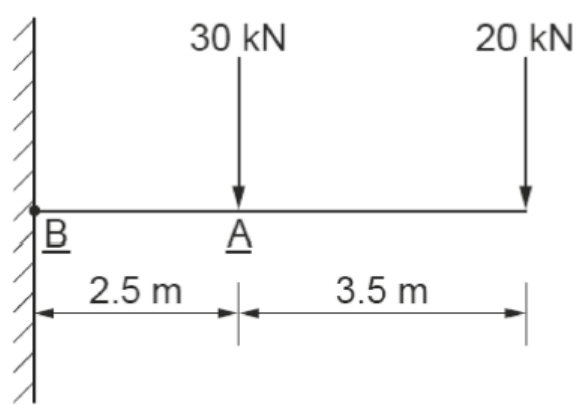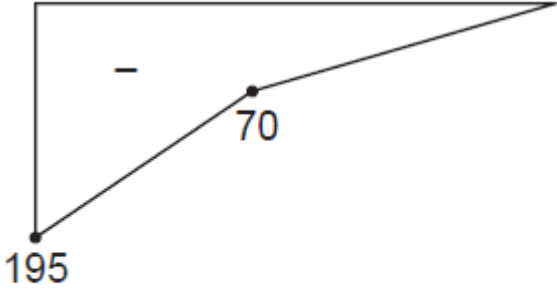**6720-556 June 2018**

6720-37 Advanced Technical Extended Diploma in Constructing the Built Environment (Civil Engineering) (1080)

1	Identify **two** of the laws of static equilibrium used to determine beam reactions.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **two** of the following at **one** mark each. • The algebraic sum of the vertical forces must equal zero (1). Accept ΣV = 0 • The algebraic sum of the horizontal forces must equal zero (1). Accept ΣH = 0 • The algebraic sum of the moments of forces must equal zero (1). Accept ΣM = 0	n/a	2

2	For the cantilever beam shown in Figure 1.
	  Figure 1

2a)	Determine the bending moment values at points A and B.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	A= 70 kNm (1) B= 195 kNm (1)	n/a	2

2b)	Produce a bending moment diagram to represent the loading.

Acceptable answer(s)	Guidance	Max marks
BM Diagram (kNm)	Marks allocated as follows: • Correct shape (1) • Correct values (1)	2

3	Describe **one** effect that eccentric loading has on columns.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Up to **two** marks for a coherent description of **one** of the following effects. • Direct stress • Bending stress • Total stress • Bend/buckle	n/a	2

4	Determine the safe axial-load for a timber post that is 75 mm square and which has an effective length of 2.5 m, using the table below. You must show **all** calculations.		

Slenderness ratio (L/b)	Permissible stress (N/mm²)
30	8.7
40	11.5

Acceptable answer(s)	Guidance	Max marks
Four marks as allocated below. L/b = 2500/75 = 33.33 (1) Permissible stress by interpolation = 9.6 N/mm2 (1) Safe Load = 9.6 x 75 x 75 (1) = 54 000N or 54 kN (1)	n/a	4

5	State the following modes of failure for a retaining wall.		

5a)	Overturning.		

Acceptable answer(s)	**Guidance**	**Max marks**
Overturning failure is a result of soil pressure causing the wall to rotate.	n/a	1

5b)	Sliding.		

Acceptable answer(s)	**Guidance**	**Max marks**
Sliding failure is a result of soil pressure to move away laterally.	n/a	1

6	A retaining wall retains water of density 10 kN/m^3. The height of the wall is 4.5 m.		

6a)	Determine the pressure per linear metre at the base of the wall.		

Acceptable answer(s)	**Guidance**	**Max marks**
P = 4.5 x 10 = 45 (1) kN/m2	Mark only for correct answer.	1

6b)	Calculate the magnitude of the total force per metre run (F_h) acting on the wall.		

Acceptable answer(s)	**Guidance**	**Max marks**
One mark for the formula and **one** mark for the correct answer. F_h= 45 x 4.5/2 (1) = 101.25 (1) kN/m	n/a	2

6c)	Calculate the height above the base of the wall at which the resultant force will act.		

Acceptable answer(s)	**Guidance**	**Max marks**
4.5 / 3 = 1.5m (1)	Mark only for correct answer.	1

7	Name **two** methods used to determine forces in statically determinate frameworks.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **two** of the following at **one** mark each: • Graphical method. • Method of resolution. • Method of sections.	n/a	2

8	Name **two** temporary methods of groundwater control that can be used on construction sites.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **two** of the following at **one** mark each. • Dewatering • Pumps • Sumps • Well points • Electro-osmosis • Freezing • Grouting • Compressed air • Cut-off trenches.	n/a	2

9	Name **two** items of earthworks plant used on construction sites.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **two** of the following at **one** mark each: • Excavators • Bulldozers • Backacters • Scraper • Grader • Loader • Dumper • Draglines	n/a	2

10	Describe the purpose of a contraction joint used in rigid pavements.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	A contraction joint is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane (1). It regulates the location of the cracking caused by dimensional changes in the slab (1).	n/a	2

11	State **three** duties under the Health & Safety at Work Act (HASWA) that **employees** must follow.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **three** from the following up to a maximum of **three** marks: • To act with due care and for themselves and others (1). • To cooperate with the employer e.g. taking part in toolbox talks (1). • To correctly use anything provided for health and safety in accordance with any instruction or training (1). • Not to misuse or damage equipment provided for health and safety purposes (1).	Max **two** marks if only talk about HSE.	3

12	Explain the advantages of using a caisson as a method of deep excavation for bridge piers.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	A coherent explanation of the following. Marks as shown to a maximum of **three** marks in total. A caisson is a box or shell-like structure which is sunk into water (1). It allows dry working (1), it can become part of the structure so does not need removing (1), can be internally pressurised to prevent water ingress (1).	n/a	3

13	A retail company is planning to build a large new distribution warehouse.

Explain why a steel portal frame may be considered the **best** design option for the building.

Acceptable answer(s)	Guidance	Max marks
A coherent explanation of the following. Marks as shown to a maximum of **three** marks in total. The frame can be prefabricated, quick and easy to construct (1). There are lower installation costs to the retail company as the speed of erection is quicker (1) and generally less skilled workers and their number are required to be part of the construction phase (1).The frame is designed so that there is more space inside the structure, hence why it is so popular in the use of industrial factories or storage facilities (1). Portal frame does not require bracing so the location of windows or doors is not affected (1). The construction and erection of the framework is not affected by the weather so there should not be delays due to in-climate weather conditions (1). There are reduced wastage on site as components are made off-site and made to measure (1).Steel is preferred to concrete or timber as its stronger and stiffer (1).	n/a	3

14	A developer is keen to incorporate a sustainable urban drainage system (SUDS) into a new eco-village development and is seeking local public opinion on the design of the SUDS.

Evaluate the design considerations the local public may require the developer to consider.

Acceptable answer(s)	Guidance	Max marks
A coherent evaluation of the following. Marks as shown to a maximum of **five** marks in total. Ponds should be made as 'natural' in appearance as possible (1). Vegetation and planting adjacent to SUDS is important and should include native species (1). Shore slopes should be gentle (1) Natural barriers (e.g. planting) should be introduced to help manage perceived safety risks (1). Deep water warning signs should be used were applicable (1). Benches should be introduced (1). Picnic tables, walkways and children's play areas should be considered (1). Land based wildlife and aquatic species, including fish, should be encouraged to colonise the system and its marginal areas (1).	n/a	5

15	Identify **two** methods used for the manual production of 3D drawings.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **two** from the list below at **one** mark each. • Axonometric. • Isometric. • Freehand sketches.	n/a	2

16	Describe what is meant by the term 'COBie'.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	A coherent description of the term and what it is, to a max of **four** marks. COBie – Construction Operations Building Information Exchange (1) is a formal process for the sharing of information (1) for new and existing buildings. It provides the owner and operator the information about the building in an easily accessible format (1). Typically, it is used for non-graphical data (1) and is presented in the form of a multi-page spreadsheet (1) and is used at level 2 of the BIM maturity model (1).	n/a	4

17	Identify **two** CAD software packages **most** appropriate to produce 3D models of a building.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Any **two** from the following at **one** mark each. • Autodesk Auto CAD. • Autodesk Revit. • Autodesk Fusion 360. • AutoDesk 3D Max. • Autodesk Inventor. • Solidworks. • Bentley Microstation. • Archi CAD. • Sketch up.	Any other appropriate 3D design package is acceptable.	2

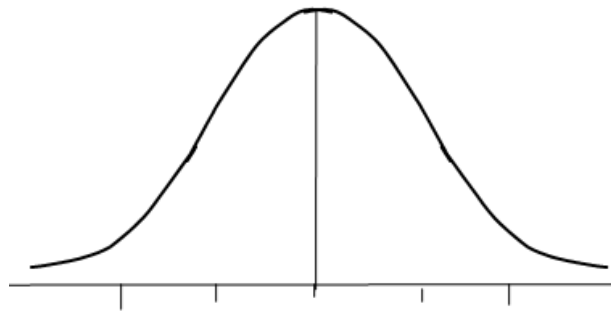| 18	Explain the challenges for BIM implementation.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	A coherent linked explanation to a maximum of **four** marks, that considers some of the following typical challenges and barriers to the implementation of BIM processes. This may include challenges such as: **Attitude:** Traditional mindsets need changing (1). Stakeholders not receptive to new approach (1). **Cost:** Supporting hardware and software may need to be purchased (1). Additional training needs (1). **Convenience:** Easier to make amendments and changes in 2D and traditional methods (1).	n/a	4
19	Summarise the implications for the adoption of a totally digital drawing office.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	A coherent and linked discussion that considers the implications. This may include some or all of the following: • Expensive to set up (1). • Additional training is required (1). • Service provision may need upgrading (1). • Increased productivity (after training) (1). • Improved output quality, 3D, coloured renders etc (1). • Improved communication and integration with other professionals (1). • Re-useable data base of information (1). • Easier alteration and adaptation (1). • Future proofing (1).	Any other appropriate answers (1 each)	4

20	State the calculus technique that can be used to determine		
20a)	the area under a curve		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Integration	n/a	1

20b)	the maximum and minimum turning points of a curve.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	Differentiation	n/a	1

| 21 | Concrete cube samples have been tested for strength on two separate construction sites. Cumulative frequency diagrams would normally be produced to show the test results taken from each site.

State which mathematical measure of dispersion, of a typical cumulative frequency diagram, should be used to identify the following. | | |
|---|---|---|---|
| 21a) | The site with the concrete of greater strength. | | |
| | **Acceptable answer(s)** | **Guidance** | **Max marks** |
| | Median | n/a | 1 |
| 21b) | The site with the least variance of strength between the samples of concrete. | | |
| | **Acceptable answer(s)** | **Guidance** | **Max marks** |
| | Inter-quartile range | n/a | 1 |

22	Describe, with the aid of a diagram, the meaning of the term 'normal distribution' as used in statistical analysis techniques.		
	Acceptable answer(s)	**Guidance**	**Max marks**
	One mark for a description and **one** mark for a diagram showing normal distribution.

Any **one** from the following for a max of **one** mark:
• Diagram of normal distribution as a bell curve. (1)
• An arrangement of a data set in which most values cluster in the middle of the range and the rest taper off symmetrically toward either extreme (1).
• The precise shape can vary according to the distribution of the population but the peak is always in the middle (1)
• The curve is always symmetrical (1).
• In a normal distribution, the mean, mode and median are all the same (1).
• Use of an example such as height. (1) | n/a | 2 |

Max **one** mark for drawing a curve.

Normal Distribution
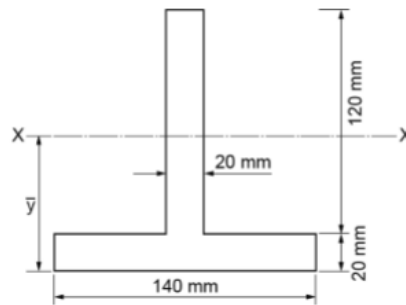
23	For the beam section shown in Figure 2.

Figure 2

23a)	Calculate, using the first moment of area principles, the position of the centroidal axis X-X.

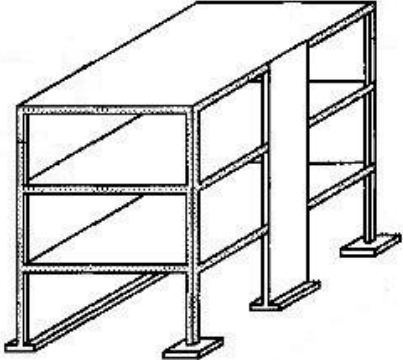| Acceptable answer(s)	Guidance	Max marks
y = (140x 20 x 10) + (120 x 20 x 80) = 220 000/5200 (1) (140 x 20) + (120 x 20) = 42.3 (1) mm from bottom (or 97.3 mm from top)	n/a for both part a) and part b).	2

23b)	Calculate the second moment of area (moment of inertia) about the X-X axis. You may use the table below to complete your calculations.

Given $y = \dfrac{\sum (A_1 y_1 + A_2 y_2)}{\sum (A_1 + A_2)}$ $I_{CG} = bd^3/12$ $I_{XX} = I_{CG} + Ac^2$

Part	A mm^2	$\dfrac{bd^3}{12}$	c	Ac^2
1				
2				
Total				

	Acceptable answer(s)	Guidance	Max marks
		n/a	5

Part	A mm^2	$\dfrac{bd^3}{12}$	c	Ac^2
1	140 x 20 = 2 800	140 x 20^3/12 9.3 x 10^4 (1)	32.3	2.92 x 10^6 (1)
2	120 x 20 = 2400	20 x 120^3/12 2.88 x 10^6 (1)	37.7	3.41 x 10^6 (1)
Total		2.97 x 10^6		6.33 x 10^6

$I_{xx} = I_{cg} + AC^2 =$ 9.3 x 10^6 (1) mm^4

24	Differentiate with respect to x

24a)	$y = 3x^4$

Acceptable answer(s)	Guidance	Max marks
$12x^3$ (1)	n/a	1

24b)	$y = 5x^3 - 2x^2 + 10$

Acceptable answer(s)	Guidance	Max marks
$15x^2$ (1) - 4x (1)	n/a	2

25	A property developer has planning permission to build a large two-storey steel frame sports complex. The new building will be rectangular and have plan dimensions of 80 m x 20 m.

25a)	Explain how the bending theory equation is used and applied to design steel beams.

Acceptable answer(s)	Guidance	Max marks
Bending formula determines the maximum bending moments (M) for beam (1) M is used to determine section modular Z (1) Z is used to size the beam from tables (1)	n/a	3

25b)	Produce a sketch or diagram showing elements of the foundation, columns, beams and floor sections of the steel frame.

Acceptable answer(s)	Guidance	Max marks
Three marks for frame to include foundations (1), columns (1) and floor sections (1). 	No labelling is required and will not be awarded marks.	3

25c)	Discuss the structural and design issues that will need to be considered for the steel frame.

Acceptable answer(s)	Guidance	Max marks
Intention: ***The aim of the question is for learners to apply a range of understanding of factors affecting the design of the steel frame structure in a synoptic contextualised scenario setting.*** **Mark Band 1 (1-4 marks)** The learner identifies a limited number of structural considerations to specify how the steel frame will affect the design of the structure and there is little in the way	**Indicative content:** Use of permissible stress design tables to size sections, understand the importance of terms in the design of axially-loaded columns: effective length, moment of inertia, cross-sectional area, radius of gyration and slenderness ratio, consider column sectional shape, consideration of using steel,	12

of description. The learner's response lacks detail and is not clearly linked to the scenario. **Mark Band 2 (5-8 marks)** The learner identifies a wide range of structural considerations of how the steel frame will affect the design of the structure used and supports this with brief descriptions. The learner's response is detailed but incomplete, makes some allowance for and has clear links to the scenario in most cases. **Mark Band 3 (9-12 marks)** The learner identifies a comprehensive range of the structural considerations to specify how the steel frame will affect the design of the structure and supports this with in-depth descriptions. Their response is detailed and complete, and has clear and accurate links to the scenario.	method of construction, foundations and cladding *For no awardable content, award 0 marks.*