UNIVERSITI KUALA LUMPUR
INSTITUTE OF MEDICAL SCIENCE TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	HDB20303
COURSE TITLE	:	BASIC HEMATOLOGY
PROGRAMME NAME	:	BACHELOR OF BIOMEDICAL SCIENCE (HONOURS)
DATE	:	03 FEBRUARY 2026
TIME	:	9:00AM - 12:00PM
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. Answer ALL questions for Section A.
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 20 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. The most appropriate site for venepuncture when collecting a blood sample from a patient who has intravenous (IV) fluids cannula in the left arm is to _____.

   A. draw above the IV site

   B. use the right arm

   C. draw below the IV site

   D. use a syringe rather than a vacutainer

2. A blood specimen appears hemolyzed despite proper venepuncture technique. Which post-collection handling error is most likely responsible?

   A. Immediate inversion 8–10 times.

   B. Blood storage at 4°C.

   C. Vigorous shaking of the tubes.

   D. Transport of sample on ice.

3. The major structural protein responsible for maintaining RBC biconcave shape and deformability is _____.

   A. ankyrin

   B. spectrin

   C. actin

   D. band 3

4. The function of the hexose monophosphate shunt (HMP) in RBCs is to _____.

   A. generate NADPH to protect against oxidative damage

   B. produce ATP for ion pumps

   C. form 2,3-BPG for oxygen release

   D. maintain membrane deformability

5. Which component of the bone marrow microenvironment is primarily responsible for maintaining HSC quiescence?

   A. Osteoblasts

   B. Sinusoidal endothelial cells

   C. Megakaryocytes

   D. Adipocytes

6. Which statement best distinguishes the osteoblastic niche from the vascular niche?

   A. Osteoblastic niche promotes HSCs proliferation while vascular niche promotes quiescence.

   B. Vascular niche supports osteoclast formation.

   C. Osteoblastic niche maintains quiescent HSCs while vascular niche supports HSC activation and migration.

   D. Both niches provide identical functions.

7. Failure to rinse the smear adequately after staining may result in which of the following?

   A. Loss of RBC central pallor.

   B. Precipitated stain granules.

   C. Disappearance of eosinophil granules.

   D. Red smudge cells.

8. A blood smear that is too short and thick is most likely caused by _____.

   A. using too little blood

   B. increasing spreader angle

   C. decreasing spreader angle

   D. slow spreading motion

9. During Wright–Giemsa staining, what is the most likely consequence of using a buffering solution with a pH of 6.2 instead of the recommended pH 6.8?

   A. Neutrophils show hypersegmented nuclei artifactually.

   B. Lymphocyte nuclei become poorly stained and appear pale.

   C. RBCs appear orange-pink due to excessive eosin uptake.

   D. Platelets appear excessively purple with clumping.

10. Which of the following explains why the depth of the hemocytometer chamber is used in cell count calculations?

   A. It affects the volume above each grid.

   B. It prevents hemolysis.

   C. It stabilizes cells.

   D. It colors the cells.

11. If a laboratory technician obtains a 15% difference in WBC counts between the upper and lower areas of a hemocytometer, what is the recommended course of action?

   A. Report immediately the discrepancy.

   B. Accept the results as they are within normal limits.

   C. Repeat the WBC count to evaluate precision and consistency.

   D. Ignore the variation and report the first count.

12. A 1:200 dilution of the patient's sample was made in a red blood cell (RBC) Thoma pipette with RBC diluting fluid. A total of 350 RBC were counted in an area of 0.2 mm^2 using a hemocytometer. The patient's total RBC count is _____.

    A. $1.75 \times 10^{12}/L$

    B. $6.16 \times 10^{12}/L$

    C. $3.50 \times 10^{12}/L$

    D. $4.47 \times 10^{12}/L$

13. A 1:20 dilution was made using a white blood cell (WBC) Thoma pipette with glacial acetic acid as the diluent. The four corner squares on both sides of the hemocytometer were counted for a total of 160 cells. The total of WBC count is _____.

    A. $8 \times 10^{9}/L$

    B. $4 \times 10^{9}/L$

    C. $16 \times 10^{9}/L$

    D. $0.40 \times 10^{9}/L$

14. Which of the following correctly represents the normal range for a white blood cell (WBC) differential in a healthy adult?

    A. Neutrophils 30–50%, Lymphocytes 20–60%, Monocytes 5–15%, Eosinophils 1–5%, Basophils 0–1%

    B. Neutrophils 40–80%, Lymphocytes 20–40%, Monocytes 2–10%, Eosinophils 1–6%, Basophils 0–1%

    C. Neutrophils 20–40%, Lymphocytes 40–80%, Monocytes 2–8%, Eosinophils 1–4%, Basophils 0–1%

    D. Neutrophils 50–70%, Lymphocytes 10–20%, Monocytes 5–10%, Eosinophils 1–4%, Basophils 0–2%

15. In cyanmethemoglobin method, a patient's blood is diluted with Drabkin's solution. The absorbance of the sample is 0.450, and the absorbance of the standard cyanmethemoglobin absorbance (20 g/dL) is 0.600. What is the hemoglobin concentration in g/dL?

    A. 20 g/dL

    B. 12 g/dL

    C. 15 g/dL

    D. 27 g/dL

16. A medical laboratory technologist performs packed cell volume (PCV) and erythrocyte sedimentation rate (ESR) tests on the same patient. The results show a falsely low PCV and a falsely high ESR. Which pre-analytical error best explains these findings?

    A. Delayed processing → RBC swelling

    B. Underfilling the ESR tube

    C. Vigorous shaking → RBC fragmentation

    D. Excess anticoagulant → RBC shrinkage

17. Based on the following result, calculate the percentage of hematocrit or packed cell volume (PCV) if the total height of the entire blood column is 65 mm, height of buffy coat is 15 mm and height of red blood cells is 27 mm.

    A. 34%

    B. 65%

    C. 42%

    D. 18%

18. A patient's Sahli hemoglobin (Hb) value is 6 g/dL, but the cyanmethemoglobin method performed immediately afterward gives 10.5 g/dL. The most likely explanation is _____.

A. cyanmethemoglobin method overestimates Hb

B. Sahli pipette delivered insufficient blood

C. cyanmethemoglobin reagents interfered with lipemia

D. Sahli acid hematin conversion was incomplete

19. Determine the hematocrit level measured by the hematocrit reader, as shown in the following figure.

Refer Below - Figure1 : Hematocrit test .

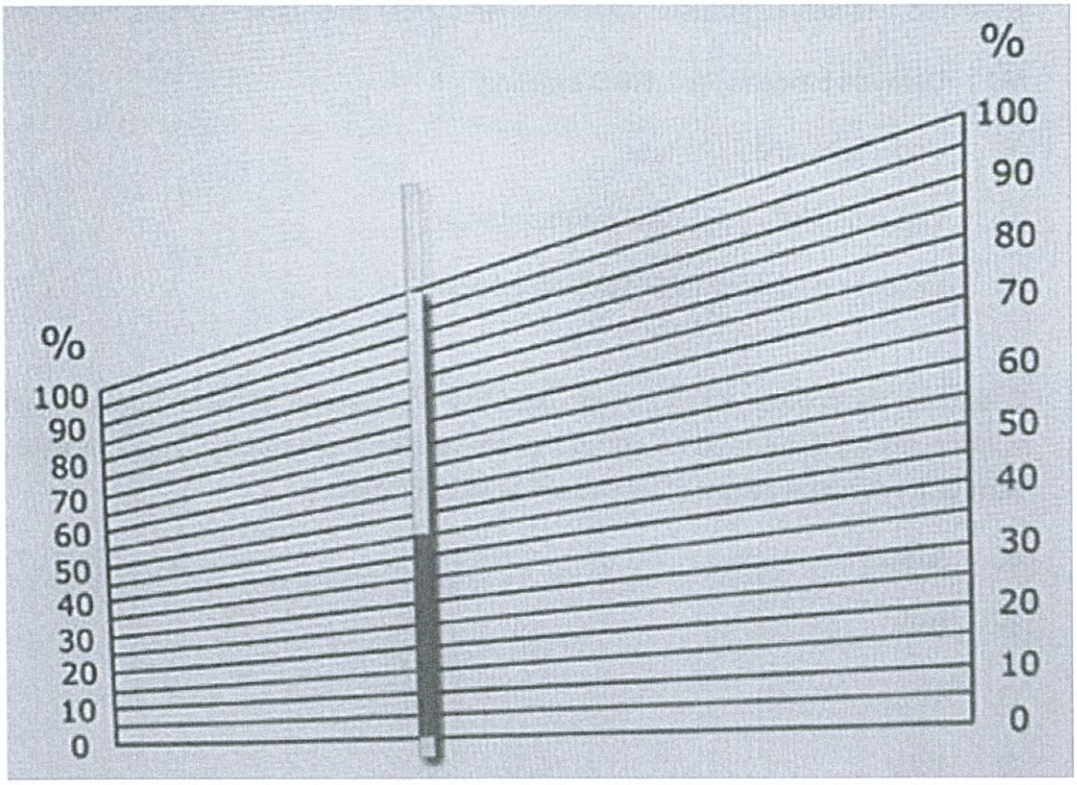

Figure 1: Hematocrit test

A. 55%

B. 45%

C. 50%

D. 40%

20. Determine the erythrocyte sedimentation rate (ESR) level measured by the Westergren method, as shown in the figure below.
Refer Below - Figure2 : Erythrocyte Sedimentation Rate (ESR) .

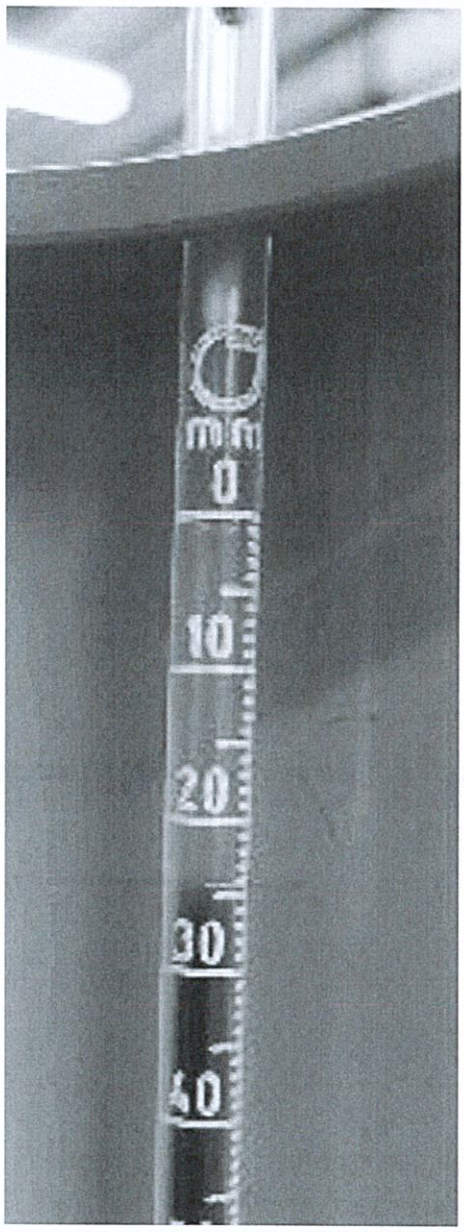

Figure 2: Erythrocyte Sedimentation Rate (ESR)

A. 35 mm/hour

B. 175 mm/hour

C. 25 mm/hour

D. 165 mm/hour

21. Given a hematocrit (Hct) of 45%, hemoglobin (Hb) of 12 g/dL, and a red blood cell count of 5×10^{12}/L, calculate the mean cell volume (MCV).

A. 240 femtoliter

B. 24 femtoliter

C. 90 femtoliter

D. 900 femtoliter

22. Coagulation result of a prolonged prothrombin time (PT) and a normal activated partial thromboplastin time (APTT) is likely due to deficiency of factor _____.

A. II

B. X

C. V

D. VII

23. Which platelet receptor is essential for platelet adhesion to von Willebrand factor?

A. TP alpha

B. P2Y12

C. GP Ib/IX/V

D. GP IIb/IIIa

24. The extrinsic coagulation pathway is triggered by tissue damage that exposes _____ expressed on fibroblasts and smooth muscle cells of the subendothelial connective tissue.

A. tissue factor (TF)

B. Stuart-Prower factor

C. Christmas factor

D. von Willebrand factor (vWF)

25. The platelet function analyzer (PFA-100) is designed to assess _____.

A. RBC aggregation

B. platelet function under shear stress

C. fibrinolytic activity

D. coagulation factor deficiencies

26. Which of the following closure times is considered normal for Collagen/Epinephrine (Col/Epi) cartridge?

A. 80–190 seconds

B. 20–120 seconds

C. 50–150 seconds

D. 100–250 seconds

27. Which assay measures functional fibrinogen levels?

A. Activated partial thromboplastin time (aPTT)

B. D-dimer

C. Prothrombin time (PT)

D. Clauss fibrinogen assay

28. Which clotting factor is most likely deficient in a patient who presents with a prolonged PT but a normal aPTT?

A. Factor VII

B. Factor XI

C. Factor VIII

D. Factor IX

29. Ms. Shila, a 35-year-old patient, presents with unexplained bleeding. Laboratory testing shows a prolonged prothrombin time (PT). A 1:1 mixing study is performed with normal plasma, and the PT returns to within the normal range. Which of the following is the most likely explanation?

A. The patient has thrombocytopenia.

B. The patient has lupus anticoagulant.

C. The patient has a coagulation factor deficiency.

D. The patient has a circulating coagulation inhibitor.

30. In optical /flow cytometric counting, cells are differentiated based on the _____.

A. size and internal complexity

B. enzymatic activity

C. hemoglobin concentration

D. membrane potential

31. A high red cell distribution width (RDW) on the automated blood cell counting analyzer indicates _____.

A. increased variation in RBC size

B. presence of microcytes only

C. clumped platelets

D. increased reticulocyte production

32. Which procedures are typically included in the internal quality control (QC) of coagulation analyzers?

A. Running control plasma with known clotting times.

B. Visual inspection of clot formation.

C. Checking tube fill levels.

D. Testing patient samples twice.

33. Which of the following explains the primary use of Levey-Jennings charts?

A. Identification of outliers, trends and shifts in data that may indicate a malfunction or other problem.

B. Determination of the best fit line through a large set of data points.

C. Generation of a standard curve from a sample concentration.

D. Maintenance of laboratory equipment with the International Sensitivity Index (ISI).

34. Which of the following is a crucial feature of a substance used as a control?

A. It should be stored at 32°C to prevent degradation.

B. It should mimic the chemical and physical properties of a typical patient specimen.

C. It should be provided and maintained by manufacturer of the assay or equipment.

D. It should be constructed from real human tissues or fluids.

35. The 4_{1s} in the Westgard rule best describe that the control has _____.

A. a point exceeds +/- three standard deviations

B. 4 consecutive points exceed +1 standard deviation, or 4 consecutive points exceed -1 standard deviation

C. one point is beyond +2 standard deviations, and the following point is beyond -2 standard deviations or vice versa

D. two consecutive points are beyond +2 standard deviations from the mean or beyond -2 standard deviations from the mean

36. In an automated cell-counting instrument, forward-angle light scatter (0°) measures the _____.

A. cellular granularity

B. cell volume

C. nuclear density

D. internal complexity of the cell

37. Modern coagulation analyzers have greatly enhanced the ability to perform coagulation testing as a result of which of the following?

A. Increase in reagent volume capabilities to improve sensitivities.

B. Maintenance of a level of accuracy and precision similar to that of manual methods.

C. Improved flagging capabilities to identify problems in sample quality or instrument function.

D. Automatic adjustment of results for interfering substances.

38. The following is a Levey-Jenning chart measuring a single control. Which of the Westgard rule is violated in this chart?

Refer Below - Figure3 : Levey-Jenning control chart .

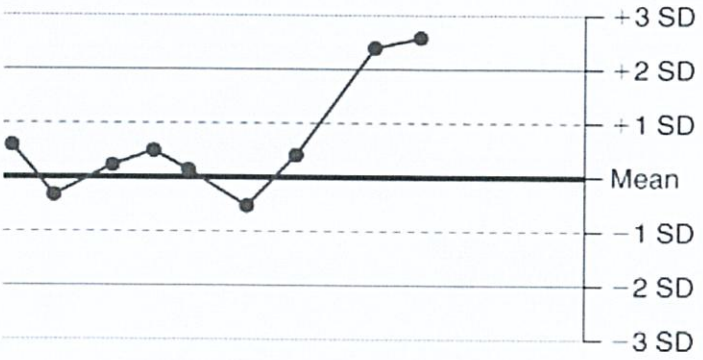

Figure 3: Levey-Jenning control chart

A. Rule 1_{3s}

B. Rule R_{4s}

C. Rule 2_{2s}

D. Rule 1_{2s}

39. Which of the following best summarizes the circled data shown in the Levey-Jennings chart below?

Refer Below - Figure4 : Levey-Jennings chart .

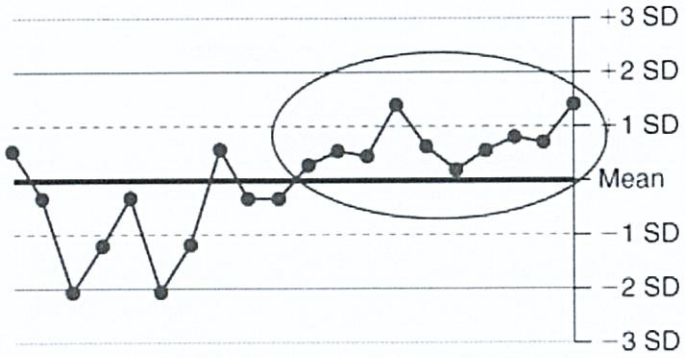

Figure 4: Levey-Jennings chart

A. The data fall within 2 SD of the mean, so the recent run can be accepted.

B. The data violate the Westgard rules of 10_{x} so the recent run must be rejected.

C. The data comply with at least 3 of the Westgard rules, so the recent run may be accepted.

D. The data have several outliers, so the recent run must be rejected.

40. Which of the following is true about the data point noted by the arrow in the Levey-Jennings chart provided?

Refer Below - Figure5 : Levey-Jennings chart .

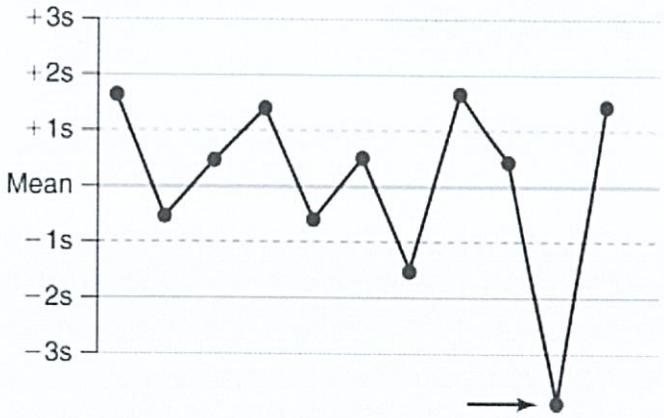

Figure 5: Levey-Jennings chart

A. It is an outlier.

B. It suggests a shift has occurred.

C. It suggests a standard dispersion.

D. It suggests the data are trending downward.

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Mr. Ezwan, a 35-year-old man, attends the clinic for his annual routine health check-up. He is asymptomatic and has no significant past medical history. He does not smoke, exercises regularly, and follows a balanced diet. Physical examination reveals no abnormalities. As part of routine screening, the doctor orders a complete blood count (CBC), fasting blood glucose, and basic coagulation tests (PT and APTT). Blood samples are collected into multiple vacutainer tubes for these investigations. The results are presented in the table below.

Based on the information given, answer the following questions:

Refer Below - Table1 : Laboratory investigation results .

Table 1: Laboratory investigation results

Test	Result	Unit	Reference Interval
WBC	6.8	x 10^9/L	4.0-11.0
Hemoglobin (Hb)	13.4	g/dL	120-16.0
RBC	4.5	x 10^{12}/L	4.0-5.0
Hematocrit	41	%	38-46
MCV	***x***	fL	80-100
MCH	***y***	pg	28-34
MCHC	***z***	g/dL	32-36
Platelet	280	x 10^9/L	150-400
Fasting blood glucose	5.1	mmol/L	3.9-5.5
PT	11.8	seconds	11-14
aPTT	30	seconds	27-35

(a) State the correct order of draw for venous blood collection using vacutainer tubes.

(3 marks)

(b) Calculate the values of **x, y and z**. Show all calculations and the formulas used.

(12 marks)

(c) If the doctor requests an examination of blood cell morphology, describe the procedure for preparing a peripheral blood film using the wedge (push-slide) method.

(5 marks)

Question 2

Mr. Majid, a 50-year-old man presents with joint pain, fatigue, and morning stiffness. His laboratory results show an erythrocyte sedimentation rate (ESR) of 48 mm/h (normal: 0–20 mm/h), indicating an elevated ESR rate. His complete blood count is normal, with a hemoglobin level of 13.2 g/dL, a white blood cell count of 7.5 $\times 10^9$/L, and a platelet count of 280 $\times 10^9$/L. C-reactive protein (CRP) is elevated at 25 mg/L, and the rheumatoid factor is positive. A peripheral blood smear shows normocytic, normochromic red blood cells.

(a) State two clinical conditions that could cause an elevated ESR.

(2 marks)

(b) Briefly explain the three factors that can affect ESR results.

(6 marks)

(c) With the aid of illustration, explain the procedure of ESR determination that you have learned in the hematology laboratory.

(10 marks)

(d) State the purpose of performing quality control in the ESR test.

(2 marks)

Question 3

Ms. Afeeya, a 25-year-old healthy female, attends her annual check-up. She has no history of abnormal bleeding, bruising, or prolonged bleeding after minor cuts. She is not on any medications that affect blood clotting. Physical examination is unremarkable. Laboratory investigations were performed as part of routine screening:
Complete blood count: normal
Platelet count: 250 $\times 10^3/\mu L$
Bleeding time: within normal limits
Prothrombin time (PT): 12 seconds (normal)
Activated partial thromboplastin time (aPTT): 30 seconds (normal)

(a) Explain how platelets contribute to primary hemostasis, including their actions at the site of vascular injury.

(10 marks)

(b) Explain the principle and procedure of the aPTT test that you have performed in the hematology laboratory.

(10 marks)

Question 4

The following figure illustrates the schematic diagram set-up of principle X used in an automated blood cell counting analyzer.

Refer Below - Figure6 : Automated blood cell counting analyzer .

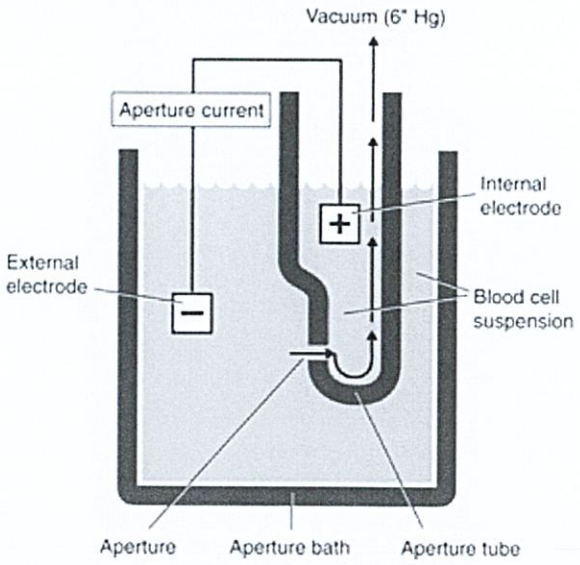

Figure 6: Automated blood cell counting analyzer

(a) Name the principle used and explain how blood cells are counted by this method.

(9 marks)

(b) State the differences between 3-part and 5-part differential cell counter of this automated blood analyzer.

(6 marks)

(c) Illustrate the distribution curve of red blood cells, platelets and white blood cells in a normal individual .

(5 marks)

END OF EXAMINATION PAPER