



THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – November 2020

GGY 3031 - STRATIGRAPHY AND PALEONTOLOGY

**INSTRUCTIONS:** ANSWER ANY FIVE QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS. USE SKETCHES WHERE POSSIBLE FOR A FULL MARK

**TIME:** THREE HOURS

Q1. Differentiate between the following terms, where possible use diagrams:

- (a) Phanerozoic and Mesozoic
- (b) Depositional Sequence and Parasequence
- (c) Principle of original horizontality and Principle of cross-cutting relationships 12
- (d) Guide fossils and Index fossils
- (e) Disconformity and Paraconformity

**Total Marks = 20**

- Q2. (a) Outline the causes proposed for the main mass-extinction events in the Geologic Stratigraphic Column.
- (b) Write short notes on the basic principles of estimating absolute ages.
- (c) Outline the four methods for direct radiochronology of sedimentary rocks including their limitations.

**Total Marks = 20**

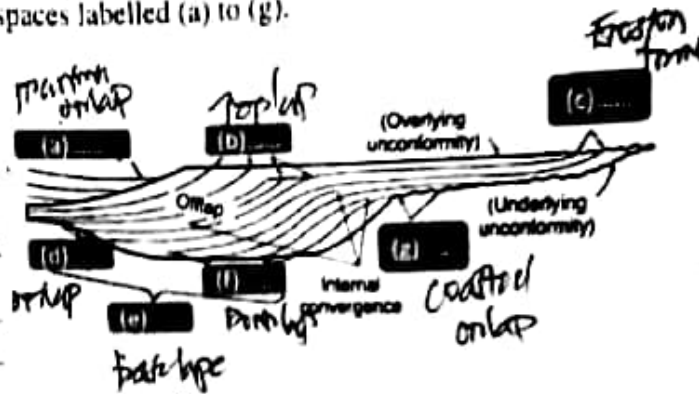
- Q3. (a) Describe Walter's Law of facies of 1894. Use diagrams to illustrate your explanations.
- (b) Outline the major events in the evolution of life in the Precambrian. (Hint 5 of them)

**Total Marks = 20**

- (a) Differentiate between the following:
- Seismic Stratigraphy and Magneto-Stratigraphy
  - Chronostratigraphy and Biostratigraphy
  - Hiatus and Unconformity
- (b) Outline the reasons why fossils are not preserved.
- (c) Describe briefly the processes that may lead to the alterations of fossils.
- Total Marks = 20**

- (a) Define Trace fossils
- (b) There are nine (9) main activities recognized in trace fossil studies as responsible for forming most of the trace fossils. Outline them.
- (c) Fill in the blank spaces labelled (a) to (g).

FIGURE 14.15 Terminology for relations that define unconformable boundaries of a depositional sequence (After Mitchum, R. M., Jr., P. R. Vail, and J. B. Sangree, 1977, Seismic stratigraphy and global changes of sea level. Part 6. Stratigraphic interpretation of seismic reflection patterns in depositional sequences, in C. E. Payton (ed.), Seismic stratigraphy—Applications to hydrocarbon exploration: Am. Assoc. Petroleum Geologists Mem. 26, Fig. 1, p. 118, reprinted by permission of AAPG, Tulsa, Okla.)



- (d) Stratigraphic information can be organized and displayed in various ways. Outline four (4) ways in which your stratigraphic information you have collected from the field and laboratory studies can be represented.

**Total Marks = 20**

- Q6. (a) Define the term lithostratigraphy.
- (b) Outline the main elements of lithostratigraphic units. Hint: nine (9) Altogether.
- (c) What do you call a mappable unit that can be shown on a Map. How is this linked to other units such as a Supergroup? Draw a sketch or diagram to illustrate this.

**Total Marks = 20**



- Q7.
- (a) ✓ Define physical correlation
  - (b) List and outline the five (5) wide variety of properties and techniques used in physical correlation, many of which have little or no time-significance
  - (c) ✓ In Biostratigraphy, fossils contained in sedimentary rocks are the "tools" used. State and outline five (5) purposes of which these tools are used.
  - (d) ✓ Charles Darwin (1859) provided a key with his explanation of organic evolution -- the origin of species by natural selection. State his observation, suggestions and conclusions (Hint 4 statements). ✓

**Total Marks = 20**

=====GOOD LUCK; END OF EXAM=====



**THE UNIVERSITY OF ZAMBIA**

**UNIVERSITY OF ZAMBIA EXAMINATIONS – NOVEMBER 2019**

**GGY 3020 – MINERALOGY AND PETROLOGY**

**PAPER II - PRACTICAL**

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**INSTRUCTIONS:** answer all questions illustrating your answers wherever possible. Use separate answer books for each section.  
**TIME:** Three Hours

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**SECTION A – MINERALOGY (1.5 hours)**

- Q1. Study the mineral Y under the microscope and using optical properties identify the mineral. [15 Marks]
- Q2. Using the provided crystal model 8 and assuming that z-axis goes through centres of 2 opposite corners, x-axis through centres of 2 opposite horizontal edges and y-axis through centres of 2 opposite horizontal edges and interfacial angle between any of the slanting face and z-axis is  $60^\circ$ . Axes x, y and z are perpendicular to each other. Axis z is longer than x and y. Axes x and y are equal in length and lie in the same plane. Do the following: [35 Marks]
- (a) Sketch the model and label all faces, crystallographic axes, and characteristic element(s) of symmetry.
  - (b) Identify and name the two open forms present on the crystal and faces that belong to each type.
  - (c) Plot a stereogram for the crystal model ensuring that all the crystallographic axes, all the faces, and elements of symmetry (i.e. rotational axes of symmetry and planes of symmetry) are clearly labeled.
  - (d) Determine the Miller indices of a face that lies in the same zone as two faces (one on the positive sides of x and z and the other on the positive sides of y and z) and  $45^\circ$  from either x or y axis and  $45^\circ$  from z axis. Plot such a face on the stereonet.

**SECTION A – PETROLOGY (1.5 hours)**

- Q3. Give a full petrographic description of the six rock samples 1, 2, 3, 4, 5 and 6 emphasizing on the following: [30 Marks]
- (a) Mineralogy
  - (b) Texture
  - (c) Name the rock

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**END OF EXAMINATION**

**The University of Zambia**  
**Department of Mathematics and Statistics**  
**MAT2602: Introduction to Statistics**

10<sup>th</sup> December, 2020

**Test**  
**Time Allowed:** Two (2) Hours  
**Instructions:**

1. Answer All Questions
2. Show All Essential Working

1. (a) Define the following:
- (i) descriptive statistics
  - (ii) a simple random sample

- (b) The following stem and leaf plot shows humidity readings taken over 20 days:

1	2 7 5
2	9 1 5 3 4 7 1 8
3	4 9 2 4 7
4	4 8 2
5	3

12 15 17 21 21 23 24 25  
 28 29 32 34 34 35 39 42  
 48 53

Key: 1 | 3 = 13

- (i) Construct a grouped relative frequency distribution table for the readings using the classes 10 - 16, 17 - 23, ...
  - (ii) Using the same classes in (i) construct a relative frequency histogram and a relative frequency polygon on the same graph.
  - (iii) Find  $P_{66}$ .
- (c) A soft drink machine is regulated so that it discharges an average of 200ml per cup. If the amount of drink is normally distributed with a standard deviation equal to 15ml, what is the probability that
- (i) the mean content of 27 cups is between 195ml and 198ml?
  - (ii) a randomly selected cup contains more than 225ml?
2. (a) A company is considering installing new machines to assemble its products. Eight assembly workers were selected to use these machines to assemble products. The table gives the times taken (in minutes) to assemble one unit of the product on each type of machine for each of the eight workers.

Machine I	23	26	19	24	27	22	20	18
Machine II	21	24	23	25	24	28	24	23

Assume the assembly times are normally distributed. Is the mean assembly time the same for the two types of machines? Use  $\alpha = 0.05$ .

$$T = \frac{\bar{x}_1 - \bar{x}_2 - \mu_0}{\sqrt{SP^2 \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}} \cdot z$$

$z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{0.5n}}$

(b) An airline claims that less than 15% of its flights are delayed. A random sample of 50 flights on a given day shows that 6 are delayed.

$\frac{7.2}{2}$   
4d

- (i) Is there sufficient evidence to support the airline's claim at the 1% level of significance?  
 (ii) How large a sample is required if we wish to be 95% confident that our sample proportion is within 0.05 of the true proportion of delayed flights?

(c)

A supermarket claims that 41% of customers pay cash, 24% use cheque, 26% use credit or debit card and 9% use other modes of payment. To test the claim 600 customers were randomly selected and modes of payment recorded. Test the supermarket's claim at a 5% level of significance.

Mode of payment	Number of customers
Cash	265
Cheque	129
Credit / Debit card	136
Other	70

3. (a) The owner of a health spa wished to study the relationship between the temperature (x) in degrees Fahrenheit and the number (y) of customers using the facilities at noon for randomly selected days during summer. The following results were obtained:

Temperature (x)	65	67	75	80	85	87
Number of customers (y)	27	25	20	22	16	10

(Additionally:  $\sum x_i = 459$  ,  $\sum x_i^2 = 35533$  ,  $\sum y_i = 120$  ,  
 $\sum y_i^2 = 2594$  ,  $\sum x_i y_i = 8920$  )

7.2

- (i) Estimate the linear regression line.  
 (ii) Determine whether there is a significant linear relationship between temperature and number of customers. Use a 5% level of significance.  
 (iii) Find  $R^2$  and explain its meaning.

$\frac{11}{2}$   
1 - 0.001  
90%

(b) A study was conducted to compare the mean yield of five varieties of maize using a completely randomized design. Copy and complete the following ANOVA table and determine whether the five varieties are significantly different. Use  $\alpha = 0.05$ .

Source	SS	df	MS	F*
Treatments	250			
Error	150			
Total		19		

End of Test

**THE UNIVERSITY OF ZAMBIA**  
**UNIVERSITY EXAMINATIONS – NOVEMBER 2019**

**GGY 3020 – MINERALOGY AND PETROLOGY**

**PAPER I (THEORY)**

**INSTRUCTIONS:** Answer at least two questions from each section and any other question illustrating your answers wherever possible.  
 Use a separate answer book for each section.

**TIME:** Three (3) Hours

**Full Marks:** 100

**SECTION A – MINERALOGY**

**Q.1. [20 Marks]**

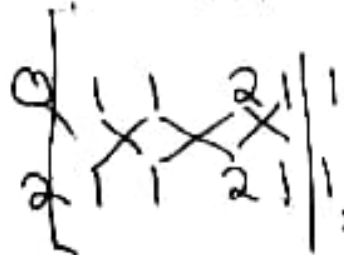
- (a) Determine axial ratios  $a/b$  and  $c/b$  for the following faces whose interfacial angles  $\alpha$  are provided and draw well labelled sketches showing face relationships. [6 marks]

FACE	$\rho$	$\phi$
(130)	$90^\circ$	$33^\circ$
(012)	$69^\circ$	$0^\circ$

- (b) Using the zone symbol method prove if the following set of faces lies in the same zone: (011), (211) and (100). [4 marks]
- (c) If the axial ratio  $a:b:c$  is 1:1.2:7475 determine interfacial angles  $\phi$  (in the x-y plane) and  $\rho$  (in the z-y plane) given faces (110) and (011). [4 marks]
- (d) Determine the unit cell volume ( $\text{cm}^3$ ) and density ( $\text{g/cm}^3$ ) of the mineral zircon [(ZrSiO<sub>4</sub>), which belongs to the tetragonal system. Unit cell parameters are as follows:  $a = 6.607\text{\AA}$ ,  $c = 5.982\text{\AA}$ ;  $\alpha = 90^\circ$ ,  $\beta = 90^\circ$ ,  $\gamma = 90^\circ$ ;  $Z = 4$ . (6 marks)

**Q.2. [20 Marks]**

- (a) Write short notes on the following terms. [8 marks]  
 (i) Radius ratio; (ii) Coordination number; (iii) Electronegativity; (iv) Pleochroism
- (b) Distinguish twin plane from zone plane. (4 marks)
- (c) Explain briefly why the sky looks blue? (3 marks)
- (d) Under what conditions in terms of the rules described above does each of the following occur?  
 (i) element capture, and (ii) element admission. (5 marks)



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FAI  
 FAI

Q.3. [20 Marks]

- (a) Calculate the mineral formulae for the minerals whose Electron Microprobe Analysis (EPMA) analytical results provided. Write down the mineral formula using up to 3 decimals. (8 marks)

Kyanite  $Al_2SiO_5$

Oxide	Wt. % Oxide
SiO <sub>2</sub>	37.08
Al <sub>2</sub> O <sub>3</sub>	62.92
TOTAL	100.00

- (b) Describe briefly the key characteristics of the following silicate structures giving at least one mineral example of each: (i) Double Chain Silicates and (ii) Cyclosilicates. (6 marks)
- (c) Forsterite, an orthorhombic mineral, has the following unit cell parameters:  $a = 4.75 \text{ \AA}$ ,  $b = 10.20 \text{ \AA}$ ,  $c = 5.98 \text{ \AA}$ ,  $\alpha = \beta = \gamma = 90^\circ$ . Determine the unit cell interplanar distance [ $d_{201}$ ] for forsterite and then  $2\theta$  using the Bragg equation. The  $CuK\alpha$  wavelength ( $\lambda$ ) for the analysis was  $1.5405 \text{ \AA}$  and  $n = 1$ . (6 marks)

**SECTION B - PETROLOGY**

Q.4. [20 Marks]

- (a) What are the main types of magma and how they are distinguished in terms of their chemical composition, temperature and viscosity.
- (b) Define the following:  
(i) sill (ii) Cone sheet (iii) Ring dyke (iv) Xenolith (v) Columnar joints

Q.5. [20 Marks]

- (a) Give brief account of the followings:-

- i. Amygdaloidal texture
- ii. Oolitic texture
- iii. Ring dyke
- iv. Periodotite
- v. Greywake

- (b) What are the three principal categories of igneous rocks? What characterizes each?

Q.6 [20 Marks]

(a) Explain the classification of crystalline sedimentary rocks in terms of origin, texture & composition.

(b) Define the following:

- i. Vesicular texture
- ii. Graded bedding
- iii. Augen gneiss
- iv. Conglomerate
- v. Crystalline limestone

Q.7 [20 Marks]

(a) Give a brief description of the main textures of metamorphic rocks

(b) How does a *felsic* mineral differ from a *mafic* mineral? Which minerals on Bowen's Series are mafic? Which are felsic?

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End of Examination



THE UNIVERSITY OF ZAMBIA

GGY3020 - MINERALOGY AND PETROLOGY

TEST I

INSTRUCTIONS: Answer all questions  
TIME: TWO (2) Hours

Q1. What distinguishes:

- a. Volcanic from plutonic rocks?
- b. Pyroclastic/volcanics?
- c. Magma from lava?

Q2. (i) Give brief account of the followings:-

- a) amygdaloidal texture
- b) Oolitic texture *spheroidal shape*
- c) Ring dyke -
- d) periodotite *ultramafic rock*
- e) Greywacke *20% clay*

(ii) What are the three principal categories of igneous rocks? What characterizes each?  
*plutonic, volcanic, extrusive*

Q3. (i) Explain the classification of crystalline sedimentary rocks in terms of origin, texture and composition. *Organic, inorganic detrital*

(ii) Define the following:

- a) Vesicular texture *air holes*
- b) Graded bedding *fine at top coarse at bottom*
- c) Conglomerate - *rounded clasts*
- d) Crystalline limestone - *clastic grains irregular boundary*

END OF TEST

UNIVERSITY OF ZAMBIA  
SCHOOL OF MINES  
GEOLOGY DEPARTMENT

GGY 3020 - MINERALOGY AND PETROLOGY

TEST 1

**Date:** Thursday 22<sup>nd</sup> October 2020 (14:00 to 15:30)

**Instructions:** Answer all questions using neatly labelled sketches wherever possible

**Time:** 1 hour 30 Minutes

- Q1. (i) Define the following terms: (a) refractive index; (b) pinacoid; (c) coordination Number, (d) centre of symmetry. (8 marks) 6
- (ii) Why are sections cut perpendicular to the optic axis (or z-axis) in hexagonal, trigonal and tetragonal minerals isotropic? (3 marks) 3
- (iii) If, in the mineral halite, the radius of Na<sup>+</sup> is 0.99 Å and that of Cl<sup>-</sup> is 1.81 Å, what is the radius ratio? (2 marks) 2
- (iv) Coordination numbers of 4 and 6 are referred to as. (2 marks) 2

Q2. The tetragonal crystal sketch shown in the figure on the next page is intersected by imaginary axes a, b and c which are the same as x, y and z, respectively. The interfacial angle ( $\rho$ ) between any inclined face and faces intersecting the z-axis is 70°. Note: ensure that you indicate on the figure your computer number and submit it with the answer sheet.

- (i) Label on the figure all the faces using Miller symbols. (5 marks) 5
- (ii) Show on the figure the tetrad and the four diads in symbol form. (5 marks)
- (iii) Calculate the latitude. (2 marks) 2

Q3. Given the faces below do two clearly labelled sketches and calculate axial ratios a/b and c/b. (10 marks)

- Faces  $\rho$   $\phi$
- (120) 90 70
- (011) 32 0

- Q4. (i) Briefly describe isomorphism and polymorphism and state one mineral example in each case. (6 marks) 6
- (ii) Briefly describe how exsolution textures form. (3 marks) 3
- (iii) Determine the density (g/cm<sup>3</sup>) of the mineral zincite (ZnO), which belongs to the tetragonal system. Unit cell parameters are as follows: a = 3.2427 Å, b = 3.2427 Å, c = 5.1948 Å;  $\alpha = 90^\circ$ ,  $\beta = 90^\circ$ ,  $\gamma = 90^\circ$ ; Z = 8. (4 marks) 4

*this results when temperature fall and also more are formed part of the of the major mol. and concentrate in one area at many spots that results phenocryst.*

$$V = a^2c$$

$$\rho = \frac{Z \cdot FW}{A \cdot V}$$

$$FW = 85.39 + 16 = 101.39$$

$$32.8536$$

**UNIVERSITY OF ZAMBIA**  
**SCHOOL OF MINES - MINING ENGINEERING DEPARTMENT**

**MIN 2019 – INTRODUCTION TO MINING: END OF 2019 TERM II TEST**

**INSTRUCTIONS: ANSWER ALL THREE QUESTIONS                      TIME: TWO HOURS**

**Question One**

- a) Timber is used in mine support; describe two methods of improving timber properties
- b) With reference to the table below:
- Natural air seasoning     artificial seasoning*
- i. Plot tension (P) torque (T) graphs for the three bolts on the same graph paper
  - ii. With help of graphs, explain the relationship between tension and torque in a rock bolt
  - iii. Select a suitable rock bolt for low stress rock condition and give reasons.

Bolt	Bolt diameter	C Factor	Bolt tension (kN)
1	16mm forged rock bolt	50	5, 8, 11, 14, 17 and 20
2	19mm forged rock bolt	40	5, 8, 11, 14, 17 and 20
3	21mm forged rock bolt	30	5, 8, 11, 14, 17 and 20

**Question Two**

A 4.5m by 3.6m drive is to be developed 150m long in pegmatite with 250MPa strength:

- 1) Describe a suitable drilling method to be applied
- 2) With help of diagrams, explain how free face will be created
- 3) Design a blasting pattern for a good fragmentation, throw and an advance
- 4) Calculate the tonnage of rock to be excavated, given SG of 2.7
- 5) Calculate the amount of explosives required, given PF of 0.7 kg/m<sup>3</sup>
- 6) Describe a suitable material handling system for this project.

*PF = 0.7*

**Question Three**

It is required to sink 860m-deep circular shaft from surface to just below the ore body using a conventional method. The operations are being carried on a three-shift per day basis. The rock hardness is about 165MPa. If other auxiliary operations take a day every after 18m advance and 19 blast holes are drilled and blasted per shift:

- 1) Estimate the cross section area of the shaft
- 2) Estimate how long it will take to complete sinking the shaft if it takes 2 days per metre to set up a 20m shaft collar
- 3) Describe the support system suitable for this shaft
- 4) Explain three advantages of conventional method of shaft sinking.

*Q = 0.001*

**THE UNIVERSITY OF ZAMBIA**  
**UNIVERSITY EXAMINATIONS – NOVEMBER 2019**  
**MIN 2019: INTRODUCTION TO MINING ENGINEERING**

**INSTRUCTIONS: THERE ARE SIX (6) QUESTIONS, ANSWER ANY FIVE**  
**EACH QUESTION CARRIES 20 MARKS**

**TIME: 3 HOURS**

**TOTAL MARKS: 100**

**Question 1**

- a) With reference to mining, differentiate between:
- Prospecting and exploration. [3 marks]
  - Mineral resources and mineral reserves. [3 marks]
- b) Describe four (4) main functions of a mine shaft. [4 marks]
- c) In comparison to conventional shaft sinking, explain four (4) advantages of raise-boring. [6 marks]
- d) If the friction winder rope will slip at  $T_1 / T_2 \leq 4.34$ , calculate the angle of wrap in degrees, given the coefficient of friction of 0.44. [4 marks]

**Question 2**

- a) List five factors which determine the selection of underground mining. [5 marks]
- b) Describe three disadvantages of surface mining compared to underground mining. [6 marks]
- c) Explain the sources and control measures of underground heat. [4 marks]
- d) If the selling price of copper concentrate is US\$1.63 per kg, the overall unit costs are US\$7.50 per tonne and the overall recovery is 92%.
- Estimate the unit profit in mining and processing of 0.6% copper ore deposit. [3 marks]
  - Calculate the cut-off grade for the same copper deposit. [2 marks]

### Question 3

- a) Describe two advantages and two disadvantages of timber support system. [5 marks]
- b) Explain briefly three classes of mine timber support system. [6 marks]
- c) In rock bolting support system, explain the relationship between the bolt tension and torque. ✓ [4 marks]
- d) Given that coefficient of friction is 0.48, angle of wrap is  $210^\circ$  and the rope tension side is 1.8, calculate the tension in the slack rope. ✓ [5 marks]

### Question 4

- a) With reference to surface mining and with help of diagrams, differentiate between:
- Berm and bench. [3 marks]
  - Overall pit slope angle and bench slope angle. [3 marks]
- b) With the help of diagrams, describe:
- Open pit mining. [3 marks]
  - Open cast mining. [3 marks]
- c) An open pit project has a cylindrical ore body with 110m height and 20m diameter and the overburden is cone shaped with 29m diameter and 160m height. [4marks]
- Calculate the stripping ratio. [2 marks]
  - If the cost of removing waste is as same as the cost of extracting ore, comment on viability of the project. [2 marks]
  - With help of diagrams, explain how the profitability of the project can be improved. [2 marks]

### Question 5

- a) With the help of diagrams and reference to rock fragmentation, explain the following terms: [2 marks]
- Primary blasting. [2 marks]
  - Stemming.
- b) With reference to underground rock transportation, explain three (3) advantages of locomotive system compared to conveyor belt. ✓ [4 marks]
- c) With the help of diagrams, describe the basic principle of blasting theory. [8 marks]
- d) Given the bench height is 2.85m, estimate spacing if blasting in rock with 160MPa strength! [4marks]

2 of 3

$$S = 1 - 1.8B$$
$$B = 25 - 800$$
$$D = 0.007 = 0.002H$$

### Question 6

a) With reference to mechanical rock fragmentation, differentiate between:

- i. Percussive and rotary drilling.
- ii. Integral and extension drilling rods.

[3 marks]

[3 marks] ✓

b) A mine excavation is being developed in andesite rock with an estimated production of 120,000 tonnes per month. Assuming the specific gravity of andesite is 2.7 and the powder factor is  $0.7 \text{ kg/m}^3$ , estimate the required amount of explosives per month?

[4 marks]

c) Label the following drilling bits shown in Figure 1.

[5 marks] ✓

d) Explain their application in the mining operations.

[5 marks] ✓

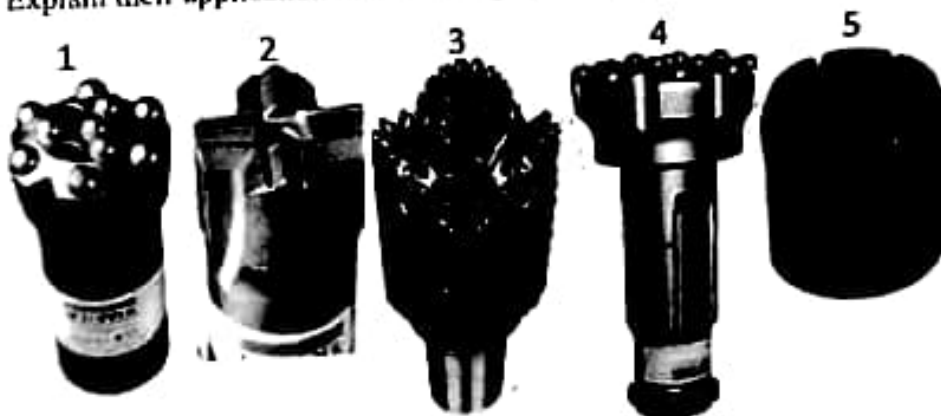


Figure 1: Types of drilling bits

**END OF EXAMINATION**

**INSTRUCTIONS: ANSWER ALL**

1. Mention the drilling equipment used in mining and how does each one operate?
2. Mention the drilling accessories used in drilling?
3. What is the use of nitrogen in drilling equipment?
4. Write a few notes on the following:
  - a. Production holes
  - b. Exploration holes
  - c. Development(face) holes
  - d. Support holes

5. Mention the physio-mechanical properties of the rock?

Why is it necessary to establish the physio-mechanical properties of the rock?

6. What are the uses of compressed air and compressed water in the mine?
7. Draw a general underground mine section (side view) showing the vertical shaft bottom.