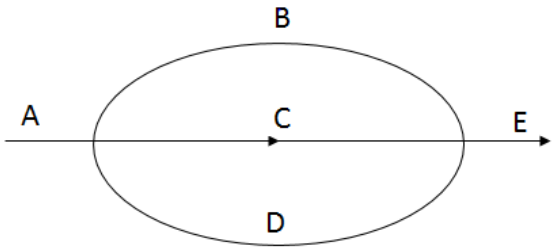
INTERMEDIATE CERTIFICATE IN MINE ENVORONMENTAL CONTROL

PAPER 1
12 MAY 2017

MEMORANDUM

QUESTION 1 [25 MARKS]

1.1 The sketch below shows diagrammatically a layout of an underground Gold Mine where there is a combination of three airways in series and parallel.



The resistances of the various airways are as follows:

A = 0,008 Ns^2/m^8

B = 0, 009 Ns^2/m^8

C = 0, 022 Ns^2/m^8

D = 0, 02 Ns^2/m^8

E = 0, 18 Ns^2/m^8

If the total air quantity flowing through this section is 120m^3/s, calculate:

a) The overall resistance of the section.
(5)

b) The overall pressure required.
(3)

c) The air quantities in each airway.
(6)

1.1 Answer:

a) $1/\sqrt{R_P} = 1/\sqrt{R_B} + 1/\sqrt{R_C} + 1/\sqrt{R_D}$

$= 1/\sqrt{0,009} + 1/\sqrt{0,022} + 1/\sqrt{0.02}$

Commented [LI(1]: No units used?

$1/\sqrt{R_P} = 1/0{,}095 + 1/0{,}148 + 1/0{,}141$

$= 24{,}5$

$RP = (1/24{,}5)^2$

$0{,}0017 Ns^2/m^8$

$R_T = R_A + R_P + R_E$

$0{,}008 + 0{,}0017 + 0.18$

$= 0{,}1897 Ns^2/m^8$

Overall resistance = $0{,}1897 Ns^2/m^8$

(5)

b) $P_T = R_T X Q_T^2$

$0{,}1897 X (1200)^2$

= 2732 Pa

Overall pressure is 2732 Pa

(3)

c) $P_p = R_p X Q_p^2$

$0{,}0017 \times 120^2$

= 24, 5 Pa

But $P_p = P_B = P_C = P_D$

and $P_B = R_B X Q_B^2$

$Q_B = \sqrt{P_B/R_B}$

$= \sqrt{24{,}5/0{,}009}$

$= 52{,}2 m^3/s$

(2)

$Q_C = \sqrt{P_C/R_C}$

$= \sqrt{24{,}5/0{,}022}$

$= 33{,}4 m^3/s$

(2)

$Q_D = \sqrt{P_D/R_D}$

$= \sqrt{24{,}5/0.02}$

$= 35 m^3/s$

(2)

Question 1.2

1.2 The energy input to a winch motor is 500kW and the output power is 400kW. Calculate the efficiency of the winch motor.

(5)

1.2 Answer:

Commented [LI(2]: No units used?

Commented [LI(3]: Units?

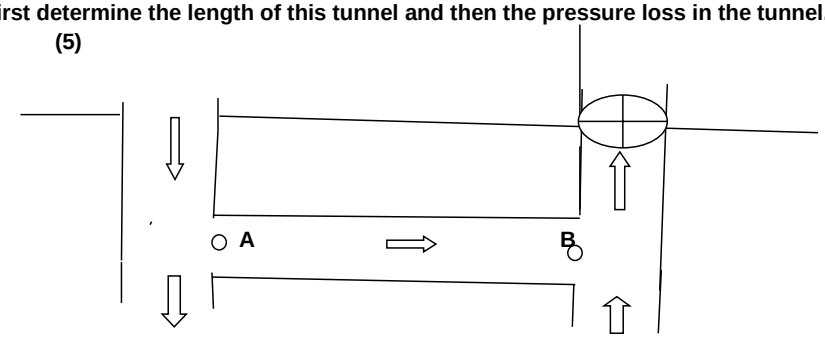
Commented [LI(4]: Units?
General comment: Candidates are expected to list units throughout the use of calculations. If they get the final answer wrong, they may still be awarded some marks for the correct procedure

Efficiency = Out power x 100%
(2)
Energy input x1
= 400 x 100/ 500x1
(2)
= 80%
(1)

Question 1.3

1.3 A tunnel in an underground mine has a resistance of 0.135Ns^2/m^8 and allows 125m^3/s of air to flow through towards a return airway system. The air density in the tunnel is 1, 3kg/m^3. The tunnel is 3.5m x 2, 8m with a friction factor of 0.017Ns^2/m$^{4.}$.

First determine the length of this tunnel and then the pressure loss in the tunnel.
(5)



1.3 Answer:

R = KCL x w / (A^3 x 1, 2)

L = RA^3 x 1, 2 / (KC x w)
(1)

= 0, 135 x (9, 8)^3 x 1, 2 / (0, 017 x 12, 6 x 1 3)

= 152, 473 / 0, 2785

547m
(2)

P= RQ^2

0.135 X 125^2

2109 Pa
(2)

1.4 Define Fan Total Pressure (FTP)

It Is the difference in pressure measured with a vertical manometer at the fan inlet and the fan discharge (1)

[25]

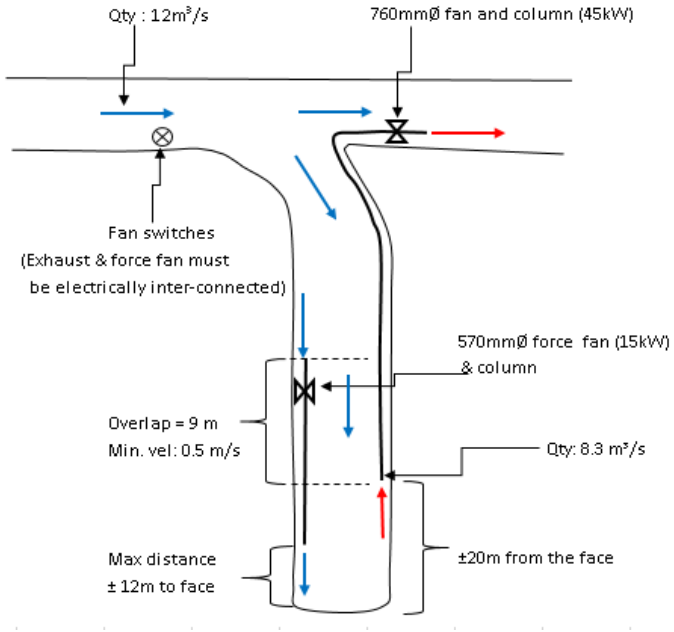
Commented [LI(5]: Inconsistent spacing and alignment creates a sloppy document.

QUESTION 2 [22 MARKS]

2.1 Make a hand drawn sketch of an Exhaust-Overlap (Force-Exhaust) ventilation system.in

a cross cut or a heading

(3)



If this system is to ventilate a development end that is 200m long and 3, 0 m x 3, 0 m in size, state the air quantities you would suggest:

a) At the face
(2)

b) At the force column discharge;
(2)

c) In the overlap;
(1)

d) At the exhaust column intake; and
(2)

e) At the exhaust column discharge.
(2)

2.1 Answer:

Commented [LI(6]:

(10% leakage assumed)

End dimensions: 3,0 x 3,0m (Given) 200m long

Min Quantity on face

= 0,15 x 3,0 x 3,0

= 1,35m^3/s

Mine standard: Minimum Quantity on face

1,35 x ±2,5

= ±3,4m^3/s

QTYs;

a) Face = 3,4m^3/s

(2)

b) Force discharge = 3,4m^3/s

(2)

c) Overlap = 0,5 x 9,0

= 4,5 m^3/s

(1)

d) Exhaust intake = Force+ Overlap Quantity

3,8 + 4,5 = 8,3m^3/s

(2)

e) Exhaust discharge = 8,3 + (16% assumed leakage)

8,3 + 1,3 = 9,6m^3/s

(2)

2.2 Answer: List five characteristics of an ideal dust filter

(5)

- Filter out all dust both fine and coarse (it should be efficient)
  (1)
- Be unaffected by humidity or moisture and should require low maintenance
- (i.e. it should be reliable)
  (1)
- Have a low resistance to airflow (i.e. the filter should be relatively small and yet be able

  to handle large volumes of air
  (1)
- Be easy to install
  (1)
- Be easily maintained and cleaned
  (1)
- Have a low capital cost
  (1)
- Have a low running cost
  (1)

Commented [LI(7]: Inconsistent between commas and points?

Commented [LI(8]: spacing

Commented [LI(9]: What is 05?

Commented [LI(10]: spacing

Commented [LI(11]: spacing

2.3 Answer: Give five main sources of fires underground
(5)

- Electrical sources
  (1)
- Frictional sources
  (1)
- Blasting and incorrect use of igniter cord
  (1)
- Welding torches
  (1)
- Smoking or contraband
  (1)
- Diesel engines and fuel
  (1)
- Flammable fluid or greases
  (1)
- PVC or other similar materials
  (1)
- Methane or other gas explosions
  (1)
- Impact generating sparks
  (1)
- Discharge of accumulation of static electricity.
  (1)

[22]

QUESTION 3 [15 MARKS]

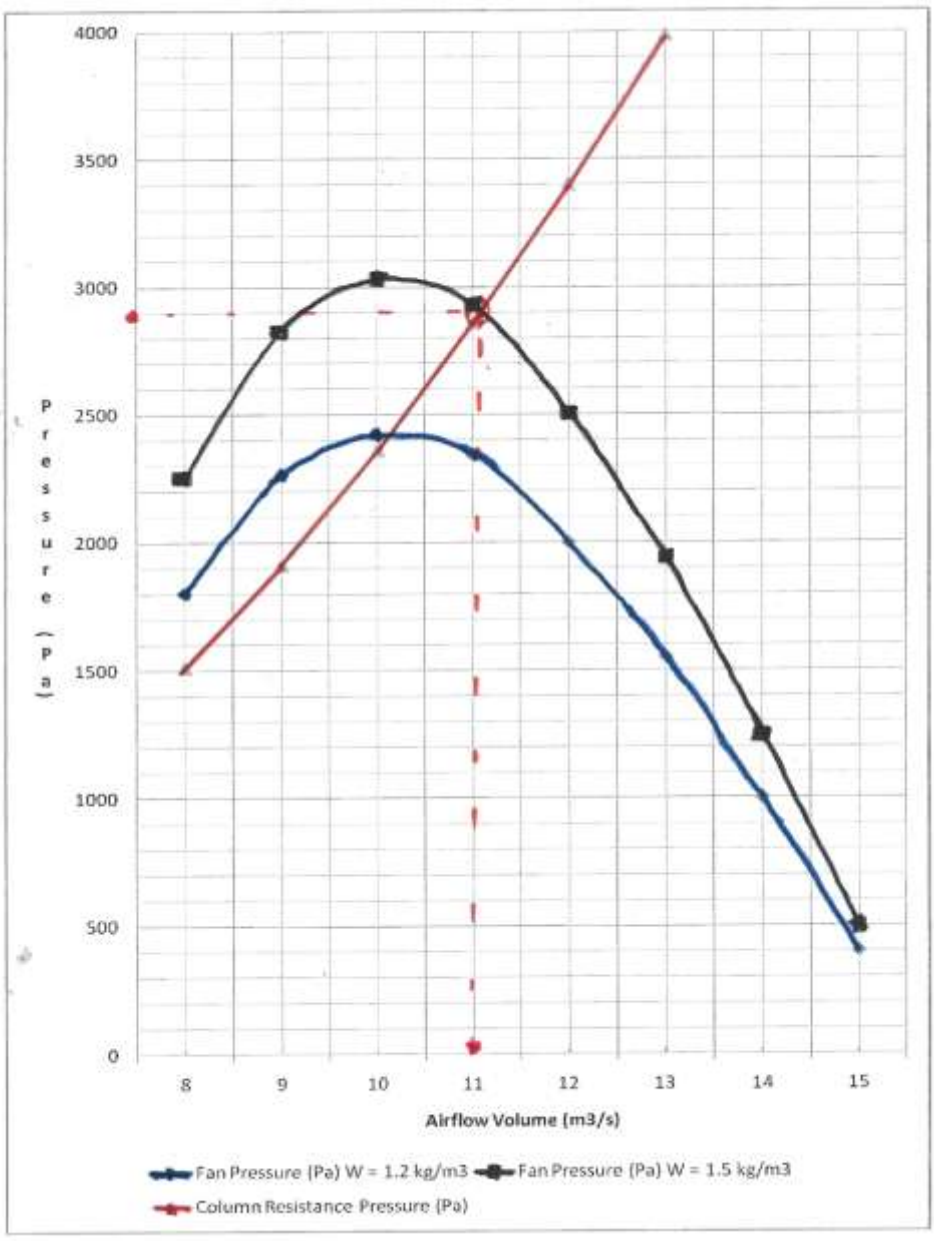
3.1 Answer: State five requirements of an ideal Ventilation door (airlock) installation.
(5)

- It should not leak excessively.
  (1)
- It must be self-closing and kept closed at all times.
  (1)
- The installation must be as such that only one door can be opened at any time (interlocking)
  (1)
- It must be economical, efficient and require minimum maintenance.
  (1)
- It should be robust, strong and easy to open.
  (1)

- Each door must be equipped with proper handle on both sides' pressure release flap and effective water trap.
  (1)
- It should be painted with black and yellow chevron lines (or any other colour as per your mine's standard) to make it visible.
  (1)

3.2 A 45kW fan is to be installed on a 760mm diameter ventilation column in an ultra-deep section of a mine. The column length will be 200m with a frictional k-factor of 0, 0037 Ns^2/m^4. The fan will be operating at a density of 1, 5kg/m^3.

3.2.1 Answer: Draw the fan performance and column resistance curves on the graph paper and determine the fan operating point.
Show the table and calculations in your examination book.
(6)



3.2.2 Answer Determine the fan operating point and comment on the suitability

of a standard 45kW fan to be used in the ultra-deep level mining.
(2)

The fan operating point is 11.1 m^3/s and 2900Pa
(1)

The standard fan will be suitable for the specific installation of 200m, but will not be suitable in longer columns of 300m.
(1)

3.2.3 Answer: Make a recommendation to management regarding the type of fans to be purchased in future for the ultra-deep level mining project.
(2)

Fan Quantity (m^3/s)	Fan Pressure (Pa) W = 1, 2 kg/m^3	Fan Pressure (Pa) W = 1, 5 kg/m^3	Column Resistance (Pa)
8	1800	2250	1510
9	2260	2825	1912
10	2420	3025	2360
11	2340	2925	2856
12	2000	2500	3399
13	1550	1938	3989
14	100	1250	4626
15	400	500	5311

(4)

1. Density change

   Q2 = Q1 x (W2/W1)

   = 1800 x (1, 5/1, 2)

   2250 (repeat for Quantities 9 to 15)

2. Resistance for galvanized duct

   $R = \frac{KCL \times W}{A^3\ 1, 2}$

   $= \frac{0, 0037 \times 2, 388 \times 200 \times 1, 5}{(0, 454)^3 \times 1, 2}$

   = 23, 605 Ns^2/m^8

   $P = RQ^2$

   = 23, 605 x $(8)^2$

   = 1510 Pa (Repeat for Quantities 9 to 15)

Recommendation: Future fans must be purchased with larger fan motors to cater for

Commented [LI(12]: Units

the reduced volume flow delivered by the fan
(1)

Improving the efficiency of fans will be more beneficial, especially when considering the increased cost of electrical power in the future.
(1)

15] **[**

QUESTION 4 [24 MARKS]

4.1 Give five types pf refrigeration systems
(5)

- Vapour Compression System
  (1)
- Absorption System
  (1)
- Steam-jet System
  (1)
- Ice making System
  (1)
- Water Vapour System
  (1)

4.2 Answer: Explain the term "Refrigeration"
(2)

Refrigeration is a process of cooling, whereby heat is removed from a substance and putt back where it does not affect workers
(2)

4.3 Answer: Calculate the approximate depth in metres for a mine in Gauteng area where the underground barometric pressure is 107KPa
(2)

Depth = (Underground BP – Surface BP) X 100
(1)

= (107, 0 – 83, 5) X 100

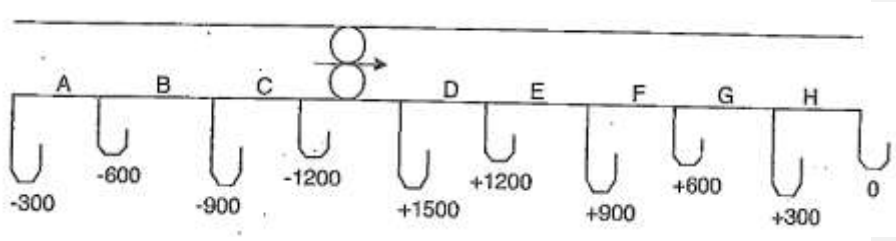
= 2350m
(1)

4.4 List five factors causing resistance to airflow
(5)

- Friction
  (1)

- Size
  (1)
- Shock losses
  (1)
- Obstruction
  (1)
- Bends or Change in airflow Direction.
  (1)

4.5 The sketch below represents a duct of uniform size, and static pressure readings taken equal distances apart.



4.5.1 Answer: Determine the fan operating pressure
(3)

Fan operating pressure = (+1500) – (-1200) Pa
(1)

= + 1500 + 1200
(1)

= 2700Pa
(1)

4.5.2 Answer: What is the pressure loss at section C
(3)

Pressure loss at section C = (- 900 – (- 1200)) Pa
(1)

= (- 900 + 1200) Pa
(1)

= 300 Pa
(1)

4.6 Answer: Mine Ventilation is a continuous supply of adequate and qualitative air to all parts of a mine. State the four main reasons why ventilation is required.
(4)

- Supply of oxygen for breathing purposes
  (1)
- Remove heat and provide comfortable working conditions
  (1)
- To dilute and remove noxious and flammable gases
  (1)
- To dilute and remove hazardous airborne pollutants.
  (1)

[24]

QUESTION 5 [14 MARKS]

5.1 Answer: Escape routes are an integral part of the mines escape strategy.
State three requirements of an escape route
(3)

- Displayed at the waiting places and all underground working places.
  (1)
- Reviewed/ revised and updated on a regular basis
  (1)
- Clearly demarcated with symbolic signs from the working place
  (1)

5.2 The cost of electricity is expected to increase gradually to 80c per kW hour in 2018.

Calculate the expected operating cost per annum for a 45kW auxiliary fan.

Assume:

5.2.1. Answer: The fan was operating for the full year.
(4)

Cost per annum = kW rated x (Cost rate x hours x days)
(2)
= 45kW x R0, 80ph x 24hrs x 365days
(1) = R 315 360
(1)

5.2.2 Answer: Calculate the operating cost of the 45kW fan per month.
The fan duty is 12m^3/s at 1500Pa
(3)

Quantity x Cost per month = Cost per annum / (months x quantity)
= 315360/ 12 x 12
(2)
= R 2190
(1)

Commented [LI(13]: Please be consistent in the use of units. Please confirm how this unit should be written.

Commented [LI(14]: Same as not 23.

5.3 Answer: List four indicators of a fan operating in a stall zone
(4)

- The fan vibrates excessively
  (1)
- The fan makes unusual noises, i.e. it whines because of marked pressure vibrations.
  (1)
- An ammeter measuring the input amps shows rapid oscillations.
  (1)
- The quantity and pressure difference of the fan may alter.
  (1)

[14]

TOTAL MARKS: [100]

Commented [LI(15]: Please check this count. I don't get it balanced