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.(a)

breaking stress	✓
stiffness constant, k	
tensile strain	
tensile stress	
Young modulus	✓

1

(b) (i) elastic limit ✓

only one attempt at the answer is allowed

1

(ii) (E = 300 × 10^6 / 4 × 10^{-2} = 7.5 × 10^9)
7.5 (Pa) ✓ allow 7.4 to 7.6 (Pa)
× 10^9 ✓

first mark is for most significant digits ignoring the power of 10. E.g. 7500 gains mark

2

(c) straight line beginning on existing line at a strain of 0.10 and hitting the strain axis at a lower non-zero value ✓

line that ends on the x -axis with strain between 0.045 and 0.055 ✓(only allow if first mark is given)

ie accuracy required ± one division

2

(d) 8.99×10^{-3} (m^3) ✓ condone 1 sig fig

allow 9.00×10^{-3}

1

(e) $0.9872 \times 8.99 \times 10^{-3}$ or $= 8.8749 \times 10^{-3}$ (m^3) ✓
allow CE from 4d

($m = \rho V$)$= 2700 \times 8.8749 \times 10^{-3} = 24$ (kg) ✓ (23.962 kg)
allow CE from first part, e.g. if 1.28% was used gives 0.311 kg

$V = 0.9872 \times$ (d)

$m = 2.665 \times$ (d)

1.28% of vol = 1.15×10^{-4} m^3

2

[9]

M3.D

[1]

M4.(a) (i) 11 (m)

B1

1

(ii) Use of $F = k\Delta L$ or $W = mg$

Allow use of $\Delta L = 12$ m

C1

3400 (N)

A1

2

(b) Sets $mg = k\Delta L$

C1

1.9 (m)

A1

2

(c) Correct use of $W = ½k\Delta L^2$ or $½F\Delta L$

$\Delta L = 5\ m$

C1

Correct use of $\Delta GPE = mg\Delta h$

$\Delta h = 25\ m$

C1

States or uses $(mg\Delta h) – (½\ k\Delta L^2) = ½mv^2$

C1

19 (m s^{-1}) cnao

A1

4

(d) Same kinetic energy when rope begins to stretch

B1

More work done per unit extension / stops in shorter distance

"Shorter time" gets no credit

B1

Increases force on jumper (increasing the risk of injury)

B1

3

[12]

M5.A

[1]

M6.C

[1]