITUTE OF MEDICAL SCIENCE TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	HDD11003
COURSE TITLE	:	INSTRUMENTATION FOR BIOMEDICAL SCIENCES
PROGRAMME NAME	:	DIPLOMA OF MEDICAL LABORATORY TECHNOLOGY
DATE	:	30 JANUARY 2026
TIME	:	3:00PM - 6:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Section A consist 25 MCQ or EMQ questions. Answer ALL questions.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 13 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 25 marks)

Answer ALL questions.

Please use the objective answer sheet provided.

1. You receive a blood sample that requires a complete blood count (CBC) analysis. Which laboratory department should the sample be sent to?

   A. Microbiology

   B. Hematology

   C. Histopathology

   D. Immunology

2. You need to dispose of 100 mL of expired 1 M hydrochloric acid (HCl). Which container should you use?

   A. Trash bin

   B. Sink with running water

   C. Biohazard bag

   D. Designated acid waste container

3. You are preparing a 0.5 L solution and the protocol requires measurements in milliliters (mL). How many mL is this?

   A. 5 mL

   B. 50 mL

   C. 500 mL

   D. 5000 mL

4. You need to prepare 1 mole of sodium chloride (NaCl). Given its molecular weight is 58.44 g/mol, which of the following masses should you weigh?

   A. 29.22 g

   B. 5.844 g

   C. 58.44 g

   D. 116.88 g

5. Calculate the volume of diluent required to prepare a 1:5 dilution if you have 2 mL of stock solution.

   A. 10 mL

   B. 8 mL

   C. 2 mL

   D. 5 mL

6. You measure a sample's concentration as 0.0250 M. Which of the following represents the correct number of significant figures in the measured value?

   A. 4

   B. 2

   C. 3

   D. 5

7. Select the correct equipment for measuring exactly 2.5 grams of powder.

   A. Graduated cylinder

   B. Spring scale

   C. Analytical balance

   D. Top-loading balance

8. Which piece of glassware is most appropriate for accurately measuring 25.0 mL of a liquid reagent?

   A. Beaker

   B. Test tube

   C. Erlenmeyer flask

   D. Graduated cylinder

9. Which combination of components is most appropriate for preparing a buffer solution required to maintain a pH of 7.4 for an enzyme assay?

   A. Distilled water only

   B. Concentrated acid only

   C. Strong acid and strong base

   D. Weak acid and its conjugate base

10. While viewing a stained blood smear under a light microscope using the 100× objective, the image appears blurry. Which of the following knobs should be adjusted first?

    A. Stage controls

    B. Fine focus

    C. Diaphragm lever

    D. Condenser adjustment

11. Select the weak acid–conjugate base pair suitable for preparing a buffer at pH 4.0 (pKa ≈ 4).

    A. Acetic acid / Acetate (pKa 4.76)

    B. Phosphoric acid / Dihydrogen phosphate (pKa 2.14)

    C. Glycine (pKa 2.34)

    D. Carbonic acid / Bicarbonate (pKa 6.1)

12. According to ISO 15189, when should you perform calibration of an analytical balance?

    A. Only when it breaks

    B. Every month

    C. Once a year

    D. According to manufacturer's schedule and after moving the instrument

13. A specimen is being observed at 400X total magnification, and more detail is required. Determine the appropriate action to achieve higher resolution.

    A. Increase light intensity

    B. Switch to the 10X objective and adjust the light

    C. Move the stage closer to the objective

    D. Add immersion oil and switch to the 100X objective

14. Which principle allows chromatographic separation of compounds based on their affinity for stationary and mobile phases?

    A. Partitioning

    B. Diffusion

    C. Precipitation

    D. Evaporation

15. In chromatographic separation, component A has a strong affinity for the stationary phase, while component B has a strong affinity for the mobile phase. Applying the principle of partitioning, predict the elution order.

    A. Component B will elute first, followed by component A

    B. Neither component will elute from the column

    C. Both components will elute simultaneously

    D. Component A will elute first, followed by component B

16. Which property of molecules is primarily exploited for separation in ion-exchange chromatography?

    A. Molecular weight

    B. Net electric charge

    C. Boiling point

    D. Solubility in organic solvents

17. Calculate the volume of 1 M NaCl stock solution required to prepare 250 mL of 0.2 M NaCl.

    A. 100 mL

    B. 200 mL

    C. 50 mL

    D. 25 mL

18. Determine the appropriate initial action when a quality control (QC) sample yields results outside the acceptable range.

    A. Replace the reagents

    B. Recalibrate the instrument

    C. Release patient results

    D. Repeat the quality control measurement

19. A sample exhibits an absorbance exceeding the instrument's measurable range. Determine the appropriate corrective action.

    A. Decrease the temperature

    B. Recalibrate the instrument

    C. Dilute the sample

    D. Increase the wavelength

20. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) are techniques that utilize the electron microscope. Identify the major difference between SEM and TEM.

A. SEM requires more sample preparation than TEM

B. SEM produces higher magnification images than TEM

C. SEM uses visible light for imaging, whereas TEM uses electron beams

D. SEM produces images of the specimen's surface, whereas TEM produces images of internal structures

21. A spectrophotometer is used to measure light absorbance in a solution. Select the correct path of light as it travels through a spectrophotometer.

A. Spectrophotometer → entry slit → exit slit → cuvette → photometer

B. Spectrophotometer → entry slit → cuvette → exit slit → photometer

C. Photometer → cuvette → entry slit → spectrophotometer → exit slit

D. Photometer → spectrophotometer → entry slit → cuvette → exit slit

22. Which of the following is the Bronsted acid / conjugate base in $H_3CO_3 + H_2O \rightarrow HCO_3^- + H_3O$ reaction?

A. H_2CO_3 and H_2O

B. H_2O and HCO^+

C. H_3O^+ and H_2CO_3

D. HCO_3^- and H_2CO_3

23. Significant figures in laboratory measurements indicate the _____.

A. precision of the measurement

B. calculation of the measurement

C. simplified calculation process

D. performance of the measurement

24. The pH scale is defined from _____.

A. logarithmic scale measurement of the salt concentration

B. linear scale that represents temperature changes

C. linear scale measurement of the solution density

D. logarithmic scale that indicates the concentration of hydrogen ions

25. Select the statements that describe the functions of a photometer.

I. Measure light intensity
II. Produces light of selected wavelengths
III. Detects the amount of light absorbed by a sample
IV. Converts the amount of light absorbed by a sample into a numerical value

A. II, III and IV only

B. I, III and IV only

C. I, II and III only

D. I, II, III and IV

SECTION B (Total: 75 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

A bright-field, also known as a light microscope, is commonly used in clinical and biological laboratories. Identify TWELVE (12) components of a standard bright-field microscope and explain the function of each component. Your answer should use scientific terminology and demonstrate an understanding of how each part contributes to image formation.

(25 marks)

Question 2

You are the Senior Medical Laboratory Scientist in charge of safety training for the Haematology department. A new laboratory assistant, Alex, has just joined your team. On Alex's first day, you are conducting an orientation. Based on this scenario, answer the following questions:

(a) While introducing Alex to the lab, you point out different workstations. Name the primary laboratory department responsible for each of the following common tests or specimens:

i. Analyzing a throat swab for bacterial infection.

(1 mark)

ii. Performing a Full Blood Count (FBC).

(1 mark)

iii. Testing a blood sample for sodium and potassium levels.

(1 mark)

iv. Performing a routine urinalysis (e.g., with a dipstick).

(1 mark)

v. Examining a stool sample for parasites.

(1 mark)

vi. Determining a patient's blood group (e.g., A, B, O, AB).

(1 mark)

vii. Processing a tissue biopsy to make microscope slides for cancer diagnosis.

(1 mark)

viii. Performing a pregnancy test on a urine sample.

(1 mark)

(b) You give Alex the laboratory's Safety Manual. State TWO (2) key information that Alex must read and understand before starting any practical work.

(4 marks)

(c) Alex will be processing blood samples. Identify ONE (1) biological hazard and ONE (1) chemical hazard specifically associated with this task.

(4 marks)

(d) While observing, you notice Alex is about to discard a used plastic serological pipette into a regular trash bin after it was used with a blood sample. Describe the immediate corrective action to be taken. In your answer, name the correct waste stream and explain THREE (3) reasons why this correction is important.

(9 marks)

Question 3

(a) In recording the mass of a precipitate, a student writes "0.5040 g" in her lab book.

i. Identify the number of significant figures in the recorded mass and justify your answer.

(3 marks)

ii. Convert the mass into kilograms (kg) and milligrams (mg) while maintaining the correct number of significant figures in both values.

(2 marks)

(b) You have a stock solution of potassium nitrate (KNO_3) with a concentration of 2.5 mol L-1.

i. Calculate the volume of the stock solution required to prepare 500 mL of a 0.4 M KNO_3 solution.

(3 marks)

ii. Describe how to prepare the stock solution in part (b) i using only a 10 mL serological pipette, a volumetric flask, distilled water, and a dropper. Explain step by step how to prepare the solution with the correct concentration using only the listed apparatus.

(12 marks)

(c) A student is preparing a 0.2 M natrium hydroxide (NaOH) solution from a 2.0 M stock solution. After preparing 250 mL, he realizes he needs to perform a second dilution to make a 0.05 M solution for his experiment.

i. Calculate the volume of 2.0 M NaOH stock solution required to prepare 250 mL of 0.2 M solution.

(3 marks)

ii. Explain why using significant figures is important when performing both the first and second dilution steps. Provide one example.

(2 marks)

Question 4

(a) Calculate the pH of a 0.025 M solution of hydrochloric acid (HCl).

(5 marks)

(b) A buffer solution is prepared by mixing 100 mL of 0.1 M acetic acid (CH_3COOH, pKa = 4.76) with 100 mL of 0.15 M sodium acetate (CH_3COONa). Calculate the initial pH of this buffer solution.

(16 marks)

(c) Define the term "buffer solution" and explain its function.

(4 marks)

END OF EXAMINATION PAPER