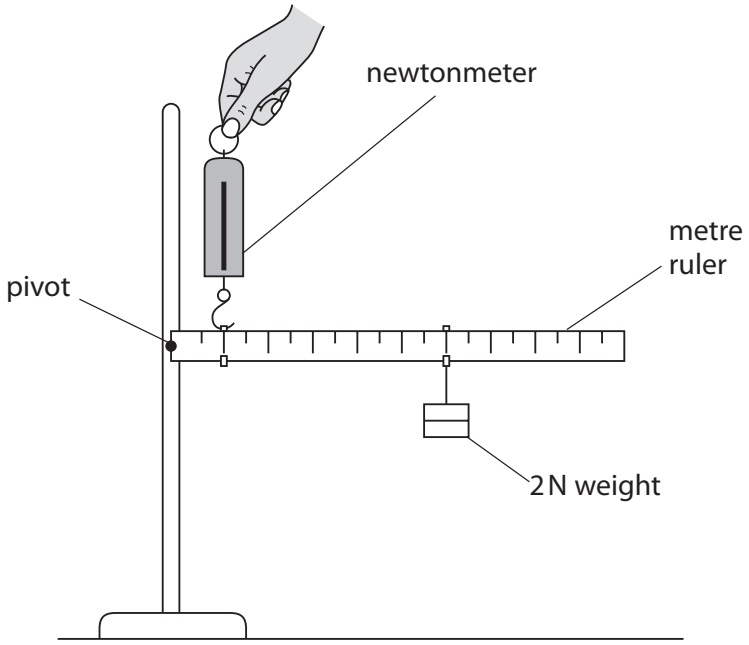
4 The diagram shows the apparatus used to investigate moments.



The 2 N weight is placed 60 cm from the pivot.

The newtonmeter is placed 10 cm from the pivot.

(a) (i) State the equation linking moment, force and perpendicular distance from the pivot.

(1)

m = f d

(ii) Calculate the reading on the newtonmeter.

Ignore the weight of the ruler.

(3)

cw moments = ccw moments
10T = 2 x 60 = 120
T = 12N

reading = ... N

(b) The metre rule is replaced by an iron bar.

The iron bar is 1 m long and has a weight of 10 N.

The newtonmeter and the 2 N weight stay in their original position.

Explain how this change affects the reading on the newtonmeter.

(3)

the weight of the bar adds an extra clockwise moment of 10N x 50cm = 500Ncm so the force exerted by the Newton meter must increase to compensate since the system remains in equilibrium so the cw and ccw moments about any point must be equal. The meter must also add 500Ncm of ccw moment so it's reading must increase by 500Ncm/ 10cm = 50N. So it shows 62N.

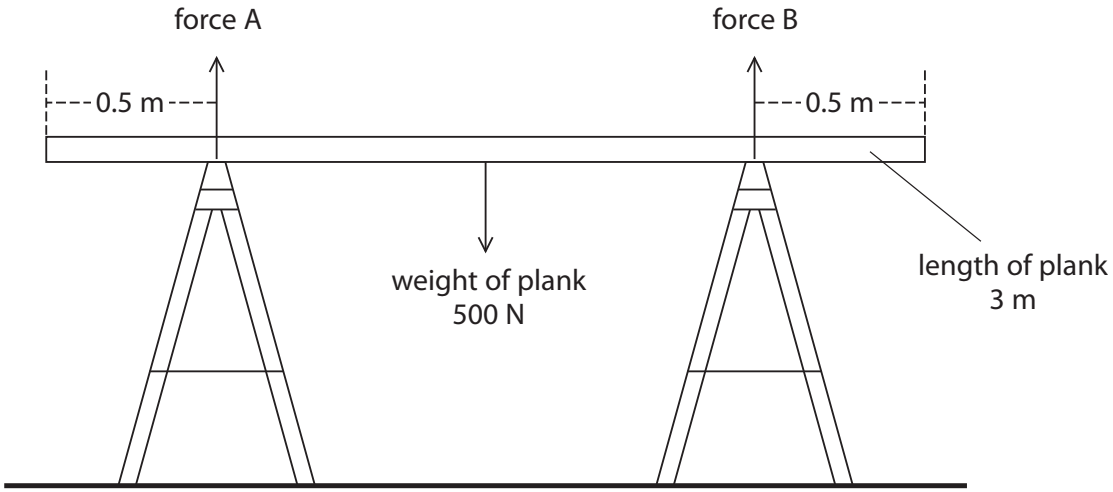
(Total for Question 4 = 7 marks)

5 (a) Which of these is a unit for the moment of a force?

(1)

- ☒ **A** N
- ☒ **B** Nm
- ☒ **C** N/m
- ☒ **D** N/m^2

(b) A painter sets up a uniform plank so he can paint a wall.



The plank is 3 m long and weighs 500 N.

(i) Use the principle of moments to show that the upward force A is 250 N.

(4)

taking moments about B
ccw = 500 * 1 = 500Nm

cw = A * 2 = 500

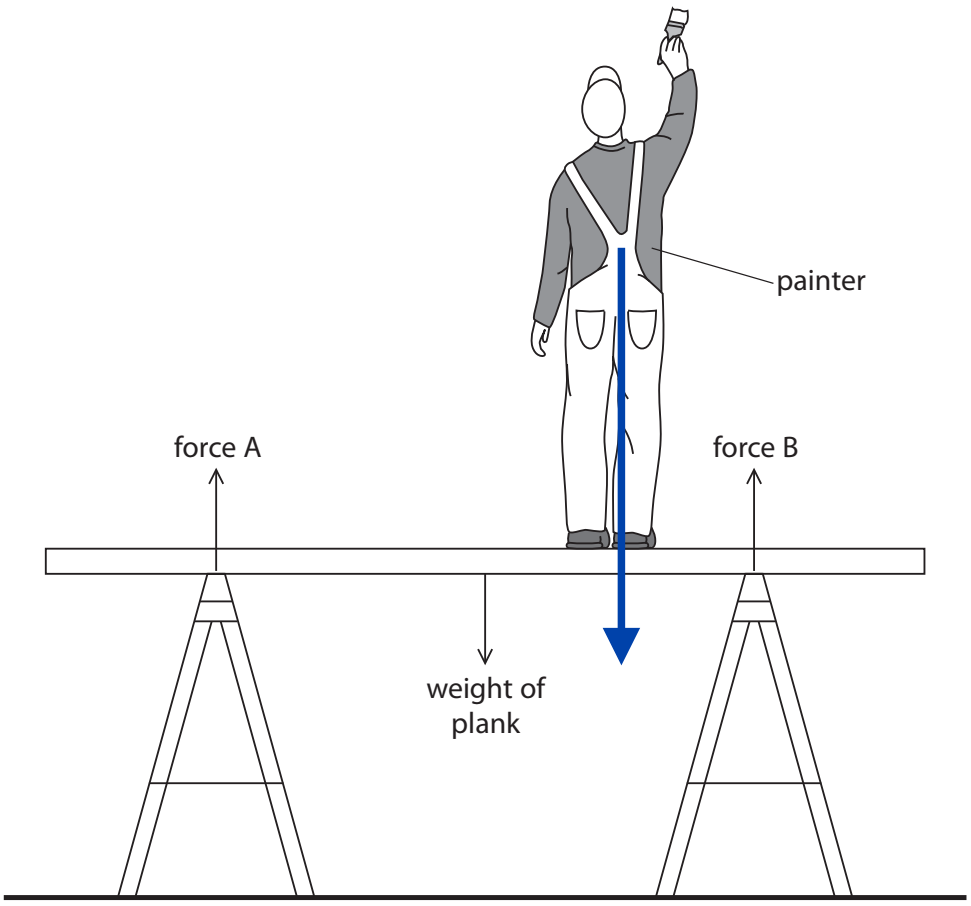
A = 500/2 = 250N

(ii) State the value of force B.

(1)

force B = **250N** ..... N

(c) The painter stands on the plank as shown.



(i) Draw an arrow on the diagram to show the weight of the painter.

(1)

(ii) Describe the changes in forces A and B when the painter stands on the plank.

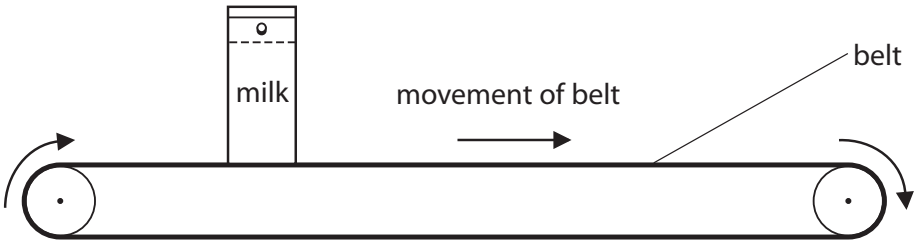
(2)

they both increase but B increases more because the painter is closer to B. The sum of the increases is equal to the painter's weight.

(Total for Question 5 = 9 marks)

1 Supermarkets use conveyer belts to move shopping at the till.

The diagram shows a carton of milk being pulled along by a horizontal conveyer belt.



The horizontal force on the carton from the belt is 1.7 N.

The carton moves a distance of 0.46 m.

(a) (i) State the equation linking work done, force and distance.

(1)

w = fd

(ii) Calculate the work done moving the carton.

(2)

w=1.7 x 0.46 = 0.782 Nm or J

Work done = ... J

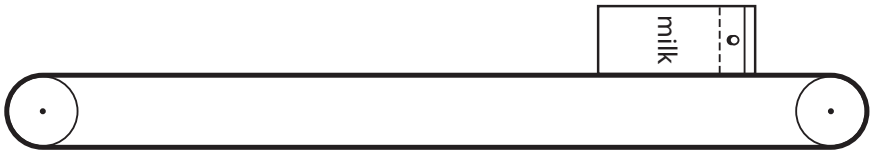
(iii) State how much energy is transferred to the carton.

(1)

0.782 J

Energy transferred = ... J

(b) The belt stops suddenly and the carton falls over.



(i) How does this affect the kinetic energy of the carton?

(1)

the ke becomes 0 because the carton is not moving.

(ii) Why does falling over reduce the gravitational potential energy of the carton?

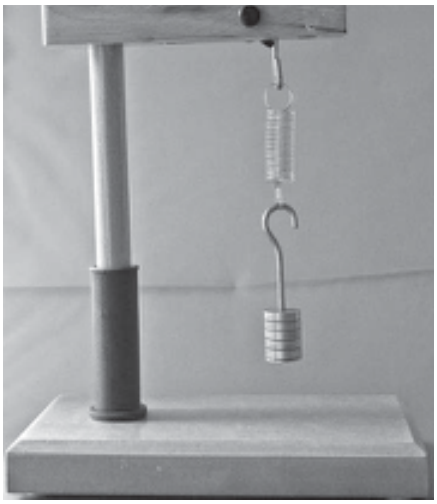
(1)

the carton's centre of mass becomes lower when it falls over.

(Total for Question 1 = 6 marks)

1 A student investigates whether a spring obeys Hooke's law.

She uses the apparatus shown in the photograph.



(a) Which additional measuring instrument does the student need for the investigation?

(1)

a ruler

(b) Explain how the student can investigate whether the spring obeys Hooke's law.

(5)

hang a known mass, perhaps 100g from the spring. Find the mass's weight using W=mg. Measure th extension of the spring by subtracting its original length from it's current length. Repeat this process with increasing masses and each time record their weight and the extension. Plot weight vs extension, the graph is linear then the spring obey's Hooke's law.

(Total for Question 1 = 6 marks)

2 An underground train enters a station.

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(a) The mass of the train and its passengers is 250 000 kg.

The total kinetic energy is 18 MJ.

(i) State the relationship between kinetic energy (KE), mass and velocity.

(1)

Ke = 1/2 m v^2

(ii) Calculate the velocity of the train as it enters the station.

(3)

ke = 1/2 m v^2

v = sqrt(2ke/m)

v = 12

velocity = ... m/s

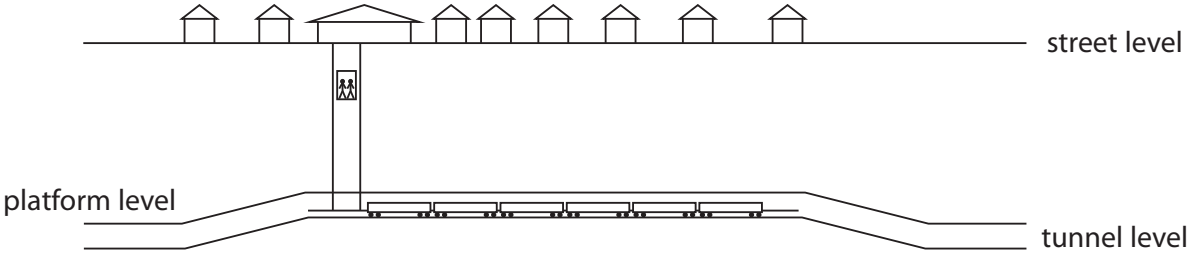
(iii) The driver applies the brakes to stop the train.

State what happens to the kinetic energy of the train.

(1)

it is converted into thermal energy in the brakes of the train.

(b) The diagram shows a section through the station.



(i) The passengers who use the station are carried from platform level to street level in a lift.

Explain why these passengers gain gravitational potential energy in the lift, even when they are below ground.

(2)

their gain in gpe = work done by the lift = force x height lifted. The fact that they are underground is irrelevant, they are still moving away from the Earth's centre of gravity.

(ii) The tunnel is designed so that the trains go up a slope as they enter the station and go down a slope as they leave.

The driver uses brakes to stop the train in the station and a motor to make the train move away.

Explain how the sloping parts of the tunnel affect the amount of work that needs to be done on the train by the brakes and by the motor.

(4)

When the train enters the station is travels up the slope and so some of its kinetic energy is converted into gravitational potential energy so that the brakes do not have to do so much work converting all of the train's kinetic energy to thermal energy to bring it to rest. When the train leaves the station it travels down the slope converting gpe to ke so it's motors do not have to do so much work restoring it to it's original speed.

(Total for Question 2 = 11 marks)