

UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
DEPARTMENT OF METALLURGY AND MINERAL PROCESSING

MET 4111 / MET 3145 TEST

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ANSWER ALL QUESTIONS.

TIME: 2 hours

Question 1

(a) State briefly what you understand by the following terms, used in mineral processing during comminution of the ore:

- reduction ratio [2]
- work index [2] ✓
- grindability [2] ✓
- set of a crusher [2] ✓
- angle of nip [2] ✓
- *or* classification
- bulk density
- Tailings
- comminution

(b) Primary crushers in particular can be operated in one of two distinct modes: "free crushing" and "choked crushing". Explain the underlined terms. [4]

(c) Very often the new feed to a crusher is screened to remove the material, which is already sufficiently fine to pass on to the next stage, and only the screen oversize passes through the crusher. State three advantages that this "scalping" of new feed gives. [6]

[20 %]

Question 2

- a) Describe the crushing action of a jaw crusher with the aid of a clearly labelled diagram. [7]
- b) How could the reduction ratio of a jaw crusher be altered for small adjustments, and for large adjustments? [3]
- c) Describe the crushing action of a gyratory crusher with the aid of a clearly labelled diagram. [7]
- d) Describe the protection mechanisms of jaw crushers and gyratory crushers when an uncrushable material (e.g. tramp metal) enters the crushing cavity.

[3]

[20%]

Question 3

- (a) Describe with a simple sketch the operation of the Symons standard cone crusher. What is the purpose of the parallel zone? [7]
- (b) Describe the protection mechanism of the Symons standard cone crusher when an uncrushable material enters the crushing cavity. [1]
- (c) What do you understand by the 'Set' of the Cone crusher and how could this be adjusted? [3]
- (d) Write Bond's third theory equation and state what each letter stands for. [9]

[20 %]

Question 4

- a) State three mechanisms by which grinding can take place with the aid of diagrams. [9]
- b) Describe the grinding action of a ball mill indicating the various zones that can be distinguished.
- c) Figure 1 shows primary crushing in a gyratory crusher and secondary crushing in a cone crusher, which is in closed circuit with a 125-mm aperture screen. The gyratory crusher is fed at F t/h (dry ore). The fraction that passes 125 mm screen aperture in the feed, gyratory crusher discharge, screen oversize, cone crusher discharge, and screen undersize respectively are as follows:

- $f = 28 \%$
- $p = 40 \%$
- $o = 10\%$
- $r = 85 \%$
- $u = 100 \%$

Calculate the circulating load as a percentage of new feed. [7]

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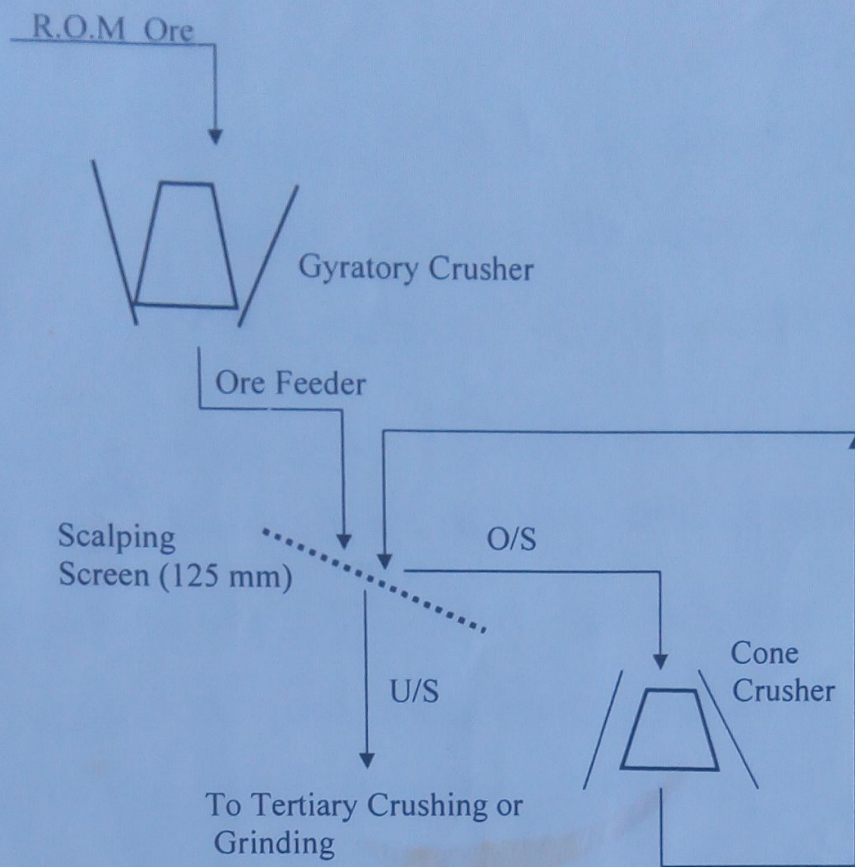


Figure 1: Primary crusher in open circuit, secondary crusher in closed circuit with screen

[20 %]

Question 5

- a) In a grinding circuit, a SAG mill operates with a 10, 000 hp motor. Typical power draw is 80% of maximum. The 80 percent passing feed size to the mill is 5 inches and the mill discharge has an 80 percent passing size of 2.1 mm. Calculate the Operating Work Index for this mill if the feed tonnage rate is 1200 t/h. [6] ✓
- b) What are the two major function liners of tumbling mill perform? Give the three main groups into which mill liners can be classified. [4]
- c) Give and discuss three factors that affect the grinding of ores. [6] ✓
- d) What are the essential differences between the grinding action of the rod mill and the ball mill? What is the effect of these differences in the grinding action on the size distribution in the respective mill products? [4] ✓

[20%]

**END OF MET 3145 TEST
GOOD LUCK!!**

Question 1

9

i) reduction ratio: this is a dimensionless ratio of the maximum size of material entering the crusher (gape) to the maximum size of material at discharge point (set)

ii) work index: work index is a Comminution parameter which shows resist to crushing and grinding of a material

iii) grindability: It refers to the ease with which material can be comminuted and data from grindability tests are used to evaluate crushing and grinding efficiency

iv) set of a crusher: this is the maximum opening of a crusher at discharge point

v) angle of nip: the largest angle that will just grip the lump of material between ~~jaws~~, ~~or~~ ~~or~~ ~~mantle~~ the crushing ~~ment~~ members

b). Free crushing: In free crushing the material particles are relatively free to fall between successive blows and the main force exerted upon a rock particle is applied directly by crushing its surface.

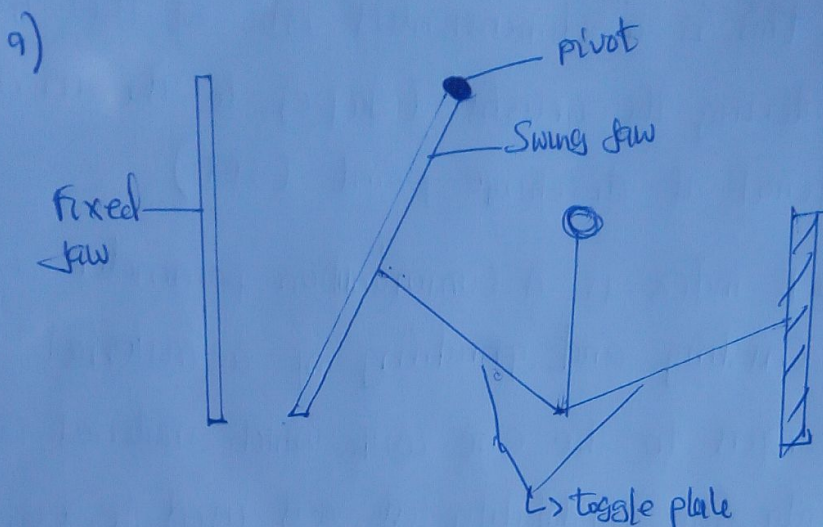
Chocked crushing: the crusher is kept chocked feed and substantial amount of comminution results from the impact of rock upon rock

c) — Increase's the capacity

— lessen dust

— less wear.

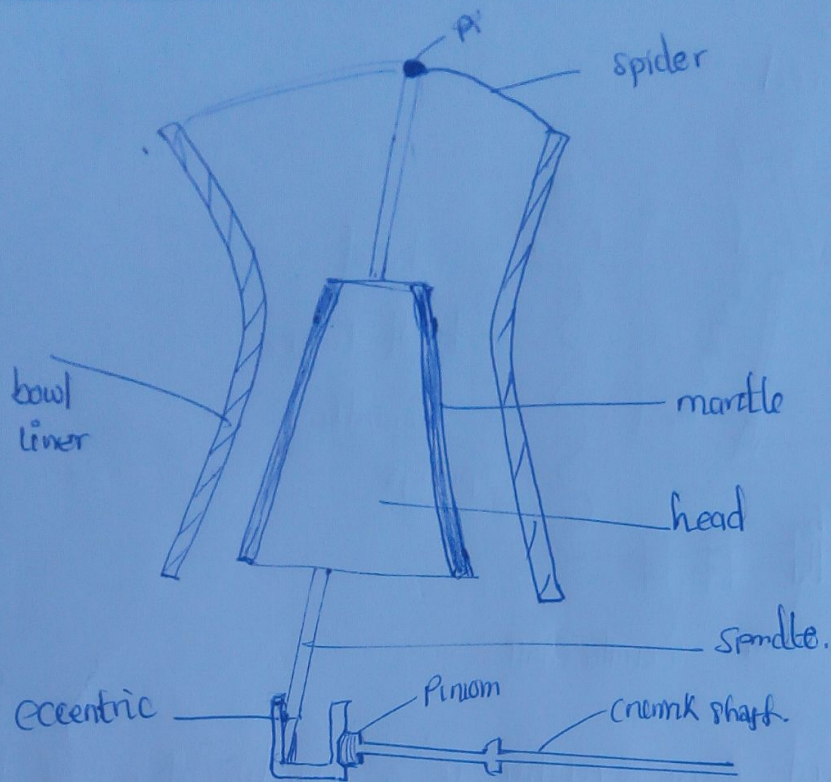
QUESTION 2



A jaw crusher is a primary crusher that reduces the run of mine, it works on the principle of a human jaws, these jaws are fixed and swing jaws, when the crusher is turned on the swing jaw moved against the fixed jaw thereby crushing the feed introduced and discharge the product through the discharge point (ref)

b). Small adjustment: Here the reduction ratio is altered by ~~screening~~ screening up or down the adjustment noble.

Larger adjustment: Replacing the toggle plate with size required.

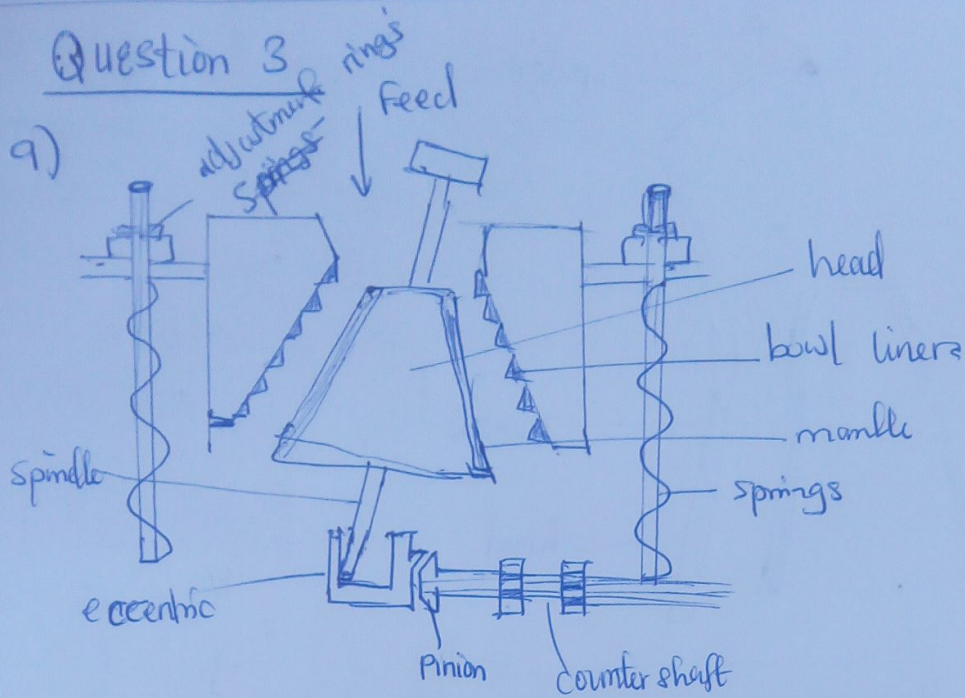


The gyratory crusher consists of the long spindle with head attached, when the crusher is turned on, the pinions of the crank shaft rotate the gear of the eccentric, thereby causing the spindle to achieve a gyratory motion, when the feed is introduced, it is crushed as the head rotates against the bowl liners until the material is discharged.

d. - Jaw crusher is protected by weak line of rivets on one of the toggle plates, which cause the swing jaw to open when tramp enters the crusher.

- The gyratory crusher has hydraulic pumps, connected to the crusher, which pumps oil into the accumulator, when tramp enters, the crusher, causing the head to go down and the tramp is released.

Question 3



The Symon standard cone crusher is a modification of the gyratory crusher, it works on the same principle as the gyratory crusher, when it consists of a short spindle that attaches the head, when it is power on, the pinion of the counter shaft rotates the gear, which cause the head to achieve a gyratory motion, when feed is introduced, the head crushes it against the bowl liners and discharge the product at discharge point.

a) purpose of the parallel zone! The parallel zone is that each particle receives a number of blows before it is discharged

b) when the uncrushable material enters the cavity, the tension springs causes the bowl to move upward, thereby allowing the material to pass through

c). Set of a cone crusher is the minimum opening between the head and the bowl.

- Can be adjusted by adjusting the rings.

d.)

$$W = W_i \left[\frac{10}{\sqrt{P_{80}}} - \frac{10}{\sqrt{F_{80}}} \right]$$

W = work output

W_i = work index

P_{80} = Product size

F_{80} = Feed size.

Question 4

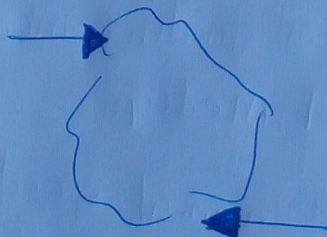
a). 3 - mechanism of grinding

- ① Impact
- ② abrasion
- ③ Attrition



Impact

rocks crushing by falling onto of other rocks.



Abrasion

rocks from opposite direction crushes each others



Attrition

rock crushes against the liners of the grinding machine

b) The ball operates under the principle of Critical speed, when the material to be ground is feed on the left end of the mill, when the mill rotates, the grinding medium is lifted along the rising side of the mill and broken by attrition and abrasion, when the medium fall it is ground by impact

Question 5

a) To solve

- b). — To protect the cylindrical shell against abrasion
— To help in tumbling and rotating mills.

main groups of liners

1. Smooth liners
2. Lifting liners
3. Gage liners

c). ①. speed of mill

②. size distribution of grinding media

③. Load of grind media.

- speed of mill \Rightarrow at normal speed the material is ground while at critical speed the balls don't fall, hence speed affect the efficiency of grinding

- size distribution of grinding media, the medium should be proportional to the feed size for effect grind

- Load of grind media, \Rightarrow when full feed it consumes alot of power and reduce the efficiency

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c). - the ball mill has a larger surface area than the rod mills which cause it to grind the material in a finer size than the rod which produces coarser products

- the ball mill operates at high speed than the rod mill this causes it to deliver a finer product than the rod mill