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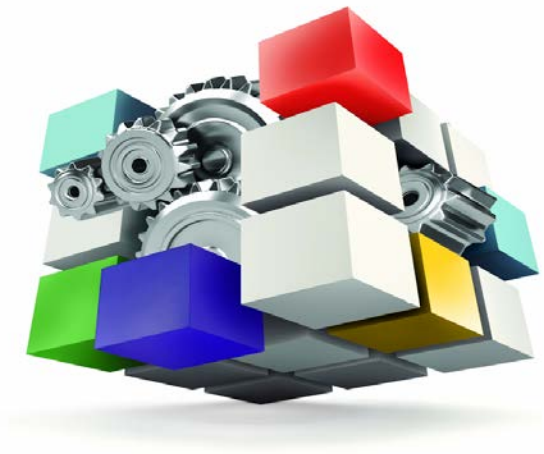
Mark Scheme (Results)

January 2018

BTEC Level 3 National in Engineering
Unit 1: Engineering Principles
(31706H)



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Engineering	Level 3 National	31706H	Unit 1: Engineering Principles

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January 2018
Publications Code xxxxxxxx*

Unit 1: Engineering Principles – marking grid

General marking guidance

- All candidates 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:

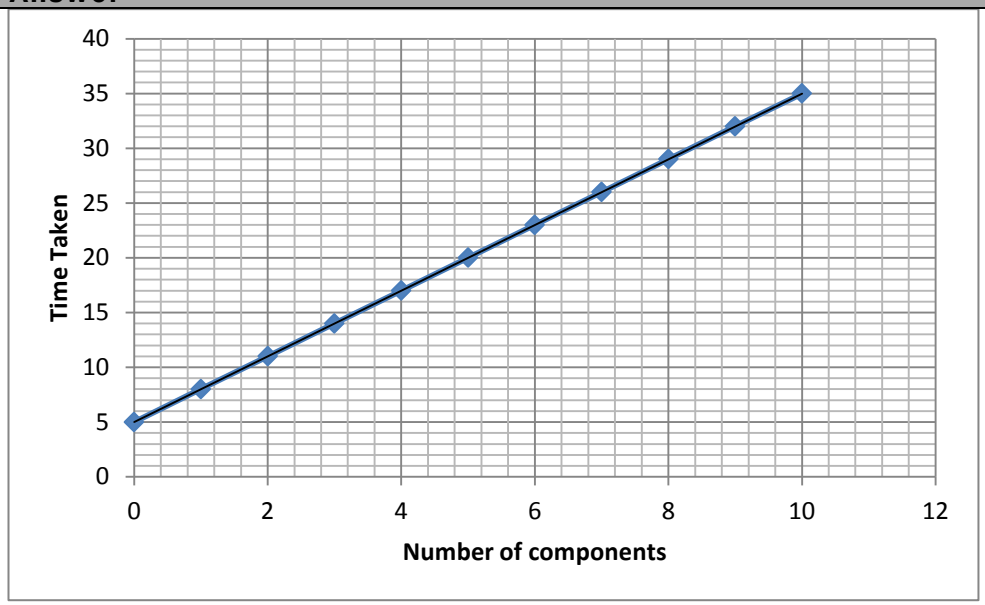
- M marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- B marks are unconditional accuracy marks (independent of M marks).
- Marks should not be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

Abbreviations:

- bod – benefit of doubt
- ft – follow through
- the symbol will be used for correct ft
- 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)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ¿ The answer is printed on the paper
- ⊏The second mark is dependent on gaining the first mark

BTEC Next Generation Mark Scheme

Engineering Unit 1 January 2018

Question number	Answer	Mark
1	 • Both axes with appropriate labels (1) • Both axes with appropriate values (1) • Correct 'y intercept' at 5 (1) • Accurate plotting of graph with a gradient of 3 (1)	**(4)**

Question number	Working	Answer	Notes	Mark
2 (i)	Area of a triangle: A = ½ base x height A = (30 x 50)/2 A = 1500 / 2 A = 750 mm^2	A = 750 mm^2 A = 0.75 x 10^{-3} m^2	M1 for substituting correct values into the equation A1 for the correct answer for A	
(ii)	Volume = area x thickness V = 750 x 5 V = 3750 mm^3	V = 3750 mm^3 V = 3.75 x 10^{-6} m^3	M1 for substituting correct values into equation (ft from Q02i) A1 for the correct arithmetic answer for V (ft)	**(4)**

Question number	Working	Answer	Notes	Mark
3	Eqn 1 $4y = 3x - 9$ Eqn 2 $y = x - 11$ $4y=4x-44$ $0 =x-35$ $x = 35$ $y = 24$ Learners could calculate 'y' first by multiplying equation 2 by 3	$x = 35$ $y = 24$ $(35,24)$ Allow ft if second variable is correct in relation to the first incorrect answer.	M1 for multiplying the equation 2 by 4 o.e M1 for subtraction eqn 1 from eqn 2 (o.e) A1 for correct answer for first variable A1 for correct answer for second variable (ft)	**(4)**

Question number	Working	Answer	Notes	Mark
4 (i)	$\theta = (70 \times \pi)/180$ $= 1.22$ rad	$\theta = 1.22$ rad $\theta = 7\pi/18$ rad oe Accept final values that round to two decimal places.	M1 for conversion to radian measure A1 for correct arithmetic value of radians	
(ii)	Arc length $s = r\theta$ $s = 40 \times 1.22$ $s= 48.8$ mm	$s = 48.8$ mm $s = 0.0488$ m	M1 for calculating arc length (ft from Q04i) A1 for correct arithmetic answer for arc length (ft) Nb All appropriate methods acceptable	**(4)**

Question number	Working	Answer	Notes	Mark
5	Sine rule a/sinA = b/sinB Or sinA/a = sinB/b 160/sin73 = X/sin43 Or sin73/160 = sin43/X X = 160sin43/sin73 <u>X = 114.11mm</u>	<u>X = 114.11mm</u> Accept correct answer in any form e.g. 0.114m.	M1 for selection of the sine rule M1 correct substitution of values M1 for correctly rearranging the equation (ft) A1 for correct arithmetic answer for X. (ft)	**(4)**

Question Number	Answer	Mark
6	D - Watts	**(1)**

Question Number	Answer	Mark
7	A – Young's modulus	**(1)**

Question Number	Answer	Mark
8	Award **one** mark for a method that can produce a mechanical advantage. ● Use a pulley system (1) ● Use a jack (1) ● Use an inclined plane/ramp (1) ● Use a lever / leverage (1) ● Use gears (1) Accept any other valid response.	**(1)**

Question number	Working	Answer	Notes	Mark
9(i)	$A = \pi(d/2)^2$ $A = \pi(0.060/2)^2$ $A = \pi x 0.03^2$ $A = 0.00283\ m^2$	Area = $0.00283\ m^2$ $A = 2827\ mm^2$ $A = 2.827 \times 10^{-3}\ m^2$	M1 for substituting the correct value A1 for the correct arithmetic answer for area (ft)	
(ii)	Mass flow rate = ρ x A x v = 1000 x 0.00283 x 2 = 5.65 kg/s	Mass flow = = 5.65 kg/s Accept final values that round to two decimal places.	M1 for substituting the correct values (ft from Q09i) A1 for correct arithmetic answer for mass flow rate (ft)	**(4)**

Question number	Working	Answer	Notes	Mark
10	M= Fd Clockwise moments = anticlockwise moments Taking moments about A: (2 x 50) + (20 x 5 x 2.5) = $5R_B$ $5R_B = 350$ $R_B = 70\ N$	$R_B = 70\ N$	M1 for recognising M= Fd M1 for reducing UDL to a point load (may be implied) M1 M1 for correct balancing of moments (ft) M1 for correct substitution of values (ft) M1 for correctly rearranging the equation in terms of R_B (ft) A1 for correct arithmetic answer of R_B	**(7)**

Question Number	Answer	Mark
11	Award **one** mark for each valid statement, up to a maximum of **two** marks. • when objects collide, the total momentum before the collision (1) is the same as the total momentum after the collision (1) • the momentum of a system in motion is constant (1) if there are no external forces acting on the system (1)	**(2)**

Question number	Working	Answer	Notes	Mark
12 (i)	Potential energy PE = mgh PE = 500 x 9.81 x 20 PE = 98100 J	PE = 98100 J PE = 98.1 kJ	M1 for correct substitution of values A1 for correct answer of PE (ft) A1 (dep) for correct unit	
(ii)	Velocity of truck KE = ½mv^2 KE = PE 98100 = ½ x 500 x v^2 v^2 = 392 v = √ 392 v = 19.8 m/s Alternative approach Note: can also be answered using v^2 = u^2 + 2as v^2 = 0^2 + 2 x 9.81 x 20 v^2 = 392.4 v = √ 392.4 v = 19.8 m/s	v = 19.8 m/s	M1 for using KE equation (conservation of energy) or v^2 = u^2 + 2as M1 for correct substitution of values (ft from Q12i) M1 for making v^2 (or v) the subject of the equation (ft) A1 for correct arithmetic answer for v (ft)	**(7)**

Question number	Working	Answer	Notes	Mark
13	Limited shear stress = 50kPa Pin is in double shear, therefore $\tau = F/2A$ $\tau = 50/2A$ $50x10^3 = 50/2A$ Rearranging: $A = 50/(2 \times 50x10^3)$ $A = 0.5 \times 10^{-3}\ m^2$ $A = 500\ mm^2$ $A = \pi(d/2)^2$ $d = \sqrt{(4 \times A/\pi)} = \sqrt{(4x500/\pi)}$ <u>d = 25.23mm</u>	<u>d = 25.23mm</u> Accept final values that round to two decimal places. Allow ft for incorrect working at earlier stages, e.g. not dividing by 2 for double shear (35.68mm) Or Considering F =100 and not dividing by 2 (50.4 mm)	M1 for identification of pin in double shear M1 for substitution of correct values (ft) M1 for rearranging the equation in terms of area M1 for correct substitution of values (ft) A1 for correct arithmetic answer for area (ft) M1 for rearranging in terms of diameter (ft) A1 for correct arithmetic answer for diameter (ft) Nb- M1,A1,M1,A1 for failure to recognise double shear	**(7)**

Question Number	Answer	Mark
14	C - kinetic energy	**(1)**

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

Question number	Working	Answer	Notes	Mark
16 (i) (ii)	$1/C = 1/C_1 + 1/C_2 + 1/C_3$ $1/C = 1/16 + 1/24 + 1/4$ $1/C = 0.0625 + 0.042 + 0.25$ $1/C = 0.35$ $C = 2.82$ F $Q = CV$ $Q = 2.82 \times 230$ $Q = 649$ C	$C = 2.82$ F $C = 48/17$ oe $Q = 649$ C Accept final values that round to 649 C. Allow follow through for rounding variations.	M1 for correct substitution of values A1 for a correct arithmetic answer of 1/C (ft) A1 for a correct arithmetic answer for C (ft) M1 for substituting correct values (ft from Q16i) A1 for correct arithmetic answer of Q (ft) A1 (dep) for correct unit	**(6)**

Question number	Working	Answer	Notes	Mark
17	$P = V^2/R$ $R = V^2/P$ $R = 230^2/12000$ $R = 4.41\Omega$	$R = 4.41\Omega$ Accept final values that round to one decimal place	M1 for correctly rearranging formula M1 for converting kW to W M1 for substituting the correct values (ft) A1 for correct arithmetic answer for resistance (ft)	**(4)**

Question number	Working	Answer	Notes	Mark
18(a)	$V_1/V_2=N_1/N_2$ $240/90=800/N_2$ N_2 = 800x90/240 <u>N_2 = 300 turns</u>	<u>N_2 = 300 turns</u> Accept final values that round to whole numbers	M1 for substitution of correct values M1 for rearranging the equation for N_2 (ft) A1 for the correct arithmetic answer for N_2 (ft)	**(3)**

Question Number	Answer	Mark
18(b)	Award **one** mark for a method of reducing losses, up to a maximum of **two** marks. • Increase the diameter/use an appropriate size of wire (1) • Use copper wire/wire with low resistance (1) • Use thin laminations for the core (1) • Use insulated laminations for the core (1) • Use materials with a low hysteresis coefficient (1) • Use amorphous metals (1) • Reduce heat/eddy currents/cool the system (1) Accept any other relevant phrasing/wording **Do not accept** 'soft iron core'	2

Question number	Working	Answer	Notes	Mark
19(a)	P=IV P= 230 x 60 = 13 800 W P = 13.8 kW Consideration of efficiency Output power = 13.8 x 0.58 = <u>8 004 W</u> <u>= 8 kW</u>	Output power = <u>8kW</u> <u>Accept</u> <u>8 004 W</u>	M1 for substituting the correct values A1 for correct arithmetic answer for input power (ft) M1 for correctly rearranging the efficiency equation A1 for correct arithmetic answer for output power (ft)	**(4)**

Question Number	Answer	Mark
19(b)	Award **one** mark for the method and **one** additional mark for the appropriate expansion to a maximum of **two** marks. • Reduce heat in the motor (1) by using cooling fans (1). • Reduce rotor losses (1) by using materials with higher conductivity (1) • Increase the mass of the conductor in the stator (1) as this reduces the electrical resistance (1) • Decreased maintenance intervals (1) to ensure optimum performance (1) • Lubricate/clean rotating/moving parts (1) to reduce friction/heat (1) • Remove parts (1) use a brushless motor (1) Accept any other valid response. **Do not accept** 'reduce heat losses'.	(2)

Question number	Working	Answer	Notes	Mark
20	$XL = 2\pi fL$ $XL = 2 \times \pi \times 50 \times 0.6$ $XL = 188.5\ \Omega$ Total impedance: $Z = \sqrt{(188.5^2 + 10^2)}$ $Z = 188.8\ \Omega$ $I = V/Z$ $I = 230/188.8$ $I = 1.22$ A	<u>I = 1.22</u> Accept final values that round to two decimal places.	M2 for fully correct substitution of values (M1 for correct substitution for either f or L) A1 for correct arithmetic answer for X_L (ft) M1 for fully correct substitution of values for impedance (ft) A1 for correct arithmetic answer for total impedance (ft) M1 for substitution of correct values (ft) A1 for correct arithmetic answer for I (ft)	**(7)**

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