Mark schemes

1 (a) moment = 280 × 0.9

1

moment = 252

1

*allow 252 with no working shown for **2** marks*
*allow 25200 with no working shown for **1** mark*

(b) the clockwise moment (of child B) decreases

1

making it is less than the anticlockwise moment (of child A)
accept so moments are no longer balanced

1

so child A moves downwards

or

so child B moves upwards

1

[5]

2 (a) motor effect

1

(b) increase the strength of the magnet

or

increase the current

1

(c) $4.8 \times 10^{-4} = F \times 8 \times 10^{-2}$

1

$F = 6 \times 10^{-3}$ (N)

1

$6 \times 10^{-3} = B \times 1.5 \times 5 \times 10^{-2}$

1

$$B = \frac{6 \times 10^{-3}}{7.5 \times 10^{-2}}$$

1

$B = 8 \times 10^{-2}$ or 0.08

1

allow 8×10^{-2} ***or*** *0.08 with no working shown for* ***5*** *marks*

a correct method with correct calculation using an incorrect value of F gains ***3*** *marks*

Tesla

accept T

1

do not accept t

[8]

3 (a) make the rod longer

1

push down on the rod with a greater force

1

(b) particles are close together

1

so no room for more movement

dependent on 1st marking point

1

(c) (i) downward force produces pressure in liquid

reference to compression of liquid negates this mark

1

this pressure is the same at all points in a liquid
or
this pressure is transmitted equally through the liquid

and $P = F / A$ ***or*** *$F = P \times A$*

1

area (at load) bigger *(so force bigger)*

1

(ii) the force acting on the car moves less distance than the effort force

1

[9]

4 (a) 3000

*allow **1** mark for correct substitution, ie 600 × 5 provided no subsequent step*

2

(b) anticlockwise moment

must be both words

1

(c) (i) 3400

allow 3.4 kilo (newtons)

1

(ii) as the distance (of the girl from point A) increases, force F increases

allow gets bigger for increases

force is (directly) proportional to distance will negate any correct response

1

[5]

5 (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]

6 (a) (i) turning

accept turning ringed in the box

1

(ii) point at which mass (or weight) may be thought to be concentrated

accept the point from which the weight appears to act

allow focused for concentrated

*do **not** accept most / some of the mass*

*do **not** accept region / area for point*

1

(b) 600 (Nm)

*400 × 1.5 gains **1** mark provided no subsequent steps shown*

2

(c) (i) plank rotates clockwise

accept girl moves downwards

*do **not** accept rotates to the right*

1

(total) CM > (total) ACM

accept moment is larger on the girl's side

1

weight of see-saw provides CM

answer must be in terms of moment

*maximum of **2** marks if there is no reference to the weight of the see-saw*

1

(ii) W = 445 (N)

*W × 1.5 = (270 × 0.25) + (300 × 2.0) gains **2** marks*

*allow for **1** mark:*

total CM = total ACM either stated or implied

or

(270 × 0.25) + (300 × 2.0)

if no other marks given

3

[10]

7 (a) centre of X drawn at centre of pendulum bob

judged by eye

accept dot drawn at centre of circle

1

(b) (i) 2

*allow **1** mark for correct substitution, ie* $\frac{1}{0.5}$ *provided no subsequent step shown*

2

(ii) 30

or

60 ÷ their (b)(i) correctly calculated

allow 1 mark for $\frac{60}{2}$

or $\frac{60}{\text{their (b)(i)}}$

or *0.5 × 60*

provided no subsequent step shown

2

(c) 51.2

*allow **1** mark for correct substitution, ie 64 × 0.8 provided no subsequent step shown*

2

(d) it increases (the moment)

must be comparative

*accept **1** mark for calculation of the moment = 64 (Nm)*

1

[8]

8 (a) 60

*allow **1** mark for correct substitution (with d in metres), ie 36 = F × 0.6*

*an answer of 0.6 **or** 6 gains **1** mark*

2

(b) the line of action of the weight lies outside the base / bottom (of the bag)

accept line of action of the weight acts through the side

accept the weight (of the bag) acts outside the base / bottom (of the bag)

1

a resultant / overall / unbalanced moment acts (on the bag)

accept the bag is not in equilibrium

*do **not** accept the bag is unbalanced*

1

[4]

9 (a) 360

*allow **1** mark for correct substitution ie 300 × 1.2 provided no subsequent step shown*

2

(b) the force is applied further from the axis of rotation

accept pivot / (tree) stump for 'axis of rotation'

1

or

this increases the moment of the force

increases the force on the (tree) stump

1

[4]

10 (a) 38 400

*allow 6.4 × 6000 for **1** mark*

2

Nm **or** newton metres

*do **not** credit 'nm', 'mN' or 'metre newtons'*

1

(b) 16 000 (N) **or** 16 kN

*allow **1** mark for 38 400 ÷ 2.4*

*accept their (a) ÷ 2.4 correctly calculated for **2** marks*

*accept their (a) ÷ 2.4 for **1** mark*

2

[5]

11 (a) (i) 75

*allow **1** mark for correct substitution ie 250 × 0.3*

*do **not** credit if subsequent step shown*

*allow **1** mark for an answer 7500*

2

(ii) Nm

1

(b) force is (applied) further from the nut / pivot / axis of rotation

handle is longer is insufficient

*do **not** accept less force needed*

1

moment (on wrench) is larger

1

[5]

12 (a) 960 (Nm)

1

see-saw is in equilibrium

accept see-saw is balanced

see-saw is stationary is insufficient

1

(total) clockwise moments = anticlockwise moment

accept no resultant moment

forces are balanced is insufficient

*an answer clockwise moments balance the anticlockwise moments gains **2** marks*

1

(b) (i) 600 (Nm)

1

(ii) 375 (N) **or** their (b)(i) ÷ 1.6 correctly calculated

*do **not** credit if (b)(i) is larger than 960*

*allow **1** mark for correct substitution **and** transformation ie*

$\frac{600}{1.6}$ *or* $\frac{\text{their (b)(i)}}{1.6}$

2

[6]

13 (a) 1250

*allow **1** mark for correct substitution*

ie 500 × 2.5 provided there is no subsequent calculation

2

(b) (i) smaller than

1

(ii) force (exerted) further from axis of rotation (than the weight)

accept pivot for axis of rotation

1

(c) increase the force (exerted)

*do **not** accept increase distance of force from axis of rotation*

1

[5]

14 (a) (i) current produces a magnetic field (around XY)

accept current (in XY) is perpendicular to the (permanent) magnetic field

1

(creating) a force (acting) on XY / wire / upwards

reference to Fleming's left hand rule is insufficient

1

(ii) motor (effect)

1

(iii) vibrate / move up and down

1

5 times a second

only scores if first mark point scores

*allow for **1** mark only an answer 'changes direction 5 times a second'*

1

(b) 0.005

*allow **1** mark for calculating moment of the weight as 0.04 (Ncm)*
and
*allow **1** mark for correctly stating principle of moments*
or
*allow **2** marks for correct substitution*
*ie F × 8 = 2 × 0.02 **or** F × 8 = 0.04*

3

[8]

15 (a) **C**

1

(b) moment

accept any unambiguous correct indication

1

(c) bigger than

accept any unambiguous correct indication

1

(d) 120 (Ncm)

*allow **1** mark for correct substitution*
ie 12 × 10

2

[5]

16 (a) 1.2

*allow **1** mark for conversion of 2.4 kN to 2400 N*
or for correct transformation without conversion
ie d = 2880 ÷ 2.4

2

metre(s)/m

1

(b) any **two** from:

- as the load increases the (total) clockwise moment increases
- danger is that the fork lift truck / the load will topple / tip forward
- (this will happen) when the total clockwise moment is equal to (or greater than) the anticlockwise moment

  accept moments will not be balanced
- (load above 10.0 kN) moves line of action (from C of M) outside base (area)

2

[5]

17 (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]

18 (a) (i) will not fall over (1)

accept will not easily fall over (2)

or

centre of mass will remain above the base (1)

(line of action of the) weight will remain above within the base

accept centre of gravity / c of g / c of m / c m

if the monitor is given a small push (1)

depends on mark above

2

(ii) (total) clockwise moment = (total) anticlockwise moment

or *they are equal / balanced*

1

(b) the position of the centre of mass has changed (1)
the line of action of the weight is outside the base (1)
producing a (resultant) moment (1)

points may be expressed in any order

3

[6]

19 (a) (i) moment

1

(ii) rotation

1

(iii) the girl moves nearer to point **P**

1

(b) (i) **X** drawn in the centre of the space enclosed by the tyre

judge by eye

1

(ii) below

1

[5]

20 (a) the point at which the (total) mass seems to act / appears to be concentrated

accept 'weight' for 'mass'

accept the point at which gravity seems to act

*do **not** accept a definitive statement eg where (all) the mass is*

1

(b) wider / larger base

marks are for a correct comparison

1

lower centre of mass

accept lower centre of gravity / c of g

1

(c) line of action (of the weight) lies / falls inside the base

in each case the underlined term must be used correctly to gain the mark

1

the resultant moment returns mixer to its original position

accept there is no resultant moment / resultant moment is zero

accept resulting moment for resultant moment

*do **not** accept converse argument*

1

[5]

21 (a) 38 400

*allow 6.4 × 6000 for **1** mark*

2

Nm **or** newton metres

*do **not** credit 'nm', 'mN' or 'metre newtons'*

1

(b) 16 000 (N) **or** 16 kN

*allow **1** mark for 38 400 ÷ 2.4*

*accept their (a) ÷ 2.4 correctly calculated for **2** marks*

*accept their (a) ÷ 2.4 for **1** mark*

2

[5]

22 (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 over/forward

1

(d) results of experiments on this mobile crane

accept any unambiguous indication

1

[6]

23 (a) centre of **X** at the centre of the concentric circles

judge by eye that the intention is correct

1

(b) drawn from any corner to the diagonally opposite corner

judge by eye that the intention is correct

or from the mid-point of any side to the mid-point of the opposite side

if more than one axis of symmetry has been drawn,
accept only if both / all are correct

1

(c) a turning

accept any unambiguous indication

1

[3]

24 (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]

25 (a) (line of action of) its weight

1

falls inside its wheel base

accept 'falls between the wheels'

the first ***two*** *points may be credited by adding a vertical line from the centre of the X on the diagram (1)*
and labelling it weight / force / with a downwards arrow (1)
provided there is no contradiction between what is added to the diagram and anything which may be written

1

(so there is) no (resultant / clockwise) moment / turning effect

1

(b) centre of mass should be lower

accept '… centre of gravity'
accept 'weight / mass low down'
***not** just 'lower the roof'*

1

wheel base should be wider

accept 'long axle(s)' for 'wide wheel base'
allow bigger / larger wheel base
*do **not** credit '<u>long</u> wheel base'*
responses in either order

1

[5]

26 (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]

27 (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]

28 (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 *centre of mass / gravity will be close(r) to the wheels / axle / ground*

(more) stable

or *less unstable*

less likely to fall over

accept 'less likely to overturn'
*do **not** accept 'will not fall over'*

the turning effect / moment (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]

29 (a) A

must be correct for reason to score

moment (due to weight) of sail is the largest

1

or

(perpendicular) distance from pivot to rope the smallest

*do **not** accept sail is low **or** sail is too heavy*

1

(b) (i) no resultant turning moment **or** in a state of balance **or** balanced

allow clockwise moments = anticlockwise moments
allow no resultant force
allow (forces are) balanced
allow no acceleration
*do **not** allow forces are equal*

1

(ii) moment = 420

*allow **1** mark for moment = 700 × 0.6*
or
700 × a distance from diagram (1.5, 2.1, 0.9)

2

(iii) force = 280

420 = F × 1.5
or

$F = \frac{\text{their (b)(ii)}}{1.5}$ ***1** mark only*

if (b)(ii) obtained by a correct method (1470, 630, 1050)

2

(c) (as wind speed increases) the force on the sail increases

accept pressure

1

aniticlockwise moment increases **or** moment on sail increases

1

so clockwise moment (**or** opposite moment) needs to increase (by increasing the distance from the pivot)

1

[10]

30 300

*allow **1** mark for rearranging equation **or** correct substitution*

[2]

31 (i) C

1

(ii) 48

*an answer of 4 800 gains **1** mark*
*if answer (b)(i) is given as A then 42 scores **1** mark*
*4200 scores **0** marks substitution of correct* figures = **1** *mark*

2

[3]

32 (a) **Z**

1

weight **or** mass acts through pivot

*accept rod **or** base for pivot*

accept centre of gravity in line with pivot

1

no (resultant) (turning) moment

accept clockwise moment equals anticlockwise moment

*do **not** accept same weight on each side of rod*

1

(b) (i) 30

*allow **1** mark for 2 × 15*

***or** 2 × 0.15*

2

N cm

or

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

0.3

Nm

*do **not** accept joules*

1

(ii) 1.5 (N)

*allow **1** mark for correct transformation*

*allow **2** marks ecf their part (b)(i)/20 (ecf only if correct physics)*

2

(c) 5 (cm)

*allow **1** mark for 6.0 (cm)*

*allow **1** mark for a subtraction of 1 from a value clearly obtained from the graph*

*allow **2** marks for correct ecf using an incorrect value for (b)(i) ± 0.2cm*

*allow **1** mark for clearly showing correct use of graph using an incorrect value for (b)(ii)*

2

[10]

33 (a) moment/torque increases as moves away
gains 2 marks

leverage/force increases as moves away
gains 1 mark

2

(b) (i) 20
gains 2 marks

else working
gains 1 mark

2

(ii) 100 000 ecf
gains 2 marks

else working
gains 1 mark

2

[6]

34 (a) *evidence of* moment = force × distance
or 200 × 1.5
gains 1 mark

but 300
gains 2 marks

2

(b) *ideas that* smaller than load
gains 1 mark

but 100 N **or** half the load
gains 2 marks

because applied further from pivot
gains 1 mark

but applied 2 × distance from pivot **or** evidence of balancing moments
gains 2 marks
(working for (b) shown in (a) gains credit – transfer mark)

4

[6]

35 lever

turning effect

pivot

for 1 mark each

[3]