

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

*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 = $250 \times 0.048 = 12$ ✓ (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) ($k = F / \Delta L$)
 $= 444.4 / 0.015$ ✓ CE from (ii)
 $= 3.0 \times 10^4$ (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) $W (= \frac{1}{2} F \Delta L) = \frac{1}{2} \times 444.4 \times 0.015$

Or

$$W (= \frac{1}{2} k \Delta L^2) = \frac{1}{2} \times 29630 \times 0.015^2 \checkmark$$

(give this mark for seeing the digits only ie ignore powers of 10 and allow CE from (ii) or (iii) as appropriate

$$= 3.3 \text{ (J)} \checkmark \text{ (3.333 J)}$$

$$W = \frac{1}{2} \times (ii) \times 0.015$$

$$W = \frac{1}{2} \times (iii) \times 0.015^2$$

treat power of 10 error as an AE

if either equation misses out the $\frac{1}{2}$ no marks

common CE is to use $F = 250 \text{ N}$ which can be used giving $W = 1.9 \text{ J}$

2
[10]

M2.B

[1]

M3.B

[1]

M4.(a) (i) $m = W/g$
 $(3.4 \times 10^4 / 9.81 =) 3500 \text{ (3466 kg)} \checkmark$
Allow use of $g = 10$

1

(ii) (moment = $34\,000 \times 5.0$) = $1.7 \times 10^5 \checkmark$ (Nm)
Nm \checkmark do not allow NM \ nM etc
allow in words

2

(iii) $170\,000 = T \times 12$ OR $T = 170\,000 / 12 \checkmark$ ecf aii
 $= 1.4(167) \times 10^4 \checkmark$ (N)

2

- (iv) (component of T perpendicular to lever) = $T \cos 24$ **OR** $14\,167 \times 0.9135$
OR 12942 (N) ✓ ecf aiii allow $2.5 \cos 24 \times T$

$$(12942) \times 2.5 = F \times 8.0$$

OR $F = ((12942) \times 2.5) / 8.0$ ✓ 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) $35 \times 110 (\times 10^{-3})$ ✓
 (= 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) $3.85 = T \times 25 (\times 10^{-3})$ ✓ ecf from (bi)

Correct answer with no working gets 2 out of three.

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

Allow 156 (160) N from rounding error

$$= 150 (154 \text{ N}) \checkmark$$

3

(c) $(P = Fv, F = P/v)$
 $= 2.8 (\times 10^3) / 15 \checkmark$
 $= 190 (186.7 \text{ N}) \checkmark$

2

[11]

M7. (a) (i) (moment = 520×0.26) = 140 (135.2) \checkmark
Nm \checkmark

2

(ii) **180 x 0.41** and **0.63 X** seen \checkmark
 $135.2 = 180 \times 0.41 + 0.63 X \checkmark \text{ ecf from (a)(i)}$
 $(X = (135.2 - 73.8) / 0.63)$
 $= 97 \checkmark \text{ (N) (97.46) allow 105 from use of 140Nm ecf from (a)(i)}$

3

(iii) $(520 - (180 + 97.46))$
 $= 240 \checkmark \text{ (242.5 N) ecf (or from correct moments calculation)}$

1

(b) (i) $(v^2 = u^2 + 2as)$
 $9.3^2 = 2 \times a \times 35 \text{ OR } 9.3^2 = 70a \text{ OR } a = v^2/2s$
 $\text{OR } 9.3^2/70 \checkmark$

OR correct alternative approach

$$1.2 (1.2356) \checkmark \text{ (m s}^{-2}\text{)}$$

2

(ii) $(m = W/g) = 520/9.81 (= 53.0) \checkmark$ (kg)

$F = ma = 53 \times 3bi (1.2356) = 65$ (N) (65.49) \checkmark

accept use of 1.2 giving 64(63.6) , allow $53 \times 124 = 65.7$

2

[10]

M8. (a) (i) $180000 \times 2.8 \checkmark$

$= 500000 \checkmark$ (504000 Nm) ecf from first line for incorrect power of 10
2

(ii) $7.4 \times$ lift fan thrust \checkmark

$= 180000 \times 2.8$ (504000 Nm) \checkmark ecf from part ai

$F = 68000$ or 68 k (N) \checkmark (68108 N) ecf

3

(iii) $180k - 68.1k = (111.9 =) 112$ k (N) \checkmark ecf from part aii

or by taking moments

1

(b) (i) $(m = W/g) = 180\ 000/9.81 \checkmark$ (= 18349 kg)

$a = F/m = 155\ 000/18349 = 8.4 \checkmark$ (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 \checkmark

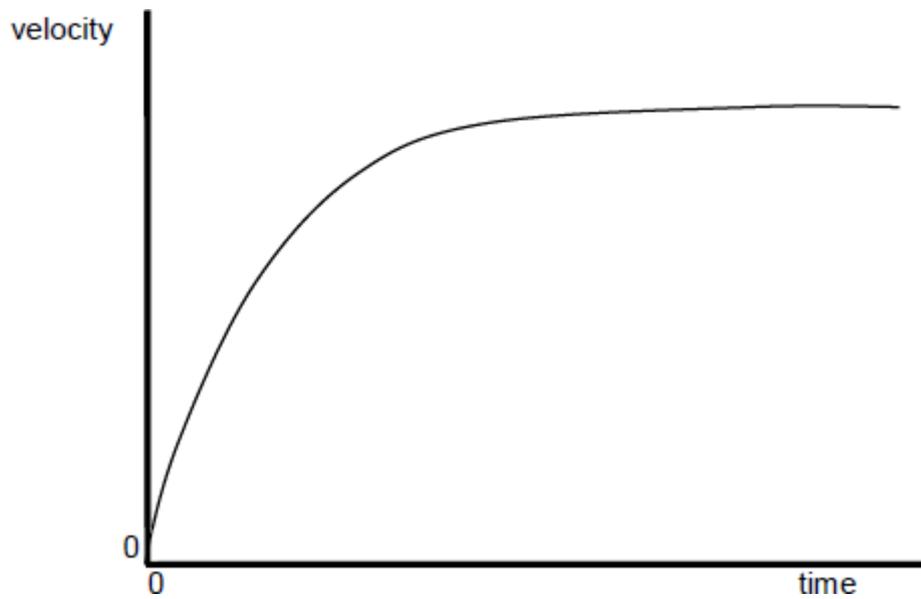
correctly linked to its effect on air resistance/drag \checkmark

or **maximum** thrust/force power of engine \checkmark

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]