exampro

Mechanics 1 Retest
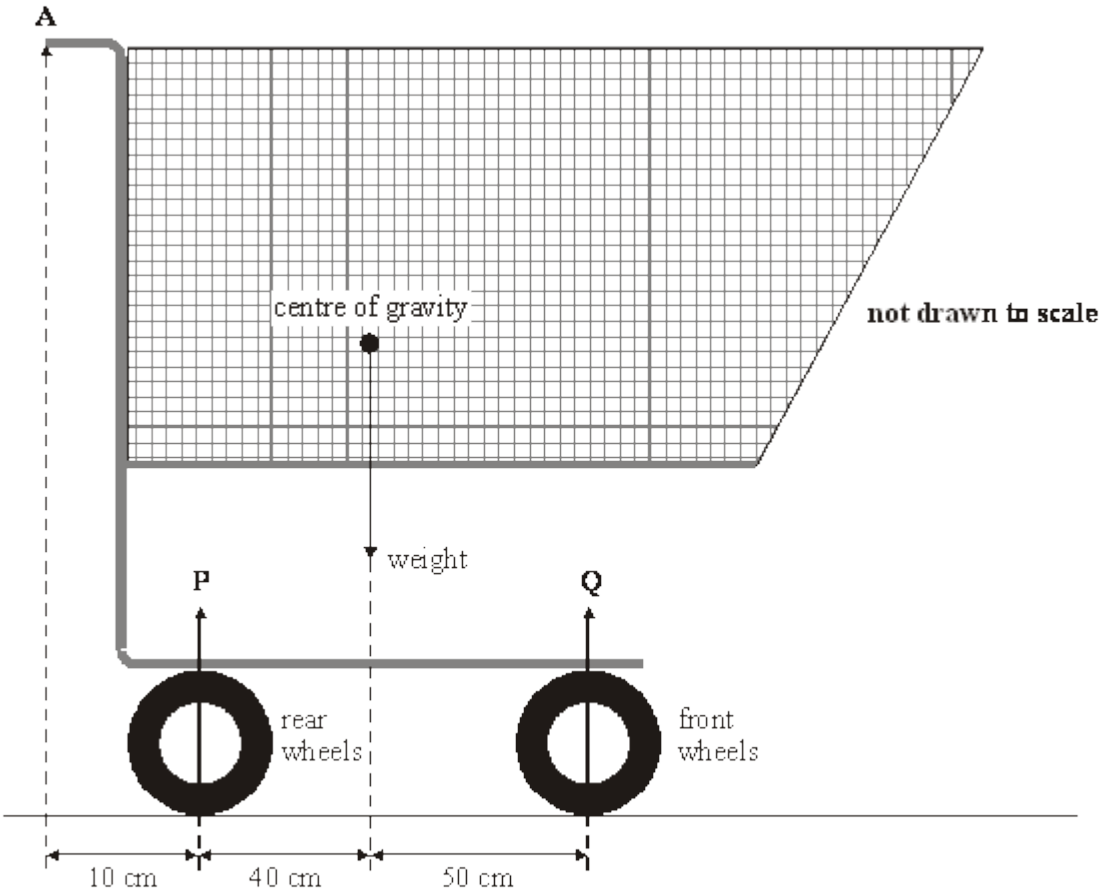### 2016

Name:

Class:

Time:

Marks:

Comments:

The figure below shows a supermarket trolley.

not drawn to scale

The weight of the trolley and its contents is 160 N.

(a)   Explain what is meant by centre of gravity.

....

....

(2)

(b)   **P** and **Q** are the resultant forces that the ground exerts on the rear wheels and front wheels respectively. Calculate the magnitude of

(i)   force **P**,

....

....

....

(ii)   force **Q**.

....

....

(3)

(c)   Calculate the minimum force that needs to be applied vertically at **A** to lift the front wheels off the ground.

....

....

....

(2)

(d)   State and explain, without calculation, how the minimum force that needs to be applied vertically at **A** to lift the rear wheels off the ground compares to the force you calculated in part (c).

You may be awarded marks for the quality of written communication in your answer.
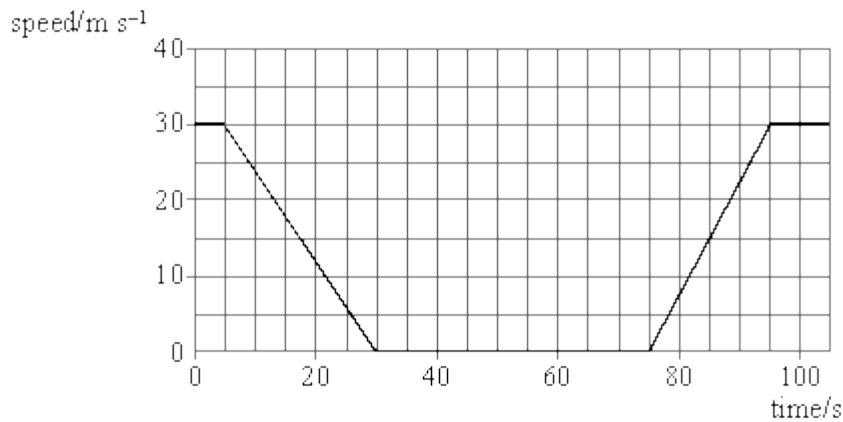
....

....

....

....

(3)
(Total 10 marks)

2   The diagram below shows a speed-time graph for a car that halts at traffic lights and then moves away.

(a)   Use the graph to show that the car travels about 380 m whilst decelerating.

                                                                                        (2)

(b)   Use the graph to calculate the acceleration of the car for the time interval from 75 s to 95 s.

                        Acceleration ....
                                                                                        (2)

(c)   Calculate the total distance travelled by the car in the time interval 5 s to 95 s.

                        Distance travelled ....
                                                                                        (1)

(d)   A second car travels the same route without being halted at the traffic lights. The speed of this car is a constant 30 m s^{-1}.

Calculate the difference in journey time between the first and second cars.

Journey time difference ....

(3)
(Total 8 marks)

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3   A digital camera was used to obtain a sequence of images of a tennis ball being struck by a tennis racket. The camera was set to take an image every 5.0 ms. The successive positions of the racket and ball are shown in the diagram below.
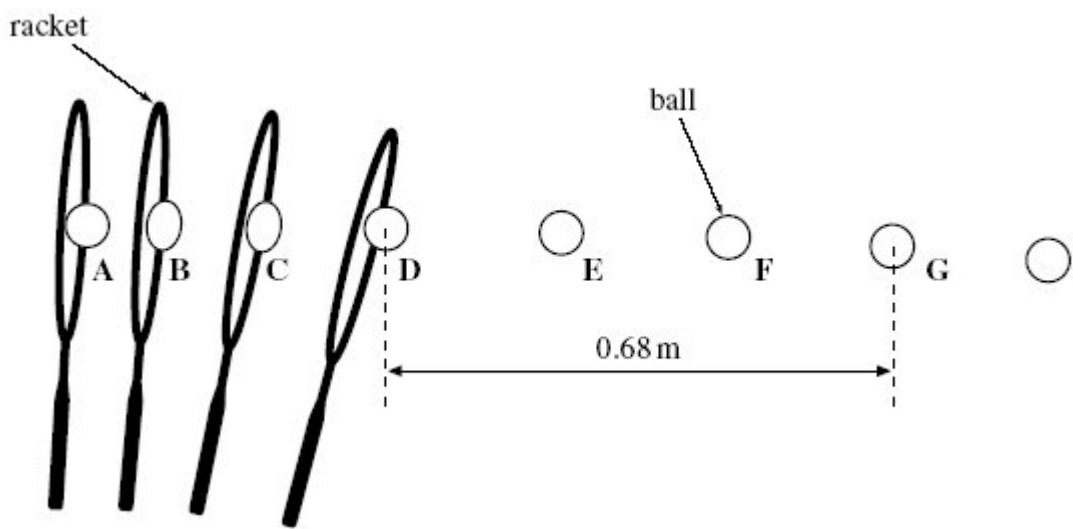
(a) The ball has a horizontal velocity of zero at **A** and reaches a constant horizontal velocity at **D** as it leaves the racket. The ball travels a horizontal distance of 0.68 m between **D** and **G**.

(i) Show that the horizontal velocity of the ball between positions **D** and **G** in the diagram above is about 45 m s^{-1}.

(3)

(ii) Calculate the horizontal acceleration of the ball between **A** and **D**.

answer = ... m s^{-2}

(1)

(b) At **D**, the ball was projected horizontally from a height of 2.3 m above level ground.

(i) Show that the ball would fall to the ground in about 0.7 s.

(3)

(ii) Calculate the horizontal distance that the ball will travel after it leaves the racket before hitting the ground. Assume that only gravity acts on the ball as it falls.

answer = ... m

(2)

(iii)   Explain why, in practice, the ball will not travel this far before hitting the ground.
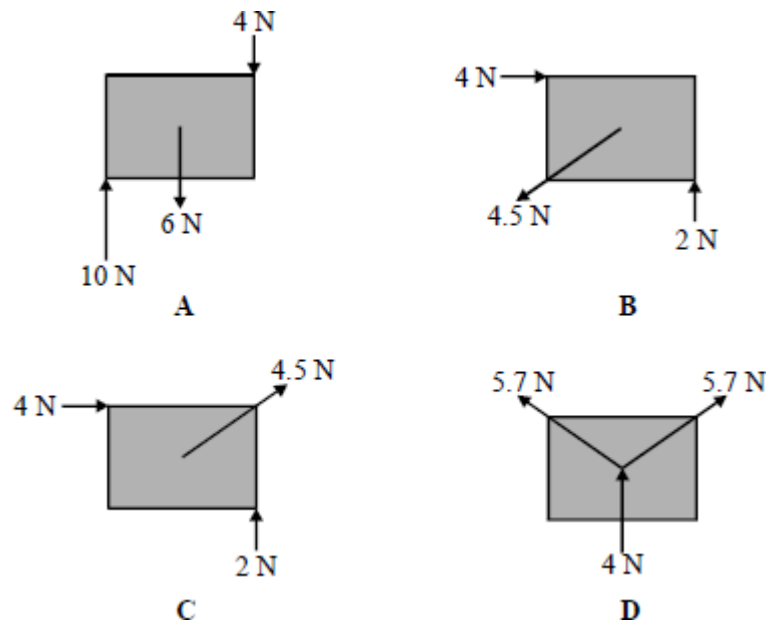
....

....

....

(2)
(Total 11 marks)

4   Two forces of 6 N and 10 N act at a point. Which of the following could **not** be the magnitude of the result?

A   16 N   ▭

B   8 N   ▭

C   5 N   ▭

D   3 N   ▭

(Total 1 mark)

5   The rectangular objects, **A**, **B**, **C** and **D** are each 2 cm long and 1 cm high. Which one of the bodies is in equilibrium?

(Total 1 mark)

6 An object falls freely from rest. After falling a distance d its velocity is v. What is its velocity after it has fallen a distance $2d$?
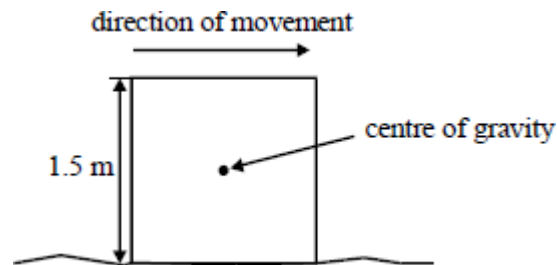
A $2\,v$

B $4\,v$

C $2\,v^2$

D $\sqrt{2}\,v$

(Total 1 mark)

7 A uniform square block is sliding with uniform speed along a rough surface as shown in the diagram.


direction of movement

centre of gravity

1.5 m

The force used to move the block is 200 N. The moment of the frictional force acting on the block about the centre of gravity of the block is

A   150 N m, clockwise

B   150 N m, anticlockwise

C   300 N m, clockwise

D   300 N m, anticlockwise

(Total 1 mark)

8

In the system shown a light rigid beam, pivoted at **X**, is held in position by a string which is fixed at **Y**. The beam carries a load of 200 N. The load is moved towards **X**. Which one of the following statements is correct?
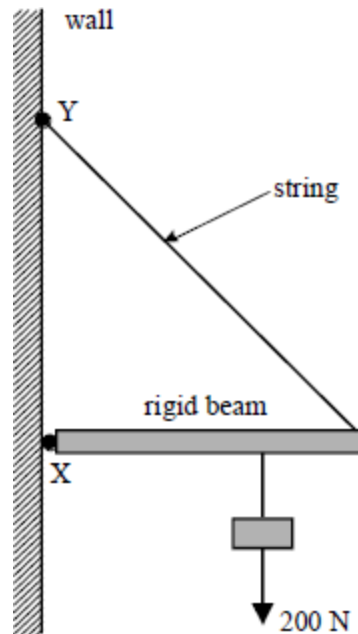
A   The tension in the string increases

B   The compression force in the beam increases

C   The moment of the load about **X** increases

D   The magnitude of the vertical component of the reaction at **X** increases

(Total 1 mark)

Mark schemes

1 (a) the point (in a body) **(1)**

where the weight (or gravity) of the object appears to act

[or resultant torque zero] **(1)**

2

(b) (i) $P \times 0.90 = 160 \times 0.50$ **(1)**
$P = 89$ N (88.9 N)

(ii) $Q = (160 - 89) = 71$ N **(1)**
(allow C.E. for value of P from (i))

3

(c) (minimum) force $\times 0.10 = 160 \times 0.40$ **(1)**

force = 640 N **(1)**

2

(d) force is less **(1)**

because distance to pivot is larger **(1)**

smaller force gives large enough moment (1)

3

[10]

2 (a) *states* area under graph = distance **or** clear evidence of
graph use

B1

½ × 30 × 25 *seen*

B1

2

(b) accel = grad of graph **or** uses a = $\Delta v / \Delta t$

M1

30/20 = 1.5 m s^{-2}

A1

2

(c) 300 + 375 = 675 m

B1

1

(d)   675/680 m (ecf) at 30m/s takes 22.5/22.7 s

                                                                                    C1

      but actually took 90 s

                                                                                    C1

      so loss of time = 67.5/67.3 s

                                                                                    A1
                                                                                          3
                                                                                                    [8]

3

(a) (i) $v = \dfrac{s}{t}$ **(1)**

            t = 0.015 (s) or 15 (ms) **(1)**

            0.68/0.015 **(1)** (= 45)

                                                                                          3

     (ii) $\left(a = \dfrac{\Delta v}{\Delta t} = \dfrac{45.3}{0.015} \right)$ = 3000 (m s^{-2}) (3022) **(1)**

                                                                                          1

(b) (i) $s = (ut) = \dfrac{1}{2} gt^2$ or $t = \sqrt{\dfrac{2s}{g}}$ **(1)**

            correct substitution seen = $\sqrt{\dfrac{2 \times 2.3}{9.81}}$ **(1)**

            0.68 to 0.69   correct answer to more than one dp seen **(1)**

                                                                                          3

     (ii) $(s = vt) = 45(.3) \times 0.685$ or 0.7 **(1)**

            = 30.6 to 32 **(1)** (m)

                                                                                          2

     (iii)   mention of air resistance or drag **(1)**

            causing **horizontal** deceleration or 'slowing down' **(1)**

                                                                                          2
                                                                                                    [11]

4 D

[1]

5 B

[1]

6 D

[1]

7 A

[1]

8 D

[1]

Examiner reports

1   Candidates found this question not very accessible. This was probably due to the trolley having two sets of wheels in contact with the ground as opposed to only one set in the previous paper. This meant that unless candidates were familiar with this type of problem, there was no obvious pivot point about which to take moments. This unfamiliarity was noticeable in the calculations for part (b), which caused difficulties for large numbers of candidates, and it was clear that not all centres had given candidates experience of this type of question on moments. Part (c) proved to be even more difficult and only the more able candidates were able to calculate the force necessary to lift the front wheels off the ground. Part (d) was answered consistently better, with even less able candidates explaining why the required force would be less than that in part (c).

2   The question told candidates to 'use the graph…'. Many failed to make it clear in any way how they did this and lost marks. Otherwise, this question was done well.
The calculation of acceleration was done well by most, but there was a smattering of incorrect units for the acceleration.
There were no major problems here apart from the few who used the distance travelled for the whole of the graph (and who had therefore failed to read the question).
Again, errors centred on the use of incorrect time periods for one or more parts of the calculation.

3   In part (a) (i), most candidates quoted the equation and correctly calculated the time. The most frequent misconception was the belief that a 'suvat' equation should be used even though the velocity is constant.

The correct answer of 3000, or 3022, was accepted in part (a) (ii) and the majority successfully produced this value.

In part (b) (i) most select and quoted the correct equation and showed the correct substitution. Some lost the mark as they did not show the answer to more than one significant figure.

Part (b) (ii) was a very easy question for over 40% of candidates who understood that the horizontal acceleration was zero. For these students, $45.3 \times 0.685 = 31$ gained two marks. However, 13% did not attempt the question and another 40% misapplied a kinematics equation to the situation often using 9.81 as the acceleration.

The vast majority of candidates identified air resistance as the key factor to part (b) (iii). However, only 7% mention that **horizontal** deceleration is caused by air resistance.