1 Which of the following is a scalar quantity?

A velocity ☐

B kinetic energy ☐

C force ☐

D momentum ☐

(Total 1 mark)

2 Coplanar forces of 5 N, 4 N and 3 N act on an object. Which force, in N, **could not possibly** be the resultant of these forces?

A 0

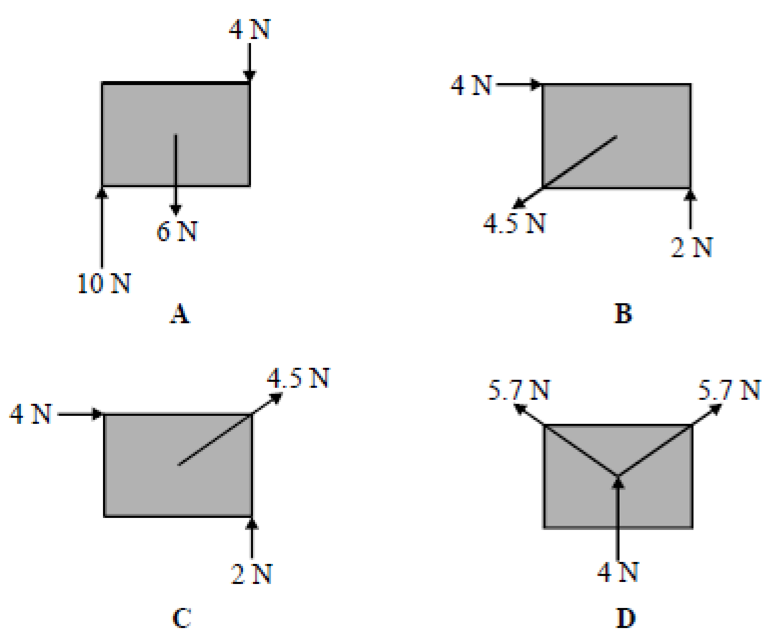
B 4

C 12

D 16

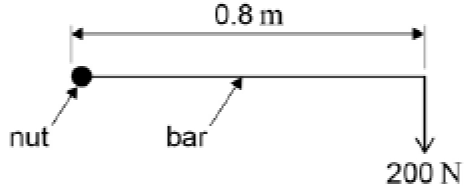
(Total 1 mark)

3 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?

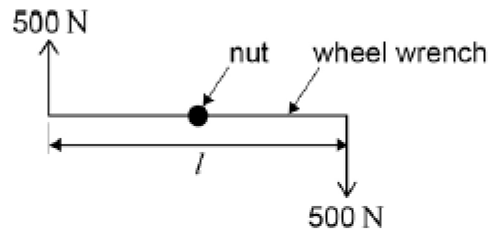


(Total 1 mark)

4 A car wheel nut can be loosened by applying a force of 200 N on the end of a bar of length 0.8 m as in **X**. A car mechanic is capable of applying forces of 500 N simultaneously in opposite directions on the ends of a wheel wrench as in **Y**.



X



Y

What is the minimum length l of the wrench which would be needed for him to loosen the nut?

A 0.16 m

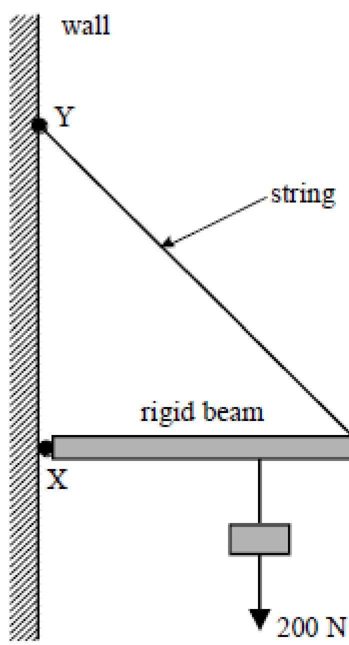
B 0.32 m

C 0.48 m

D 0.64 m

(Total 1 mark)

5 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)

6 A lunar landing module is descending to the Moon's surface at a steady velocity of 10.0 m s^{-1}. At a height of 120 m a small object falls from its landing gear. Assuming that the Moon's gravitational acceleration is 1.60 m s^{-2}, at what speed, in m s^{-1} does the object strike the Moon?

A 22.0

B 19.6

C 16.8

D 10.0

(Total 1 mark)

7 An object is dropped from a cliff. How far does the object fall in the third second? Assume that g = 10 m s^{-2}.

A 10 m

B 20 m

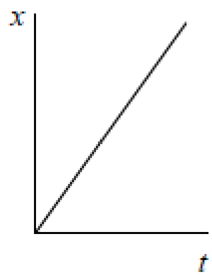
C 25 m

D 45 m

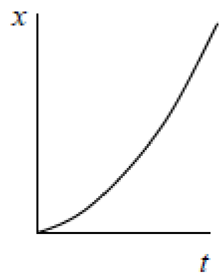
(Total 1 mark)

8 A car accelerates uniformly from rest along a straight road. Which graph shows the variation of displacement *x* of the car with time *t*?

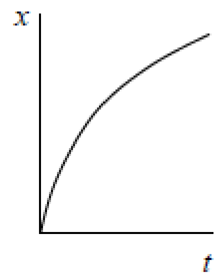
A



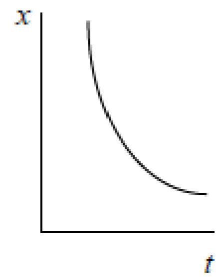
B



C



D



A ☐

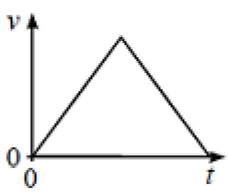
B ☐

C ☐

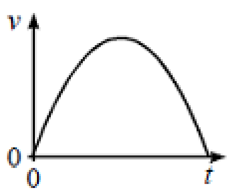
D ☐

(Total 1 mark)

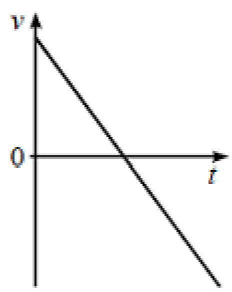
9 A perfectly elastic rubber ball falls vertically from rest and rebounds from the floor. Which one of the following velocity-time, *v*–*t*, graphs best represents the motion from the moment of release to the top of the first rebound?



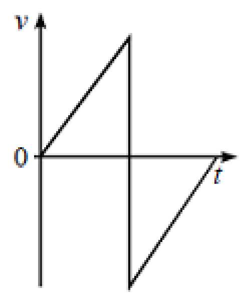
A



B



C



D

(Total 1 mark)

10 A ballbearing **X** of mass $2m$ is projected vertically upwards with speed u. A ballbearing **Y** of mass m is projected at 30° to the horizontal with speed $2u$ at the same time. Air resistance is negligible. Which of the following statements is correct?

A The horizontal component of **Y**'s velocity is u. ⬭

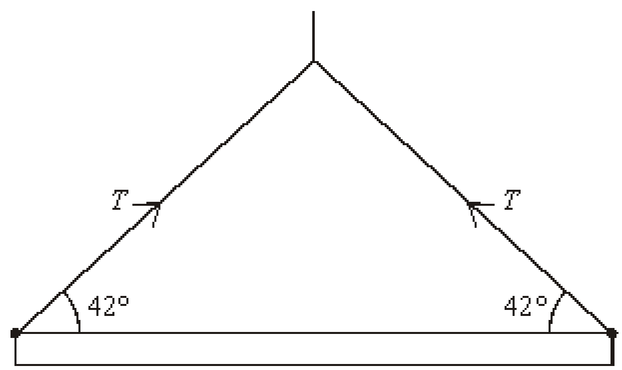
B The maximum height reached by **Y** is half that reached by **X** ⬭

C **X** and **Y** reach the ground at the same time. ⬭

D **X** reaches the ground first. ⬭

(Total 1 mark)

11 The figure below shows a uniform steel girder being held horizontally by a crane. Two cables are attached to the ends of the girder and the tension in each of these cables is T.



(a) If the tension, T, in each cable is 850 N, calculate

(i) the horizontal component of the tension in each cable,

....

....

(ii) the vertical component of the tension in each cable,

....

....

(iii) the weight of the girder.

....

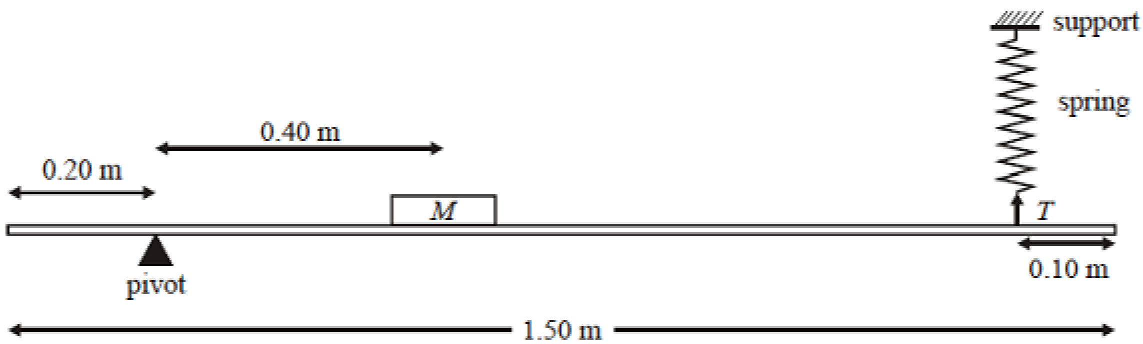
....

(4)

(b) On the figure draw an arrow to show the line of action of the weight of the girder.

(1)
(Total 5 marks)

12 The diagram below shows a laboratory experiment to test the loading of a uniform horizontal beam of weight W. The length of the beam is 1.50 m. The load, M, has a weight of 100 N and its centre of mass is 0.40 m from the pivot. The beam is held in a horizontal position by the tension, T, in the stretched spring.



(a) Add clearly labelled arrows to the diagram above so that it shows all of the forces acting on the beam.

(2)

(b) The tension, T = 36 N. Calculate the moment of T about the pivot.

Moment ....

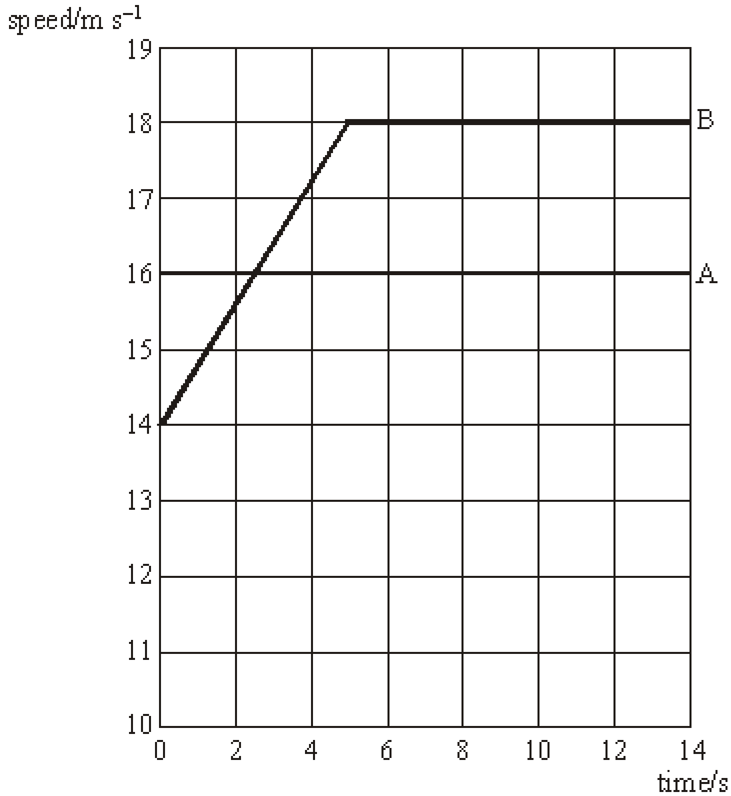
(2)

(c) Calculate the weight, W, of the beam.

Weight W ....

(3)
(Total 7 marks)

13 The graph represents the motion of two cars, A and B, as they move along a straight, horizontal road.



(a) Describe the motion of each car as shown on the graph.

(i) car A: ....

....

(ii) car B: ....

....

(3)

(b) Calculate the distance travelled by each car during the first 5.0 s.

(i) car A: ....

....

....

(ii) car B: ....

....

....

(4)

(c) At time t = 0, the two cars are level. Explain why car A is at its maximum distance ahead of B at t = 2.5 s

....

....

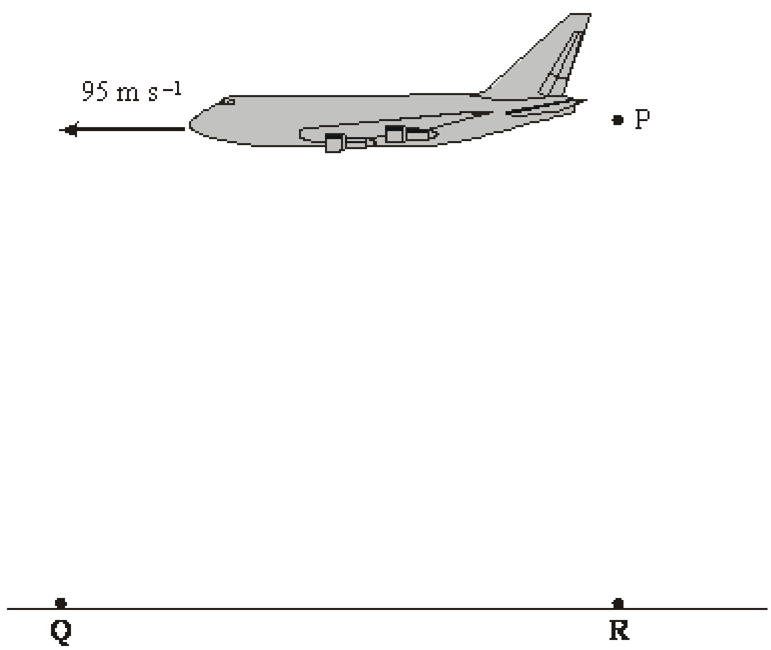
....

....

....

(3)
(Total 10 marks)

14 The aeroplane shown in the diagram below is travelling horizontally at 95 m s^{-1}.
It has to drop a crate of emergency supplies.
The air resistance acting on the crate may be neglected.



(a) (i) The crate is released from the aircraft at point **P** and lands at point **Q**. Sketch the path followed by the crate between **P** and **Q** as seen from the ground.

(ii) Explain why the horizontal component of the crate's velocity remains constant while it is moving through the air.

....

....

....

(3)

(b) (i) To avoid damage to the crate, the maximum vertical component of the crate's velocity on landing should be 32 m s^{-1}. Show that the maximum height from which the crate can be dropped is approximately 52 m.

....

....

....

(ii) Calculate the time taken for the crate to reach the ground if the crate is dropped from a height of 52 m.

....

....

(iii) If **R** is a point on the ground directly below **P**, calculate the horizontal distance **QR**.

....

....

(6)

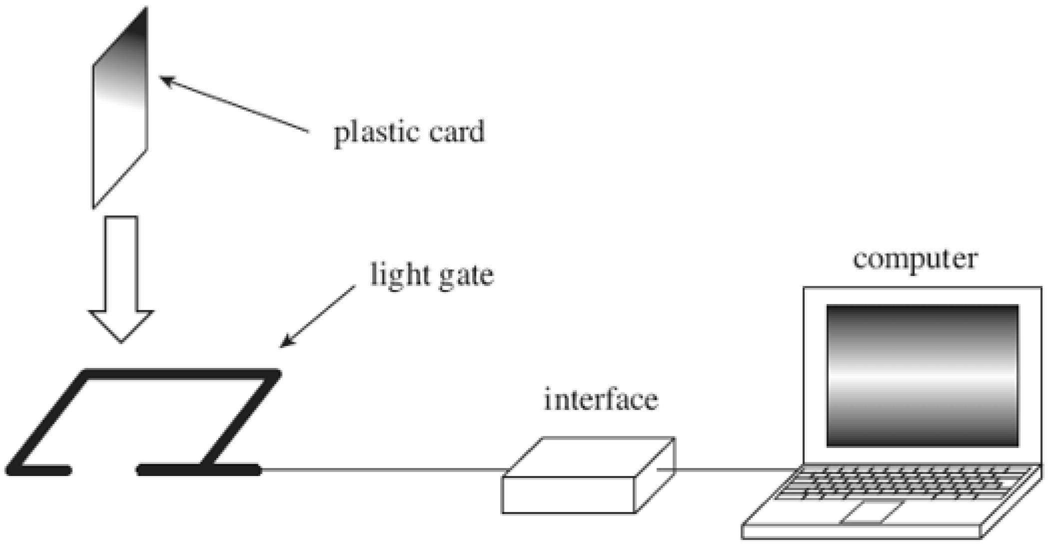
(c) In practice air resistance is **not** negligible. State and explain the effect this has on the maximum height from which the crate can be dropped.

....

....

(2)
(Total 11 marks)

15 A student measures the acceleration due to gravity, *g*, using the apparatus shown in the figure below. A plastic card of known length is released from rest at a height of 0.50m above a light gate. A computer calculates the velocity of the card at this point, using the time for the card to pass through the light gate.



(a) The computer calculated a value of 3.10 m s^{-1} for the velocity of the card as it travelled through the light gate. Calculate a value for the acceleration due to gravity, *g*, from these data.

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

(2)

(b) The student doubles the mass of the card and finds a value for *g* that is similar to the original value. Use the relationship between *weight*, *mass* and *g* to explain this result.

....

....

....

....

(1)

(c) State and explain **one** reason why the card would give more reliable results than a table tennis ball for this experiment.

....

....

....

....

(2)
(Total 5 marks)

Mark schemes

1 B **[1]**

2 D **[1]**

3 B **[1]**

4 B **[1]**

5 D **[1]**

6 A **[1]**

7 C **[1]**

8 B **[1]**

9 D **[1]**

10 C **[1]**

11 (a) (i) horizontal component = 850 × cos 42 **(1)**
= 630 N **(1)** (632 N)

(ii) vertical component = 850 × sin 42 = 570 N **(1)** (569 N)
(if mixed up sin and cos then CE in (ii))

(iii) weight of girder = 2 × 570 = 1100 N **(1)** (1142 N)
(use of 569 N gives weight = 1138 N)
(allow C.E. for value of vertical component in (ii))

4

(b) arrow drawn vertically downwards at centre of girder **(1)**

1

[5]

12 (a) two correct weight arrows *with labels* (100N, W)
arrows must ***act on beam*** *(horiz. scope: M, 50 m respectively)*

B1

normal reaction arrow at pivot point (with label)

B1

(2)

(b) Use of 36 × a distance **C1**

moment = 43.2 Nm *(36 × 1.3 = 46.8)* **A1**

(2)

(c) clockwise moment = anti-clockwise moment **C1**

43.2 = 0.40 × 100 + 0.55w **M1**

w = 5.8 N **A1**

allow ecf from (b) (46.8 gives 12.4 N)

(2)

[7]

13 (a) (i) car A: travels at constant speed **(1)**

(ii) car B: accelerates for first 5 secs (or up to 18 m s^{-1}) **(1)**
then travels at constant speed **(1)**

3

(b) (i) car A: distance = 5.0 × 16 **(1)**
= 80 m **(1)**

(ii) car B: (distance = area under graph)
distance = [5.0 × ½ (18 + 14)] **(1)**
= 80 m **(1)**

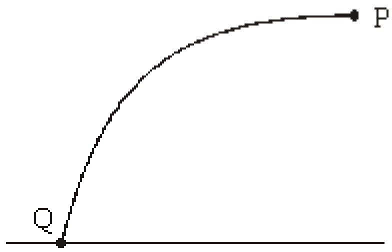
4

(c) car B is initially slower than car A (for first 2.5 s) **(1)**
distance apart therefore increases **(1)**
cars have same speed at 2.5 s**(1)**
after 2.5 s, car B travels faster than car A (or separation decreases) **(1)**

max 3

[10]

14 (a) (i)



(1)

(ii) no **horizontal** force acting **(1)**
(hence) no (horizontal) acceleration **(1)**
[or correct application of Newton's First law]

3

(b) (i) (use of $v^2 = u^2 + 2as$ gives) $32^2 = (0) + 2 \times 9.81 \times s$ **(1)**

$s = \frac{1024}{19.62}$ **(1)** (= 52.2 m)

(ii) (use of $s = \frac{1}{2} at^2$ gives) $52 = \frac{1}{2}\, 9.81 \times t^2$ **(1)**

$t = \sqrt{\left(\frac{104}{9.81}\right)} = 3.3$ s **(1)** (3.26 s)

[or use of $v = u + at$ gives $32 = (0) + 9.81 \times t$ **(1)**

$t = \frac{32}{9.81} = 3.3$ s **(1)** (3.26 s)]

(iii) (use of $x = vt$ gives) × (= QR) = 95 × 3.26 **(1)**
= 310 m **(1)**

(use of t = 3.3 gives x = 313.5 m)
(allow C.E. for value of t from (ii))

6

(c) maximum height is greater **(1)**
because vertical acceleration is less **(1)**
[or longer to accelerate]

2

[11]

15 (a) correct substitution in ($v^2 = u^2 + 2as$)

or correct rearrangement g = $\frac{v^2}{2s}$ **or** $\frac{3.10^2}{2 \times 0.50}$ ✓

= 9.6 (9.61 m s^{-1}) ✓

2

(b) $g = W/m$ **or** $W = mg$ (= ma) and weight is proportional to mass/doubling the mass doubles the weight/'masses cancel'/the factor of two cancels (so g remains the same) ✓

1

(c) ball's acceleration will decrease/be less than card's **or** card's acceleration will be unaffected/nearly constant ✓

air resistance affects cards less or card is more streamlined
or card does less work against air resistance ✓

alternative *timing/(velocity/speed/acceleration) uncertain/(inaccurate /imprecise/less reliable)* ✓

indication that full width of ball may not pass through gate/difficulty in determining 'length' of ball passing through gate ✓

2

[5]

Examiner reports

11 This question was answered well and it was clear that candidates were skilled in resolving vectors. Full marks were common in part (a). A minority of candidates confused the vertical and horizontal components and consequently lost the first two marks. The arrow showing the line of action proved a very accessible mark, although some candidates spoilt their answers by a lack of care in their drawing. It was not clear from these drawings that the arrow pointed vertically downwards.

12 Generally the force arrows were poorly drawn and / or not labelled, or left out altogether. Parts (b) and (c) were often well answered although unit errors were quite common.

13 This question proved to be very accessible and full marks were awarded frequently. The only real confusion arose in part (c) where weaker candidates had difficulty organising their thoughts and expressing them in a logical way. Loose use of language was evident, with statements such as "accelerating at a constant speed" cropping up in a significant minority of scripts.

14 This question caused problems for all but the most able candidates. This was particularly true with part (a) in which the path of the crate was often shown as a straight line or curving the wrong way. Candidates also found it difficult to express themselves clearly when trying to explain why the horizontal component of velocity remained constant.

Part (b) was better answered and frequently scored full marks. In part (c) the majority of candidates correctly surmised that the crate could be dropped from a greater height but found it more difficult to explain why. Very often the answer stated that air resistance slowed the crate down, and not that it decreased its acceleration.

15 Most candidates gained full marks in part (a). A few performed a calculation using $t = s/v$, with 3.1 as the average speed. This gave a value for g twice the required size.

In part (b) correct answers should have included 'weight is proportional to the mass and $W/m = g$', or 'doubling the mass will double the weight and g will remain the same' or similar. Many said increasing m will increase W but this was not sufficient for the mark.

A large majority of candidates seemed to be familiar with the use of a light-gate to measure velocity in part (c). Most said that air resistance would affect the ball more. However, very few then went on to explain that the increased air resistance would reduce the acceleration. Many said that air resistance 'slows down' the ball. They may be thinking, incorrectly, that the ball slows down as it falls, or they may be indicating that the ball is slower than it would be if there were no air resistance. Students therefore need to be able to describe the motion of an object in an unambiguous manner, eg 'when an object falls, the acceleration decreases due to air resistance'.

Few candidates were able to explain that the full diameter of the ball was unlikely to pass through the beam. This is a difficult idea to express. Candidates should be encouraged to include a simple sketch to help illustrate a point if they are finding it difficult to put into words. Some said that that there is more uncertainty in the measurement of the diameter of the ball. However, this would depend on the measurement technique, so credit could not be given.