Mark Scheme (Results)

June 2019

BTEC Level 3 Nationals

Engineering

Unit 1: Engineering Principles

(31706H)

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Unit 1: Engineering Principles

General marking guidance

- All learners must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do, rather than be penalised for omissions.
- Examiners should mark according to the mark scheme, not according to their perception of where the grade boundaries may lie.
- All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.

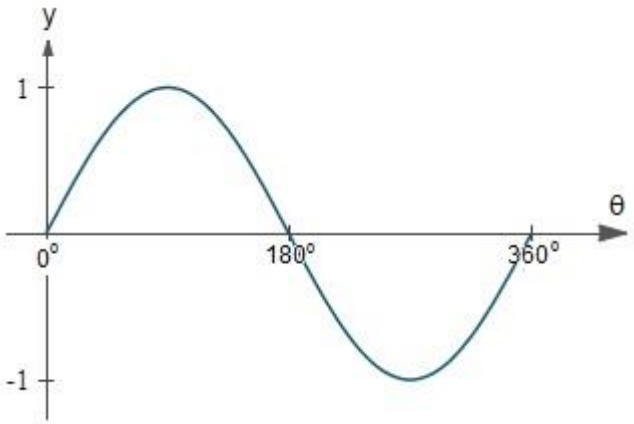
Specific marking guidance

This mark scheme uses the following types of marks:

- M marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- B marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

Abbreviations:

- ft – follow through
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC - special case
- oe – or equivalent (and appropriate)
- dp - decimal places
- sf - significant figures

Question number	Answer	Mark
1	 • Both axes with appropriate labels (1) • Both axes with appropriate values (1) • Correct form of graph (1) • Accurate plotting of graph crossing y axis at 0, 180(or π) and 360 (or 2π) (1)	(4)

Question number	Working	Answer	Notes	Mark
2	Area of square 24 x 24 = 576 mm^2 Area of channel 16 x 20 = 320 mm^2 Area = 576-320 A = 256mm^2 **Alternative approach 1** Area of sides (24 x 4) + (24 x 4) = 192 mm^2 Area of bottom piece (16 x 4) = 64 mm^2 Area = 192 + 64 A = 256mm^2	<u>Area</u> = <u>256mm^2</u>	M1 for area of square M1 for area of channel A1 for correct answer for A (ft) M1 for area of two sides M1 for area of base piece A1 for correct answer for A (ft)	(3)

	Alternative approach 2 Area of sides (20 x 4) + (20 x 4) = 160 mm^2 Area of bottom piece (24 x 4) = 96 mm^2 Area = 160 + 96 A = 256mm^2		M1 for area of two sides M1 for area of base piece A1 for correct answer for A (ft)	

Question number	**Working**	**Answer**	**Notes**	**Mark**
3 (a)	$l = (n^2)^3$ $l = n^{2 \times 3}$ $l = n^6$	$\underline{l = n^6}$	M1 for application of laws of indices A1 for correct simplified expression for l	(2)
(b)	$l = n^6$ $l = 4^6$ $l = 4096$	$\underline{l = 4096}$	A1 for correct answer for l (ft)	(1)

Question number	**Working**	**Answer**	**Notes**	**Mark**
4	Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$ $a^2 = 6^2 + 4^2 - 2x4x6 \cos 25$ $a^2 = 52 - 48 \cos 25$ $a = \sqrt{8.49}$ a = 2.92m	$\underline{a = 2.92\,m}$ Answers that round to 2.9m	M1 for identification of the cosine rule M1 for correct substitution of values M1 for rearranging in terms of a A1 for correct answer for a	**(4)**

Question number	Working	Answer	Notes	Mark
5	$32 = -4t^2 + 24t$ $-4t^2 + 24t - 32 = 0$ $-t^2 + 6t - 8 = 0$ $-(t - 4)(t - 2)$ $t = 2$ and $t = 4$ **Alternative method 1** $-4t^2 + 24t - 32$ $-4t^2 + 16t + 8t - 32$ $-4t\ (t - 4) + 8\ (t - 4)$ $-4t + 8 = 0$ $t - 4 = 0$ $t = 2$ and $t = 4$ **Alternative method 2** $32 = -4t^2 + 24t$ $4t^2 - 24t + 32 = 0$ $t^2 - 6t + 8 = 0$ $(t - 4)(t - 2)$ $t = 2$ and $t = 4$	$\underline{t = 2}$ $\underline{\text{and}}$ $\underline{t = 4}$	M1 for creating the equation when h=32 M1 for rearranging of equation to equal 0 (ft) M1 for simplification by extraction of common factor (ft) M1 for factorising to give factors in terms of t (ft) A1 for correct answer for time 1 (ft) A1 for correct answer for time 2 (ft)	(6)

Section B

Question number	Answer	Mark
6	A - linear	**(1)**

Question number	Answer	Mark
7	D - radians per second	**(1)**

Question number	Working	Answer	Notes	Mark
8	Clockwise moments = anticlockwise moments Clockwise moment = 4 x F Anticlockwise moments = 5 x 12 + 2 x 20 60 + 40 = 4F F = 100/4 F = 25 N	F = 25 N	M1 for recognising M = Fd M1M1 for correctly setting up the equation (or M1 for ACW, M1 for CW) M1 for rearranging in terms of F (ft) A1 for correct answer for F (ft)	**(5)**

Question number	Working	Answer	Notes	Mark
9i	PE = mgh PE = 500x9.81x25 PE = 122625 J	PE = 122625 J	M1 for correct substitution of values A1 for correct answer for PE (cao)	
9ii	Conservation of energy $154000 = PE + 1/2mv_2^2$ $154000 = 122625 + 0.5x\ 500xv_2^2$ $154000 = 122625 + 250v_2^2$ $v_2^2 = 31375/250$ $v_2 = \sqrt{125.5}$ $v_2 = 11.2$ m/s	$v_2 = 11.2$ m/s	M1 for correct substitution of values (ft) M1 for rearranging in terms of v_2 (ft) A1 for correct answer for v_2 (ft) A1 (dep) for correct unit	**(6)**

Question number	Answer	Mark
10	Award **one** mark for any of the following. ● Area (inlet or outlet) (1) ● Velocity (1) ● Diameter of the pipe (1) ● Roughness/ friction / length of the pipe (1) ● Any obstructions / bends in the pipe (1) ● Angle/gradient of the pipe (1) ● Viscosity / density of the fluid (1) ● Temperature (1) ● Pressure (1) ● Volume of liquid (1) Accept any other reasonable response Do not accept size or stress.	**(1)**

Question number	Working	Answer	Notes	Mark
11	Area to cut = circumference x thickness $A = 0.2 \times \pi \times 0.004$ $A = 2.5 \times 10^{-3}\ m^2$ 50 MPa = 50 000 000 Pa Or 50 MPa = 50×10^6 Pa $\tau = F/A$ $F = \tau A$ $F = 50\,000\,000 \times 2.5 \times 10^{-3}$ F = 125 kN or F = 125 000 N	<u>F = 125 kN or F = 125 000 N</u> <u>Accept answers from a range of 125 to 126 kN</u> <u>Accept answers in standard form</u>	M1 for recognising that the cut area is the circumference x thickness M1 for correct substitution of values A1 for correct answer for A (ft) M1 for conversion from MPa to Pa M1 for rearranging in terms of F (ft) M1 for correct substitution of values (ft) A1 for correct answer for F (ft)	**(7)**

Question number	Working	Answer	Notes	Mark
12	Volume = $\pi r^2 h$ V = π x 0.3^2 x 0.7 V = 0.198 m^3 V = 0.063 π Weight of water = mg Mass of water = weight/g Mass of water = 22/9.81 Mass of water = 2.24 kg Density = mass/volume D = 2.24/0.198 Density =11.3 kg/m^3	<u>Density = 11.31 kg/m^3</u> Accept answers that round to 11.3 kg/ m^3	M1 for correct substitution of values A1 for correct answer for V (ft) M1 for recognising weight = mg M1 for rearranging in terms of Mass (ft) M1 for recognising that as the object is in static equilibrium the mass of water = mass of cylinder M1 for correct substitution of values (ft) A1 for correct answer for mass of water (ft) M1 for correct substitution of values (ft) A1 for correct answer for density (ft)	**(9)**

Section C

Question Number	Answer	Mark
13	C - Inductor	**(1)**

Question Number	Answer	Mark
14	A - Coulombs per second	**(1)**

Question Number	Answer	Mark
15	Award **one** mark for any of the following. • Converts / changes / turns an AC supply into a DC supply (1) • Provides a steady/smooth DC supply (1) Accept named product applications of rectifier circuits e.g. power supply, battery charger.	**(1)**

Question number	Working	Answer	Notes	Mark
16	P = IV P = 5.5 x 12 P = 66 W	<u>P = 66 W</u>	M1 for correct substitution of values A1 for correct answer for Power (cao)	**(2)**

Question number	Working	Answer	Notes	Mark
17(a)	$1/C_t = 1/C_1 + 1/C_2$ $1/C_t = 1/33\ nF + 1/58\ nF$ $1/C_t = 0.0303 + 0.0172$ $C_t = 1/(0.0303 + 0.172)$ $C_t = 21\ nF$ simplified formula solution (C1 x C2)/(C1 + C2)	$\underline{C_t = 21\ nF}$	M1 for correct substitution of values M1 for correct rearranging in terms of C_t (ft) A1 for correct answer for capacitance (ft)	**(3)**
(b)	$W = 1/2\ CV^2$ $W = 0.5 \times (21 \times 10^{-9} \times 12^2)$ $W = 1.51 \times 10^{-6}$ J	$\underline{W = 1.51} \times 10^{-6}$ J $\underline{W = 1.51\ \mu J}$	M1 for recognising nF = 10^{-9} F M1 for correct substitution of values (ft) A1 for correct answer for Energy stored (ft) A1 (dep) for correct unit	**(4)**

Question number	Working	Answer	Notes	Mark
18	$\Delta R/R_0 = \alpha\Delta T$ $\Delta T = 17$ $\Delta R = 15 - 12 = 3\,\Omega$ $\alpha = \Delta R/(\Delta T \times R_0)$ $\alpha = 3/(17 \times 12)$ $\alpha = 0.0147$	$\underline{\alpha = 0.0147}$ Accept 1/68 And answers rounded to 0.015	A1 for correct value for ΔR M1 for rearranging the equation in terms of α M1 for correct substitution of values (ft) A1 for the correct answer for α (ft)	**(4)**

Question number	Working	Answer	Notes	Mark
19	$X_c = 1/2\pi fC$ $X_c = 1/(2\pi x50x100x10^{-6})$ $X_c = 1/31.42x10^{-3})$ $X_c = 31.83\ \Omega$ $Z = \sqrt{(X_c^2 + R^2)}$ $Z = \sqrt{(31.83^2 + 10^2)}$ $Z = \sqrt{(1012.5 + 100)}$ $Z = 33.35\ \Omega$	<u>Z = 33.35 Ω</u>	M1 for recognising relationship between μF and F M1 for correct substitution of values (ft) A1 for correct answer for Xc (ft) M1 for correct substitution of values (ft) A1 for correct answer for Z (ft)	**(5)**

Question number	Working	Answer	Notes	Mark
20	**Method 1** $B/H = \mu_0 \mu_r$ $H = B/\mu_0 \mu_r$ $H = NI/l$ therefore $B/\mu_0 \mu_r = NI/l$ $B = \mu_0 \mu_r NI/ l$ $B = (4\pi \times 10^{-7} x 150 x 200 x 3)/0.25$ $B = 0.452$ T $B = \Phi/A$ $\Phi = BA$ $\Phi = 0.452 \times 0.4$ $\Phi = 0.181$ Wb	$\underline{\Phi = 0.181 \text{ Wb}}$	M1 for rearranging the magnetic permeability equation in terms of MFS M1 for recognition of the relationship between magnetic field strength (MFS) and permeability and making the substitution in terms of MFS M1 for rearranging MFS equation in terms of flux density (B) M1 for correct substitution of values (ft) A1 for correct answer for B (ft) M1 dep recognition of the relationship between B and Φ M1 for rearranging in terms of Φ (ft) M1 for correct substitution of values (ft) A1 for correct answer for Φ (ft)	**(9)**

	Method 2 H = NI// H = (200 x 3)/0.25 H = 2400 B/H = $\mu_0 \mu_r$ B = H $\mu_0 \mu_r$ B = 2400 x $4\pi x10^{-7}$ x 150 B = 0.452 T B = Φ/A Φ = BA Φ = 0.452 x 0.4 Φ = 0.181 Wb	$\underline{\Phi = 0.181 \text{ Wb}}$	M1 for substituting values into the equation for H A1 for correct answer for H (ft) M1 for rearranging the equation in terms of flux density (B) M1 for correct substitution of values (ft) A1 for correct answer for B (ft) M1 recognition of the relationship between B and Φ M1 for rearranging in terms of Φ (ft) M1 for correct substitution of values (ft) A1 for correct answer for Φ (ft)	

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