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TOTAL MARKS

Sequence number

NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2026

PHYSICAL SCIENCES: PAPER I

EXAMINATION NUMBER

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Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 31 pages and a Data Sheet of 2 pages (i–ii). Please check that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your examination number in the space provided.**
4. Use the data and formulae whenever necessary.
5. Show your working in all calculations.
6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
7. Answers must be expressed in decimal format, not left as proper fractions. Where appropriate, express answers to TWO decimal places.
8. It is in your own interest to write legibly and to present your work neatly.
9. Two blank pages (pages 30 and 31) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the number of the question you are answering, should you use this additional space.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total
Mark											
Marker Initial											
Moderated Mark											
Moderator Initial											
Question Total	20	19	13	31	30	15	15	24	19	14	200
Re-mark											
Initial											
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QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice answer sheet below. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

A	☒ B	C	D
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Here, option B has been marked as an example.

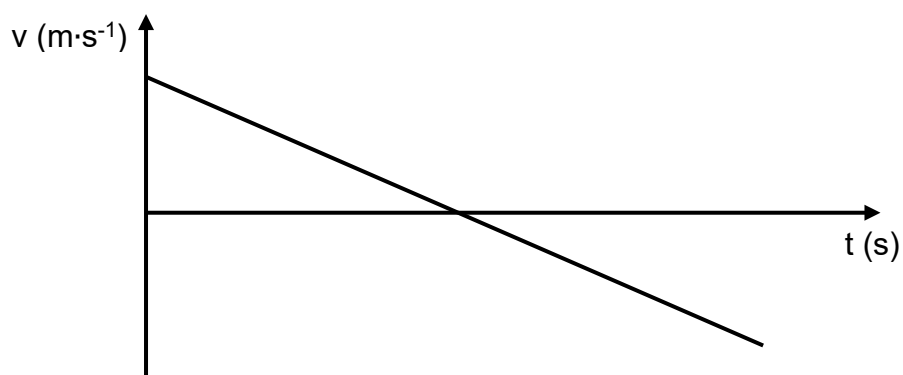
1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

YOU ARE ENCOURAGED TO USE THE SPACE BETWEEN THE MULTIPLE-CHOICE QUESTIONS TO SOLVE THESE QUESTIONS, BUT YOU MUST INDICATE YOUR CHOSEN ANSWER FOR EACH QUESTION IN THE GRID ABOVE.

1.1 The equation $s = ut + \frac{1}{2} at^2$ or $\Delta x = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$ shows the sum of two terms ($ut + \frac{1}{2} at^2$ or $v_i \Delta t + \frac{1}{2} a(\Delta t)^2$). Which option gives the correct unit for each of these terms?

	<i>Unit of ut or $v_i \Delta t$</i>	<i>Unit of $\frac{1}{2} at^2$ or $\frac{1}{2} a(\Delta t)^2$</i>
A	m·s ⁻¹	m·s ⁻¹
B	m	m·s ⁻¹
C	m·s ⁻¹	m
D	m	m

1.2 The velocity-time graph below represents the vertical motion of an object.



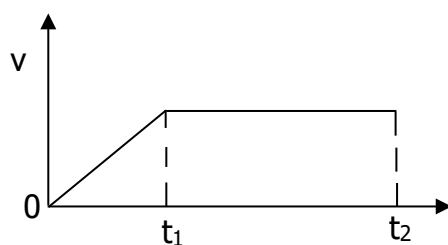
Choose the option that shows the direction of the acceleration of the object as it moves upwards and then downwards.

	Direction of acceleration as the object moves upwards	Direction of acceleration as the object moves downwards
A	Downwards	Upwards
B	Downwards	Downwards
C	Upwards	Downwards
D	Upwards	Upwards

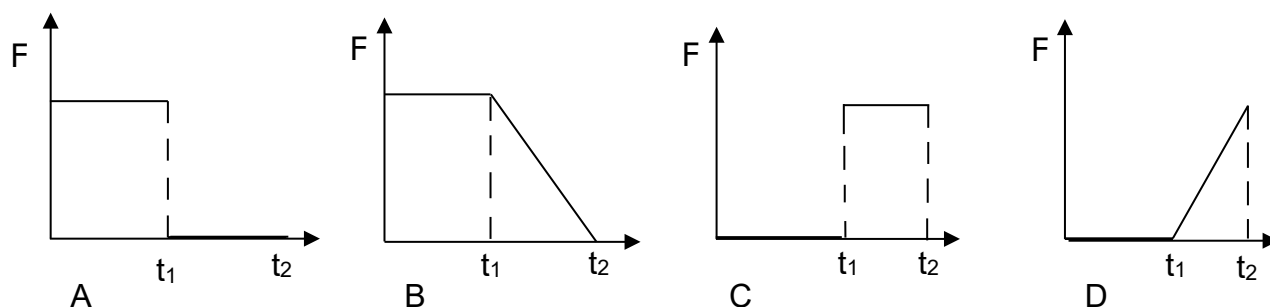
1.3 An object is moving along a horizontal surface at a constant velocity. The net force on the object is equal to ...

- A the normal force.
- B the frictional force.
- C zero.
- D the change in momentum.

1.4 Consider the accompanying velocity-time graph of an object moving in a straight line.



The corresponding graph representing the net force (F) acting on the object versus time (t) is ...

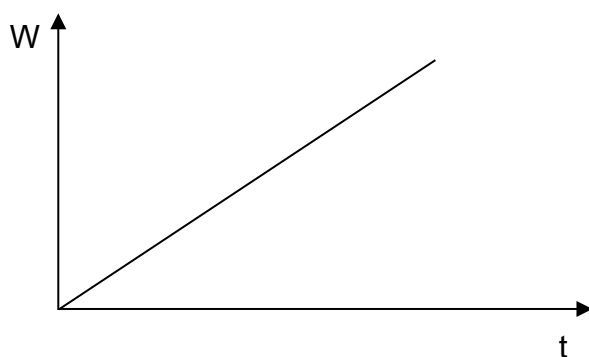


1.5 A heavy ball is suspended from the ceiling in a classroom on Earth. When a horizontal force is applied to it, it accelerates sideways at $0,1 \text{ m}\cdot\text{s}^{-2}$. The ball can also be lifted.

The same ball is taken to the Moon, where the acceleration due to gravity is significantly less than on Earth. The ball is again suspended from the 'ceiling' of a stationary spacecraft and lifted.

	Force required to accelerate the ball sideways at $0,1 \text{ m}\cdot\text{s}^{-2}$ on the Moon	Force required to lift the ball at a constant velocity on the Moon
A	Same as on Earth	Same as on Earth
B	Same as on Earth	Less than on Earth
C	Less than on Earth	Same as on Earth
D	Less than on Earth	Less than on Earth

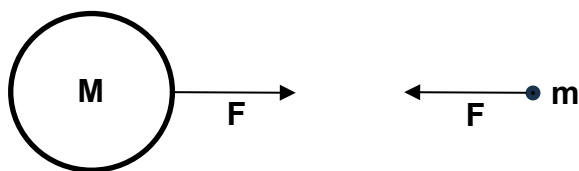
1.6 The graph below shows the work done, W , on an object over time, t .



The gradient of the graph gives ...

- A power.
- B change in momentum.
- C change in kinetic energy.
- D change in gravitational potential energy.

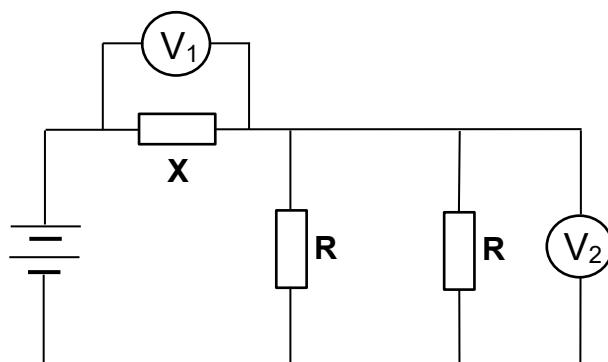
1.7 An object with mass m is near a planet with mass M . Each mass experiences a force F .



Mass m is in the gravitational field due to the planet with mass M . The magnitude of the gravitational field of planet M experienced by mass m is ...

- A FmM
- B $\frac{F}{mM}$
- C $\frac{F}{m}$
- D $\frac{F}{M}$

- 1.8 The circuit below shows three resistors with resistances **X**, **R**, and **R**. Voltmeters V_1 and V_2 have the same reading.

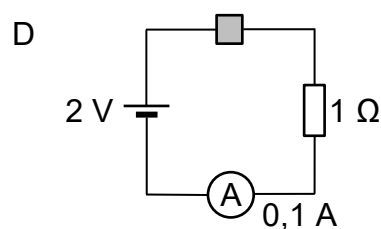
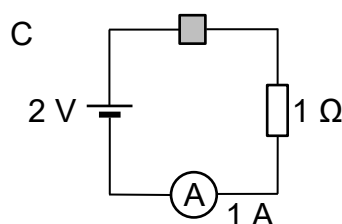
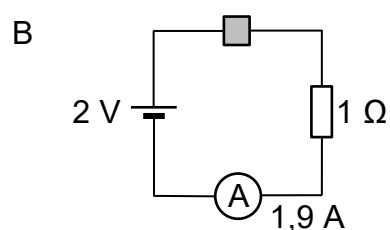
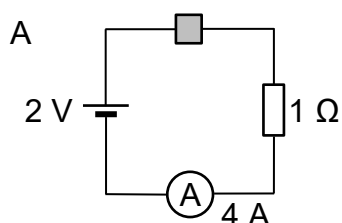


The value of **X**, in terms of **R**, is:

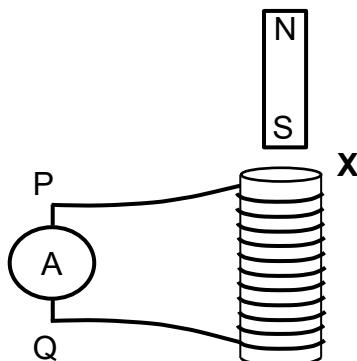
- A $2R$ B $\frac{3R}{2}$ C R D $\frac{R}{2}$

- 1.9 The circuits below contain a 2 V cell, a $1\ \Omega$ resistor, and an ammeter, as well as an additional component, shown in the circuit diagram as a grey square. In three of the circuits, this additional component is a resistor, but in one of the circuits, this additional component is a cell. The current in the circuit is shown alongside the ammeter in each circuit.

Identify the circuit which must contain an additional cell.



- 1.10 A bar magnet is dropped through a solenoid that is positioned vertically, as shown in the diagram below.



As the magnet is dropped into the coil from the position shown, choose the magnetic pole that will be induced at the top of the solenoid (point X) and the current direction through the ammeter.

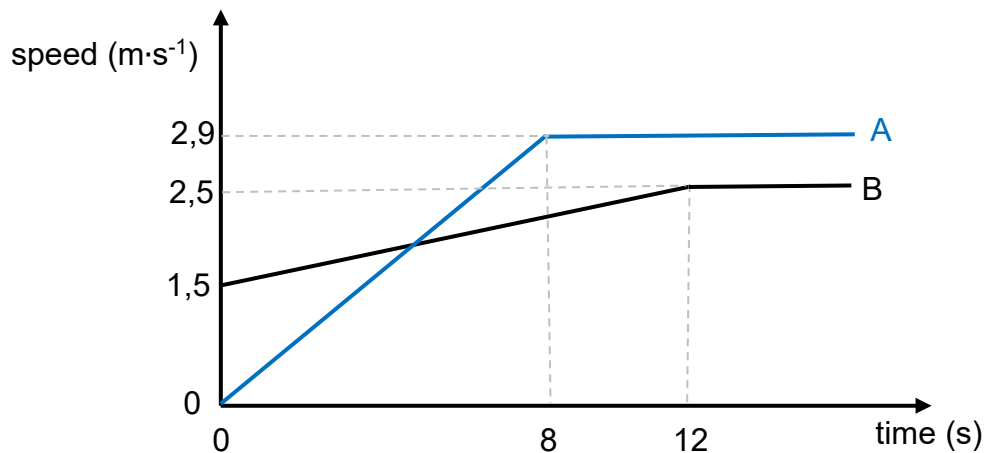
	Magnetic pole induced at the top of the solenoid (point X)	Direction of current through the ammeter
A	North	P to Q
B	South	P to Q
C	North	Q to P
D	South	Q to P

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QUESTION 2 KINEMATICS

The graph below shows the speed of two athletes (A and B) plotted against time, as they train. The graph is not drawn to scale.

The athletes run around a circular track that is 400 m in circumference.



Runner B runs past the start line as Runner A begins his training, starting from rest at the start line.

2.1 Define *speed*. (2)

2.2 How far will Runner B have run past the start line after 12 seconds? (3)

2.3 Determine the average speed of Runner B over the first 12 seconds. (2)

- 2.4 Which runner is ahead after 12 seconds? Support your answer with a calculation. (4)
- 2.5 At what time (after $t = 0$ s on the graph) will the runners be alongside one another again, if they continue running at their constant velocities beyond 12 seconds? (4)
- 2.6 If these athletes maintain their speeds around the circular 400 m track, how far apart would the runners be when they return to the start line? (4)

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QUESTION 3 GRAPH SKILL

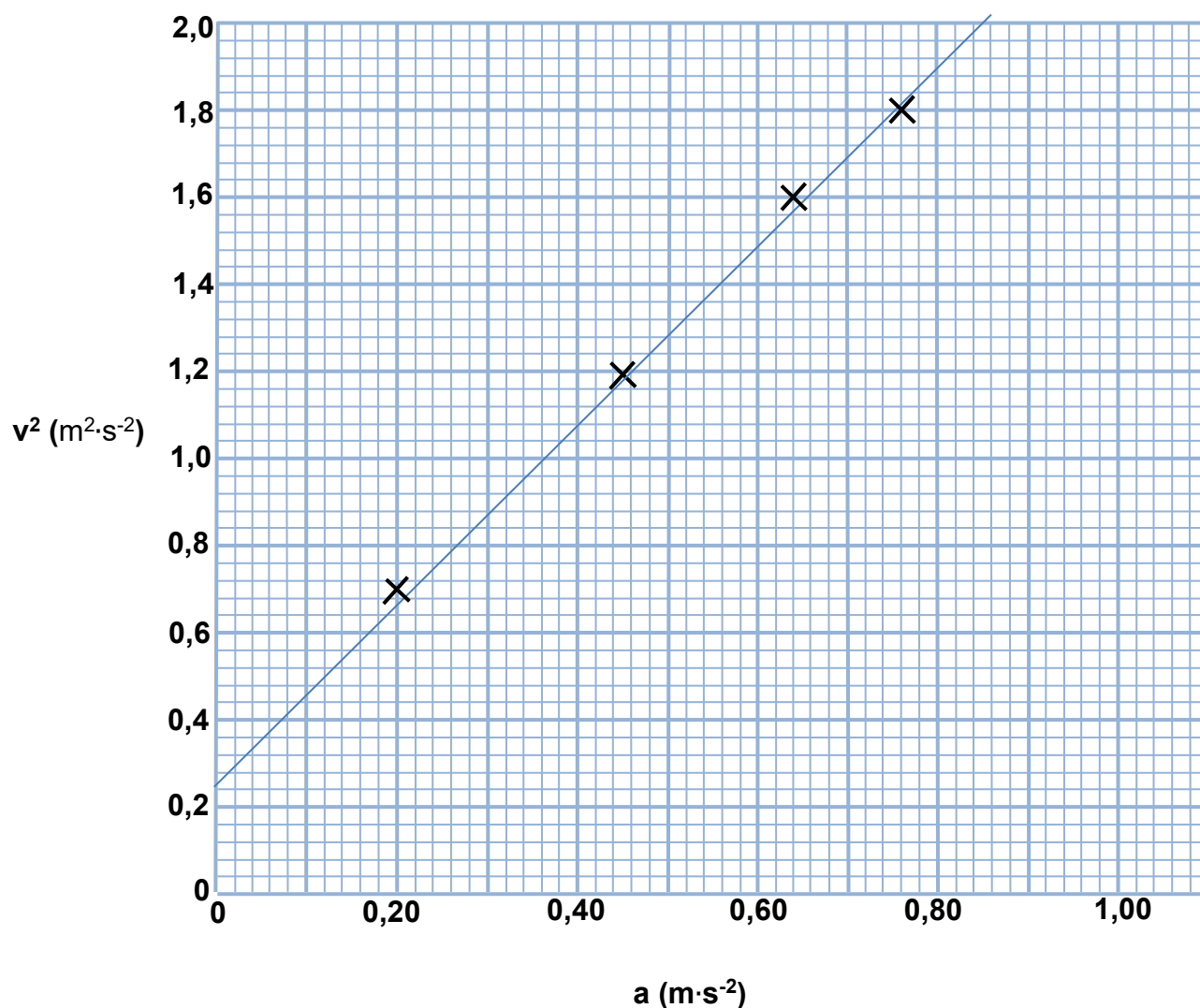
During an investigation, a trolley is accelerated along a frictionless surface by an applied force. The final velocity reached by the trolley is measured after the force has been applied for a certain distance. The experiment is repeated and the applied force is varied, producing a different acceleration, a , of the trolley, resulting in a different final velocity, v , for each experiment.

The results of the investigation are given below.

$a \text{ (m}\cdot\text{s}^{-2}\text{)}$	$v \text{ (m}\cdot\text{s}^{-1}\text{)}$	$v^2 \text{ (m}^2\cdot\text{s}^{-2}\text{)}$
0,20	0,83	0,70
0,45	1,09	1,19
0,52	1,14	1,30
0,76	1,34	1,80
0,88	1,41	2,0

The final velocity squared (v^2) of the trolley is plotted against the acceleration (a) of the trolley on a partially completed graph on the next page.

- 3.1 Plot the point for the set of values from the table that has not been shown on the graph on the next page. (1)
- 3.2 Calculate the gradient of the graph. Show your working and the points that you used on your graph. (4)
- 3.3 Hence, determine the distance over which the force was applied to the trolley. (4)

Final velocity squared vs acceleration of the trolley

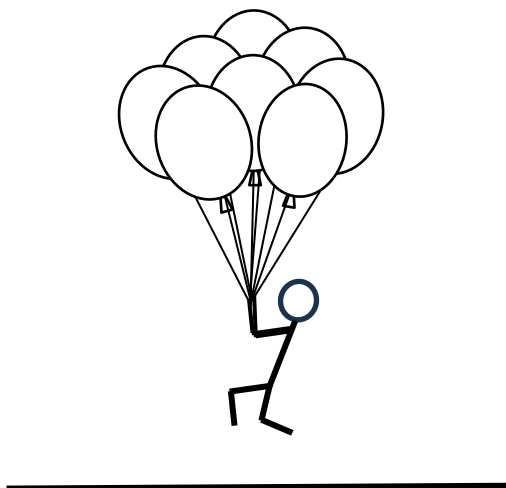
3.4 If the investigation was repeated on a rough surface, how would the graph differ? (2)

3.5 The investigation is repeated on the original frictionless surface, but the trolley begins each experiment with half the original initial velocity. On the graph provided above, draw a line showing the relationship between v^2 and a when the initial velocity is halved. (2)

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QUESTION 4 LIFT OFF!

A child (mass 25 kg) is lifted off the ground by a bunch of balloons.

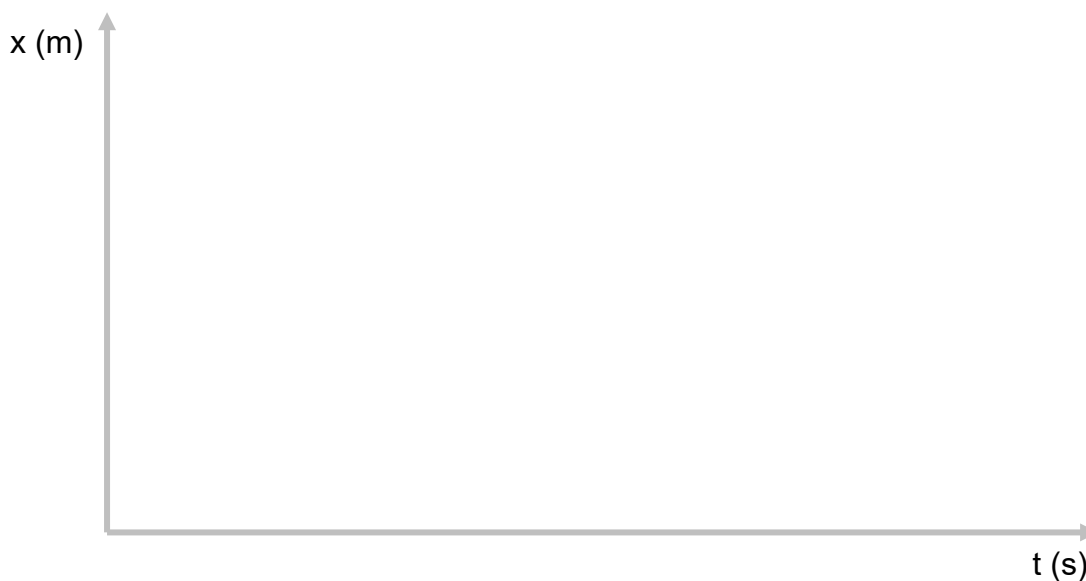


When the child's feet are at a height of 0,6 m above the ground, she lets go of the balloons. At this moment, the child is moving upwards at $1,8 \text{ m}\cdot\text{s}^{-1}$.

- 4.1 Determine the maximum height above the ground that the child reaches. (4)
- 4.2 Calculate the time that the child is in the air from when she lets go of the balloons until she lands on the ground. (3)
- 4.3 Calculate the magnitude of the acceleration of the child as she is lifted by the balloons to a height of 0,6 m. (3)

4.4 How long was the child off the ground (in the air)? (4)

4.5 On the axes below, sketch a graph showing the position of the child from the moment she leaves the ground to when she lands on the ground again. Use the ground as the reference position and include all known time and position values. (5)



4.6 Draw an acceleration-time graph for the child, from the moment her feet left the ground until she lands on the ground again. Show all relevant time and acceleration values. (4)



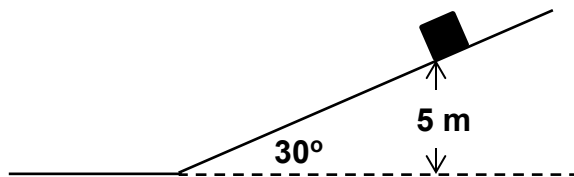
- 4.7 State *Newton's second law*. (2)
- 4.8 Determine the upward force that the balloons exert on the child when her feet have left the ground. (4)
- 4.9 Not all the strings are vertical; many are at an angle to the vertical. Each balloon experiences the same upward force. As the angle of the string to the vertical increases, will the upward force that the balloon exerts on the child INCREASE, STAY THE SAME or DECREASE? Give a reason for your answer. (2)

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QUESTION 5 APPLICATION OF NEWTON'S LAWS

A block with a mass of 1,5 kg is held at rest on a rough slope inclined at an angle of 30° to the ground. The block is 5 m above the ground, as shown in the diagram below. The block is released, slides down the slope and reaches a velocity of $3,6 \text{ m}\cdot\text{s}^{-1}$ at the bottom of the slope.



- 5.1 Define *gravitational potential energy*. (2)
- 5.2 Calculate the block's gravitational potential energy when it is held stationary on the slope. (3)
- 5.3 Draw a labelled free-body diagram of the forces acting on the block as it slides down the slope. (3)
- 5.4 Calculate the work done by the frictional force as the block slides down the slope. (3)

5.5 Determine the magnitude of the frictional force acting on the block as it slides down the slope. (4)

5.6 Determine the acceleration of the block as it slides down the slope. (5)

The coefficient of friction between the block and the surface remains the same for the slope and the flat area below the slope.

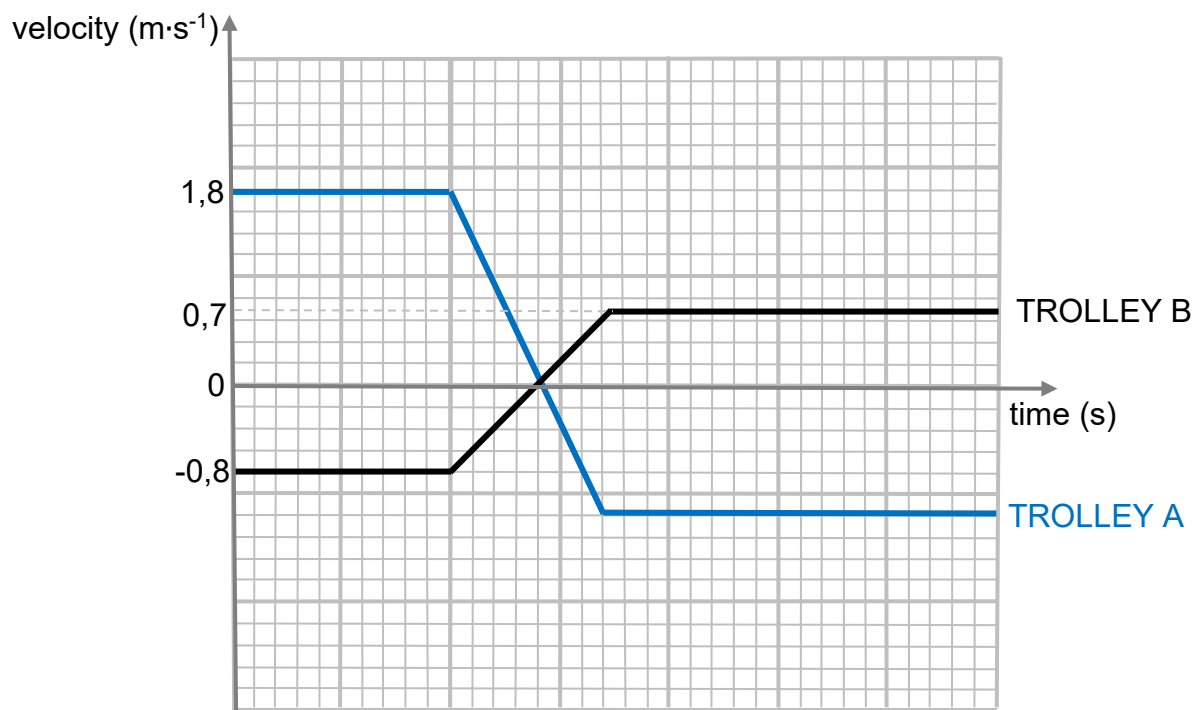
5.7 Determine the magnitude of the frictional force experienced by the block on the flat surface. (4)

5.8 State *the work-energy theorem*. (2)

5.9 Calculate the distance travelled by the block from the bottom of the slope before it comes to rest. (4)

QUESTION 6 MOMENTUM, IMPULSE

Trolley A of mass m , initially moving East, collides with trolley B. Trolley B has twice the mass of trolley A. The velocities of the trolleys before and after the collision are shown on the graph below.



6.1 Calculate the change in momentum of trolley A in terms of mass m . (4)

6.2 Define *impulse*. (2)

6.3 Which of the trolleys will experience a greater force during the collision? Justify your answer. (2)

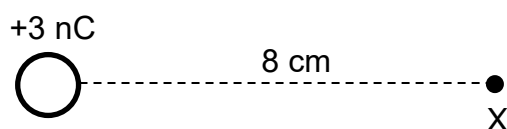
6.4 State *the law of conservation of linear momentum*. (2)

6.5 Use the information provided on the graph and in the question to determine whether the system of trolleys was isolated when the trolleys collided. (5)

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QUESTION 7 FIELDS

A small object with a charge of $+3 \text{ nC}$ is placed 8 cm from point X in empty space.



- 7.1 On the diagram provided below, draw the electric field around a positively charged object. (2)



- 7.2 Define *electric field at a point*. (2)

- 7.3 Calculate the magnitude of the electric field at point X due to the $+3 \text{ nC}$ charge. (3)

A small object carrying a charge of $+5 \text{ nC}$ is placed at point X.

- 7.4 Determine the magnitude and direction of the electrostatic force that the 5 nC charge would experience. (4)

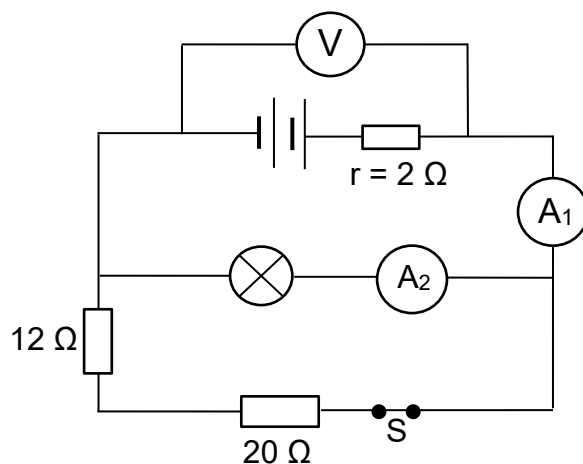
- 7.5 At what distance from the $+3 \text{ nC}$ charge would the net electric field due to both charges be zero? (4)

[15]

QUESTION 8 ELECTRIC CIRCUITS

In the circuit below, a battery of unknown emf with an internal resistance of $2\ \Omega$ is connected to a bulb and two resistors.

Switch S is initially closed, and the voltmeter reads $18\ \text{V}$. The energy dissipated in the bulb in 2 minutes is $3\ 024\ \text{J}$.



8.1 Define *current*. (2)

8.2 Determine the reading on ammeter A_2 . (4)

8.3 Calculate the resistance of the bulb. (3)

8.4 Calculate the current through the $12\ \Omega$ resistor. (3)

8.5 Determine the power rating of the $20\ \Omega$ resistor. (3)

The switch is opened.

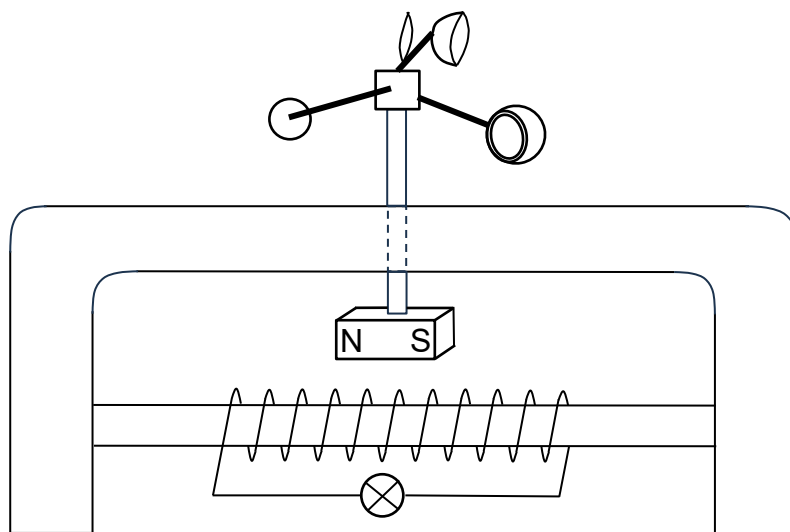
8.6 In the table below, choose the appropriate phrase to describe the effect of opening the switch and give brief reasoning in point form.

	When the switch is opened, what will happen to the ...	INCREASE / DECREASE / STAY THE SAME	Explain your choice in point form	
8.6.1	reading on the ammeter A_1 ?		• •	(3)
8.6.2	reading on the voltmeter V?		• •	(3)
8.6.3	brightness of the bulb?		• •	(3)

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QUESTION 9 ELECTRODYNAMICS

- 9.1 The diagram below shows a simple model of a wind generator. The spindle (with cups) spins in the wind, turning a magnet (with a small mass) next to the solenoid. The solenoid is connected to a light bulb that requires only a small current to light up.



- 9.1.1 What energy change occurs in a generator? (2)

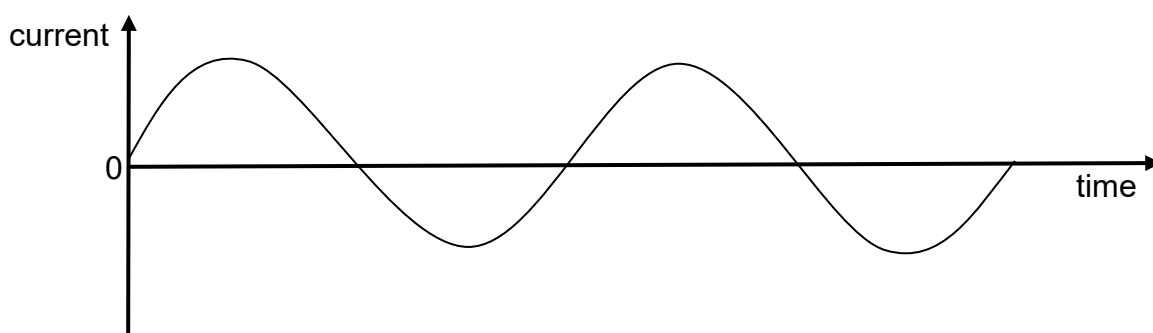
- 9.1.2 Describe how the wind generates an electric current in this generator. (4)

-
-
-
-

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

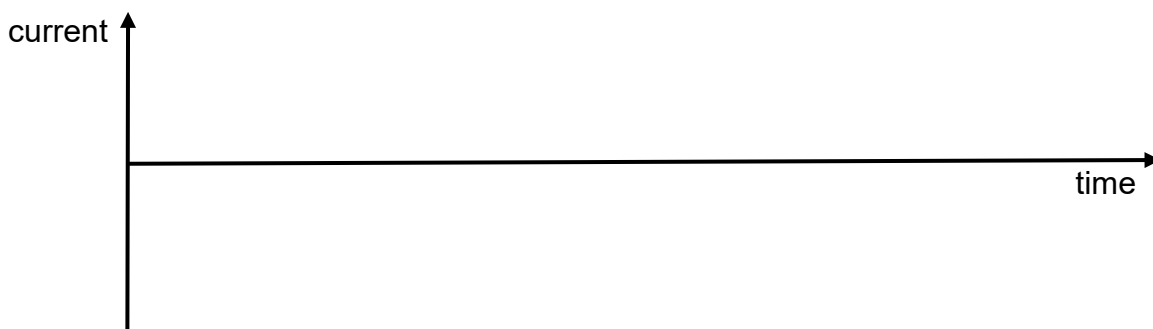
9.1.4 Explain, with reference to Faraday's law, how the wind speed influences the brightness of the light bulb. (3)

The current through the bulb is plotted on the graph below:



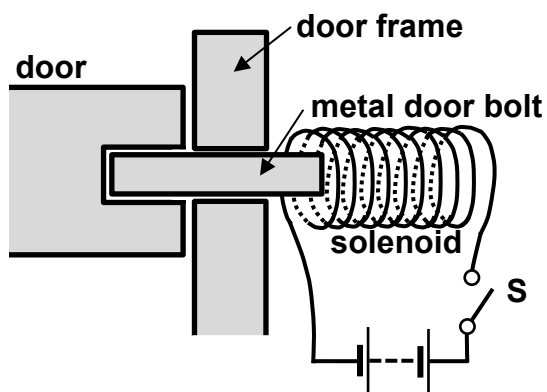
9.1.5 What can be used to fully rectify this current? (1)

9.1.6 On the axes below, sketch the fully rectified current output. (1)

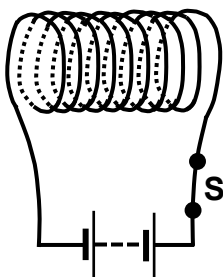


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- 9.2 A simplified sketch of an electric door lock is shown below. The metal door bolt can slide horizontally through the door frame and a power supply is connected to the solenoid. When switch S is closed, the metal door bolt moves to allow the door to open.



- 9.2.1 Draw the magnetic field around the solenoid when switch S is closed. Include at least three field lines and indicate the north and south poles of the solenoid. (3)



- 9.2.2 Explain why the metal door bolt moves when switch S is closed. (3)

[19]

QUESTION 10 PHOTONS AND ELECTRONS

When UV light is shone on calcium, electrons are emitted from the metal surface. The emitted electrons travel at a maximum speed of $5,72 \times 10^5 \text{ m}\cdot\text{s}^{-1}$.

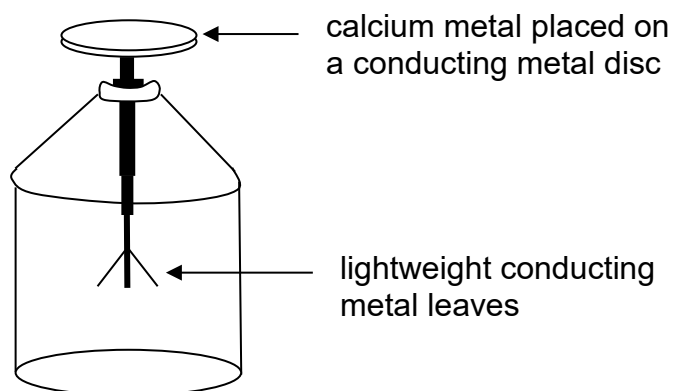
The work function of calcium is 2,9 eV.

10.1 Define *work function*. (2)

10.2 Calculate the maximum kinetic energy of the emitted electrons. (3)

10.3 Determine the maximum wavelength of light required to emit electrons from the calcium metal surface. (4)

The same UV light is shone on calcium metal placed on the metal disc of an electroscope. The leaves of the electroscope lift up.



10.4 Explain why the leaves of the electroscope lift up. (2)

10.5 The intensity of the UV light is increased. Describe and explain any change to the electroscope that you might observe, giving a reason for your answer. (3)

[14]

Total: 200 marks

ADDITIONAL SPACE (ALL QUESTIONS)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.

ADDITIONAL SPACE (ALL QUESTIONS)

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE
ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.**