Exemplar examination paper

QUESTION 1

Choose the correct word(s) from those given in brackets. Write only the word(s) next to the question number.

1.1 *Instrument* is a common name given to any (surveying instrument on a tripod/handheld instrument/type of tape measure).

1.2 A traveller is mainly used to control (an excavation/pipework/water mains hydraulic pressure).

1.3 One of the basic requirements when setting up a levelling instrument is to (adjust the circular bubble to be in its centre/make sure that the tripod feet are not firmly placed on the ground/make sure that the top of the tripod is sloping gently).

1.4 A theodolite can be used to set out (vertical angles/horizontal angles/levelling/all three).

1.5 Errors are classified as (gross errors/systematic errors/accidental errors/all three).

(5×2) (10)

[10]

QUESTION 2

2.1 State FIVE objectives of surveying. (5)

2.2 The surveying process consists of THREE stages. Name them. (3)

2.3 Explain the principle of working from the whole to a part. (5)

2.4 What is the difference between *accuracy* and *precision*? (6)

[19]

QUESTION 3

3.1 The standard temperature of a tape is 14 °C and the coefficient of expansion is 0,000012/°C. What is the reduced horizontal distance if the measured distance is 548 m on a slope of 5° 35' 25"? (5)

3.2 State FIVE requirements that must be met to obtain accuracy when taping. (5)

3.3 Given the coordinates:

A   –1 046,36   +310 869,16

B   –9 667,84   +369 642,67

Calculate the join between A and B. (6)

[16]

QUESTION 4

4.1 Name FIVE purposes of levelling. (5)

4.3 A theodolite is set up at a distance of 615 m from a building. The angle of elevation to the top of the building is 9° 18' 45". If the staff reading held on the benchmark (RL 355 m) is 1,73 m, find the reduced level of the top of the building and also do corrections for the earth's curvature and refraction. (6)

4.3 TABLE 1 in ANNEXURE 1 (attached) gives the data for a levelling task with benchmark (TBM) at A used as point of reference. Use the given data to find the reduced level of ALL points on which readings were taken using the rise and fall method. Do all the calculations and the necessary checks in TABLE 1. (10)

[21]

QUESTION 5

5.1 The data given below, of circle left and circle right observation angles, are from a field book page taken from station G.

Calculate the angles RGM, MGN, NGL, LGP and PGR.

Observations at G:

Target station	Circle left	Circle right
R	98:42:21	278:41:45
M	184:18:15	04:18:35
N	281:25:10	101:25:50
L	358:22:14	178:22:56
P	06:31:40	186:32:06
R	98:42:30	278:43:06

(10)

5.2 A theodolite is set up at station K and observation is taken at L. The upper and lower stadia read 1,98 and 0,65, respectively. The angle of elevation from K to L is 22° 15' 26". Calculate the horizontal and the vertical distance KL. (6)

[16]

QUESTION 6

6.1 Explain the relationship between building regulations and building construction practices. (6)

6.2 Calculate the length and the slope ratio, as a percentage, of a drainage pipe laid between points P and Q. Make use of the data given below.

Description	At P	At Q
Ground level	12,45	10,75
Invert level	11,29	9,32
Chainage	550,00	620,00

(6)

6.3 A drainage between is to be set out using a tilting level.

Given the following information:

- Length of drain = 190 m
- Gradient AB falling from A to B = 0,8%
- Ground level at A = 107,49 m
- Depth of excavation at A = 1,10 m
- Length of traveller = 1,45 m
- A backsight of 1,50 m is taken on a benchmark with an elevation of 108,21 m.

Calculate the staff reading necessary to locate sight rails over A and B. (6)

[18]

Total: 100 marks

ANNEXURE

Table 1

Point	Backsight	Intersight	Foresight	Rise	Fall	Reduced level	Remarks
A	1,153						TBM 33,71
B	1,545		1.333				
D		1,264					
E	1,963		1,344				
F			1,342				TBM 34,848

Exemplar examination paper memorandum

QUESTION 1

1.1 Surveying instrument on a tripod

1.2 Control an excavation

1.3 Adjust the circular bubble to be in its centre

1.4 All three

1.5 All three   (5 x 2) (10)

[10]

QUESTION 2

2.1 All of the following:

- To determine the relative position of any objects or points of the earth

- To determine the distance and angle between different objects

- To prepare a map or plan to represent an area on a horizontal plan

- To develop methods through the knowledge of modern science and technology, and to use them in the field

- To solve measurement problems in an optimal way.   (5)

2.2 The three stages are:

- Reconnaissance

- Field work and measurement

- Office work.   (3)

2.3 Working from the whole to the parts means first establishing a system of control points covering the whole area, with very high degree of precision. Then minor details are located by less precise methods.   (5)

2.4 *Accuracy* refers to how closely a measurement or observation is to measuring a true value, since measurements and observations are always subject to error.

Precision refers to how closely repeated measurements or observations come to duplicating measured or observed values.   (6)

[19]

QUESTION 3

3.1 $C_t = L \times e(t_m - t_s)$

$C_t = 548 \times 0,000012(20 - 14)$

$C_t = -0,0395$

$S_c = L(1 - \cos \theta)$

$S_c = 548(1 - \cos 5{:}35{:}25)$

$S_c = 2,6063$

Correct distance $= 548 + 0,0395 - 2,6063 = 545,354$ m   (5)

3.2   Any FIVE of the following:

- Tape must be held horizontal.

- Tape must be held on its correct zero mark.

- The correct tension must be applied to the tape.

- Remove all kinks before taping.

- Tape must be held on the correct peg.

- View tape vertically over the peg.

- Measure from and to the centre of the ranging rod.   (5)

3.3 $\Delta y_{AB} = -9\ 667,84 - (-1\ 096,38) = -8\ 571,46$

$\Delta x_{AB} = 369,64 - 310\ 869,16 = +58\ 773,51$

$AB = \sqrt{(-8,571,46)^2 + (58\ 773,51)^2} = 59\ 395,247$ m

Direction $AB = \tan^{-1}\left(\frac{\Delta y}{\Delta x}\right) + 270$

$$= \tan^{-1}\left(\frac{58\ 773,51}{8\ 571,46}\right) + 270$$

$$= 81{:}42{:}09 + 270$$

$$= 351{:}42{:}09 \tag{6}$$

[16]

QUESTION 4

4.1   Any FIVE of the following:

- To find the elevations of points on the Earth's surface for topographic maps

- For design of highways, railways, canals, etc.

- For locating grade lines

- For laying out of construction projects

- For locating excavating levels

- To determine the drainage characteristics of an area

- To determine volumes of earthwork. (5)

4.2 $V = D \tan\theta$

$V = 615 \tan 09{:}18{:}45$

$V = 100{,}848$ m

$C_d = 0{,}0673 D^2$

$C_d = 0{,}0673(0{,}615)^2$

$C_d = 0{,}025$ m

$RL_{\text{Top of building}} = RL_{\text{BM}} + Bs + V + C_d$

$RL_{\text{Top of building}} = 1\,355 + 1{,}73 + 100{,}848 + 0{,}025$

$RL_{\text{Top of building}} = 1\,457{,}603$ m (6)

4.3

POINT	BS	IS	FS	Rise	Fall	RL
A	1,153					33,71
B	1,545		1,333		0,18	33,53
C	1,730		1,234	0,311		33,841
D		1,264		0,466		34,307
E	1,963		1,344		0,08	34,227
F			1,342	0,621		34,848
	6,391		5,253	1,398	0,26	34,848
	-5,253			-0,260		-33,710
	1,138			1,138		1,138

(10)
[21]

QUESTION 5

5.1

Target	Circle left	Circle right	Mean angle	Correction	Corrected angle
R	98:42:21	278:41:45			
M	184:18:15	04:18:35			
	85:35:54	85:37:10	85:36:32	– 00:00:09	85:36:23
M	184:18:15	04:18:35			
N	281:25:10	101:25:50			
	97:06:55	97:06:55	97:06:55	– 00:00:09	97:06:46
N	281:25:10	101:25:50			
L	358:22:14	178:22:56			
	76:57:04	76:57:06	76:57:05	– 00:00:09	76:56:56
L	358:22:14	178:22:56			
P	06:31:40	186:32:06			
	08:09:26	08:09:10	08:09:18	– 00:00:09	08:09:09
P	06:31:40	186:32:06			
R	98:42:30	278:43:06			
	92:10:50	92:11:00	92:10:55	– 00:00:09	92:10:46
			360:00:45		360:00:00

(10)

5.2　HD = KIcos² θ

HD = 100(1,98 − 0,65)(cos 22:15:26)²

HD = 113,919 m

VD = 50Isin θ

VD = 50(1,98 − 0,65) × sin(2 × 22:15:26)

VD = 46,622　　　　　　　　　　　　　　　　　　　　　　(6)

　　　　　　　　　　　　　　　　　　　　　　　　　　　[16]

QUESTION 6

6.1　Building regulations are set national standards for building work, whether it is a new build or an extension of an existing building. Building construction practices follow the rules for new builds, or extensions or alterations to a house or building. The rules and regulations cover all aspects of construction, including foundations, damp-proofing, overall stability of the building, insulation, ventilation, heating, fire protection, fire and disabled facilities in certain types of building. Construction companies carrying out building work are responsible for complying with the building regulations.　(6)

6.2　$PQ = \sqrt{(11,29 − 9,32)^2 + (620 − 550)^2}$

$PQ = \sqrt{1,97^2 + 70^2}$

PQ = 70,028 m

$Slope\ ratio = \dfrac{11,29 − 9,32}{620 − 550}$

$= 2,814\%$　　　　　　　　　　　　　　　　　　　　　(6)

6.3　Collimation height = 108,21 + 1,5 = 109,71 m

$\Delta h = \dfrac{0,8}{100} \times 190 = 1,52\ m$

Invert level at A = 107,49 − 1,1 = 106,39 m

Invert level at B = 106,39 – 1,52 = 104,87 m

Staff reading at A = 109,71 – (106,39 + 1,45) = 1,26 m

Staff reading at B = 109,71 – (104,37 + 1,45) = 3,89 m   (6)
                                                            [18]

Total: 100 marks