Mark Scheme (Results)

January 2019

Pearson BTEC Level 3

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 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:

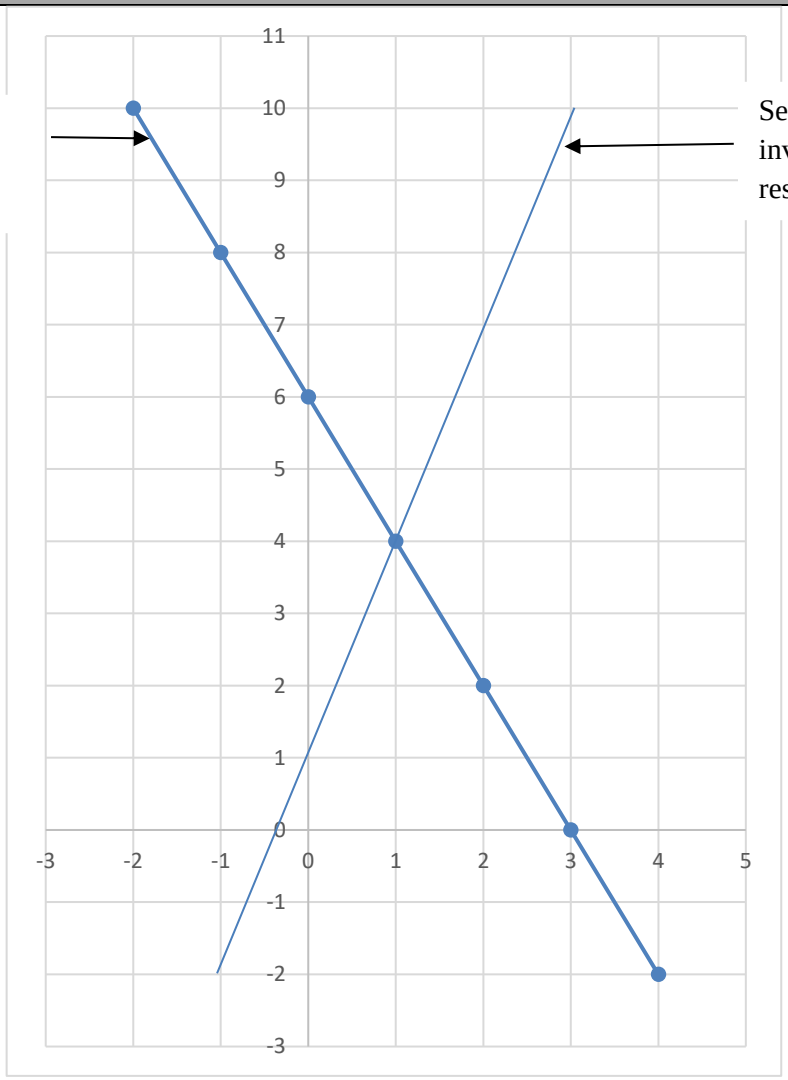
- M marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- B marks are unconditional accuracy marks (independent of M marks)
- Marks should not be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

BTEC Next Generation Mark Scheme

Engineering Unit 1 - 1901

Question number	Answer	Mark
1 a	 M1 for y intercept at y=1 M1 for correct gradient of 3 M1 for accurately plotting the straight line	**(3)**

Question number	Working	Answer	Notes	Mark
1 b	Co-ordinates read from the graph x = 1 y = 4	(1, 4)	A1 for x (ft) A1 for y (ft)	**(2)**

Question number	Working	Answer	Notes	Mark
2	Revolutions = 1750/3.5 Revolutions = 500	<u>Revolutions = 500</u> Accept final answers rounding to 500.	M1 for recognition of relationship between angular velocity and RPM A1 for correct answer for revolutions	**(2)**

Question number	Working	Answer	Notes	Mark
3	Tan ϴ = 15/30 Tan ϴ = 0.5 ϴ = $\tan^{-1}0.5$ ϴ = 26.6º **Alternative approaches** AC = $\sqrt{(15^2 + 30^{2)}}$ AC = 33.54 ϴ = $\sin^{-1}(15/33.54)$ Or ϴ = $\cos^{-1}(30/33.54)$ Or Sin ϴ/15 = sin90/ 33.54	<u>ϴ = 26.6º</u> Accept final values that round to one decimal place.	M1 for correct substitution of values M1 for rearranging in terms of ϴ A1 for correct answer for ϴ (ft) M1 for calculating AC M1 for rearranging in terms of ϴ	**(3)**

	sin θ/15 = 1/ 33.54 sin θ = 15/33.54 θ = $\sin^{-1}$ (15/33.54) θ = 26.6º		A1 for correct answer for θ (ft)	

Question number	Working	Answer	Notes	Mark
4(a)	$l = \sqrt{(2^2 + 3^{2)}}$ $l = \sqrt{13}$ l = 3.61 m Award full marks for alternative approaches with the correct answer	$\underline{l = 3.61 \text{ m}}$ or $\underline{l = \sqrt{13} \text{ m}}$ Accept final values that round to two decimal places.	M1 for recognition of Pythagoras Theorem M1 for correct substitution of the values A1 for correct answer for l (ft)	**(5)**
4(b)	Curved Surface Area (CSA) = π r l CSA = π x 2 x 3.61 CSA = 22.68 m^2 Award full marks for alternative approaches with the correct answer	$\underline{A = 22.7 \text{ m}^2}$ Accept final values that round to one decimal place.	M1 for correct substitution of the values (ft) A1 for correct answer for CSA	

Question number	Working	Answer	Notes	Mark
5	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $x = \frac{-(-24) \pm \sqrt{(-24)^2 - 4 \times 32 \times 4}}{2 \times 32}$ $x = \frac{24 \pm \sqrt{576 - 512}}{64}$ $x = \frac{24 \pm \sqrt{64}}{64}$ x = (24 + 8)/64 = 0.5 X = (24 - 8)/64 = 0.25 **Allow maximum 2 x B1 marks, for correct factorisation**	x = 0.5 x = 0.25	M2 for fully correct substitution of values (M1 for two correct values) M1 for simplification of formula (ft) B1 for correct first value of x (ft) B1 for correct second value of x (ft)	**(5)**

Question number	Answer	Mark
6	D - pascal	**(1)**

Question number	Answer	Mark
7	C - torque	**(1)**

Question number	Answer	Mark
8	Award **one** mark for a valid statement. • Diameter/radius/thickness/cross sectional area/area (1) • Load/force/mass/weight/tension (1) • Temperature (1) • Length of the original cable (1) • Fatigue/corrosion (1) • Damage (1) Accept any other reasonable response Do not accept the general term 'dimensions'	**(1)**

Question number	Working	Answer	Notes	Mark
9	$A_1v_1 = A_2v_2$ $v_2 = A_1v_1/A_2$ $v_2 = 0.5 \times 15/0.3$ $v_2 = 7.5/0.3$ $v_2 = 25$ m/s	$v_2 = 25$ m/s	M1 for rearranging in terms of v_2 M1 for correct substitution of values (ft) A1 for the correct answer for v_2 (cao)	**(3)**

Question number	Working	Answer	Notes	Mark
10	$\varepsilon = \Delta L/L$ ΔL 3 mm = 0.003 m (or 3×10^{-3}) $\varepsilon = \Delta L/L$ $\varepsilon = 0.003/5$ or 5m = 5000mm $\varepsilon = 3/5000$ $\varepsilon = 0.0006$ $\varepsilon = 6 \times 10^{-4}$ Accept 600×10^{-6} and equivalents	$\varepsilon = 6 \times 10^{-4}$	M1 for correct conversion of mm to m (or m to mm) M1 correct substitution of values (ft) A1 for correct answer for direct strain (ft)	**(3)**

Question number	Working	Answer	Notes	Mark
11 (a)	N = mg N = 50 x 9.81 N = 490.5 N	N = 490.5 N	M1 for recognising N = mg M1 for correct substitution of values A1 for the correct answer for N (ft) A1 (dep) unit	**(4)**
(b)	$F_A = \mu N$ $F_A = 0.3 \times 490.5$ $F_A = 147.15$ N	$F_A = 147.15$ N	M1 correct substitution of values (ft) A1 for correct answer for F_A (ft)	**(2)**

Question number	Working	Answer	Notes	Mark
12(a)	$S = 1/2(4 + 4)t$ $2 \times 200 = 8t$ $t = 400/8$ $t = 50$ s	<u>$t = 50$ s</u>	M1 for correct substitution of values M1 for rearranging the equation in terms of time A1 for correct answer for time NB: All appropriate methods acceptable (e.g. SUVAT equations)	**(3)**
12(b)	E_M before collision = $E_M + T_M$ after the collision $50000 \times 4 = (50000 + 5000)v_f$ $200\,000 = 55000\ v_f$ $V_f = 200000/55000$ $V_f = 3.64$ m/s	<u>$V_f = 3.64$ m/s</u>	M1 for recognising momentum = mass x velocity M1 for correct selection of conservation of momentum M1 for correct substitution of values M1 for rearranging the equation in terms of V_f B1 for correct answer for velocity	**(5)**

Question number	Working	Answer	Notes	Mark
13	$v^2 = u^2 + 2as$ $a = (v^2 - u^2)/2s$ $a = (3^2 - 2^2)/2s$ $a = (9 - 4)/(2 \times 5)$ $a = 5/10$ $a = 0.5\ m/s^2$ $F = mg + ma$ $F = 30 \times 9.81 + 30 \times 0.5$ $F = 294.3 + 15$ $F = 309.3N$ $WD = Fs$ $WD = 309.3 \times 5$ $WD = 1546.5\ Nm$	<u>WD = 1546.5 Nm</u> Accept final values that round to two decimal places. Accept 1.55kJ or 1.55kNm.	M1 rearranging the equation in terms of a (ft) M1 for correct substitution of values (ft) A1 for correct answer for a (ft) M1 for recognising $F = mg + ma$ M1 for correct substitution of values (ft) A1 for correct answer for F (ft) M1 for correct substitution of values (ft) A1 for correct answer for WD (ft)	**(8)**

Question Number	Answer	Mark
14	A - amplitude	**(1)**

Question Number	Answer	Mark
15	D - reluctance	**(1)**

Question number	Working	Answer	Notes	Mark
16	E = V/d V = 75kV = 75000 V d = 25 mm = 0.025 m E = 75000/0.025 E = 3000000 V/m 0r E = $3x10^6$ V/m Accept: 3kV/mm and other equivalent value/unit combinations	E= 3 kV/mm E = 3 MV/m E= 3000 V/mm E= 3000 kV/m E = $3x10^6$ V/m E = 3000000 V/m	M1 for conversion from kV to V or mm to m (M1 for both) M1 for correct substitution of values (ft) A1 for correct answer for E (ft) A1 (dep) for correct unit	**(4)**

Question Number	Answer	Mark
17	Award **one** mark for a relevant factor • Type of material (1) • Length of the conductor (1) • Thickness/cross sectional area (1) • Temperature (1) • Resistivity of material (1) • Purity of the material (1) • Number of free moving electrons (1) Accept any other relevant response.	**(1)**

Question number	Working	Answer	Notes	Mark
18(a)	$R_A = R_1 + R_2 + R_3$ $R_A = 22 + 47 + 33$ $R_A = 102\ \Omega$	$\underline{R_A = 102\ \Omega}$	M1 for the correct substitution of values A1 for correct answer for R_A (ft)	
18(b)	Parallel resistance $1/R_p = 1/100 + 1/102$ $1/R_p = 0.0198$ $R_p = 50.5$ Total resistance = 50.5 + 56 $R_t = 106.50\ \Omega$ Or R = R1*R2/R1+R2 R = (100x102)/(100+102) R = (1020/202) = 50.5 Total resistance = 50.5 + 56 $R_t = 106.50\ \Omega$	$\underline{R_t = 106.50\ \Omega}$	M1 for correct substitution of values (ft) M1 for rearranging in terms of R_p A1 for correct answer for R_p (ft) A1 for correct answer for R_t (ft)	**(6)**

Question Number	Answer	Mark
19	Award **one** mark for an initial statement and **one** further mark for an expansion, up to a maximum of **two** marks. • It produces a DC smooth output waveform (1) as each cycle of the input AC current/voltage converts to DC (1) • Converts an AC current/voltage into a DC supply (1) by converting a negative current/voltage into a steady state (1) A full wave rectifier uses an array of diodes (1) to change an AC input into a DC output (1) Accept any other relevant response.	**(2)**

Question number	Working	Answer	Notes	Mark
20 (a)	$\tau = RC$ $\tau = 220 \times 10^3 \times 33 \times 10^{-6}$ $\tau = 7.26$ s	$\underline{\tau = 7.26 \text{ s}}$ Accept final values that round to one decimal places.	M1 for conversion of mF to F *or* kΩ to Ω M1 for correct substitution of values (ft) A1 for correct value for time constant (cao)	**(3)**
(b)	$v_c = Ve^{(-t/\tau)}$ $v_c = 12\ e^{(-20/7.26)}$ $v_c = 12\ e^{-2.75}$ $v_c = 12 \times 0.064$ $v_c = 0.763$ V	$\underline{v_c = 0.77 \text{ V}}$ Accept final values that round to one decimal place	M1 for correct substitution of values (ft) M1 for calculating $e^{-2.75}$ A1 for final answer for v_c	**(3)**

Question number	Working	Answer	Notes	Mark
21	$B = \Phi/A$ $B = 0.1 \times 10^{-3} / (250 \times 10^{-6})$ $B = 0.4$ T From BH chart: B = 0.4 then H = 1500 H = NI/l Rearranging I = Hl/N I = 1500 x 0.9/300 I = 4.5 A	<u>I = 4.5 A</u> Accept final values that round to one decimal place	M1 for conversion of mWb to Wb M1 for correct substitution of values A1 for correct answer for B (ft) M1 for interpretation of BH chart to find H (ft) M1 for recognising the relationship between magnetic field and current M1 for rearranging equation in terms for I M1 for correct substitution of values (ft) A1 for correct answer for I	**(8)**

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