Question 1

1.a.

Seam & Panel	SF	Justification
2 and 4 seam - Development	2.0	Depending on the standard at different operations, the life span on main developments are normally higher than that of the production panels.
2 and 4 seam – production panels	1.6	Industry norm
5 seam development and production panels	2.1	Shallow mining guidelines

1.b. Mining height has to be assumed

- Either completed seam (numbers 4 and 5 seams)
- Portion of the number 2 seam depending on the values.
- Bordwidth needs to be assumed

$$SF = 140\frac{w^3}{hH(w+B)^2}$$

Seam	Mining Height	Bord Width	Depth	C1 narrow	C2	SF (vd M 2003)	CM SF (vd M 2003)	W:H
2	4.2	7.2	89.84	19	19	1.69	1.96	2.81
4	3.71	7.2	65.95	16	16	1.52	1.86	2.37
5	1.78	6.5	30.91	13	13	4.13	5.39	3.65

Calculating the 5 seam the extraction ratio needs to be taken into account.

1.c.

$$T = \left[\frac{d}{mh^x}\right]^{\frac{1}{1-x}}$$

$$d = w - \left[0{,}00714 S_{\min} HhC^2\right]^{0{,}333}$$

Seam	Mining Height	Depth	C1 narrow	C2	We	d	PLI (vd M 2003)
2	4.2	89.84	19	19	11.8	4.51	105715
4	3.71	65.95	16	16	8.8	3.18	27519
5	1.78	30.91	13	13	6.5	3.52	1177211

1.d. Formulas used to determine subsidence.

$$S_{m,he} = 0{,}39h\left(\frac{W}{H}\right)^{0{,}32}$$

$S_{m,pf} = 0.1h_e$ to $S_{m,pf} = 0.5h_e$ (Depth > 80m)

$$S_{m,pf} = 0.8h_e$$

$$h_e = he$$

Tilt

$$T_m = 21.6S_m + 7$$

Maximum tensile and compressive strain

$$\varepsilon_{m+} = 4.2S_m + 1.7$$

$$\varepsilon_{m-} = -9.1S_m - 2.8$$

1.e. An assessment on sinkhole analysis and multi seam analysis to be done in addition to the pillar design above.

In the recommendations the candidate must state, from the multi seam analysis, whether or pillars need to be super imposed between the different seams.

He should also note that the number 4 upper seam will not be mined as it is too low for extraction.

Question 2

2.a.
- Roof bolts using resin is used for primary support,
- Cable anchors using resin for secondary support,
- Osro Straps and W-straps used for primary and secondary support of geological discontinuities (joints, fault planes, brows, etc),
- Steel sets can also be used in those areas where very poor ground conditions and deadweight problems are encountered, either with or without an aerated cement product to fill the voids on the outside,
- Aerial support in the form of wire mesh / nets can also be used for primary and secondary support,
- The application of shotcrete / Thin Sprayed Liner [TSL] can also be used as a secondary support to provide additional confinement and limit the weathering of the coal pillar, and
- Timber poles / cluster sticks acting as breaker lines or to provide support for deadweight applications.

2.b. The candidate must be able to give a clear understanding of the suspension and beam building theory and state where each of the methods would be applicable

2.c.

$$\eta = \frac{\gamma B^4}{32Et^2}$$

Rock Type	p	g	y	Modulus	Thickness	Deflection		Difference
			kN	GPa	m	6.5	7.2	
Sandstone	2400	9.81	124.7832	5000	5.3	0.049561	0.074613	0.025052
Coal	1500	9.81	48.5595	5000	3.3	0.049748	0.074896	0.025147
Siltstone	2480	9.81	38.92608	10000	1.6	0.084821	0.127697	0.042876
Shale	2400	9.81	124.7832	5000	5.3	0.049561	0.074613	0.025052

2.d. Candidate to determine the weight of the beam per unit length to be suspended

Support resistance required

*2480*1.63*9.81*1.5 = 59.5 kN/m^2*

$$n = F\,\frac{pgh}{P_f}$$

For a 7.2 m bord width the required resistance / m will be 428.3 kN/m

Bolts / m^2

60 kN/m^2 / 140 kN (to 190 kN)= 0.43 to 0.32

Bolt spacing to be

1/0.43 = 2.33 m^2 / bolt

$\sqrt{2.33} = 1.52\ m$

OR

1/0.32 = 3.13 m^2 / bolt

$\sqrt{3.13} = 1.77\ m$

Anchor length

$$l_a = \frac{F_T}{\pi d_h \tau_c}$$

Bolt yield load varies between 140 and 190 kN

2.e. $$l_c = \frac{l_a\left(d_h^2 - d_b^2\right)}{\left(d_h - .002\right)} \qquad l_c = \frac{l_a\left(d_h^2 - d_b^2\right)}{d_c^2}$$

Question 3

3.a Using the formula given, three spot checks should be done to assess the correctness of the calculations. From the graph an error can be expected between 85 and 105. This needs to be one of the areas that is assessed. A comment should be that there is an error in the calculation.

3.b. D/2.7 = 220 / 2.7 = 81.5 m. Could also use Regulation which of 100 m from surface structure.

3.c. The formula used is only applicable to the calculation of the strength of the pillar. This formula takes into account the strength and the load therefore the formula cannot be used.

Question 4

Candidate must note that during the walking over the area, there will be times that the complete dead weight to be calculated as it will stop and walk in cycles. The load on the beam must be calculated for each

Load on the tub = (3600000*9.81/254.5 m^2) = 138.8 kPa (2)

Load on the pontoons = (3600000-9.81/57.6 m^2) = 613.1 kPa (2)

Load while standing = (3600000*9.81/(115.2 + 254.5) m^2 = 95.5 kPa (2)

Walking the dragline =

- Candidate should make his assumption on the load distribution between the pontoons and the tub and calculate the load from there. (3)

Incorporating a safety factor in the calculation of the beam strength (1)

Maximum stress can be calculated on the thickness of the sandstone overburden.

Manipulation of the formula to determine t

$t = \sqrt{\frac{sfph^2}{2Q}}$ =

Depending on the load when walking the thickness will be calculated (3)

Question 5

5.a. Any 5 can be discussed

Caliper – detect caving in borehole wall, identify large-scale breakout

Density – In situ bulk density of rock, acoustic impedance calculations, seismic parameters

Sonic – Compression and shear wave velocities (calculate E and v

Resistivity – provide information on fractures, porosity, grain size, lithological formation, weathering.

Acoustic Televiewer – fracture mapping, derive stress direction, measures breakout

Optical Televiewer – works in a dry hole

Flow meter – detects zones of water ingress into the borehole

5.b. Lithology

Depth below surface

RQD

DAV

Seams mined

Geological features

etc.

5.c. Candidate should demonstrate that he has knowledge of the different packages. He need to describe advantages and disadvantages, ease of work, input parameters, type of output obtained from the model and relevance to the bord and pillar mining.