Mark Scheme (Results)

June 2018

Pearson BTEC Level 3

Engineering

Unit 1: Engineering Principles (31706H)

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Unit 1: Engineering Principles – 1806

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

Dep - mark can only be awarded dependent on the award of the previous mark

Indept - mark can be awarded independent of the award of the previous mark

BTEC Next Generation Final Mark Scheme

Engineering Unit 1 - 1806

Question number	Working	Answer	Notes	Mark
1 (i)	Gradient (m) x_2-x_1 = (2-1) = 1 $y_2 - y_1 = (5 - 3) = 2$ m = (y2-y1)/(x2-x1) m = 2/1 m = 2	<u>m = 2</u>	M1 for recognising the formula for gradient A1 for the correct answer of gradient Other values of x and y could be used to find the gradient m	**(2)**
(ii)	Equation of a line y = mx + c Intercept (c) x = 0, y = 1, therefore c = 1 Equation of line <u>y = 2x + 1</u>	<u>y = 2x + 1</u>	M1 for recognising the equation of a straight line y = mx + c A1 for the correct equation of the line	**(2)**

Question number	Working	Answer	Notes	Mark
2 i)	$\theta = 60 \times 2\pi/360$ $\theta = 1.047$ rad	$\underline{\theta = 1.047 \text{ rad}}$ $\underline{\text{Accept } \theta = \pi/3}$	M1 for correct substitution of values A1 for correct answer for radians	**(2)**
(ii)	Area = $1/2r^2\theta$ A = ½ x 2^2 x 1.047 A = 2.094 m^2	$\underline{A = 2.094 \text{ m}^2}$ $\underline{\text{Accept awrt } 2.1 \text{ m}^2}$	M1 for correct substitution of values (ft) A1 for correct answer for area of base (ft)	**(2)**
(iii)	Volume = base area x height V= 2.094 x 3 $\underline{V = 6.282 \text{ m}^3}$ Alternative Volume of cylinder $V = \pi r^2 h = \pi \times 2^2 \times 3$ V = 37.7 m^3 Volume of tank V= 37.7/6 = 6.28m^3	$\underline{V = 6.282 \text{ m}^3}$	M1 for correct substitution of values (ft) A1 for correct answer for volume (ft) M1 for volume of cylinder A1 for volume of tank	**(2)**

Question number	Working	Answer	Notes	Mark
3	**METHOD 1** Cos Θ = adjacent/hypotenuse Cos 75 = 50/AC AC = 50/cos 75 AC = 193 mm **METHOD 2** sinΘ = opposite/hypotenuse Sin15 = 50/AC AC = 50/sin15 AC = 193 mm **METHOD 3** a/sinA = b/sinB 50/sin15 = AC/sin90 AC = 50sin90/sin15 AC = 193 mm	<u>AC = 193 mm</u> <u>AC = 0.193 m</u> <u>AC = 19.3 cm</u> Accept awrt 193mm (oe)	M1 for recognition of cosine ratio M1 for correct substitution of the values M1 for correctly rearranging the equation in terms of AC (ft) A1 for correct answer for AC (ft) ---------- M1 for recognition of sine ratio M1 for correct substitution of the values M1 for correctly rearranging the equation in terms of AC (ft) A1 for correct answer for AC (ft) ---------- M1 for recognition of the sine rule M1 for correct substitution of values M1 for correct rearranging the equation in terms of AC (ft) A1 for correct answer for AC (ft)	(4)

Question number	Working	Answer	Notes	Mark
4	**Resolving forces horizontally:** 26 cos 20+8 cos 70 = Ecos θ + 32 cos 60 Ecos θ = 24.43 + 2.74 -16 Ecos θ = 11.17 N Alternative approach Force 1 26 cos 20 = 24.43 N Force 2 8 cos 70 = 2.73 N Force 3 -32 cos 60 = -16 N Ecos θ = 24.43 + 2.74 -16 Ecos θ = 11.17 N	Horizontal component: 11.17 N	M1 M1 for correct statement of both sides of the equation M1 for correctly rearranging the equation in terms of Ecos θ A1 for correct answer for horizontal component (ft) B1 for Force 1 B1 for Force 2 B1 for Force 3 A1 for correct answer for horizontal component (ft)	**(4)**

Question number	Working	Answer	Notes	Mark
5	$e^{2x} = 6$ $2x = \ln 6$ (or $\log_e 6$) $x = \frac{\ln 6}{2}$ (or $\log_e 6/2$) $x = 0.8959$ $x = 0.90$	<u>X = 0.90</u>	M1 for correctly applying laws of logarithms M1 for rearranging the equation in terms of x A1 for the correct answer for x Allow follow through for rounding variations	**(3)**

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

Question number	Answer	Mark
7	B - mechanical advantage	**(1)**

Question number	Answer	Mark
8	Award **one** mark for a valid statement. ● The resultant sum of forces is zero (1) ● The vector sum of forces is zero (1) ● The sum of anticlockwise and clockwise moments is zero (1) ● upwards forces = downwards forces (1) ● leftward forces = rightward forces (1) ● Forces must be balanced (1) ● Forces are equal in both directions (1) Do not accept 'equal forces'	**(1)**

Question number	Working	Answer	Notes	Mark
9 (i)	A = 6x8 A = 48 m^2	A = 48 m^2	M1 for correct substitution of values A1 for the correct answer for area (cao)	**(2)**
(ii)	F = ρgAx x = h/2 x = 6/2 x = 3 F = 1000 x 9.81 x 48 x 3 F = 1412640 N F = 1.41 MN	F = 1.41 MN F = 1412640 N F = 1413 kN Do not penalise if centre of area is calculated as h/3 (F = 0.94 MN oe)	A1 for finding the centre of area x (may be implied) M1 correct substitution of values (ft) A1 for correct answer for F (ft)	**(3)**

Question number	Working	Answer	Notes	Mark
10 (i)	$A = \pi d^2/4$ $A = \pi \times (20\times10^{-3})^2/4$ $A = 314.2 \times 10^{-6}\ m^2$ Alternative approach: $A = \pi r^2$ $A = \pi \times (0.02/2)^2$ $A = 0.0003142$	$\underline{A = 314.2 \times 10^{-6}\ m^2}$ Also accept $\underline{A= 0.0003142 m^2}$ $\underline{A = 0.314 \times 10^{3}\ m^2}$ $\underline{A = 3.14 \times 10^{-4}\ m^2}$ $\underline{A = 314\ mm^2}$ $\underline{A = 3.142\ cm^2}$	M1 correct substitution of values A1 for correct answer for cross-sectional area (ft)	**(2)**
(ii)	Stress = force/area Stress = $3/314.2 \times 10^{-6}$ Stress = 9549 kN/m^2 or 9548058.6 N/m^2 or 9.55 MPa	$\underline{\text{Stress} = 9549\ kN/m^2}$ $\underline{\text{Also accept}}$ $\underline{9.55\ MPa}$ $\underline{9.55\ MN/m^2}$ $\underline{9.55\ N/mm^2}$ $\underline{9548058.6\ N/m^2}$	M1 correct substitution of values (ft) A1 for correct answer for direct stress (ft) A1 for unit (dep)	**(3)**

Question number	Working	Answer	Notes	Mark
11 (i)	r = d/2 r = 0.06/2 r = 0.03 m v =$4\pi r^3/3$ v =$(4/3)x\ \pi\ x\ 0.03^3$ v =$113.1x10^{-6}$ m^3	v =$113.1x10^{-6}$ m^3 Also accept v = 0.000113 m^3 v = 113 100mm^3 v = 1.13 x 10^{-4} m^3 V = 113 cm^3	M1 for calculating the radius M1 for correct substitution of values (ft) A1 for the correct answer for volume (ft)	**(3)**
(ii)	Density = m/v Density = $0.35/113.1x10^{-6}$ Density = 3094.6 kg/m^3	Density = 3094.6 kg/m^3 Accept answers that round to 3100 kg/m^3 Accept 3.095 g/cm^3	M1 for correct substitution of values (ft) A1 for the correct answer for density based on previous values	**(2)**

Question number	Working	Answer	Notes	Mark
12	$v^2 = u^2 + 2as$ $15^2 = 75^2 + 2 \times a \times 270$ $225 = 5625 + 2 \times a \times 270$ $225 = 5625 + 540a$ $540a = -5400$ $a = -10\ m/s^2$	<u>$a = -10\ m/s^2$</u> accept: $10\ m/s^2$ deceleration	M1 for selection of the correct equation M1 for correct substitution of values M1 for rearranging the equation in terms of deceleration A1 for correct answer for deceleration (ft) NB: All appropriate methods acceptable	**(4)**

Question number	Working	Answer	Notes	Mark
13	r = d/2 r = 0.6/2 r = 0.3 m Convert RPM into radians per second $(2\pi \times 60) / 60 = 6.3$ rads per sec. Inertia: $I = kmr^2$ k = 1 $I = 1 \times 10 \times 0.3^2$ $I = 0.9\ kgm^2$ Rotational KE = $\frac{1}{2} I\ \omega^2$ Rotational KE = $\frac{1}{2} \times 0.9 \times 6.3^2$ Rotational KE = 17.86 J	<u>Rotational KE = 17.86 J</u> Accept answers in the range 17.7 J - 17.9 J Allow follow through for rounding variations	M1 conversion of 'd' to 'r' (may be implied) M1 for substitution of correct values (conversion of RPM) A1 for correct answer rad/s M1 for recognising inertia M1 for substitution of correct values A1 for correct answer for I (ft) M1 for correct substitution of values (ft) A1 for correct value of rotational KE (ft)	**(8)**

Question Number	Answer	Mark
14	**C** - hertz	**(1)**

Question Number	Answer	Mark
15	**B -** diode	**(1)**

Question number	Working	Answer	Notes	Mark
16	P = IV I = P/V 2 kW = 2 000 W I = 2 000/110 I = 18.18 A Accept amps, amperes	I = 18.18 A	M1 for correctly rearranging the equation in terms of I M1 for conversion from kW to W M1 for correct substitution of values (ft) A1 for correct answer for I (ft) A1 (dep) for correct unit	**(5)**

Question number	Working	Answer	Notes	Mark
17	**METHOD ONE** Total capacitance: C= C1 + C2 + C3 $C = 68 \times 10^{-6} + 12 \times 10^{-6} + 47 \times 10^{-6}$ $C = 127 \times 10^{-6}$ F ($C = 127\ \mu F$) Q = CV $Q = 127 \times 10^{-6} \times 110$ Q = 0.014 C **METHOD TWO** $Q_1 = 110 \times 68 \times 10^{-6} = 7.48 \times 10^{-3}$ $Q_2 = 110 \times 12 \times 10^{-6} = 1.32 \times 10^{-3}$ $Q_3 = 110 \times 47 \times 10^{-6} = 5.17 \times 10^{-3}$ $Q = 7.48 \times 10^{-3} + 1.32 \times 10^{-3}$ $+ 5.17 \times 10^{-3}$ $Q = 13.97 \times 10^{-3}$ C Q = 0.014 C	Q = 0.014 C	M1 for the correct substitution of values A1 for correct answer for capacitance M1 for correct substitution of values (ft) B1 for correct answer for total charge (ft) ---------- B1 for Q_1 B1 for Q_2 B1 for Q_3 B1 for correct answer for total charge (ft)	**(4)**

Question Number	Answer	Mark
18	Award **one** mark for an initial statement and **one** further mark for an expansion, up to a maximum of **two** marks. • Conventional current flows from the positive terminal (1) to the negative terminal of a power supply (1) • Conventional current moves in the same direction as the positive charge flow (1) which is in the opposite direction to the flow of electrons (1) • Flow of current from positive (1) to negative terminals (1) Accept any other relevant application with expansion.	**(2)**

Question number	Working	Answer	Notes	Mark
19 (i)	$V_{RMS} = V_{PEAK}/\sqrt{2}$ $V_{PEAK} = V_{RMS} \times \sqrt{2}$ $V_{PEAK} = 100 \times \sqrt{2}$ $V_{PEAK} = 141.4$ V	$V_{PEAK} = 141.4$ V	M1 for rearranging equation in terms of V_{PEAK} M1 for correct substitution of values A1 for peak voltage (ft)	**(3)**
(ii)	Average value = $(2 / \pi) \times V_{PEAK}$ Average value = $(2 / \pi) \times 141.4$ Average value = 90.02	Average value = 90.02 V Accept awrt 90V	M1 for correct substitution of values (ft) A1 for average voltage (ft)	**(2)**
(iii)	Form factor = V_{RMS}/average value Form factor = 100/90.02 Form factor = 1.11	Form factor = 1.11 Accept final values that round to one decimal place Allow follow through for rounding variations	M1 for correct substitution of values (ft) A1 for correct value of form factor (ft)	**(2)**

Question number	Working	Answer	Notes	Mark
20	**METHOD 1** I_1 = current in LH loop I_2 = current in RH loop $I_3 = I_1 + I_2$ LH loop $12V = (10+2)I_1 + 6(I_1 + I_2)$ $12V = 12I_1 + 6(I_1 + I_2)$ $12V = 18I_1 + 6I_2$ RH loop $9V = 22I_2 + 6(I_1 + I_2)$ $9V = 28I_2 + 6I_1$ $6I_1 = 9V - 28I_2$ Substituting into the LH loop: $12V = 3(9V - 28I_2) + 6I_2$ $12V = 27V - 84I_2 + 6I_2$ $78I_2 = 15V$ $I_2 = 0.19A$ Therefore: $18I_1 = 12 - (6x0.19)$ $18I_1 = 12 - 1.15 = 10.85A$ $I_1 = 0.61A$ $I_3 = I_1 + I_2$ $I_3 = 0.19A + 0.61A = \underline{0.80A}$	$I_3 = \underline{0.80A}$ Accept final values that round to one decimal place Allow follow through for rounding variations	M1 for recognising the need to calculate current in both LH loop and RH loop M1 for correct substitution into equation M1 for determining the relationship between I_1 and I_2 in LH loop M1 for correct substitution into equation M1 for determining the relationship between I_1 and I_2 in RH loop M1 for correct substitution into equation A1 for value of I_2 (ft) A1 for value of I_1 (ft) A1 for value of I_3 (ft)	**(9)**

	METHOD 2 Loop 1 $12 = (10 + 2 + 6)I_1 + 6I_2$ $12 = 18I_1 + 6I_2$ [1] Loop 2 $9 = 6I_1 + (22 + 6)I_2$ $9 = 6I_1 + 28I_2$ [2] Multiply [2] by 3 and eliminate I_1 $27 = 18I_1 + 84I_2$ [2a] $12 = 18I_1 + 6I_2$ [1] Subtract $15 = 78I_2$ $I_2 = \frac{15}{78} = 0.1923\ A$ Substitute back in [1] to calculate I_1 $12 = 18I_1 + 6(0.1923)$ $18I_1 = 12 - 6(0.1923) = 10.8462$ $I_1 = \frac{10.8462}{18} = 0.6026\ A$ Calculate I_3 $I_3 = I_1 + I_2 = 0.7949\ A$ $= 0.80\ A\ (to\ 2dp)$		M1 for recognising the need to calculate current in both LH loop and RH loop M1 for correct substitution into equation M1 for determining the relationship between I_1 and I_2 in Loop 1 M1 for correct substitution into equation M1 for determining the relationship between I_1 and I_2 in Loop 2 M1 for process of eliminating I_1 A1 for value of I_2 (Ft) A1 for value of I_1 (Ft) A1 for value of I_3 (Ft)	

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