Moments

Questions

Q1.

(i) Figure 8 shows a force of 70 N turning a lever about point P.

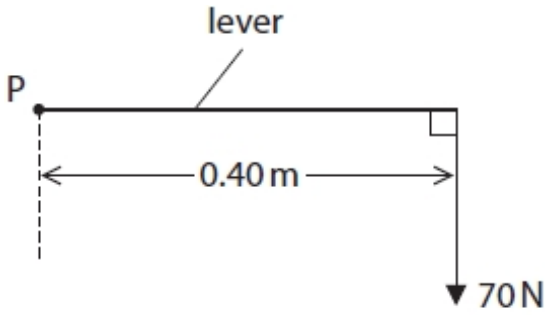

Figure 8

Calculate the moment of the 70 N force about point P.
State the unit.
Use the equation

moment = force × distance normal to the direction of the force

(3)

moment = ...unit .....

(ii) Figure 9 shows a worker using a wheelbarrow to move some sand.

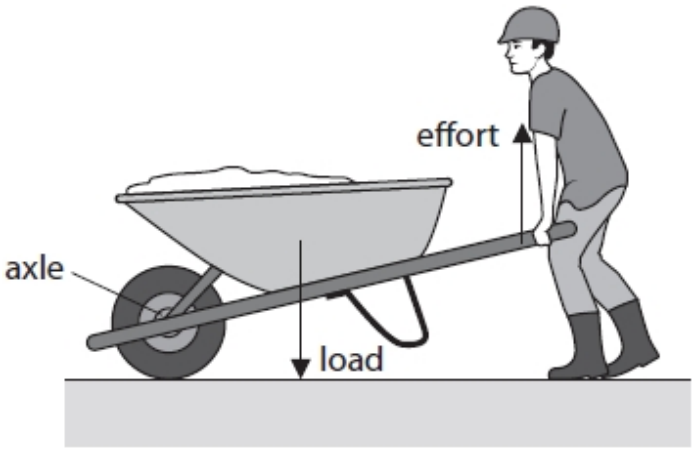

Figure 9

The load is equal to the total weight of the sand and the wheelbarrow.
The effort is the force that the worker applies to the wheelbarrow handles.
The worker applies just enough effort to lift the load.
Explain why the effort is smaller than the load.

(2)

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(iii) Some sand falls down and sticks between the wheel and the axle.

State why it might be harder to push the wheelbarrow along when there is some sand between the wheel and
the axle.

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(Total for question = 5 marks)

Q2.

(i) Figure 6 shows two gears.

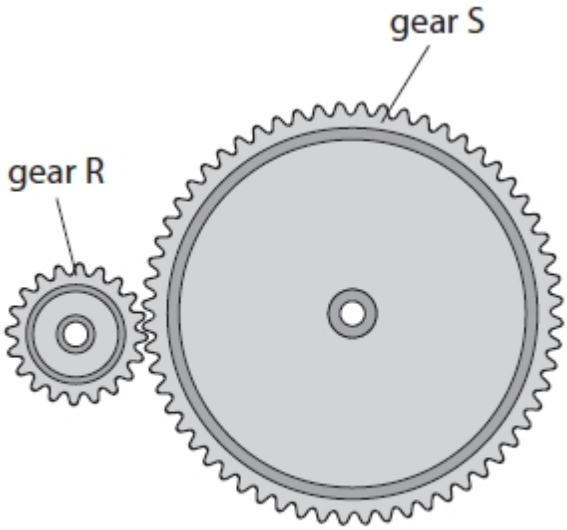

Figure 6

Gear R and gear S can rotate. Gear R has 20 teeth. Gear S has 60 teeth. Gear S rotates through 2 complete revolutions. Calculate how many complete revolutions gear R rotates by.

(2)

gear R has rotated through ..... revolutions

(ii) Figure 7 shows two gears, S and T.

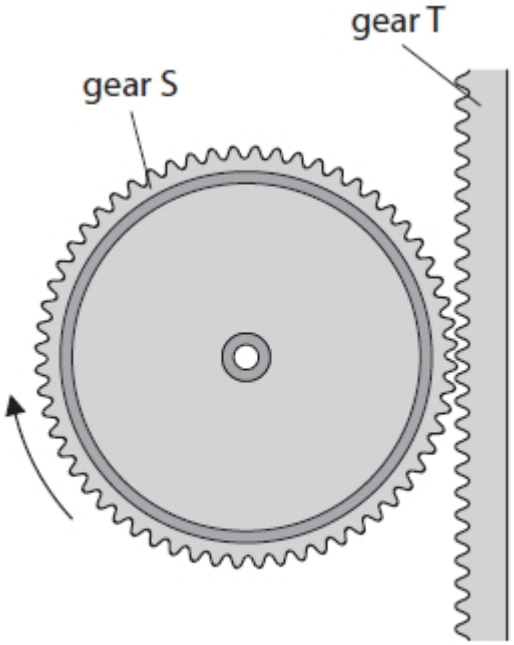

Figure 7

Gear S can rotate on a fixed axle.
Gear T can move up and down.
Gear S has 60 teeth.
The distance between each of the teeth on gear S and on gear T is 2 mm.
Gear S moves through one complete revolution in the direction shown.
Which of these describes the motion of gear T?

(1)

- ☒ A 60 mm up
- ☒ B 60 mm down
- ☒ C 120 mm up
- ☒ D 120 mm down

(Total for question = 3 marks)

Q3.

A student investigates moments of forces.

Figure 14 shows the apparatus used.

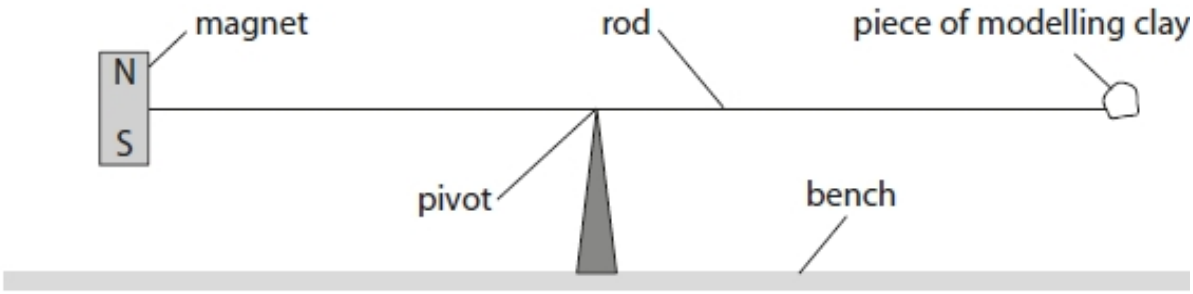

Figure 14

The pivot is under the centre of the rod. A magnet is fixed to one end of the rod. A piece of modelling clay is fixed to the other end of the rod. The system is in equilibrium. (a) The student fixes a coil to the bench under the magnet as shown in Figure 15.

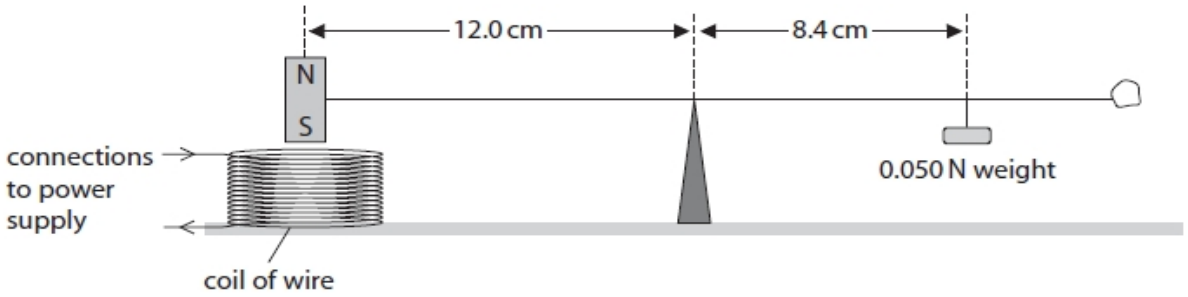

Figure 15

The coil of wire is connected to a d.c. power supply so that there is a current in the coil.
To bring the system back into equilibrium, the student hangs a 0.050 N weight on the rod, 8.4 cm away from the pivot, as shown in Figure 15.
Calculate the size of the force between the magnet and the coil.

(3)

force = ... N

(b) Describe how the student could develop the investigation to determine if the size of the force between the magnet and the coil is directly proportional to the size of the current in the coil.

(4)

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(Total for question = 7 marks)

Q4.

Figure 3 is a diagram of the forces acting on a swing.

The swing is not moving.

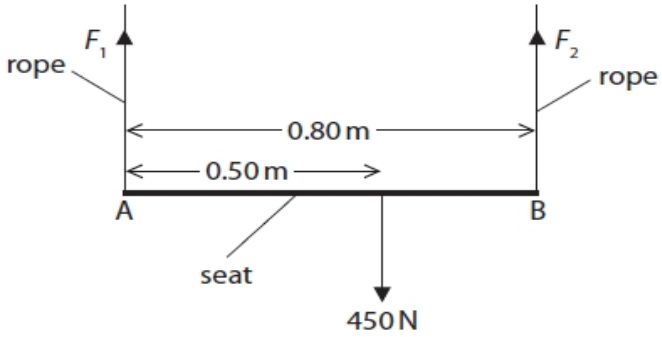

Figure 3

The seat of the swing, AB, is 0.80 m long. A person of weight 450 N sits on the seat. The person's weight acts at a distance of 0.50 m from A as shown in Figure 3.

Ignore the weight of the seat.

The upward forces exerted by the ropes on the seat are *F*1 and *F*2.

Calculate the force *F*2 by taking moments about A.

(3)

force *F* 2 = ... N

(Total for question = 3 marks)

Q5.

Figure 3 shows a force of 200 N acting at the end of a plank of wood.

The force acts at right angles to the plank and at 3.0 m away from a pivot.

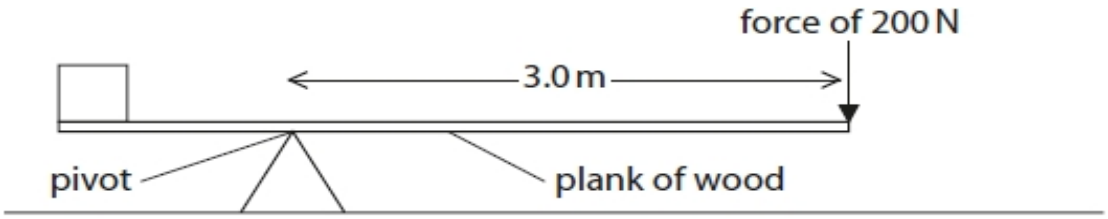

Figure 3

Calculate the moment of the 200 N force about the pivot.

State the unit of the moment of the force.

Use the equation

moment of a force = force × distance at right angles to the direction of the force

(3)

moment of the force about the pivot = ... unit

.....

(Total for question = 3 marks)

Q6.

Figure 12 shows three toy animals hanging from a rod.

The rod hangs from the ceiling by a string tied to the centre of the rod.

The system is in equilibrium.

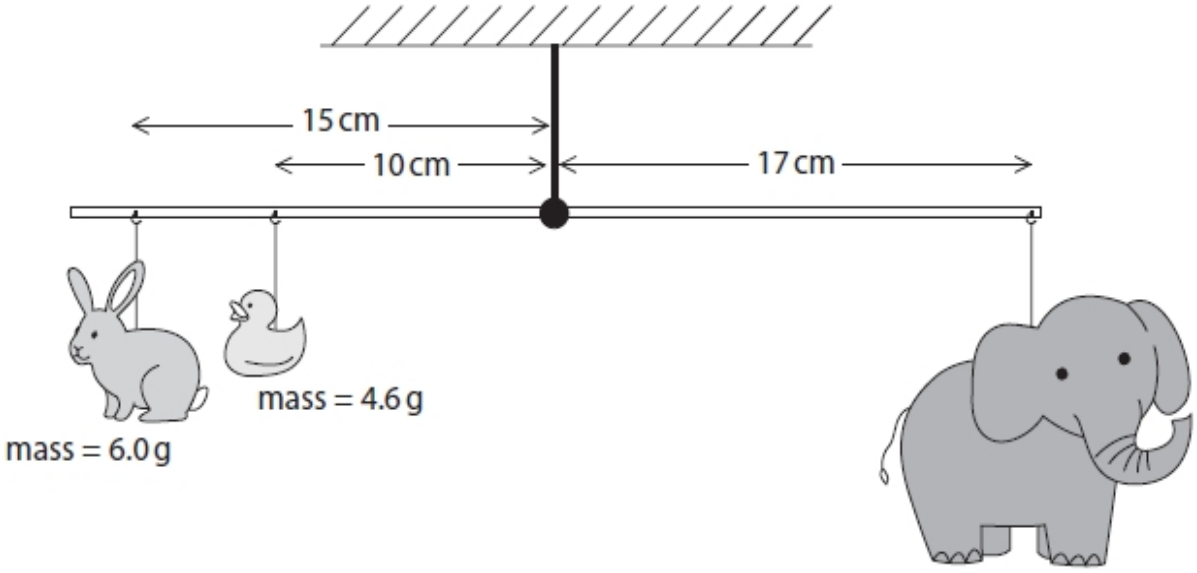

Figure 12

Use the principle of moments to calculate the mass of the toy elephant.

(4)

mass = ... g

(Total for question = 4 marks)

Q7.

A student investigates moments of forces.

Figure 14 shows the apparatus used.

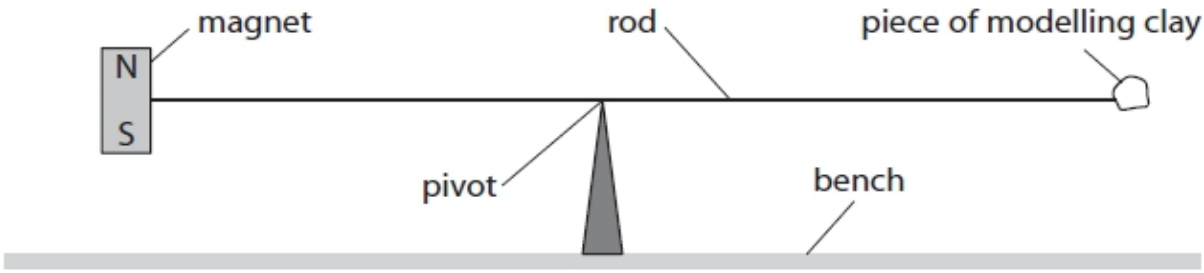

Figure 14

The pivot is under the centre of the rod. A magnet is fixed to one end of the rod. A piece of modelling clay is fixed to the other end of the rod. The system is in equilibrium. The student reverses the direction of the current in the coil.

Describe how the student can bring the system back into equilibrium without making any changes to the magnet.

(2)

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(Total for question = 2 marks)

Q8.

Figure 2 shows an open door.

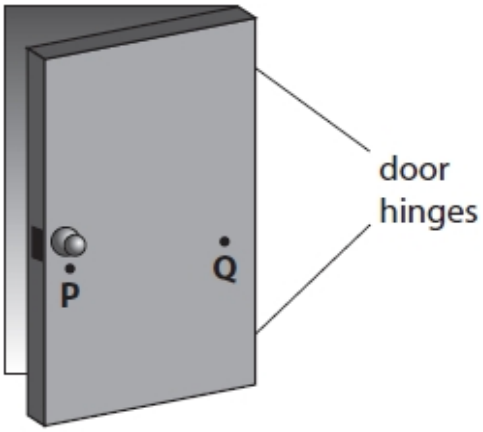

Figure 2

Explain why it is easier to close the door by pushing at point P rather than pushing at point Q.

(2)

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(Total for question = 2 marks)

Q9.

Figure 20 shows a person trying to lift a large rock using a metal bar.

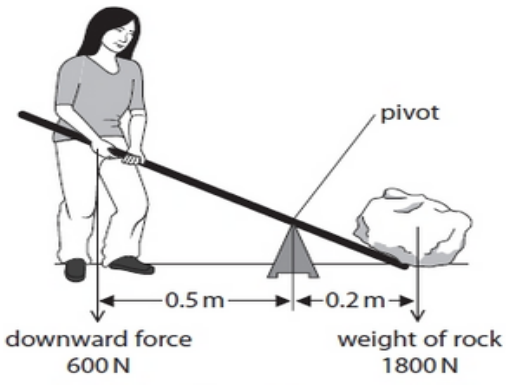

Figure 20

The rock weighs 1800 N.

The person can only produce a downwards force of 600 N.

The person cannot lift the rock.

(i) Explain, using calculations, why the person cannot lift the rock.

(3)

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(ii) Explain one change to the arrangement that will make it possible for this person to lift the rock.

(2)

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(Total for question = 5 marks)

Q10.

Figure 19 shows four forces, P, Q, R and S, acting on a rod.

The rod can rotate around an axle.

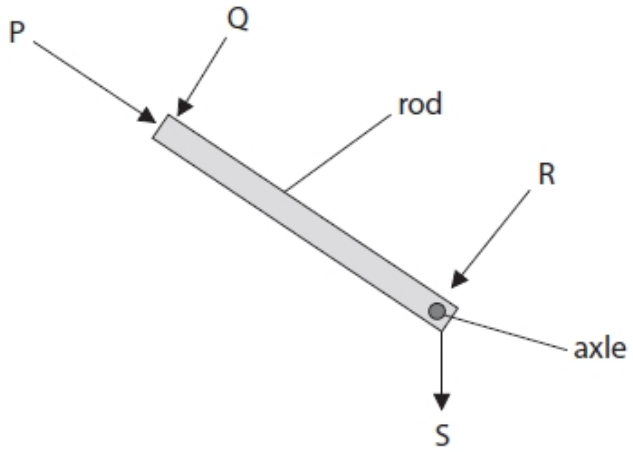

Figure 19

Which force will make the rod rotate about the axle?

(1)

- ☒ A P
- ☒ B Q
- ☒ C R
- ☒ D S

(Total for question = 1 mark)

Q11.

Figure 1 shows some forces acting on a seesaw.

The forces shown have the same magnitude but act in different directions.

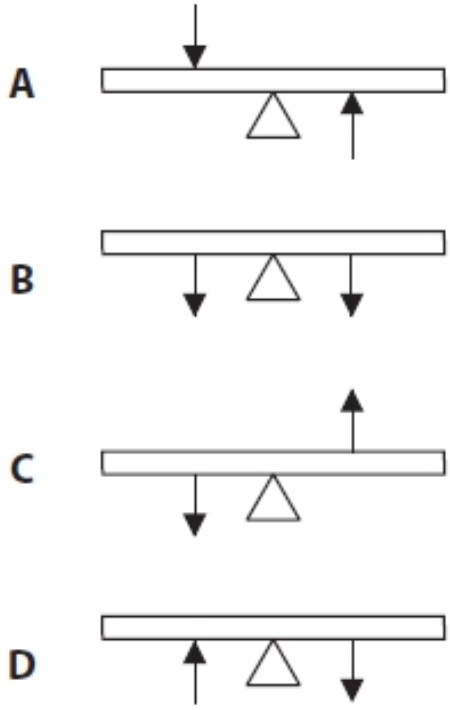

Figure 1

In which of these could the forces acting on a seesaw be in equilibrium?

(1)

- ☒ A
- ☒ B
- ☒ C
- ☒ D

(Total for question = 1 mark)

Q12.

Figure 11 shows a lever used to lift a heavy load.

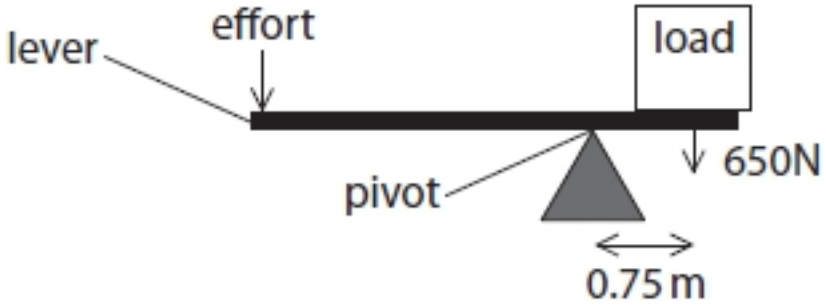

Figure 11

(i) The weight of the load is 650 N.

The centre of the load is 0.75 m from the pivot.
Calculate the moment of the load about the pivot.
State the unit.
Use the equation

moment = force × distance from the pivot

(3)

moment = ... unit .....

(ii) State the principle of moments.

(1)

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.....

(iii) An effort of 160 N is applied to the end of the lever to balance the load in Figure 11.

Calculate the distance between the effort and the pivot.

(3)

distance = ... m

(Total for question = 7 marks)

Q13.

A student investigates moments of forces.

Figure 14 shows the apparatus used.

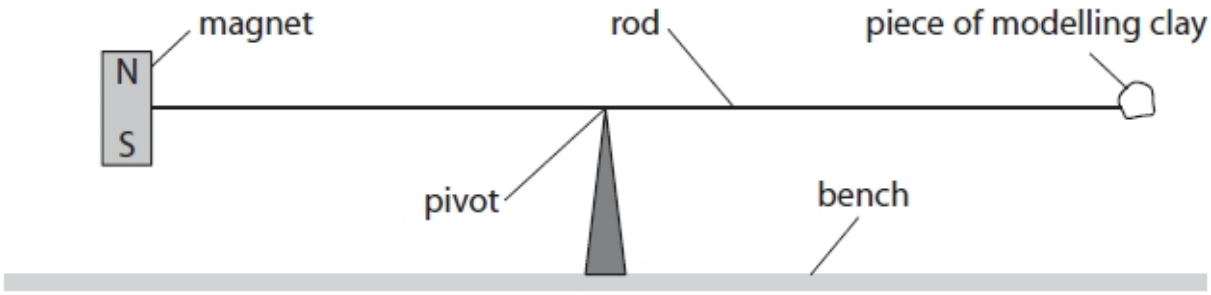

Figure 14

The pivot is under the centre of the rod. A magnet is fixed to one end of the rod. A piece of modelling clay is fixed to the other end of the rod. The system is in equilibrium. State the relationship between the moment of the weight of the magnet and the moment of the weight of the piece of modelling clay about the pivot.

(1)

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(Total for question = 1 mark)

Mark Scheme - Moments

Q1.

Question number	Answer	Additional guidance	Mark
i	substitution (1) (moment=) 0.40 × 70 evaluation (1) 28 Nm (1)	 independent mark award full marks for the correct answer without working	**(3)**

Question number	Answer	Additional guidance	Mark
ii	an explanation linking the effort is at a bigger distance (1) from fulcrum (than the load) (1)	allow reverse argument for load (magnitudes of) moments are the same allow wheel/axle/pivot for fulcrum	**(2)**

Question number	Answer	Additional guidance	Mark
iii	(there will be more) friction (between the axle and wheel)	inside the bearing	**(1)**

Q2.

Question number	Answer	Additional guidance	Mark
i	evaluation of gear ratio (1) 1:3 evaluation of number of revolutions (1) 6	allow 1 mark if 60/20 or 20/60 or 20:60 or 60:20 seen award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
ii	D 120mm down A and C are incorrect because gear T moves down B is incorrect because gear T moves 2mm per tooth		(1)

Q3.

Question number	Answer	Additional guidance	Mark
a	recall and substitution (1) (force x 12.0 =) 0.050 x 8.4 rearrangement (1) (force =) $\frac{0.050 \times 8.4}{12.0}$ evaluation (1) (force =) 0.035 (N)	allow substitution and rearrangement in either order award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers that round to 29 (eg 28.57) (substitution mark)	**(3)** **AO2**

Question number	Answer	Additional guidance	Mark
b	a description to include **four** of the following measure the value of current (1) measure force or distance(1) vary the current (1) restore equilibrium of system (1) calculate ratio between force and current or distance and current (1) if ratio is the same then they are proportional (1)	 accept calculate for measure increase weight or move (existing) weight to new position plot a graph of force / distance against current graph would be a straight line (through the origin)	**(4)** **AO3**

Q4.

Question number	Answer	Additional guidance	Mark
	any correct moment (1) 450 x 0.50 or 225 or 0.80 x F_2 substitution into prin. of moment equation (1) 450 x 0.50 = 0.80 x F_2 evaluation (1) 280 (N) (for question at end)	 allow 450 x 0.3 moment taken about B allow statement of prin. of moments accept numbers which round to 280 such as 281.25 award full marks for correct answer without working.	**(3)**

Q5.

Question number	Answer	Additional guidance	Mark
	substitution (1) (moment) = 200 x 3(.0) evaluation (1) 600 (Nm) unit (1) Nm	 award full marks for correct answer without working independent mark ignore J / Joules	**(3)** **AO2**

Q6.

Question Number:	Answer	Additional Guidance	Mark
	recall clockwise moment = anticlockwise moment (1) moment = force x (perpendicular) distance (1) substitution (1) $m \times 17 = (6 \times 15) + (4.6 \times 10)$ rearrangement and evaluation (1) m = 8.0 (g)	calculations need not include g (which cancels out from all terms) substitution and rearrangement in either order $m \times 17 = 90+46$ $m = \frac{(6\times15)+(4.6\times10)}{17}$ $m = 136/17$ award full marks for correct answer without working	**(4)** AO 1 1 AO 2 1

Q7.

Question number	Answer	Additional guidance	Mark
	move the (position of) the (0.050 N) weight (1) to the other side of the pivot/3.6 cm from the magnet (1)	adjust mass of modelling clay reduce (mass of modelling clay) by taking some away add (additional) weight between pivot and magnet scores 2 marks	**(2)** **AO3**

Q8.

Question number	Answer	Additional guidance	Mark
	an explanation linking distance from hinge/pivot increased (1) (therefore) smaller force needed (to close door)	 P further from hinge than Q accept the greater distance gives greater moment for 2 marks	**(2)**

Q9.

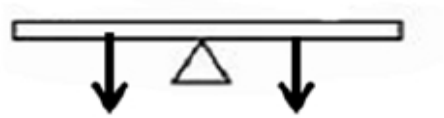
Question Number	Answer	Additional guidance	Mark
(i)	recall of moment = force x distance (1) (moment of force from person =) 600 x 0.5 **and** (moment of weight of rock =) 1800 x 0.2 (1) **moment** of force from person is less than **moment** of weight of rock. (1)	may be implied in a calculation 300 (Nm) 360 (Nm) independent mark accept reverse argument	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that links increase distance between person and pivot/ reduce distance between rock and pivot / increase force from person (1) increase the moment of the force from the person / decrease the moment of the weight of the rock (1)	 use longer lever / hold lever nearer the end / move pivot nearer to rock / get someone to help to push value of new distance and calculation of new moment	**(2)**

Q10.

Question Number	Answer	Mark
	The only correct answer is B: force Q **A is incorrect** because the moment of force P about the axle is zero. **C is incorrect** because moment of force R about the axle is zero. **D is incorrect** because moment of force S about the axle is zero.	**(1)**

Q11.

Question number	Answer	Mark
	B  A,C and D are incorrect as the forces would cause the seesaw to turn	**(1)**

Q12.

Question Number:	Answer	Additional guidance	Mark
(i)	substitution(1) (moment) =650 x 0.75 evaluation(1) 490 unit (1) Nm	 accept any value that rounds to 490 e.g. 487.5 allow a maximum of 1 mark out of the first two marking points for a power of ten error independent mark award full marks for the correct answer without any working	(3) AO 1 1 AO 2 1

Question Number:	Answer	Additional guidance	Mark
(ii)	(sum of the) clockwise moments (about a point) = (sum of the) anticlockwise moments (about that point) (1)	idea that moments on each side of a pivot can be balanced	(1) AO 1 1

Question Number:	Answer	Additional guidance	Mark
(iii)	substitution(1) 160 x distance of effort from pivot = 490 rearrangement (1) distance of effort from pivot = $\frac{490}{160}$ evaluation (1) 3.1(m)	substitution and rearrangement in either order accept 160 x distance of effort from pivot = 487.5 160 x distance from pivot =650 x 0.75 accept $\frac{650 \times 0.75}{160}$ $\frac{487.5}{160}$ accept any value which rounds to 3 maximum of two marks for a power of ten error award full marks for the correct answer without working	**(1)** AO 2 1

Q13.

Question number	Answer	Additional guidance	Mark
	(sum of) the clockwise moments = (sum of) the anticlockwise moments	moment of magnet = moment of modelling clay moments are equal (size)	**(1)** **AO1**