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ST BENEDICT'S

SUBJECT	Physical Sciences Paper 1: Physics	DATE	18 July 2016
GRADE	12	MARKS	200
EXAMINER	Mrs Esterhuizen	MODERATOR	Mr F van der Linde Mrs F Holpert Mr S Graham (Reddam)
NAME		DURATION	180 min
CLASS			

**LOW
ORDER**

50%

HIGH ORDER

50%

INSTRUCTIONS

1. This examination consists of 20 pages.
2. It is in your own interest to write legibly and to present your work neatly.
3. Answer all questions on folio question paper.
4. Start each question at the top of a new page.
5. An approved calculator (non-programmable, non-graphical) may be used.
6. Show your working in all calculations.
7. Rough work and planning may be done as long as it is clearly indicated as rough work. Rough work will not be marked.
8. Round all final answers to 2 decimal places unless otherwise instructed.
9. An information sheet is provided.

Question	1	2	3	4	5	6	7	8	Total
Marks	20	33	15	23	27	27	33	22	200

ENSURE YOUR CALCULATOR IS SET TO DEGREES AND **NOT** RADIANS

Questions in this paper were inspired by items in the following examinations:

- Cambridge International Advanced Level PHYSICS 9702/53
Paper 5 Planning, Analysis and Evaluation October/November 2014
- AQA GCSE PHYSICS Higher Tier Paper 1H Specimen 2018
- UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS General
Certificate of Education Advanced Level **PHYSICS 9702/41** Paper 4 A2
Structured Questions **October/November 2013**
- IEB: NATIONAL SENIOR CERTIFICATE: PHYSICAL SCIENCES: PAPER I –
SUPPLEMENTARY
- New South Wales Board of Studies HIGHER SCHOOL CERTIFICATE
Physics EXAMINATION 2006
- AQA A-level PHYSICS (7408/1) Paper 1 Specimen 2014
- Cambridge Pre-U Certificate PHYSICS (PRINCIPAL) 9792/01
Paper 1 Multiple Choice For Examination from 2016 SPECIMEN PAPER

QUESTION 1 – MULTIPLE CHOICE

20 MARKS

Write down only the question number and the letter of your choice of correct answer.

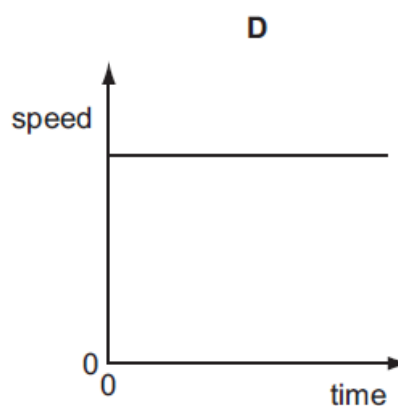
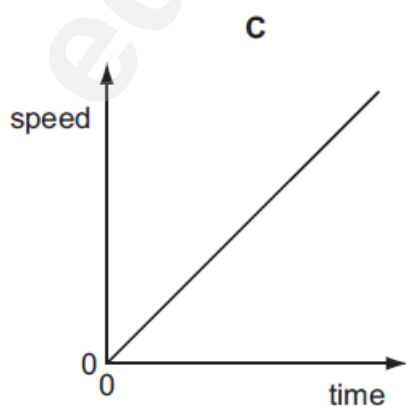
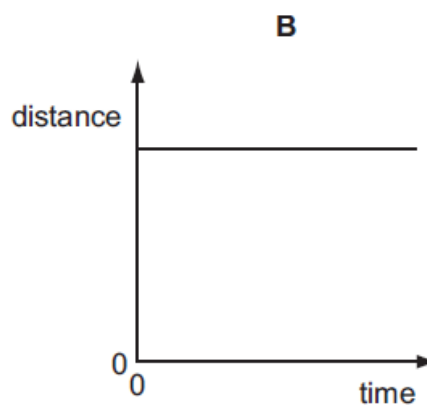
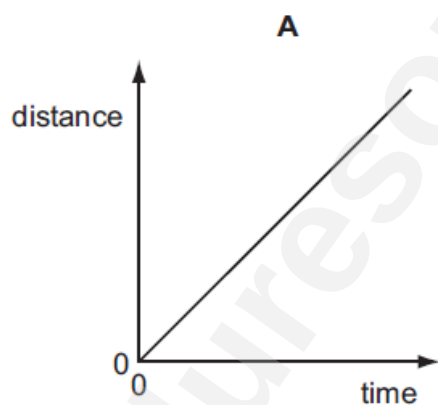
1.1 Which of the following options lists one vector and one scalar quantity? (2)

- A. velocity and impulse
- B. mass and energy
- C. work and position
- D. acceleration and momentum

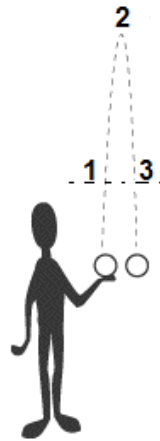
1.2 Two forces of 6 N and 10 N act at a point. Which of the following could **not** be the magnitude of the resultant? (2)

- A. 16 N
- B. 8 N
- C. 5 N
- D. 3 N

1.3 Two distance-time graphs and two speed-time graphs are shown. Which graph represents an object that is at rest? (2)



1.4 Krynauw throws a tennis ball vertically upwards and catches it again.



<http://img.sparknotes.com/content/testprep/bookings/sat2/physics/0001/1Dmotion.gif>

Which statement regarding the motion of the ball after being released from the hand is **correct**?

(2)

- A. The velocity of the ball at position 2 is 0 m.s^{-1}
- B. The acceleration of the ball at position 2 is 0 m.s^{-2}
- C. The velocity of the ball is the same at position 1 and 3
- D. The acceleration of the ball changes direction at position 2

1.5 A mass of M kg of water flows over a water fall of vertical height H every minute. 80% of the power that the water has due to its gravitational potential energy is converted to electrical power in a generator. The power output from the generator can thus be calculated as follows:

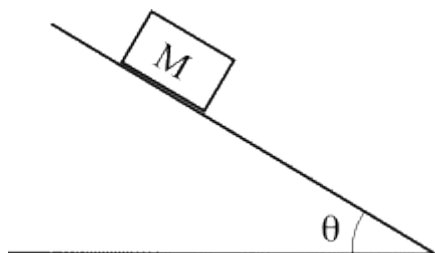
A. $\frac{MgH}{60 \times 0,8}$

B. $\frac{60 \times 0,8}{MgH}$

C. $\frac{60}{0,8MgH}$

D. $\frac{0,8MgH}{60}$

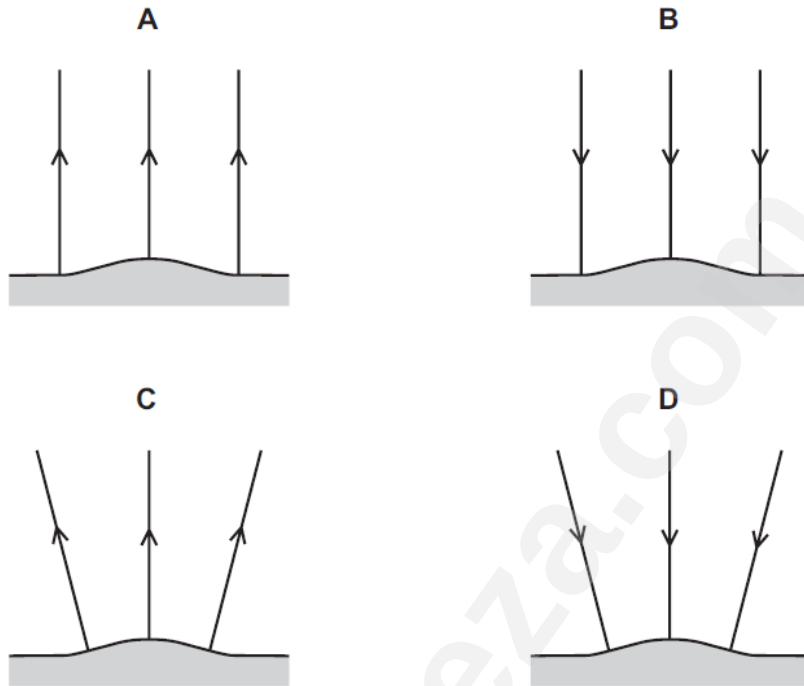
- 1.6 Consider a mass M stationary on a rough slope at an angle of θ to the horizontal. At this angle the mass just begins to slide.



The coefficient of static friction, μ , can be calculated in the following way:

- A. $\mu = \frac{Mg \cos \theta}{\sin \theta}$
- B. $\mu = \frac{Mg \sin \theta}{\cos \theta}$
- C. $\mu = \frac{\cos \theta}{\sin \theta}$
- D. $\mu = \frac{\sin \theta}{\cos \theta}$
- 1.7 Which of the following is an equivalent unit for impulse?
- A. N.kg^{-1}
- B. kg.m.s^{-1}
- C. J.s
- D. N.m.s^{-1}
- 1.8 Two masses experience a gravitational force $\mathbf{F}$ when a fixed distance apart. What force will they experience if the distance between their centres doubles **and** both their masses double?
- A. $4F$
- B. $2F$
- C. F
- D. $\frac{1}{2} F$

- 1.9 Which diagram shows the gravitational field line pattern **close to the surface of the earth**? (2)



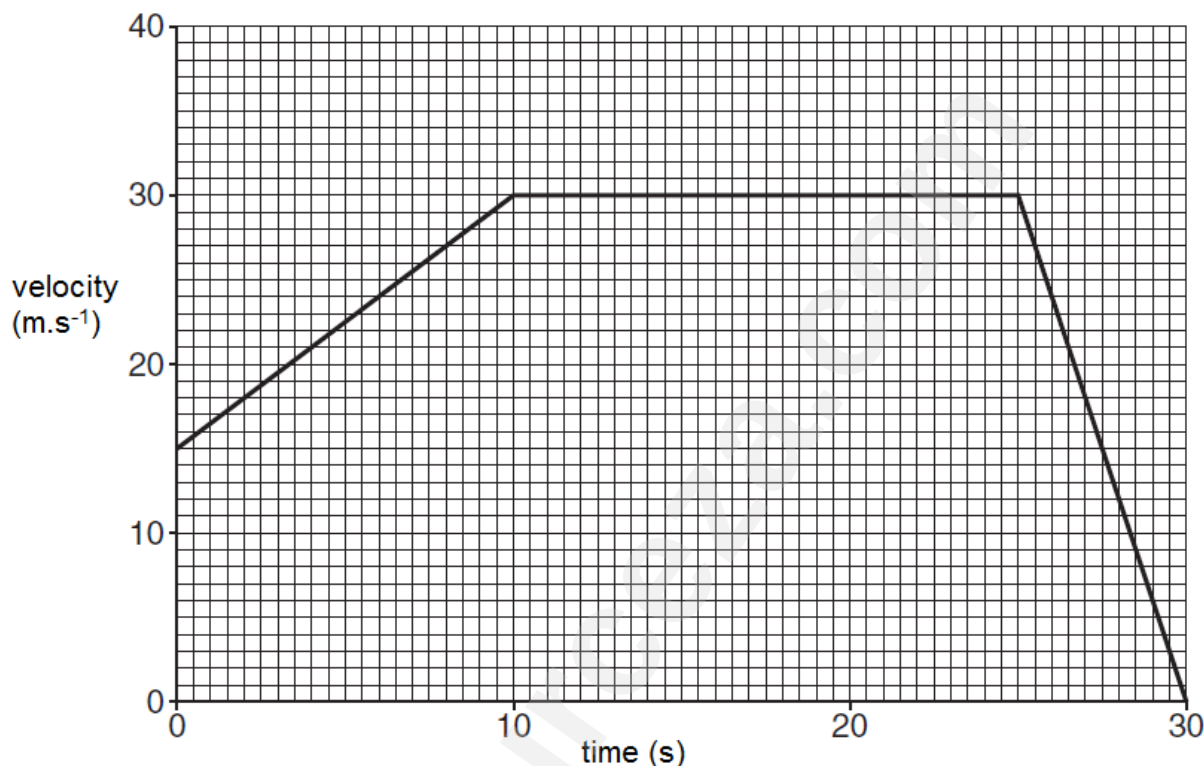
- 1.10 The property of a body that causes it to resist a change in its state of rest or uniform motion is defined as: (2)
- A. impulse
 - B. momentum
 - C. acceleration
 - D. inertia

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FOR ROUGH WORK**

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QUESTION 2 – START ON THE TOP OF A NEW PAGE 33 MARKS

- 2.1 The graph below shows how the rectilinear velocity of an object varies during a period of 30 s. The object is travelling **North** during this motion.

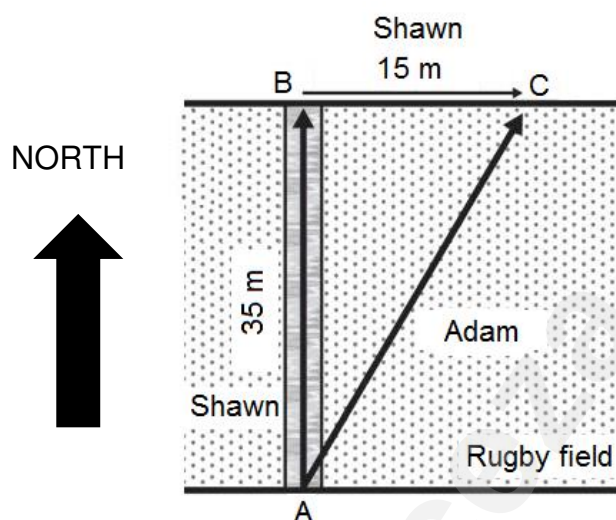


- 2.1.1 Define displacement. (2)
- 2.1.2 Clearly describe the motion of the object from:
- 0 – 10 seconds. (3)
 - 10 – 25 seconds. (2)
- 2.1.3 Calculate the displacement of the object in the 30 s motion. (4)
- 2.1.4 Sketch an acceleration vs time graph for the object in these 30 seconds. Fill in relevant times and previously calculated values. (4)

- 2.2 Shawn and Adam are on the side of the rugby field at position A. The coach calls them onto the field to position C. They set off at the same time.

Shawn jogs 35 m North along the field to B at an average speed of $5,0 \text{ m.s}^{-1}$ and then turns and walks 15 m directly to C. He takes a total of 13 seconds to get to C.

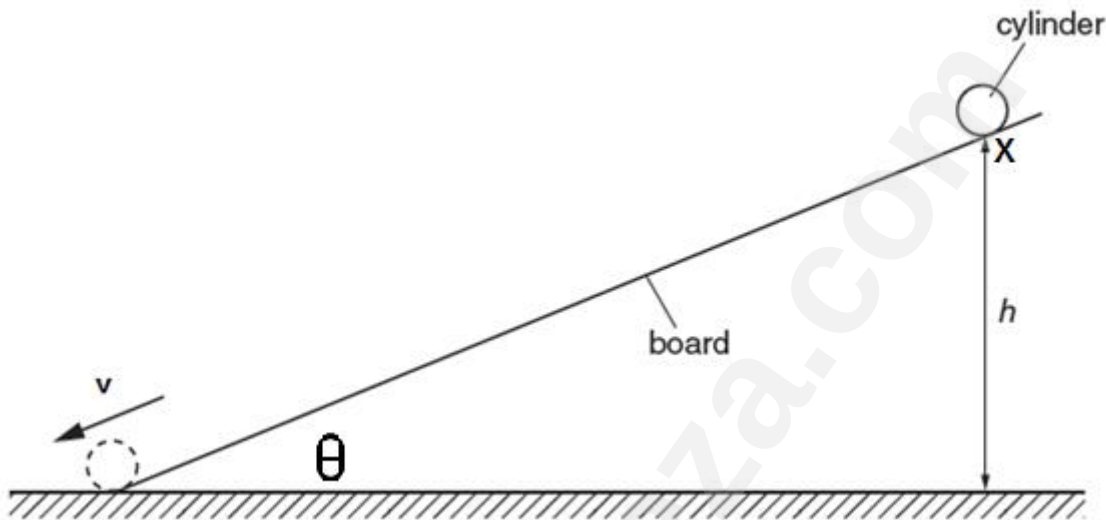
Adam jogs directly from A to C and arrives at the same time as Shawn.



- 2.2.1 Calculate Adam's displacement from A to C. (5)
- 2.2.2 Does Shawn or Adam have the greatest average speed in getting to C? Explain your answer. (3)
- 2.2.3 Determine Shawn's average **velocity** from B to C. (6)
- 2.3 Kuda is doing experiments with his rugby ball. He drops it over the edge of the staircase and it falls a distance h to hit the ground in a time of t_1 seconds.
- He then goes up and drops the ball from a height of $2h$. It takes a time of t_2 seconds to hit the ground. **Derive** an expression for the time t_2 in terms of the time t_1 . (4)

QUESTION 3 – START ON THE TOP OF A NEW PAGE 15 MARKS

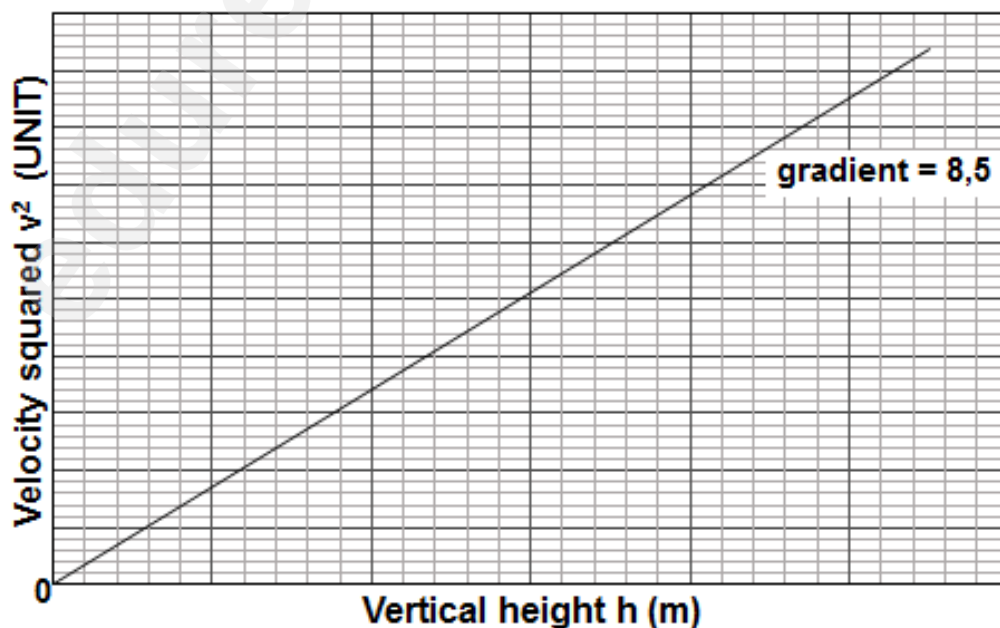
Gavin investigates how the final velocity v of a cylinder **rolling** down a **rough** board from position **X** varies with the vertical height h of the board as shown in the diagram below (not to scale). (NB: the vertical height is changed by changing the angle θ)



For different values of h , the velocity v at the end of the board is determined (using a light sensor connected to a computer).

The following graph is plotted using the gathered data:

Graph showing the relationship between the squared velocity and the vertical height of release of a rod rolling down a slope.

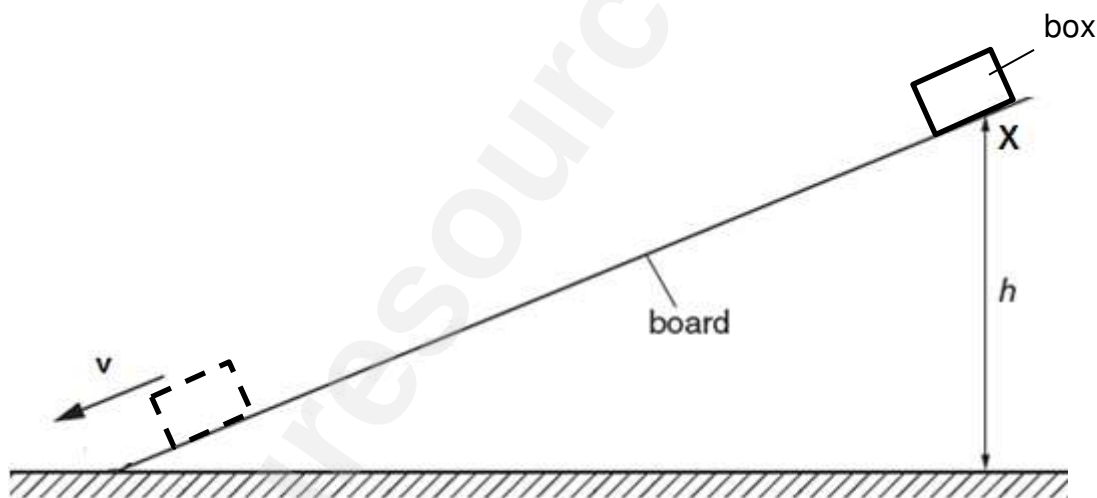


- 3.1 In this investigation, vertical height is the independent variable. What is meant by the term “independent variable”? (2)
- 3.2 What is the unit missing on the vertical axis? (2)
- 3.3 State in words the relationship between the variables given by the graph. (2)
- 3.4 Gavin does some research and finds out that his experiment can be described by the following relationship:

$$2gh = v^2 Z$$

where **g** is the acceleration due to gravity and **Z** is a constant.

- 3.4.1 Determine an expression for the gradient in terms of **g** and **Z**. (2)
- 3.4.2 Gavin determines the numerical value of the gradient to be 8,5. Use this and your answer to 3.4.1 to determine the value of the constant **Z** (to three decimal places). (2)
- 3.4.3 Determine the magnitude of the velocity of the rod at the bottom of the slope when the vertical height **h** is 0,32 m. (2)
- 3.5 Gavin repeats the experiment using a box of the same mass on the same rough board.

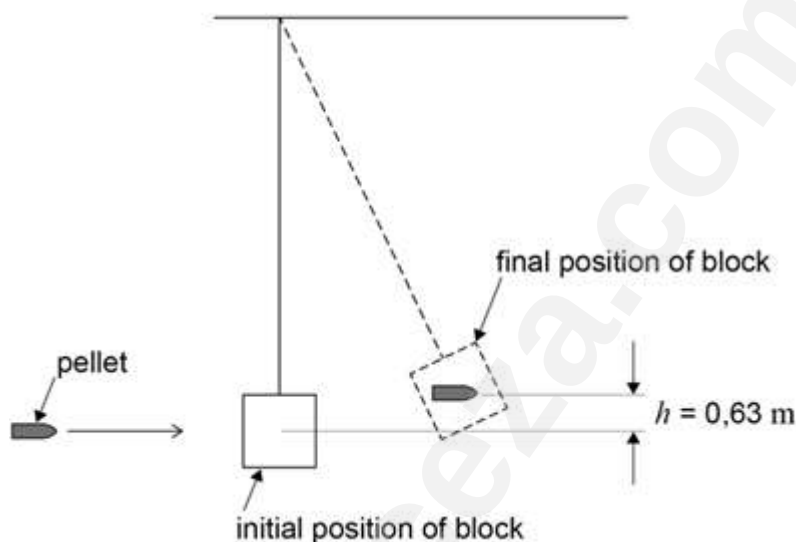


Sketch the graph of the results he would get if he plots a graph of **v² vs h** for the box. Do not try to include values – just indicate the shape of the expected graph. (3)

QUESTION 4 – START ON THE TOP OF A NEW PAGE 23 MARKS

Reabetswe and Ricky try to determine the speed of an air rifle pellet by firing it directly into a wooden block suspended from a rigid support.

The wooden block can swing freely at the end of a light inextensible string as shown in the diagram below (not to scale).

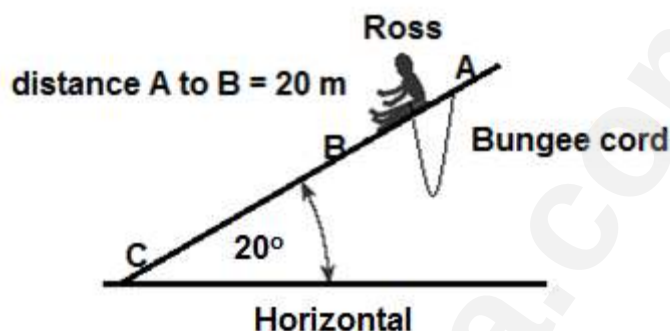


A pellet of mass 8,80 g strikes a stationary wooden block and is completely embedded in it. The centre of mass of the block rises by 0,63 m. The wooden block has a mass of 450 g. Assume that the system is frictionless.

- 4.1 State the principle of conservation of mechanical energy. (3)
- 4.2 Determine the potential energy of the pellet/block system at its final position relative to the initial position of the block. (3)
- 4.3 Hence show that the magnitude of the velocity of the pellet/block system directly after the pellet struck the block was $3,51 \text{ m}\cdot\text{s}^{-1}$. (4)
- 4.4 State the law of conservation of linear momentum. (2)
- 4.5 Determine the speed of the pellet as it strikes the wooden block. (4)
- 4.6 Ricky replaces the wooden block with a steel block of the same mass. They repeat the experiment with the steel block and an identical pellet. The pellet rebounds after striking the block.
 - 4.6.1 Which block exerted the greater force on the pellet? Explain your answer in point form and / or using suitable equations. (3)
 - 4.6.2 Discuss how the height the steel block reached compares with the height of 0,63 m reached by the wooden block. In your answer compare the energy and momentum changes that occur in the two experiments. (4)

QUESTION 5 – START ON THE TOP OF A NEW PAGE 27 MARKS

The diagram below (not to scale) shows Ross sliding from rest down a frictionless 20° ice slope from A to C. Ross slides **20,0 m** from A to B before the bungee cord starts to act on him and bring him to a stop at C. Ross has a mass of 63 kg.



- 5.1 Define weight. (2)
- 5.2 From A to B Ross accelerates at $3,35 \text{ m.s}^{-2}$. Just **before the cord starts** to act on Ross, calculate the magnitude of his:
 - 5.2.1 Velocity. (3)
 - 5.2.2 Kinetic energy. (3)
- 5.3 The bungee then does 10 556 J of work between B and C to bring Ross to a stop at C.
 - 5.3.1 Draw a labelled free body diagram showing all the forces acting on Ross as he slides from B to C. (3)
 - 5.3.2 State the Work-Energy theorem. (3)
 - 5.3.3 Determine the distance between point A and C. Show all working. (6)
- 5.4 Draw a distance vs time **sketch** graph for Ross from the beginning of the slide at point A to the end of the slide at point C using point A as your reference point. Fill in any known or already calculated values. (3)
- 5.5 Tiago does the same slide as Ross with the same cord. Tiago has a greater mass than Ross. Assuming the cord does not break and he does not go off the end of the slope, use the words **GREATER THAN OR EQUAL TO OR LESS THAN** to correctly complete the sentences below.
You must write out the entire sentence.
 - 5.5.1 At B Tiago's velocity is ____ Ross's velocity. (2)
 - 5.5.2 The work done to stop Tiago will be ____ the work done to stop Ross. (2)

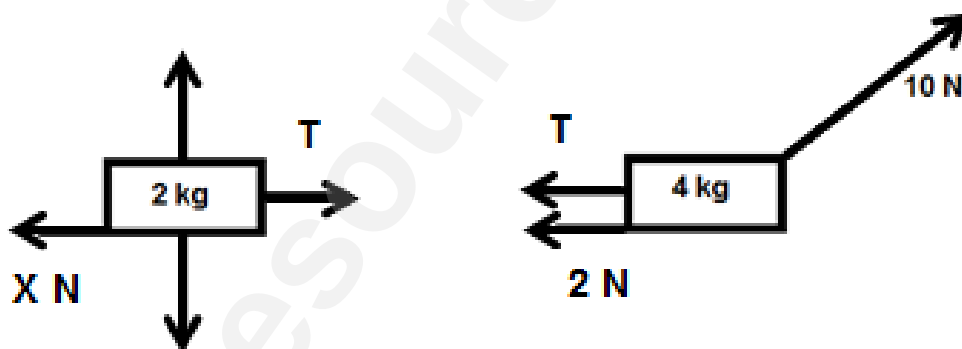
QUESTION 6 – START ON THE TOP OF A NEW PAGE 27 MARKS

Luke and Allan are investigating the motion of two sleds. At a time t_0 Luke starts pulling two sleds across ROUGH ice with a force of 10 N at an angle of 30° to the horizontal. The sleds are connected by a light, inextensible string. There is tension T in the string. Each sled experiences friction as indicated in the picture.



The sleds accelerate at $0,943 \text{ m.s}^{-2}$ to the right.

- 6.1 Define the term normal force. (2)
- 6.2 Consider the force diagrams of the 2 kg and 4 kg sleds given below that Allan draws.



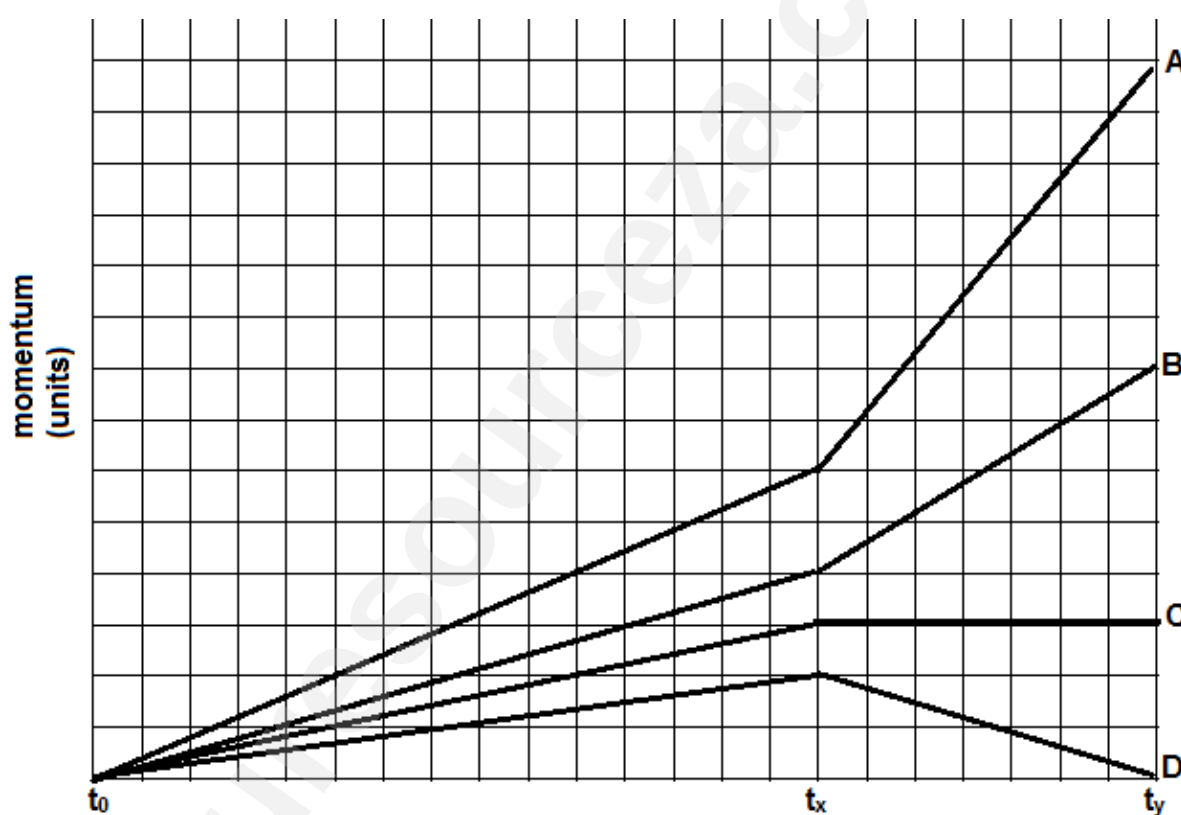
- 6.2.1 The diagram for the 4 kg sled is missing two forces. Redraw the diagram adding in and labelling the two missing forces. Ensure you show the relative size of these two forces. (3)
- 6.2.2 Use your diagram in 6.2.1 to:
- Calculate the normal force acting on the 4 kg sled. (4)
 - Calculate the magnitude of the tension T in the string. (5)
- 6.2.3 Calculate the frictional force X acting on the 2 kg sled. (3)
- 6.2.4 Clearly describe one factor - unrelated to the mass of the sled - that affects the friction experienced by the 2 kg sled. (2)

- 6.3 At a time t_x Allan reaches forward and – without exerting any forces on the sleds – cuts the string between them. Luke continues exerting the same force until a time t_y .

They then repeat their entire investigation, but pulling the sleds on FRICTIONLESS ice.

They plot the following motions (1 – 4) on the grid below:

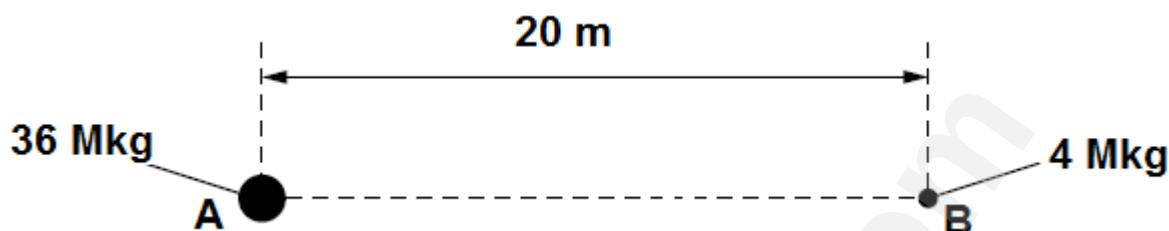
- 1 - Momentum of 2 kg sled from t_0 to t_y on the rough ice.
- 2 - Momentum of 4 kg sled from t_0 to t_y on the rough ice.
- 3 - Momentum of 2 kg sled from t_0 to t_y on the frictionless ice.
- 4 - Momentum of 4 kg sled from t_0 to t_y on the frictionless ice.



- 6.3.1 Which graph – A, B, C or D - corresponds with motion 2? Explain your choice. (4)
- 6.3.2 Which graph – A, B, C or D - corresponds with motion 3? Explain your choice. (4)

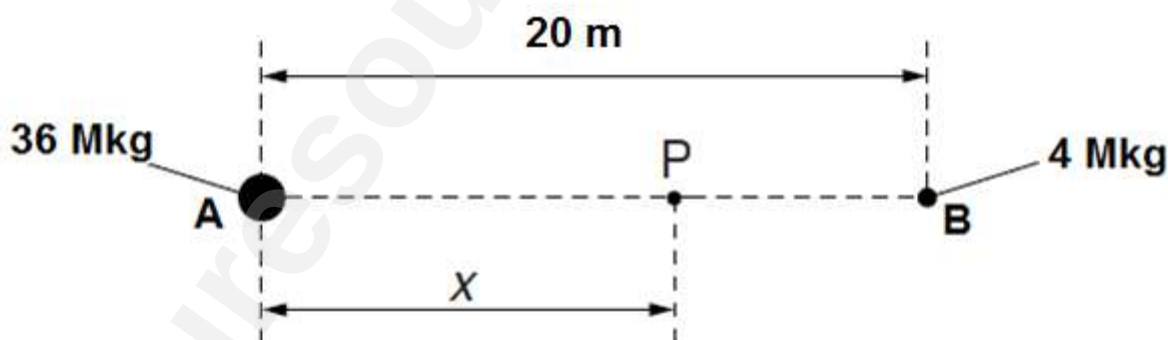
QUESTION 7 – START ON THE TOP OF A NEW PAGE 33 MARKS

- 7.1 Two masses A and B are at rest a distance 20 m apart in deep space, as illustrated below (diagram not to scale):



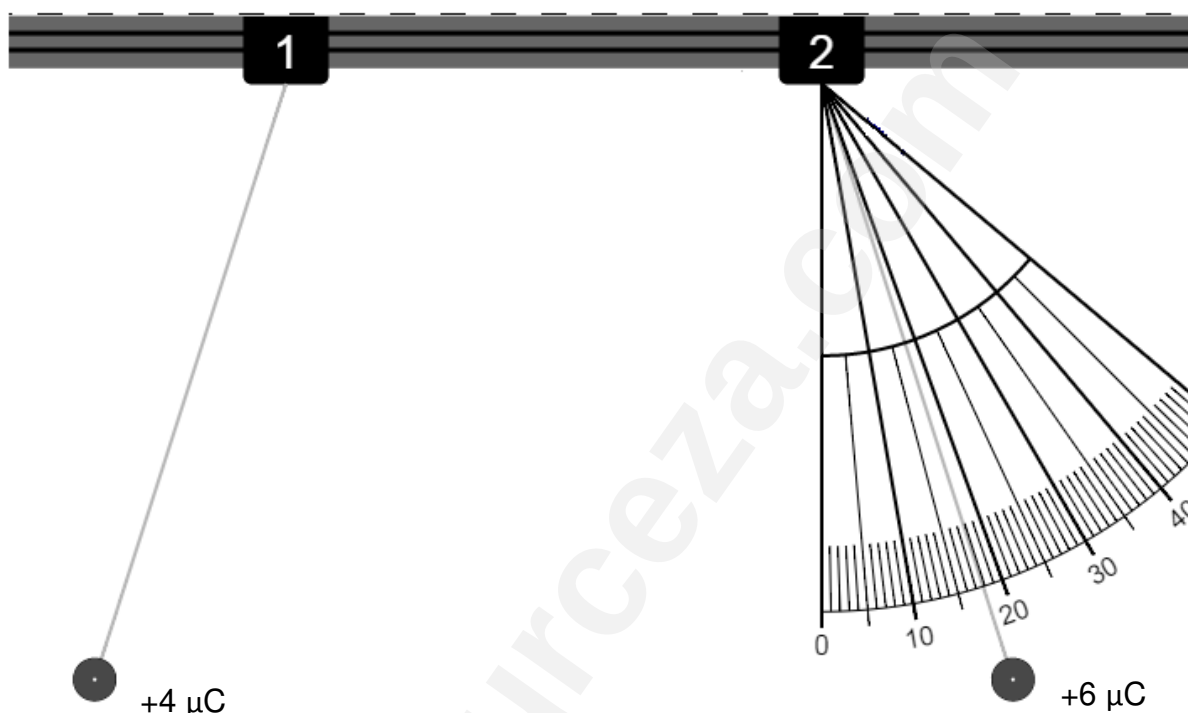
Please use left and right as directions where appropriate.

- 7.1.1 State Newton's law of universal gravitation. (3)
- 7.1.2 Calculate the gravitational force exerted by A on B. (5)
- 7.1.3 What is the gravitational force exerted by B on A? **State a Law** to justify your answer. (5)
- 7.1.4 An object P is placed a distance X from mass A, between A and B. P experiences no net force as there is no net gravitational field at distance X .



- a) Explain how it is possible that there can be no net gravitational field between A and B. (2)
- b) Calculate the distance X . Show all working. (4)

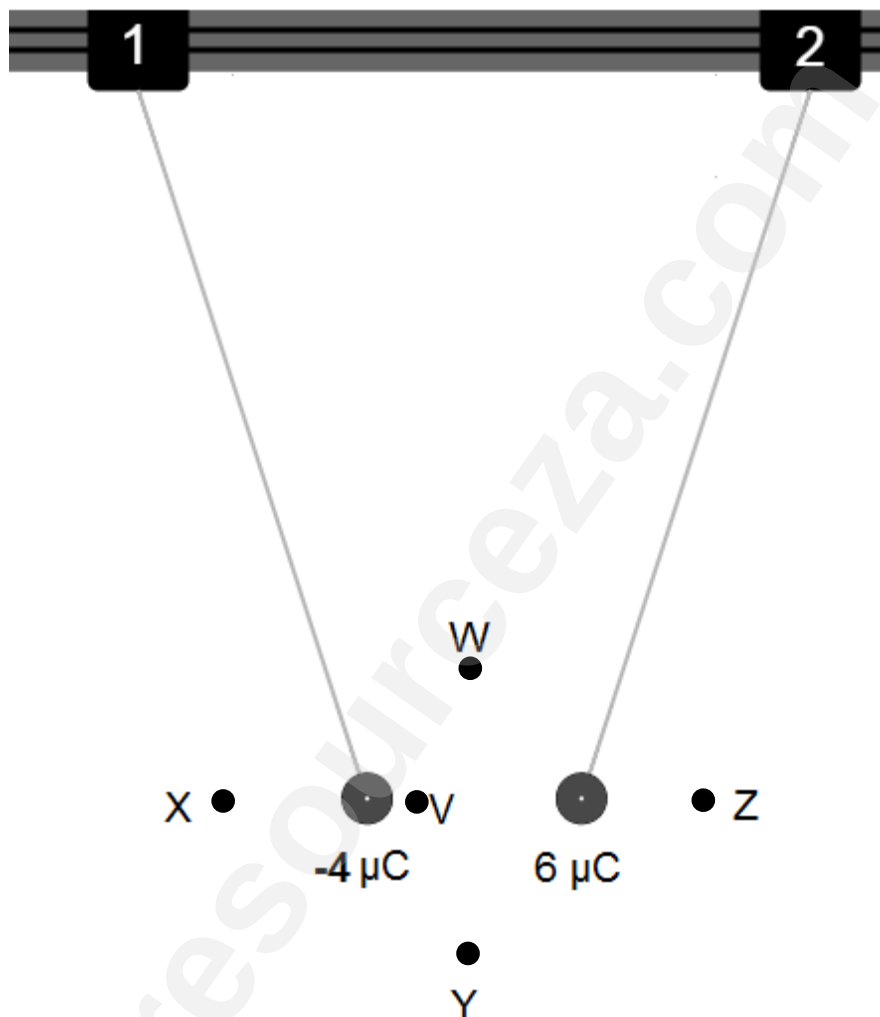
- 7.2 Jared and Matthew suspend charged conductive sphere 1 ($4\ \mu\text{C}$) and sphere 2 ($6\ \mu\text{C}$) using light threads from the ceiling. After a while the spheres attain equilibrium and remain still as shown in the picture. They use a protractor app to measure the angle to the vertical that sphere 2 is at. (The diagram is not to scale but the protractor reading is correct.)



<http://www.thephysicsaviary.com/Physics/Programs/Labs/CoulombsLawLab/index.html>

- 7.2.1 Draw a labelled vector diagram for sphere 2. (3)
- 7.2.2 The mass of sphere 2 is 10 g. Determine the magnitude of the electrostatic force exerted by sphere 1 on sphere 2. (3)

- 7.2.3 The charge of sphere 1 is now changed to $-4 \mu\text{C}$ and a new equilibrium is attained. Jared draws a sketch of the result and indicates **five** positions in the same vertical plane as the spheres – V, W, X, Y and Z.

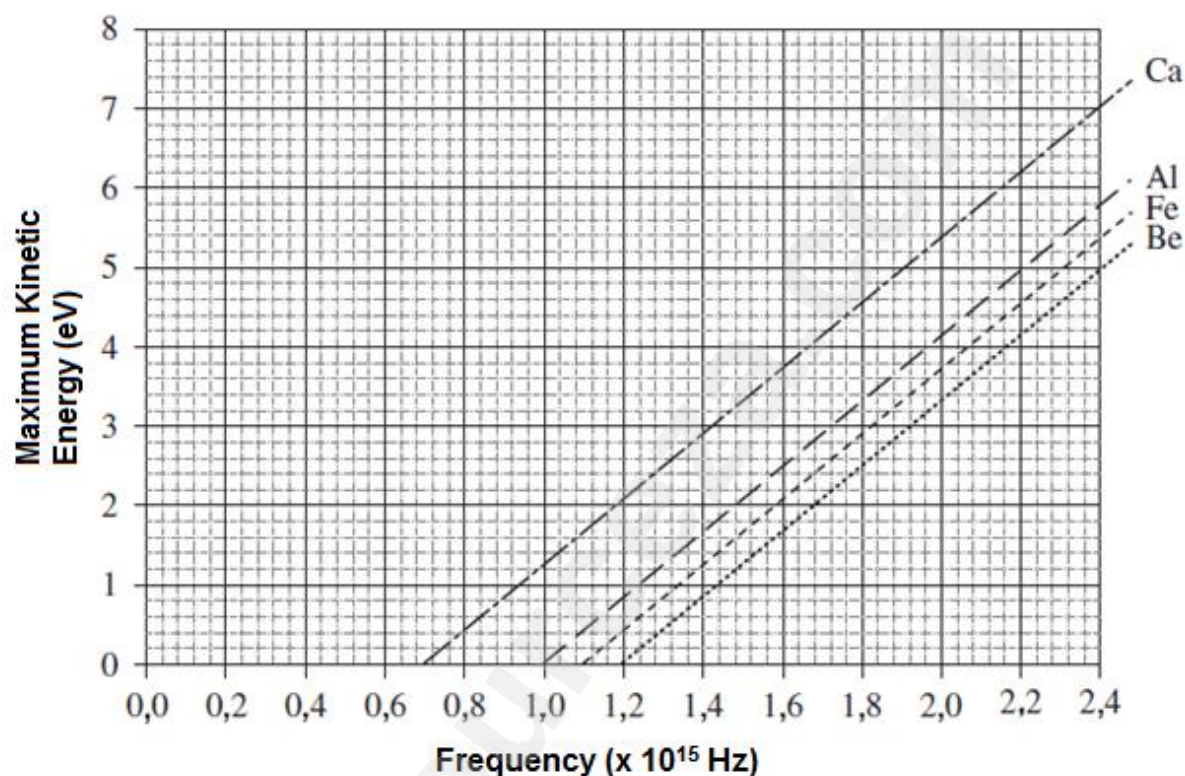


<http://www.thephysicsaviary.com/Physics/Programs/Labs/CoulombsLawLab/index.html>

- Draw the net electric field produced by sphere 1 and sphere 2. (4)
- Define the term “magnitude of electric field”. (2)
- State at which position - V, W, X, Y or Z - the magnitude of the electric field could be zero. (2)

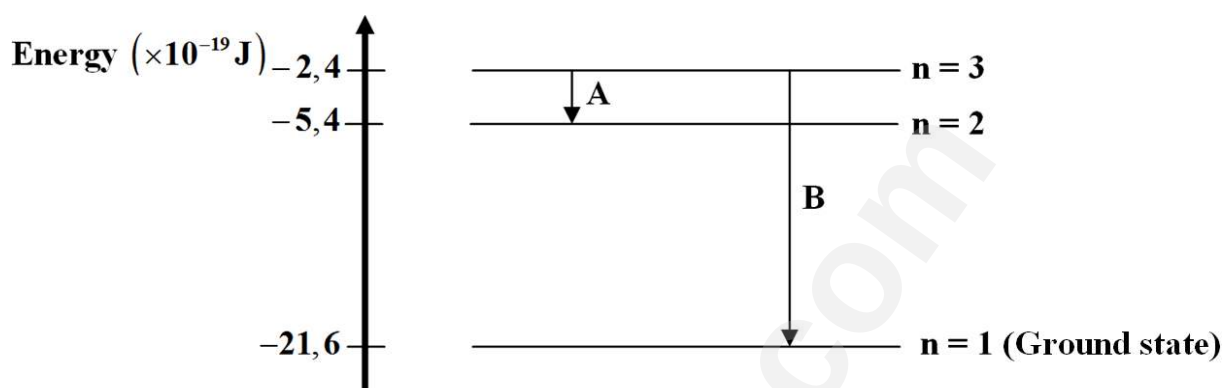
QUESTION 8 – START ON THE TOP OF A NEW PAGE 22 MARKS

- 8.1 When electromagnetic radiation shines on metals, photoelectrons may be emitted. The maximum kinetic energy of emitted photoelectrons is plotted against radiation frequency for four metals as shown in the graph.



- 8.1.1 Define work function. (2)
- 8.1.2 Calculate the work function of Iron (Fe). (3)
- 8.1.3 Electromagnetic radiation falls onto Beryllium and causes electrons to be released with a kinetic energy of 4,0 eV.
- Convert the kinetic energy of these photoelectrons into Joules. (2)
 - Calculate the maximum speed of these photoelectrons. (3)
- 8.1.4 Electromagnetic radiation of wavelength 187 nm shines upon an unknown metal and the maximum kinetic energy of the photoelectrons is found to be 2,5 eV.
- Determine which one of the four metals on the graph is the unknown metal. Show any calculations. (4)

- 8.2 The diagram shows some of the energy levels of an isolated hydrogen atom. The arrows, labelled A and B, represent transitions of electrons between the energy levels.



- 8.2.1 Calculate the frequency of the photon emitted when an excited electron falls from energy level $n = 3$ to $n = 2$. (4)
- 8.2.2 Compare the wavelength of the photon emitted in transition A to the wavelength of the photon emitted in transition B. Use the words **GREATER THAN OR LESS THAN OR EQUAL TO** in your comparison. (1)
- 8.2.3 **Explain** your answer to Question 8.2.2, making reference to one or more suitable formulae. No further calculations are required. (3)

END OF EXAMINATION ☺