M1.(a) (moment =) Force x <u>perpendicular</u> distance ✓
<u>between line of action</u> (of force) <u>and pivot / point</u> ✓

both marks need to be clear − avoid bod
if the force is named specifically (e.g. weight) mark the work but give a maximum of 1 mark
ignore extra material such as law of moments

2

(b) (i) moment = 250 × 0.048 = 12 ✓ (allow 12000 for this mark)

only allow answers in other units if consistent e.g. 1200 N cm

N m ✓ (stand alone mark if no number is present but only for N mm, N cm and N m)

no working shown can gain full marks if answer and unit are consistent
newton should be upper case if a symbol and metre should be in lower case (but only penalise if it is very obviously wrong)

2

(ii) $Y \times 0.027 = 12$ OR $Y = 12 / 0.027$ ✓
(allow use of 12 and 27 for this mark)
= 440 (N) ✓ (444.4 N) CE from (i)

Y = (i) / 0.027
treat power of 10 error as an AE
note 450 N is wrong
1 sig fig is not acceptable

2

(iii) *(k = F / ΔL)*
= 444.4 / 0.015 ✓ CE from (ii)
= 3.0×10^4 (Nm^{-1}) ✓ (29630 Nm^{-1})

k = (ii) / 0.015
treat power of 10 error as an AE
using 440 gives 2.9 × 10^4 (Nm^{-1})
1 sig fig is not acceptable

2

(iv) *W* (= ½ *F ΔL*) = ½ × 444.4 × 0.015

Or
W (= ½ $k \Delta L^2$) = ½ × 29630 × 0.015^2 ✓
(give this mark for seeing the digits only ie ignore powers of 10 and allow CE from (ii) or (iii) as appropriate
= 3.3 (J) ✓ (3.333 J)

W = ½ × (ii) × 0.015
W = ½ × (iii) × 0.015^2
treat power of 10 error as an AE
if either equation misses out the ½ no marks
common CE is to use F = 250 N which can be used giving W = 1.9 J

2

[10]

M2.B

[1]

M3.B

[1]

M4.(a) (i) $m = W / g)$
(3.4 × 10^4 / 9.81 =) 3500 (3466 kg) ✓
Allow use of g = 10

1

(ii) (moment = 34 000 × 5.0) = 1.7 × 10^5 ✓ (Nm)
Nm ✓ do not allow NM \ nM etc
allow in words

2

(iii) 170 000 = T x 12 OR T = 170 000 / 12 ✓ ecf aii
= 1.4(167) × 10^4 ✓ (N)

2

(iv) (component of T perpendicular to lever) = T cos 24 **OR** 14 167 × 0.9135 **OR** 12942 (N) ✓ ecf aiii allow 2.5cos24 × T

(12942) × 2.5 = **F** × 8.0
OR F = ((12942) × 2.5) / 8.0 ✓ ecf for incorrect component of T or T on its own
F = 4000 (N) ✓ (4044) ecf for incorrect component of T or T on its own

allow 4100 for use of 14 200 (4054)

Some working required for full marks. Correct answer only gets 2

Failure to find component of T is max 2 (4400 N)

3

[8]

M5.A

[1]

M6.(a) (sum of) clockwise moment(s) = (sum of) anticlockwise moment(s) ✓
sum of clockwise moment **s** = **sum of** anticlockwise moment **s** (about any given point) ✓
(for a system in) equilibrium ✓ allow 'balanced'

third mark depends upon the first
Don't allow references to 'forces' being balanced.
Don□t allow 'stationary'.
Allow 'total', etc instead of sum
Ignore definitions of moment

3

(b) (i) 35 × 110 (×10^{-3}) ✓
(= 3.85) = 3.9 (or 3.8) ✓

allow 4 or 3.90 but not 4.0

(3.9) **Nm** / allow (3850, 3900) **Nmm** ✓ don't allow nm, NM

unit must match answer

3

(ii) 3.85 = T × 25 (×10^{-3}) ✓ ecf from (bi)

Correct answer with no working gets 2 out of three.

T = 3.85 / 25 ($\times 10^{-3}$) = 0.150 ($\times 10^{3}$) ✓ ecf

Allow 156 (160) N from rounding error

= 150 (154 N) ✓

3

(c) *(P = Fv , F = P / v)*

= 2.8($\times$ 10^{3}) / 15 ✓

= 190 (186.7 N) ✓

2

[11]

M7. (a) (i) (moment = 520 x 0.26) = 140 (135.2) ✓

Nm ✓

2

(ii) **180 x 0.41** and **0.63 X** seen ✓

135.2 = 180 x 0.41 + 0.63 X ✓ ecf from (a)(i)

(X = (135.2 – 73.8) / 0.63)

= 97 ✓ (N) (97.46) allow 105 from use of 140Nm ecf from (a)(i)

3

(iii) (520 – (180 + 97.46))

= 240 ✓ (242.5 N) ecf (or from correct moments calculation)

1

(b) (i) ($v^2 = u^2 + 2as$)

9.3^2 = 2 x a x 35 OR 9.3^2=70a OR a = $v^2/2s$
OR $9.3^2/70$ ✓

OR correct alternative approach

1.2 (1.2356) ✓ (m s^{-2})

2

(ii) *(m = W/g)* = 520/9.81 (= 53.0) ✓ (kg)

F = ma = 53 × 3bi (1.2356) = 65 (N) (65.49) ✓

accept use of 1.2 giving 64(63.6) , allow 53 x 124 = 65.7

2

[10]

M8. (a) (i) 180000 × 2.8 ✓

= 500000 ✓ (504000 Nm) ecf from first line for incorrect power of 10

2

(ii) 7.4 × lift fan thrust ✓

= 180000 × 2.8 (504000 Nm) ✓ ecf from part ai

F = 68000 or 68 k (N) ✓ (68108 N) ecf

3

(iii) 180k − 68.1k = (111.9 =) 112 k (N) ✓ ecf from part aii

or by taking moments

1

(b) (i) (*m = W/g*) = 180 000/9.81 ✓ (= 18349 kg)

a = F/m = 155 000/18349 = 8.4 ✓ (8.4475 ms^{-2})
ecf for use of 180 in 1st mark

use of weight rather than mass gets zero

2

(ii) **cross-sectional or surface** area / shape / streamlining / aerodynamics / nature of surface / drag coefficient ✓

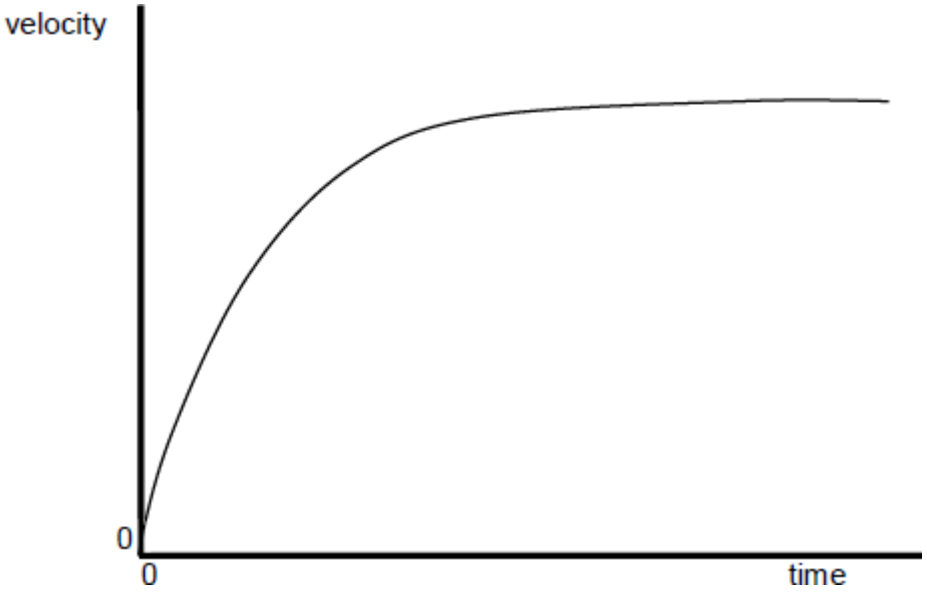
correctly linked to its effect on air resistance/drag ✓

or maximum thrust/force power of engine ✓

counterforce increases with speed

or when drag equals thrust (forces are balanced) ✓

2



line starting at zero and **curving with decreasing gradient** ✓

reaching a constant velocity ✓

2

(c) steepest/maximum gradient ✓

1

[13]