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GRADE 12
Physical Science: Paper 1 (Physics)
July 2017

TIME: 3 Hours + 10 minutes reading time.

Examiner: K van Schoor

Marks: 200

Moderator: M Naidoo

READ THESE INSTRUCTIONS:

1. This paper consists of 17 pages (including the front page). Ensure that your paper is complete.
2. A data sheet and an answer sheet is provided.
3. Take note of mark allocation and read the question thoroughly.
4. You must show all working for calculations and give appropriate units for numerical answers
5. Start each question on a new page.
6. Where appropriate write all final numerical answers to a maximum of 2 decimal places.

Name:	Class:
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	Level 1	Level 2	Level 3	Level 4
TOTAL %				
TARGET %	15	35	40	10

Acknowledgements: www.tesd.net, ST STITHIANS COLLEGE 2016, CIE, Cluster group, Everything Science, <http://www.physicsclassroom.com>

Question 1: Make a clear cross over the letter of the correct answer on your answer sheet.

1.1. Identify the following quantities as a scalar or vector. (2)

	Mass of a moving car	Water velocity Hartebeespoort dam
A	vector	vector
B	vector	scalar
C	scalar	scalar
D	scalar	vector

1.2. Which of the following pairs of forces **could** produce a resultant force of 45 N?

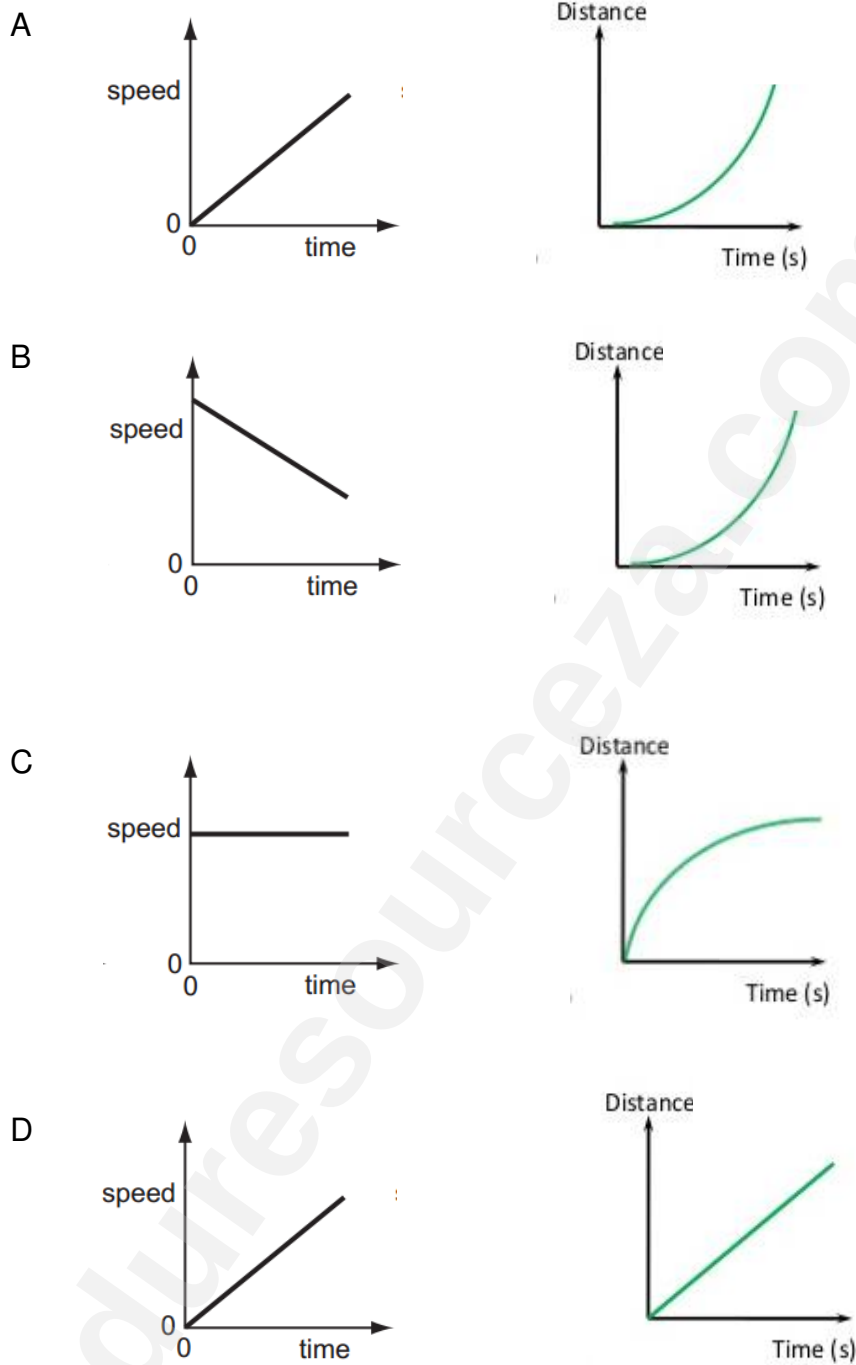
- A 45 N and 45 N
 - B 50 N and 100 N
 - C: 30 N and 30 N
 - D: 10 N and 25 N
- (2)

1.3. Two identical netball balls, A and B, are thrown with the same speed from the top of the pavilion. Ball A is thrown downward and B is thrown upwards.

Choose from the combinations below, the one that is **true** for the two balls just before they hit the ground. (2)

	Total distance	Total displacement	Average acceleration
A	$A < B$	$A < B$	$A > B$
B	$A = B$	$A < B$	$A = B$
C	$A = B$	$A = B$	$A > B$
D	$A < B$	$A = B$	$A = B$

1.4. Which of the following sets of graphs represent the same motion?



(2)

- 1.5. Trolley X, moving along a horizontal frictionless track, collides with a stationary trolley Y. The two trolleys become attached and move off together. Which statement about this interaction is correct?

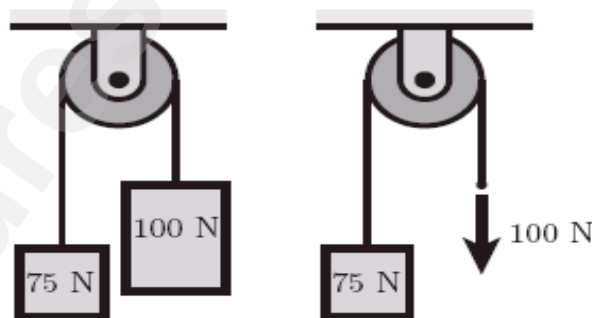
A Some of the kinetic energy of trolley X is changed into momentum during the collision.
 B Some of the momentum of trolley X is changed into kinetic energy during the collision
 C Trolley X shares its kinetic energy with trolley Y but loses some of its momentum as heat in the collision.
 D Trolley X shares its momentum with trolley Y but some of its kinetic energy is lost as heat during the collision.

- 1.6. Stuart's Phone is lying on his book. Which force would be the Newton III reaction force to the weight of his phone (2)

A The force of the book on the phone
 B The force of the phone on the Earth
 C The normal force
 D The force of the table on the phone.

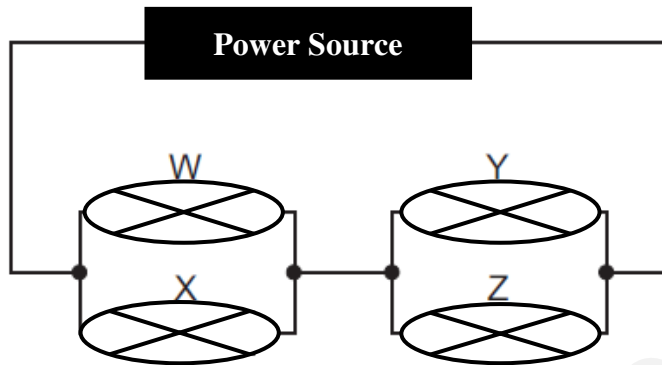
- 1.7. The pulley system on the left shows a block with a weight of 75 N connected by a light string and a pulley to a block of weight 100 N. The pulley system on the right is identical except that the block is replaced with a force of 100N downwards.

Initially the systems are at rest, but because of the imbalance of the forces, the 75 N blocks both accelerate upward and eventually hit the pulley. Which 75 N block hits the pulley first? (2)



A System on the left
 B System on the right
 C Both systems hit at the same time
 D We cannot determine which one will hit first

- 1.8. Four lightbulbs of equal resistance are connected as shown to a power source. (Internal resistance can be ignored)



How will the brightness of the resistors change when resistor W is removed?

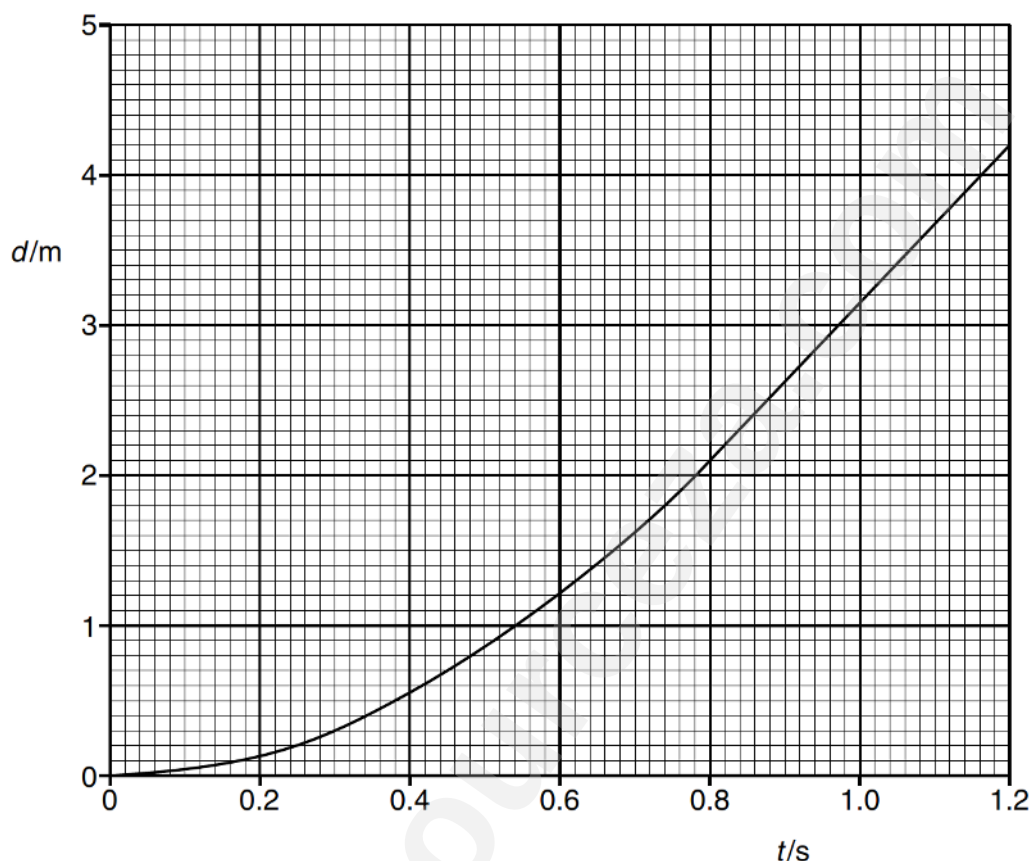
- A The brightness of X, Y and Z will increase.
 - B The brightness of X will decrease and the brightness of Y and Z will increase.
 - C The brightness of X will increase and the brightness of Y and Z will decrease.
 - D The brightness of X will increase and the brightness of Y and Z will remain unchanged from before the removal of W. (2)
- 1.9. A magnet as well as an iron block of the same size and mass are dropped down a copper tube. The magnet falls slower than the iron block. Choose the correct reason for the magnet falling slower from the options below.
- A The magnet is repelled by a permanent magnetic field.
 - B The iron block experiences less air resistance
 - C The magnet is repelled by an induced magnetic field
 - D The iron block is attracted by an induced magnetic field (2)
- 1.10. In a class investigation students make a transformer. They observe the current in the primary and secondary coils. When the current in the primary coil becomes constant, what would they observe on the ammeter connected to the secondary coil?

- A The reading becomes zero.
- B The reading reaches a maximum.
- C The reading reaches a constant average between the maximum and zero.
- D The reading keeps fluctuating. (2)

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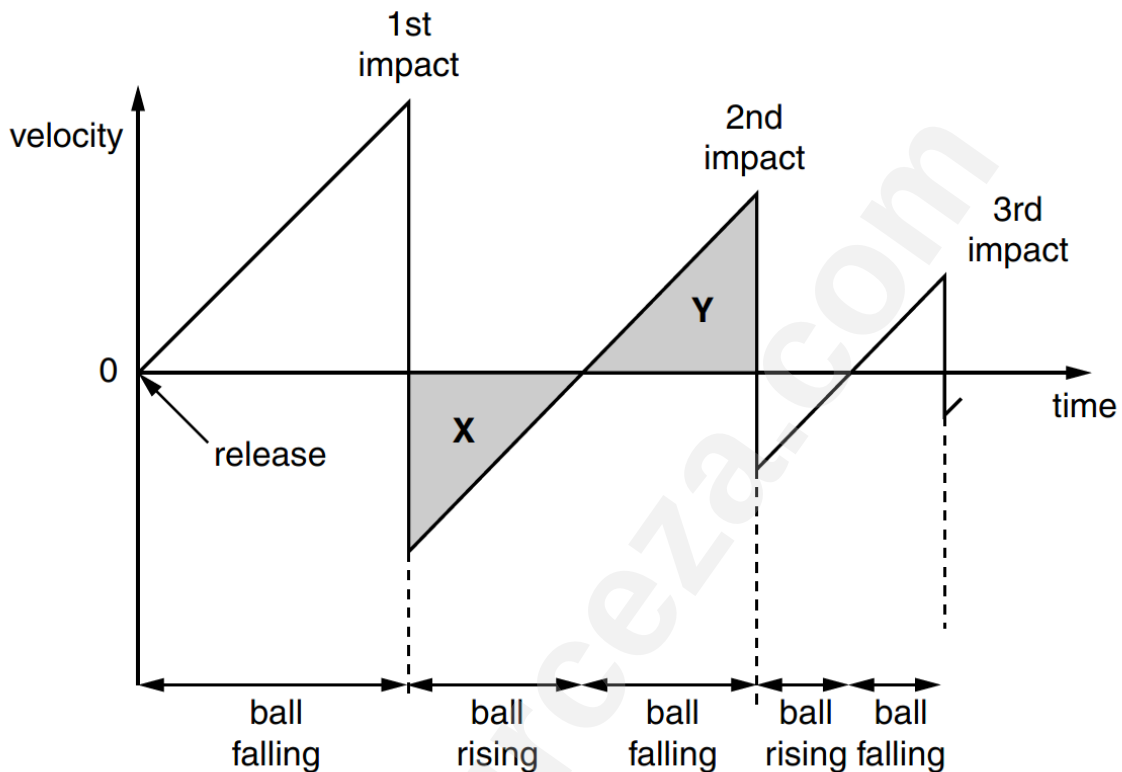
Question 2

A ball falls vertically in air from rest. The variation with time t of the distance d moved by the ball is shown in the figure below



- 2.1 Use the graph above to explain how it can be deduced that
- 2.1.1. the ball is initially at rest, (2)
 - 2.1.2. Air resistance is not negligible (2)
- 2.2 Use the graph to determine the speed of the ball at a time of 1,0 s after it has been released. (4)
- 2.3 On the copy of this graph on your answer sheet, sketch a graph to show the variation with time t of the distance d moved by the ball for negligible air resistance. You are not expected to carry out any further calculations. (2)

The ball reaches the ground and bounces a few times. The diagram below shows the variation of the velocity with time of the ball. For this part air resistance can be neglected.

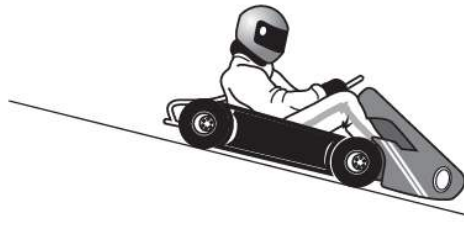


- 2.4 The ball hits the ground at a speed of $5,3 \text{ m.s}^{-1}$. Determine the time it will take the ball to reach the ground with no air resistance present. (3)
- 2.5 The ball (550 g) leaves the floor with a speed of $4,6 \text{ m.s}^{-1}$. Determine the impulse on the ball. (4)
- 2.6 The ball is in contact with the floor for 0,03 s. Calculate the net force of the ball on the floor. (4)

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Question 3

Emiel (78 kg) wants to steer the grade 8 science project cart (103 kg) with **no engine** down a sloping track as shown below.



3.1 Draw a labelled force diagram showing all the forces acting on the cart (with Emiel inside) while he is stationary on the slope. (3)

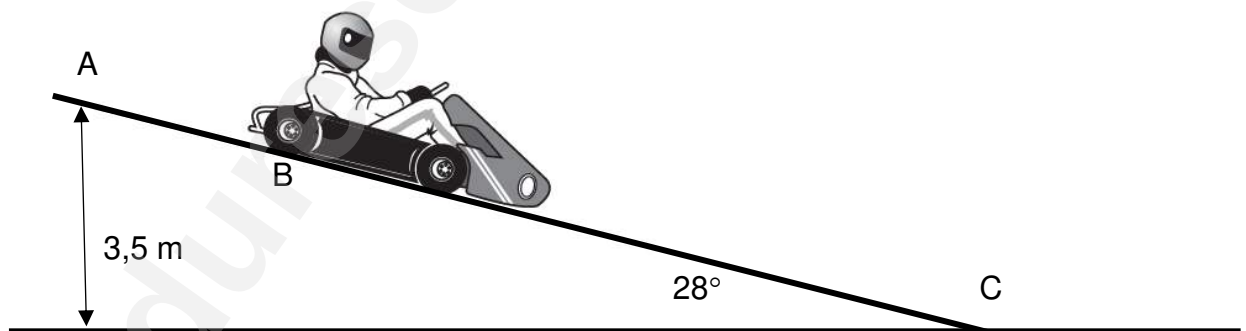
3.2 The slope makes an angle of 28° with the horizontal.

3.2.1 The coefficient of friction between the cart and the surface is 0,3. Calculate the magnitude of the maximum frictional force acting on Emiel and the cart. (3)

3.2.2 Determine by calculation if the cart will start to move down the hill without getting a push start from Jordan. (4)

The guys decide to take the cart to a height of 3,5 m up the slope to point A as shown. At that height Jordan gives the cart a push and it starts to move down the track.

The track becomes horizontal at the bottom of the slope.



3.3. Determine the potential energy of the cart and Emiel at this height of 3,5 m. (3)

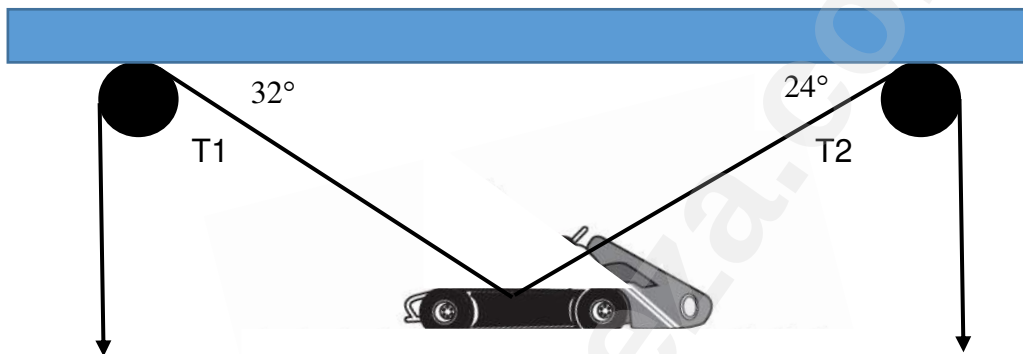
3.4 Define mechanical energy. (2)

3.5 When the cart passes point B it is at a height of 2,3 m and moving at a speed of $1,6 \text{ m.s}^{-1}$. Determine the speed of the cart when it reaches the bottom of the slope at point C. The work done against friction between B and C is 2400 J. (4)

3.6 State the work energy theorem. (2)

3.7 The cart comes to rest on the horizontal surface due to a frictional force of 368 N. Determine the distance that the cart still travels after passing point C. (4)

As expected the matrices are not satisfied with the speed of the cart and they decide to add in a battery powered motor. To do this they use the frictionless pulleys in the school workshop to lift the cart (103 kg) into the air for easy access as shown in the diagram.



3.8 Draw a labelled free body diagram showing the forces acting on the cart as it hangs suspended by the two cables. (3)

3.9 What is meant by forces in equilibrium? (2)

3.10 Determine the Tensions (T_1 and T_2) in both cables by using vector components. (6)

In the next ride down the hill the cart reaches the bottom of the hill at a velocity of 13 m.s^{-1} . In all the excitement Emiel does not see Julia heading directly towards him on the skateboard (combined mass of 68 kg). They have a head on collision and Julia lands on the cart moving with the cart in its original direction. They move off together at a velocity of $8,2 \text{ m.s}^{-1}$.

3.11 State the law of conservation of linear momentum. (2)

3.12 Determine the speed that Julia is moving at as she collides with the cart. (5)

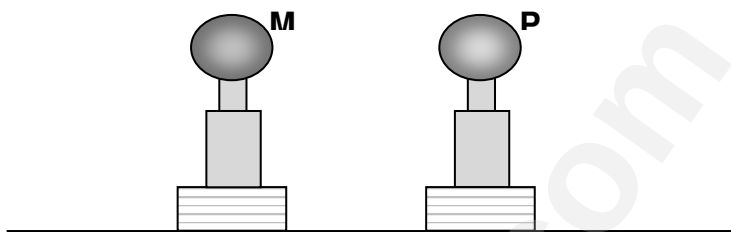
3.13 Use a calculation so show that this collision is not elastic. (6)

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Question 4

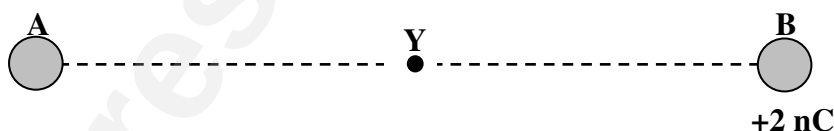
The figure shows two identical metal spheres M and P which are placed a certain distance apart and are supported on insulated stands. M is initially uncharged. P carries a positive charge of 8 nC.

P is moved to touch M and then it is moved back to its original position.



- 4.1 Calculate the charge on M after contact with P. (2)
- 4.2 Were electrons added to or removed from P as a result of the contact? (Write only ADDED or REMOVED.) (1)
- 4.3 Calculate the number of electrons added to or removed from P. (3)
- 4.4 Calculate the distance between M and P if the electrostatic force between M and P after contact and separation is found to be 0,32 N. (3)

Two charged particles are placed 200 mm apart at points A and B as shown. Y is a point midway between points A and B. The charge at point A is UNKNOWN while the charge at point B is +2 nC.



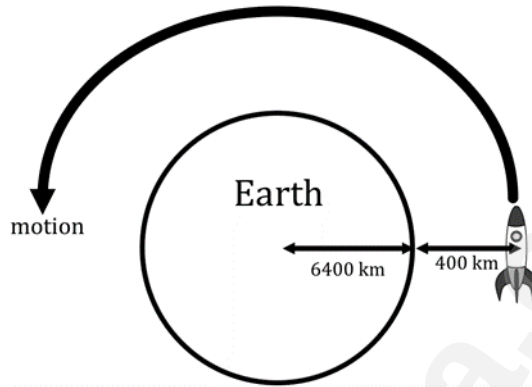
The resultant electric field strength at Y due to the presence of both charges is $5\,400\text{ N}\cdot\text{C}^{-1}$ towards the charge at point A.

- 4.5 Define the electric field strength at a point in space. (2)
- 4.6 Draw a labelled force diagram to show the two electric fields creating the resultant electric field of $5400\text{ N}\cdot\text{C}^{-1}$. (2)
- 4.7 Determine the magnitude of the charge at point A. (7)
- 4.8 Calculate the magnitude of the electrostatic force a charge of -3 nC would experience if it were placed at point Y. (3)

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Question 5

- 5.1 When in orbit at 400 km above the Earth's surface, a rocket reaches a final constant speed of $28\,500\text{ km}\cdot\text{h}^{-1}$ and its engines are switched off. The mass of the rocket that reaches space at this speed is $2\,500\text{ kg}$.



The Earth has a radius of $6\,400\text{ km}$ and a mass of $5,98 \times 10^{24}\text{ kg}$.

- 5.1.1 State Newton's law of gravitation. (2)
- 5.1.2 At 400 km above the Earth, the effect of gravity is reduced. Calculate the magnitude of the new force of gravitational attraction between the rocket and the Earth at this height. Express your answer in scientific notation. (4)
- 5.1.3 The rocket remains in orbit at 400 km above the Earth's surface for years. Someone says that this is because "There is no force of gravity in space." Give a reason why this statement is incorrect, and give a correct reason why the rocket stays in this orbit. (3)

The table below shows the value of g at various locations from Earth's centre.

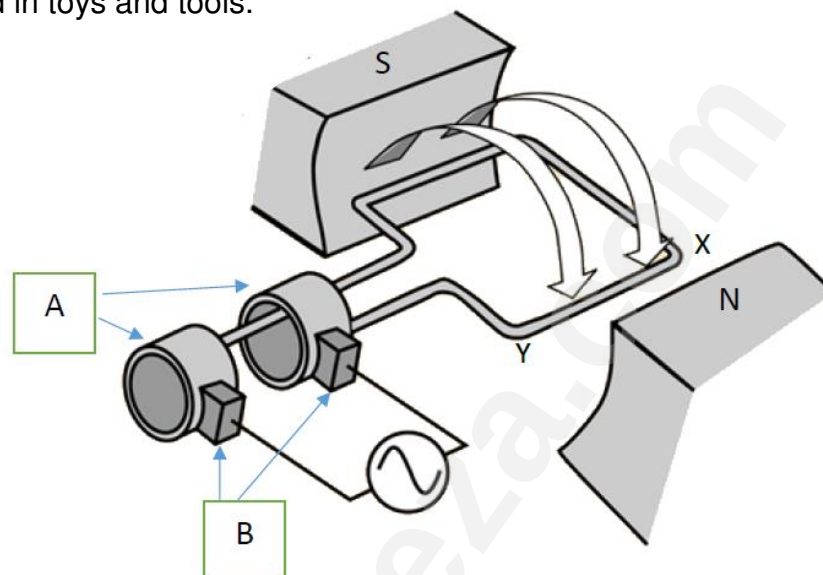
Value of g (m/s^2)	Distance from Earth's center ($\text{m} \times 10^7$)	$1/r^2$
9,80	0,63	2,52
7,33	0,73	A
5,68	0,83	1,45
4,53	0,93	B
3,70	1,04	0,93
3,08	1,14	0,77

- 5.2 In the copy of the table on your answer sheet, complete the table by filling in
- the unit for the column $1/r^2$
 - the values marked A and B. (3)
- 5.3 Use the values from the table to plot a graph of g vs $1/r^2$ on the graph paper provided on your answer sheet. Include a line of best fit. (7)
- 5.4 What relationship is shown by your graph? (2)
- 5.5 Determine the gradient of your graph. (3)
(Show how you obtained your answer from the graph)
- 5.6 Use your answer in 5.5 and an appropriate equation to determine G , the gravitational constant. You should also make reference to the straight line equation ($y = mx + c$). Show all working. (4)

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Question 6

6.1. Electric motors are used in many appliances that we use daily. For example AC motors are used in washing machines and DC motors are used in toys and tools.



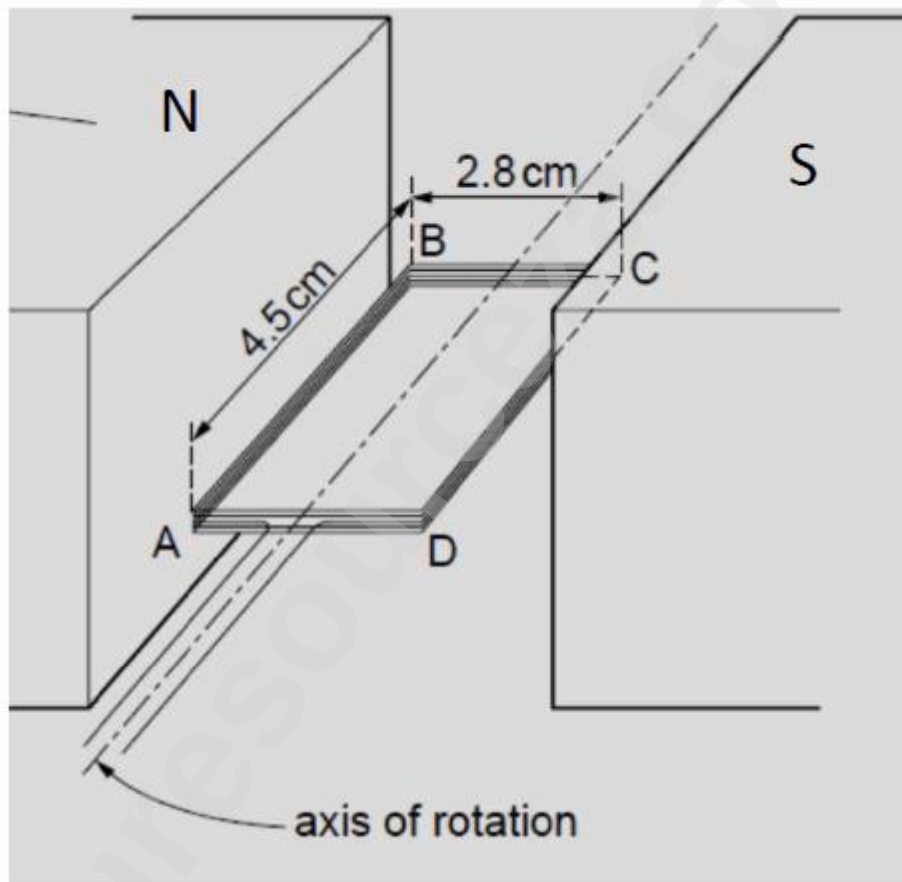
- 6.1.1. Examine the diagram above and state why we can refer to this set-up as a motor and not a generator. (1)
- 6.1.2. Name the energy conversion that takes place in an electric motor. (2)
- 6.1.3. This motor has AC as input and therefore does not require a split ring commutator.
 - i. Explain the function of the split ring commutator in a DC motor. (2)
 - ii. When the motor rotates as shown in the diagram, in which direction will the current flow in the coil. Answer by only stating Y to X or X to Y. (2)
 - iii. Name the components labelled A (1)
 - iv. Name the components labelled B (1)
 - v. Give a function of the component you labelled **A**. (1)
- 6.1.4. Will the coil experience a maximum or a minimum turning force if the coil is in the position as shown above? (2)

6.1.5. List 3 ways in which the output force of this motor can be improved. (3)

6.2. Another application of electromagnetism is generators.

The diagram below shows part of a simple generator.

A rectangular coil ABCD contains 140 turns of wire. The sides AB and BC of the coil has lengths 4,5 cm and 2,8 cm respectively as shown in the diagram.



6.2.1. The coil is rotated so that side AB moves upwards and CD downwards (clockwise rotation). In what direction will the current flow? (A to B or B to A)? (2)

6.2.2. The magnetic flux density between the poles of the magnets is 70 mT. Determine

i. the maximum magnetic flux for the coil. (3)

ii. the maximum magnetic flux linkage. (3)

6.3. State Faraday's law of electromagnetic induction. (2)

6.4. The coil rotates through 90° in a time of 0,125 s. Calculate the emf induced in the coil for this movement. (3)

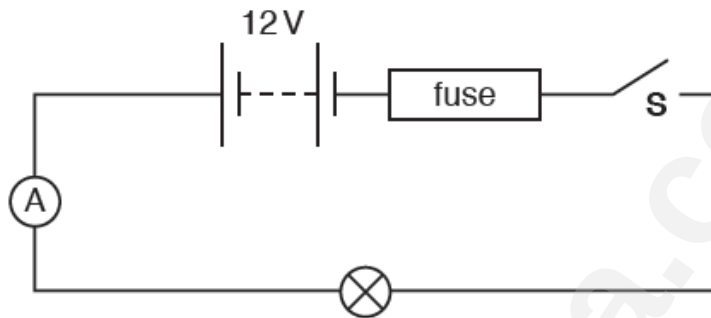
6.5. The coil is now rotated at half the original speed. Sketch a graph for the output emf vs time for 2 revolutions. Indicate the appropriate times as well as the maximum emf on your graph. (5)

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Question 7

Zoe sets up a circuit diagram as shown below. The emf of the battery is 12 V and the resistance of the lightbulb is $2,2 \Omega$.

Fuses are placed in a circuit to prevent the current from getting too high, by burning and stopping the flow of current.

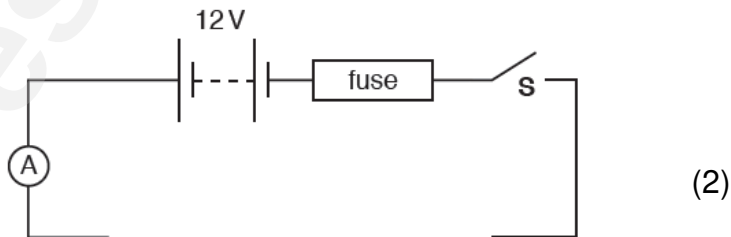


She closes the switch S and the reading on the ammeter shows 3,2 A. Internal resistance can be ignored.

7.1 Calculate the resistance of the fuse. (5)

7.2 Zoe decides to add an identical second lamp, in parallel with the original lamp.

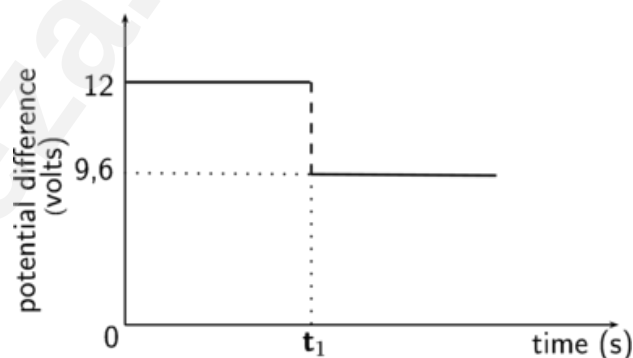
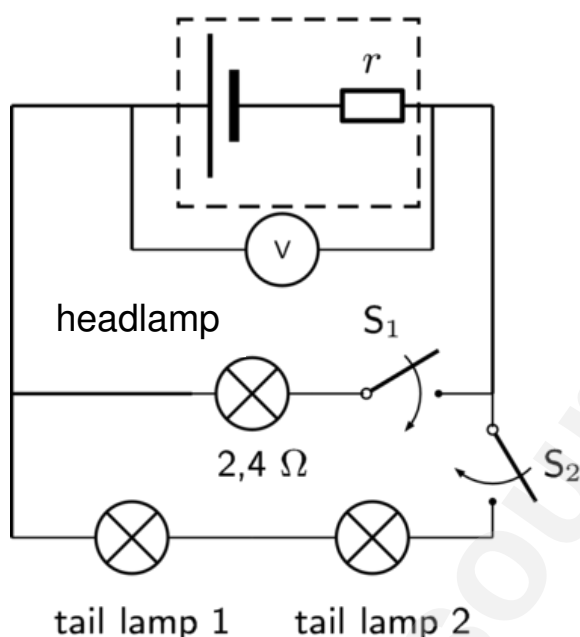
7.2.1 On your answer sheet there is a copy of the diagram below. Complete the figure on your answer sheet to show the two lamps connected in parallel in the circuit.



7.2.2 When the switch is now closed in this second circuit, the fuse burns off. Explain why the fuse blows. (3)

The headlamp and two IDENTICAL tail lamps of Matthew's motorbike are connected in parallel to a battery with unknown internal resistance as shown in the simplified circuit diagram below. The headlamp has a resistance of $2,4 \Omega$ and is controlled by switch S_1 . The tail lamps are controlled by switch S_2 . The resistance of the connecting wires may be ignored.

The graph alongside shows the potential difference across the terminals of the battery before and after switch S_1 is closed (whilst switch S_2 is open). Switch S_1 is closed at time t_1 .



7.3. Use the graph to determine the emf of the battery. (1)

7.4. WITH ONLY SWITCH S_1 CLOSED, calculate the following:

7.4.1 Current through the headlamp (3)

7.4.2 Internal resistance, r , of the battery (3)

7.4.3 BOTH SWITCHES S_1 AND S_2 ARE NOW CLOSED.
The battery delivers a current of 6 A during this period.
Calculate the resistance of each tail lamp. (5)

7.4.4 The headlamp burns out.

i How will the reading on the voltmeter be affected
(Both switches S_1 and S_2 are still closed.)
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

ii Give an explanation for the answer in i. (3)

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