M1. (a) 3800

*allow **1** mark for 2000*

*allow **1** mark for 1800*

*if neither of above scored, allow correct substitution for **1** mark (800 × 2.5) + (600 × 3)*

if moments have been calculated incorrectly, allow 1 mark for adding their two moment values correctly

3

newton metres **or** Nm

*do **not** allow nm **or** NM*

1

(b) as the girl increases her distance (from the pivot) the clockwise moment increases

1

(F must increase) as the anticlockwise moment must increase

1

so (the anticlockwise moment) is equalled / balanced by the clockwise moment
or
so resultant / overall moment (on the board) is zero

accept to balance / equal the moments

to balance the board is insufficient

1

[7]

M2. (a) (i) **X** at the centre of the lifebelt

*measuring from the centre of **X**, allow 2 mm tolerance in any direction*

1

(ii) any **two** from:

if X is on vertical line below the hanger (but not at centre) can gain the first point only

below the point of suspension

*accept '(vertically) below **Y**'*

at the centre (of the lifebelt)

accept 'in the middle'

(because) the lifebelt / it is symmetrical

or *(because) the mass / weight is evenly distributed*

2

(b) Nm **or** newton metre(s)

accept Newton metre(s)
*do **not** accept any ambiguity in the symbol ie NM, nM or nm*

1

750

(moment) = force × (perpendicular) distance (between line of action and pivot)
or *(moment) = 500 × 1.5 gains **1** mark*

2

(c) Quality of written communication:

*for **2** of the underlined terms used in the correct context*

1

any **three** connected points from:

low(er) centre of mass / gravity

or *<u>centre of mass / gravity</u> will be close(r) to the wheels / axle / ground*

(more) <u>stable</u>

or *less <u>unstable</u>*

less likely to fall over

accept 'less likely to overturn'

*do **not** accept 'will not fall over'*

the <u>turning effect / moment</u> (of the weight of case) is less

***or** so less effort is needed to hold the case*
ignore references to pulling the case

so the pull on her arm is less

3

[10]

M3. (a) 810 000

*allow 45 000 × 18 for **1** mark*

2

newton-metres / Nm

1

(b) any **three** from:

ignore references to force throughout

- their weight / mass can be altered / adjusted
- so that the crane remains stable

  allow does not topple
- so that the (total) clockwise moment equals the (total) anticlockwise moment

  *do **not** allow just 'moments are equal'*
- because not all containers are the same weight / mass

  *do **not** allow 'not all containers are the same size / volume'*
- because not all containers will be / need to move the same distance (from the crane)
- to keep the centre of mass (of the upper crane and container) in/ above the base of the tower
- so that the crane remains in equilibrium/balanced

3

[6]

M4. (a) point at which its mass (seems to) act **or** point at which gravity (seems to) act

accept ... its weight acts

accept correct statements if the intent is clear e.g.. .. if suspended, the centre of gravity will be directly under the point of suspension

*e.g.... (if the object is symmetrical), the centre of gravity is on the **or** an axis (of symmetry)*

*do **not** credit just 'it is a point'*

1

(b) *The answer to this question requires good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme*

*maximum of **4** marks if ideas not well expressed*

any **five** from:

clamp (steel) rod (horizontally)

***no** marks if method quite unworkable*

hang plastic / sheet by rod through (one) hole

hang plumb line from rod

mark ends of plumb line on the sheet and use the ruler to draw a straight line

repeat with other hole

centre of mass is where the lines cross

check by balancing at this point

*maximum of **3** marks if no 'repeat with other hole'*

5

(c) (i) (turning) effect **or** moment
force
distance

all three correct

accept weight
accept length

1

(ii) 17.6

allow 44 x 0.4 ***or*** *0.4 x 44 for* ***1*** *mark*

2

Nm **or** newton metre(s)

do ***not*** *accept N/m* ***or*** *N/cm*

1760 Ncm gains all ***3*** *marks*

1

[10]

M5. (a) (i) turning effect

accept turning force

accept force x distance

(accept symbols only if correctly defined)

*do **not** accept newtons x metres*

1

(ii) stop apparatus falling over

accept holds the stand in place

accept make it safer / stable

references to balanced / equilibrium are insufficient

1

(iii) as *x* increases *y* increases

1

in same proportion / ratios

allow both marks for they are directly proportional

or

a specific example eg doubling y, doubles x

allow both marks for a correct answer giving figures

eg they increase in the ratio of 1 to 7

*allow for **1** mark positive correlation*

1

(iv) the centre of mass of the ruler is at the axis of rotation

1

(b) 108

*allow **1** mark for correct substitution ie 240 x 0.45*

2

newton metres / Nm

symbols must be correct

for full credit the unit must be consistent with the numerical answer

1

[8]

M6. (a) moment

or *torque do* ***not*** *credit 'leverage'*

1

(b) 4 (2)

either *0.20 × 20 (1)* ***or*** *allow '400' (1)*

2

(c) use a longer spanner

or *increases the perpendicular distance / length*

or 'fit a pipe over the (end of the) spanner (to lengthen it)'

note 'lever' refers to 'spanner'
note change the . . . (0)
ignore references to wider / larger nut

1

use a greater force / pull

either order

1

[5]

M7. (a) any **two** from:

- inversely proportional
- as the load gets biggerthe (maximum safe) distance gets less

  allow 'as the mass increases the distance decreases'
  accept an unspecified response e.g. 'big load at a short distance' for (1)
- load × distance = 60 (kNm)

2

(b) yes, because 30 × 2 = 60 (2)

accept for (1) a correct but insufficiently explained response e.g. 'yes because it's safe'

accept for (2) a correct response which is sufficiently explained

e.g. 'yes, because 60 (kNm) at 1 metre is safe and 30 (kNm) is half the load at twice the distance

*do **not** accept 'no' and do not accept just 'yes'*

*do **not** accept 'yes, because 30 is between 24 and 40 and 2 is between 2.5 and 1.5'*

*do **not** accept 'the crane/ cable may break' or other dangers*

2

(c) the crane may/will topple over/fall <u>over/forward</u>

1

(d) results of experiments on this mobile crane

accept any unambiguous indication

1

[6]