



PROGRAM : NATIONAL DIPLOMA
ENGINEERING METALLURGY
SUBJECT : **Metallurgy I**
CODE : **MET 111**
DATE : **EXAMINATION**
12 JUNE 2015
DURATION : (X-PAPER) 08:30 - 11:30
WEIGHT : 40 : 60
TOTAL MARKS : 185

EXAMINER : MR H BROWN/GA COMBRINK/T MADZIVHANDILA
Sanso Number
MODERATOR : MR JT DAVIES File Number
NUMBER OF PAGES : 14 PAGES

INSTRUCTIONS : *THE EXAM HAS THREE (3) SEPARATE SECTIONS. ANSWER EACH SECTION IN ITS OWN SEPARATE ANSWER SCRIPT.*

WHERE SPECIFIC ANSWER SHEETS ARE PROVIDED, USE THESE AND PLACE THEM INSIDE THE APPROPRIATE ANSWER SCRIPT WHEN YOU HAND IN.

ALL WORK SHALL BE HANDED IN

ALL UJ EXAMINATION REGULATIONS APPLY.

REQUIREMENTS : 1 POCKET CALCULATOR
NO CORRECTION FLUID SHALL BE USED

THREE (3) EXAM ANSWER SCRIPTS PER STUDENT

SECTION ONE: GEOLOGY

ANSWER ALL QUESTIONS ON THE ANSWER SHEET PROVIDED. DETACH THIS ANSWER SHEET AND PLACE INSIDE A SEPARATE ANSWER BOOK.

QUESTION 1

State whether the following statements are true or false.

1. A gemstone that easily floats on top of a liquid has a relative density that is either greater or less than that of the liquid, the determining factor being the size
2. A mineral's lustre is a physical property that depends on the emission of light after some light is absorbed
3. From your knowledge of the composition of the rock-forming minerals, the evidence is that all elements are found in only a few minerals
4. Composition is what the rock is made of, texture is the size of the crystals in the rock
5. In a cooling magma, the first minerals to crystallise will be the first to melt if the solid rock again slowly becomes molten
6. Plagioclase is part of Bowen's continuous series
7. Three agents which have the most importance in creating different sedimentary rocks are heat, pressure and fluids
8. Detrital sedimentary rocks are made up of mechanically formed solid particles
9. Most of the heat for contact metamorphism is supplied by deep burial within the earth
10. Shale is the most abundant sedimentary rock because quartz is not as durable as clay
11. The rock cycle implies that any rock type can ultimately be derived from any other rock type
12. Shale and slate are both argillaceous detrital rocks
13. Granite is a volcanic rock
14. Plagioclase is an essential mineral in diorite
15. Quartz cannot be found together with orthoclase in an igneous rock (15)

QUESTION 2

Give one word for the following statements.

1. The name of a mineral which is part of a solid solution series
2. A silic micaceous mineral
3. A deep-seated ultrabasic rock
4. A lava rich in pyroxene and plagioclase
5. The extrusive equivalent of syenite
6. The planar surfaces which separate strata from each other

7. The most common mineral in arenaceous sedimentary rocks
8. A carbonaceous sedimentary rock
9. The name of a metamorphic rock intermediate between slate and schist
10. A magnetic mineral with a black streak (10)

QUESTION 3

Match the rock/mineral on the left with the description on the right. Give your answer as 1(a), 2 (b) etc. Do not write out your answer.

- | | |
|---------------|---------------------------------|
| 1. Granite | a. Glacial origin |
| 2. Pyrite | b. Rhombohedral cleavage |
| 3. Slate | c. Micaceous cleavage |
| 4. Arkose | d. Abyssal igneous rock |
| 5. Dolerite | e. Calcareous sedimentary rock |
| 6. Calcite | f. Iron sulphide |
| 7. Gneiss | g. Lava |
| 8. Microcline | h. Argillaceous |
| 9. Mudstone | i. Salic mineral |
| 10. Tillite | j. Pressure-induced cleavage |
| | k. Magnetic mineral |
| | l. Contains detrital feldspar |
| | m. Dyke rock |
| | n. Banded metamorphic rock (10) |

QUESTION 4. MULTIPLE CHOICE. CIRCLE THE CORRECT ANSWER ON THE ANSWER SHEET. THERE IS ONLY ONE CORRECT ANSWER

1. Minerals **are** grouped or classified as oxides, sulphides etc., by
 - a. colour
 - b. type of cation
 - c. type of anion
 - d. hardness
 - e. none of the above are correct

2. Minerals which have the same composition but different internal crystal structures are
 - a. isomorphs
 - b. phenocrysts
 - c. isotopes
 - d. polymorphs

3. A piece of glass will be scratched by
 - a. orthoclase
 - b. corundum
 - c. apatite
 - d. gold
 - e. all of the above are correct
 - f. a and b are both correct

4. Quartz can be distinguished from calcite by
 - a. its lack of cleavage
 - b. its colour
 - c. its hardness
 - d. all of the above are correct
 - e. a and c are both correct

5. Hornblende
 - a. is a silic mineral
 - b. has a higher RD than microcline
 - c. is a pyroxene
 - d. has cleavages intersecting at 90 degrees
 - e. none of the above are correct

6. A volcanic rock with a high silica content is
- a. rhyolite
 - b. basalt
 - c. granite
 - d. andesite
 - e. none of the above are correct
 - f. both a and c are correct
7. The texture of an igneous rock
- a. is controlled by the composition of the magma
 - b. is the shape of the rock body
 - c. determines the colour of the rock
 - d. records the rock's cooling history
 - e. both c and d are correct
 - f. none of the above are correct
8. Lava
- a. may be fluid
 - b. may be acid or basic
 - c. includes rocks such as rhyolite and basalt
 - d. all of the above are correct
 - e. only a and b are correct
9. Granite
- a. has a composition the same as basalt, but differs in being coarse-grained
 - b. is generally pale in colour and has quartz as an essential mineral
 - c. has a composition the same as basalt but differs in being fine-grained
 - d. is generally dark-coloured and does not have any quartz present
 - e. none of the above are correct
 - f. a and b are both correct

10. Which of the following is a characteristic of all sedimentary rocks?
- fossils
 - bedding
 - angular grains
 - formed from chemical processes
 - formed from mechanical processes
 - contain small grains
 - none of the above are correct
11. Which of the following groups contain only clastic rocks?
- limestone, conglomerate, sandstone
 - conglomerate, grit, tillite
 - sandstone, shale, chert
 - conglomerate, agglomerate, banded ironstone
12. Arkose is
- a shale composed of pure quartz
 - a shale composed of quartz and feldspar
 - a sandstone composed of pure quartz
 - a sandstone composed of quartz and feldspar
 - a conglomerate composed of quartz and rock fragments
 - none of the above are correct
13. A fragment in a clastic sedimentary rock that is 1.6mm in diameter is a
- sand grain
 - clay particle
 - pebble
 - boulder
 - none of the above are correct
14. Which of the following describes the correct sequence of events that lead to the formation of a sedimentary rock?
- compaction, deposition, transportation, cementation
 - deposition, transportation, cementation, compaction
 - transportation, cementation, deposition, compaction
 - transportation, deposition, compaction, cementation
 - none of the above are correct
15. Sedimentary rocks
- are always deposited from water
 - may be of either mechanical or chemical origin
 - seldom contain quartz
 - are only of marine origin

16. Which statement best describes what happens during the metamorphism of limestone?

- a. changes under extreme heat and removal of impurities
- b. extreme pressure causes a decrease in grain size
- c. the addition of new ions produces a chemically altered rock
- d. larger crystals are formed to produce marble
- e. foliation occurs to produce a gneiss

17. Minerals found in metamorphic rocks can indicate

- a. the temperature the rock was subjected to
- b. the pressure the rock was subjected to
- c. the composition of the parent material
- d. all of the above are correct
- e. a and b are both correct

18. Most of the heat for contact metamorphism is supplied by

- a. frictional heating along a fault
- b. high concentrations of radioactive elements
- c. deep burial within the earth
- d. nearby igneous pluton
- e. heat trapped by cap rock

19. Which of the following combinations of factors is important in the development of metamorphic rock?

- a. temperature, and pressure
- b. the weight of overlying rock, solar heat, and nuclear fusion
- c. horizontal pressures developed as rocks become deformed, covalent bonding, and heat released during rock crystallisation
- d. the internal heat of the Earth, nuclear bonding, and heat released during chemical weathering

20. The rocks of the earth's crust

- a. only contain silicate rock-forming minerals
- b. may contain ore minerals
- c. were all formed at the same time in earth history

(40)

Full marks = 75

SECTION TWO: PHYSICAL METALLURGY

INSTRUCTION: Answer this section in its own separate answer script and hand it is separately.

Question 1

1.1 Which are the most important criteria for the engineering materials selection process? Give reason for your answer? (8)

- a. application - loading conditions
- b. materials available
- c. price
- d. joining
- e. manufacturing
- f. recycling

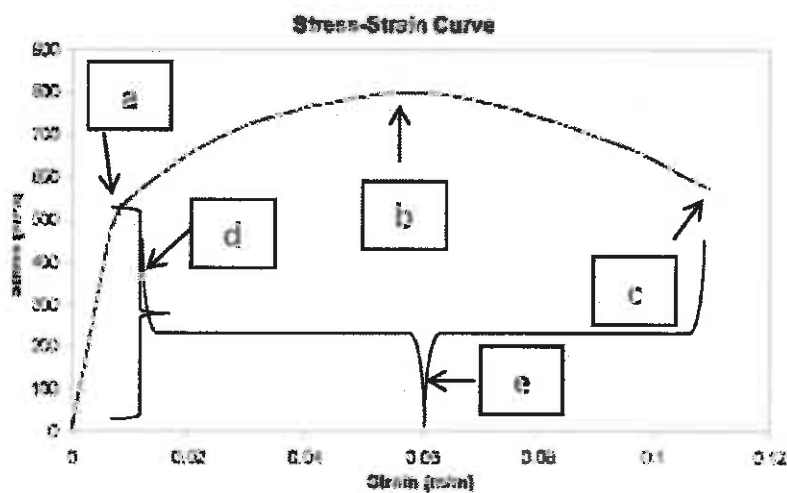
1.2 suggest a suitable material and process for the following purpose with Justification. (8)

- a. Car wheel rims
- b. structural shapes
- c. Rails
- d. Car engine blocks

Question 2

Label the stress strain plot below:

(5)



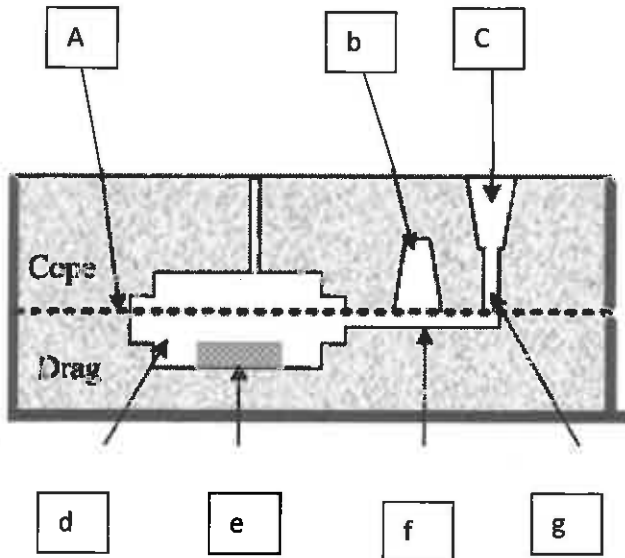
Question 3

3.1 What is Metal casting process

(2)

3.2 label the diagram below

(6)



2.3 What is the purpose of a riser

(2)

Question 4

4.1 briefly explain the process of die casting, also give example of products made using die casting (1

(10)

4.2 What is the different between Cold and hot rolling

(4)

Question 5

5.1 What is a phase diagram?

(2)

5.2 Explain the lever rule with a tie line

(3)

TOTAL MARKS SECTION TWO

[50]

SECTION THREE: EXTRACTIVE METALLURGY

INSTRUCTION: *Answer this section in its own separate answer script and hand it is separately.*

QUESTION 1:

- 1.1. What is Pyrolusite?
- 1.2. What is Bornite?
- 1.3. What is Skutterudite?
- 1.4. What is Cinnabar?
- 1.5. What minerals can we exploit to extract titanium from? Also give their chemical formula.

(12)

QUESTION 2:

- 2.1. Why is it necessary to remove tramp metals such as pieces of steel and small mining implements from run-of-mine material?
- 2.2. Often during the mining process the ore delivered to the extractive plant is contaminated with wood (such as what is used in underground temporary support structures), explain why it is important to remove these contaminants before they are feed into the crushing and milling operations of an extractive plant.
- 2.3. During mineral processing the presence of clays and slimes are also troublesome, explain why this is so.

(8)

QUESTION 3:

What type of ROM are the following examples fluorite, apatite, diamonds and gemstones, vermiculite, barite, wollastonite and chromite?

As what are the ROM mentioned above often (alternatively) referred to?

(4)

QUESTION 4:

Make a sketch of a cyclone explaining the principle of which it operates

(10)

QUESTION 5:

Draw and fully label the typical processing flow sheet for metaliferrous ores.

(10)

QUESTION 6:

What is the main difference between Hematite and Magnetite? Also give the chemical formula's and the metal(s) extracted from these minerals.

(4)

QUESTION 7:

Calculations of grade, recovery and value

You send a 50 gram sample of gold bearing ore to the assay laboratory for analysis, they use the whole 50 gram ore sample and they report that there is 0.35 milligrams of gold in the sample (take note it is expressed in milligrams). You subsequently process 10 000 tons of this gold ore through you concentrator (flotation) plant. Of this total amount of ore processed 99.5% (by mass) of the processed ore ends up as tailings i.e.9950 tons with a gold content of 0.8 grams per ton. Assume that there are no spillages in the plant and that all the rest of the gold is in the concentrated product.

7.

- 7.1. Calculate how much gold have you have in total in the concentrated product.
 - 7.2. Calculate the percentage recovery.
 - 7.3. What is the grade of the gold ore (i.e. before its concentrated) in grams per ton?
 - 7.4. How much gold in kilograms has not been recovered?
 - 7.5. If the price of gold is R460 000.00 per kilogram what is the value of gold still in the tailing?
 - 7.6. If the price of gold is R460 000.00 per kilogram what is the value of the gold that you have recovered?
- (12)

TOTAL MARKS SECTION THREE

[60]

FULL MARKS FOR EXAM

[185]

SURNAME.....INITIALS.....

STUDENT NUMBER.....

METALLURGY 1 MET 111 MAY/JUNE EXAMINATION 2015

GEOLOGY MODULE ANSWER SHEET

QUESTION 1

- | | | |
|--------|---------|---------|
| 1..... | 6..... | 11..... |
| 2..... | 7..... | 12..... |
| 3..... | 8..... | 13..... |
| 4..... | 9..... | 14..... |
| 5..... | 10..... | 15..... |

QUESTION 2

- 1.....
- 2.....
- 3.....
- 4.....
- 5.....
- 6.....
- 7.....
- 8.....
- 9.....
- 10.....

SURNAME.....INITIALS.....

STUDENT NUMBER.....

QUESTION 3

- | | |
|--------|---------|
| 1..... | 6..... |
| 2..... | 7..... |
| 3..... | 8..... |
| 4..... | 9..... |
| 5..... | 10..... |

QUESTION 4

- | | |
|---------------------|-------------------|
| 1. a b c d e | 11. a b c d |
| 2. a b c d | 12. a b c d e f |
| 3. a b c d e f | 13. a b c d e |
| 4. a b c d e | 14. a b c d e |
| 5. a b c d e | 15. a b c d |
| 6. a b c d e f | 16. a b c d e |
| 7. a b c d e f | 17. a b c d e |
| 8. a b c d e | 18. a b c d e |
| 9. a b c d e f | 19. a b c d |
| 10. a b c d e f g | 20. a b c |