Western Cape Government
Education
FOR YOU

WEST COAST EDUCATION DISTRICT

PHYSICAL SCIENCES PAPER 1
GRADE 12

COMMON EXAMINATION
SEPTEMBER 2026

MARKS: 150

TIME: 3 hours

This paper consists of 17 pages.

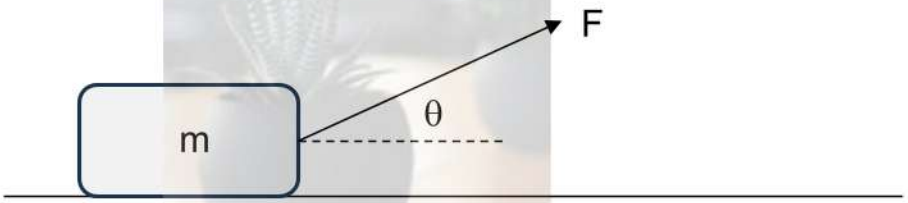
EXAM INSTRUCTIONS:

1. Write your **NAME** on your answer sheet.
2. Answer all questions on your **ANSWER SHEET**.
3. **NEATNESS** and **ACCURACY** will count in your favour.
4. **START EACH QUESTION ON A NEW PAGE**.
5. **FORMULA SHEETS** are attached to the back of the paper.
6. **NUMBER** the answers correctly according to the numbering system in this paper.
7. Leave **ONE LINE** open between two sub-questions, e.g. Between QUESTION 2.1 and 2.2
8. You may use a non-programmable **CALCULATOR**.
9. Show **ALL FORMULAS** and substitutions in **ALL CALCULATIONS**.
10. Round all FINAL numeric answers to a minimum of **TWO DECIMAL PLACES**.
11. 5. Give short (concise) **MOTIVATIONS** where necessary.
12. Attach all **GRAPHS** and extra **ANSWER SHEETS** to your answer sheet.

QUESTION 1

Four options are given as possible answers to the following questions.
Each question has only ONE correct answer. Select the answer and write only the letter (A-D) next to the question number (1.1 to 1.10) in your ANSWER BOOK, e.g.: 1.11 E.

1.1 A block of mass **m** is pulled across a flat horizontal surface with a force **F** that makes an angle **θ** with the horizontal.



What is the magnitude of the normal force, **N**, exerted by the surface on the block?

A $N = mg + F\sin\theta$

B $N = mg + F\cos\theta$

C $N = mg - F\sin\theta$

D $N = mg - F\cos\theta$ (2)

1.2 How do airbags in vehicles reduce the risk of serious injuries during a collision?

A It reduces the occupants' initial kinetic energy before the collision.

B It reduces the total change in momentum of the occupants.

C It increases the net force acting on the occupants to come to a stop more quickly.

D This extends the time in which the occupants come to rest. (2)

1.3 Under what circumstances is a system considered as **isolated** ?

A When only conservative forces do work.

B When only non-conservative forces do work.

C When both conservative forces AND non-conservative forces do work.

D When only an applied force acts on the object and there is no frictional force. (2)

1.4 A sound source moves away from a stationary observer.

How do the observed wavelength and observed pitch compare to that of the source?

	Observed wavelength (λ_L)	Observed pitch
A	INCREASE	INCREASE
B	INCREASE	DECREASE
C	DECREASE	INCREASE
D	DECREASE	DECREASE

(2)

1.5 Two point charges exert an electrostatic force of magnitude **F** on each other when they are a distance **r** apart. The distance between the charges is doubled to **2r**.

What is the new magnitude of the electrostatic force?

A $\frac{1}{4}$ F

B 4F

C $\frac{1}{2}$ F

D 2F (2)

1.6 Two identical light bulbs are connected in parallel to a battery with internal resistance.

How will the terminal voltage and the lost volts in the battery change if a third identical light bulb is added in parallel?

	Terminal Voltage ($V_{External}$)	Lost Volts ($V_{Internal}$) in battery
A	INCREASE	INCREASE
B	INCREASE	DECREASE
C	DECREASE	INCREASE
D	DECREASE	DECREASE

(2)

1.7 According to Faraday's law of electromagnetic induction, which ONE of the following will increase the induced EMF in a generator?

A Increase the electrical resistance of the coil.

B Reduce the number of turns around the coil.

C Increase the rotation speed of the coil.

D Reduce the strength of the magnetic field. (2)

1.8 The threshold wavelength (λ_0) of a metal is the:

A minimum wavelength of light that can release photoelectrons.

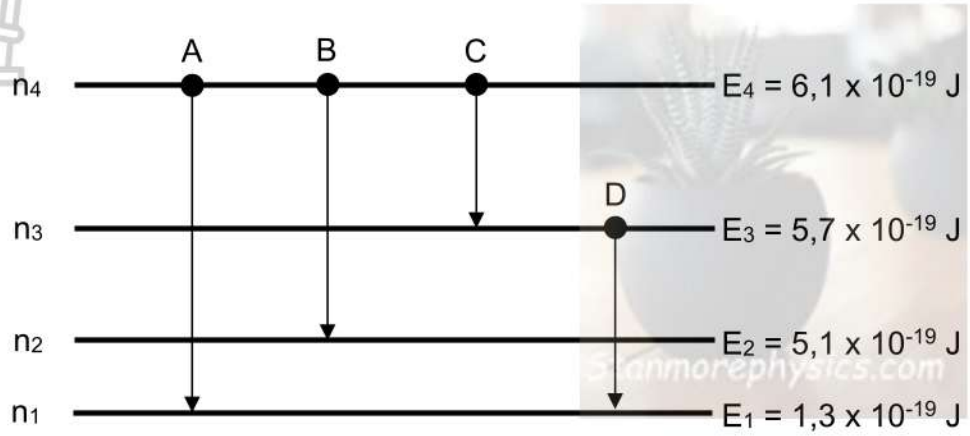
B wavelength of light that does not transfer any energy to electrons in the metal.

C maximum wavelength of light that can release photoelectrons.

D minimum wavelength of light that transfers energy to electrons in the metal. (2)

1.9 The diagram below shows electrons moving from higher energy levels to lower energy levels and releasing energy as photons.

Which electron (A, B, C or D) will emit a photon (electromagnetic wave) with the shortest wavelength (λ)?



(2)

1.10 The photoelectric effect provides evidence that:

A Metals contain electrons.

B Light has a particle nature.

C Light has a wave nature.

D Light is an electromagnetic wave.

(2)

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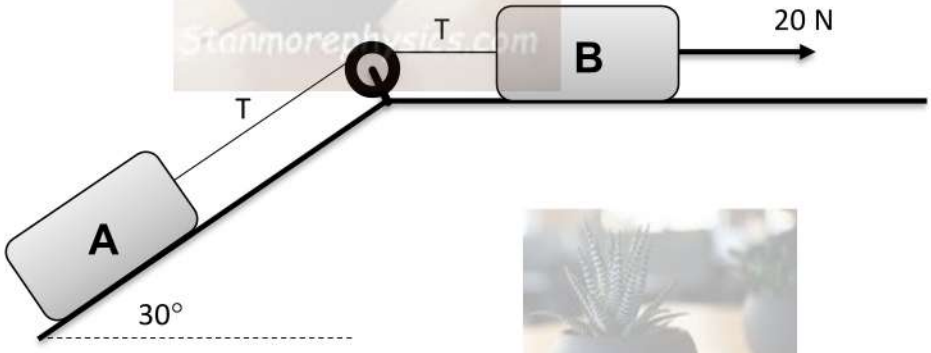
QUESTION 2 (Start on a new page)

Two identical blocks, A and B, (1,6 kg each) are connected by a light, inextensible string over a frictionless pulley. Block A moves upwards on a rough inclined plane that makes an angle of 30° with the horizontal and Block B moves to the right on a rough horizontal surface when a force of 20 N is applied to block B.

The two surfaces (inclined plane and the horizontal surface) are NOT made of the same material.

The system accelerates at 0,5 $m.s^{-2}$. The diagram is not drawn to scale.

Assume that the magnitude of the frictional force between both blocks and the surface over which each block moves has EXACTLY THE SAME value ($f_A = f_B$).



2.1 State Newton's second law of motion in words. (2)

2.2 Draw a neatly labelled free-body diagram of ALL the forces acting on the following block:

2.2.1 Block A (4)

2.2.2 Block B (5)

2.3 Calculate the magnitude of the kinetic frictional force acting on each block. (6)

2.4 Calculate the coefficient of kinetic friction (μ_k) between the inclined plane and Block A. (3)

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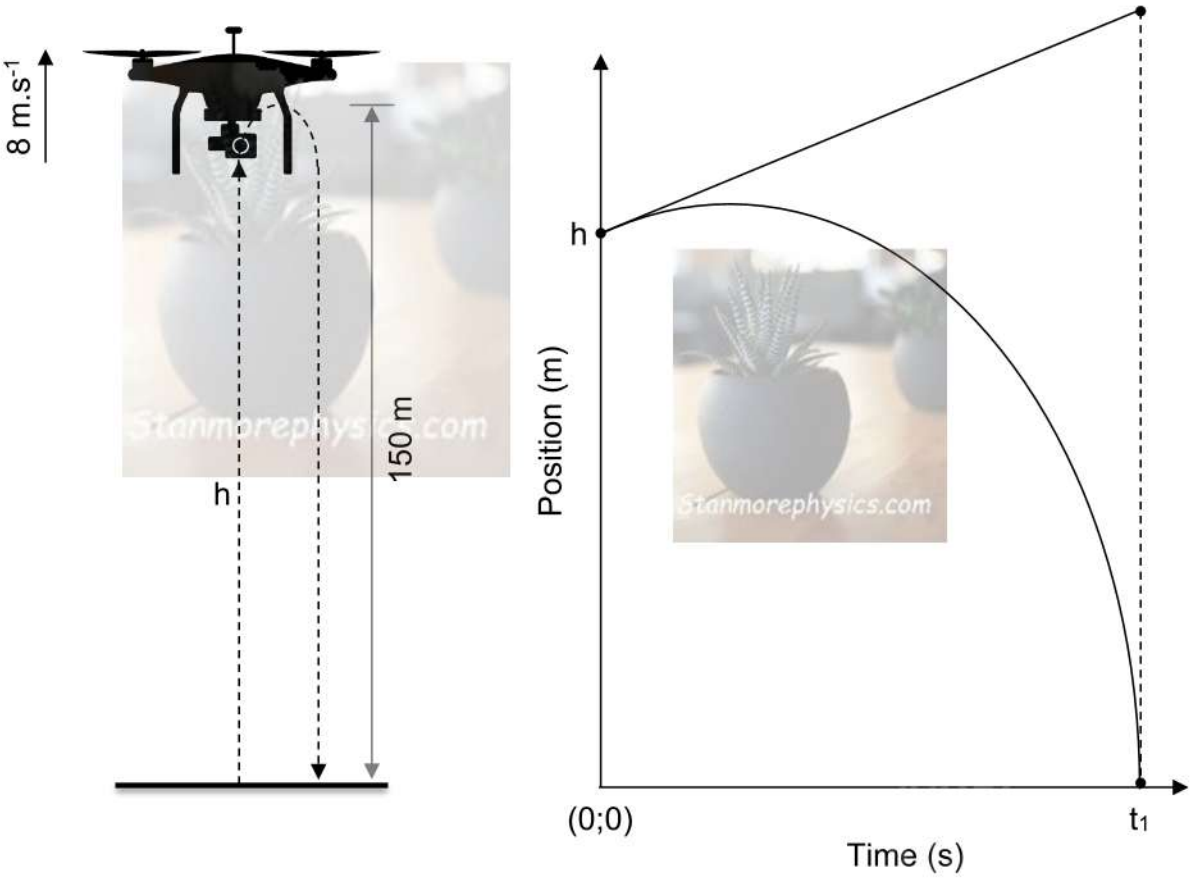
QUESTION 3 (Start on a new page)

During an investigation, a drone rises vertically into the air at a constant speed of 8 $m.s^{-1}$. There is a camera attached to the bottom of the drone. At a height of **h** meters, the screw that attaches the camera to the drone comes loose and the camera falls to the ground.

The position versus time graphs of both the drone and the camera are shown from the moment the camera starts falling to the moment, t_1, that it hits the ground. The CAMERA reaches a MAXIMUM HEIGHT of 150 m.

The graph is not drawn to scale.

Ignore the effect of air resistance in this question.



3.1 Define the term: FREEFALL (2)

3.2 Why is the drone NOT considered a projectile? (1)

3.3 What are the values **and** directions of the following vectors with respect to the camera at the moment it starts to fall:

3.3.1 Initial velocity (v_i) (1)

3.3.2 Acceleration (1)

3.4 Calculate the following values on the graph:

3.4.1 The height, **h**, from which the camera is released. (4)

3.4.2 The total time, t_1, from the moment the camera starts falling until it hits the ground. (4)

3.5 On the same set of axes, draw a velocity versus time graph for the motion of the camera and the drone from the moment the camera starts falling until it hits the ground.

Show the following values clearly on your graph:
- The initial velocity of both the drone and the camera.
- The time it takes the camera to fall to the ground. (4)

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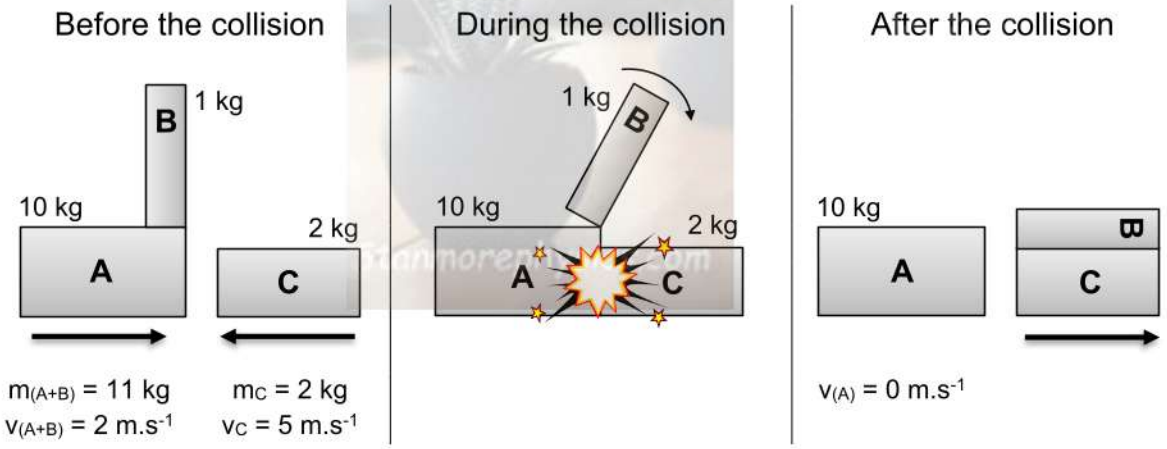
QUESTION 4 (Start on a new page)

Block **A** (10 kg) with block **B** (1 kg) placed on top of it is moving at 2 m.s^{-1} to the right and collides with block **C** (2 kg) which is moving at 5 m.s^{-1} to the left. During the collision, block **B** tips over and falls onto block **C** as shown in the diagram.

Immediately after the collision, block **A** comes to rest.



4.1 Define the term: INELASTIC COLLISION (2)

4.2 Calculate the velocity of Blocks **B** and **C** (combined) after the collision. (4)

4.3 Calculate the magnitude of the frictional force acting on blocks **B** & **C** (combined) if they come to a stop after one minute. (3)

4.4 How did the following values for block **C** change after the collision compared to what they were before the collision?

Write only INCREASE, DECREASE or STAY THE SAME.

4.4.1 Coefficient of friction (μ_K) between block **C** and the surface. (1)

4.4.2 Frictional force acting on block **C**. (1)

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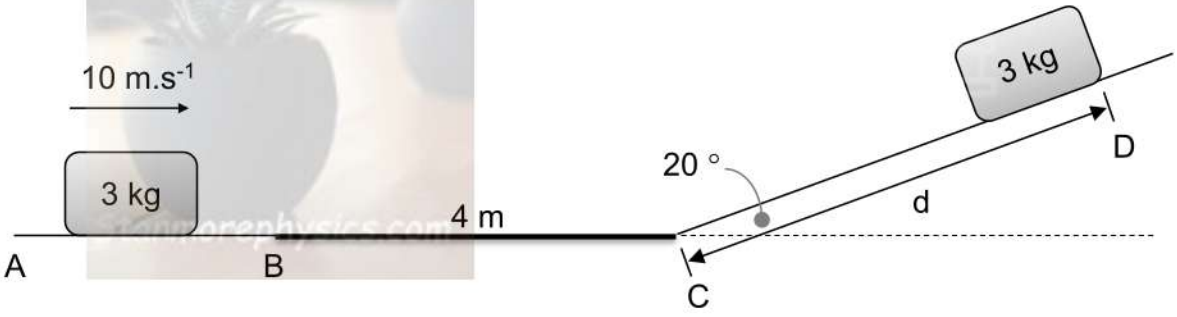
QUESTION 5 (Start on a new page)

A 3 kg block slides at a constant velocity of 10 $m.s^{-1}$ from point A to point B across a smooth horizontal surface. It then moves from B to C across a ROUGH horizontal surface over a distance of 4 m. The block's velocity at point C is 3.5 $m.s^{-1}$.

It then moves up a FRICTIONLESS inclined plane that makes an angle of 20° with the horizontal and comes to rest at point D.

The diagram is not drawn to scale.

You may only use ENERGY PRINCIPLES to answer this question.



5.1 State the WORK-ENERGY THEOREM in words. (2)

5.2 Calculate the WORK done by the frictional force on the block between point B and C. (3)

5.3 Calculate the distance (d or **CD**) that the block moves up the inclined plane. (4)

5.4 How would the answer in question 5.3 change if the angle of the inclined plane were changed to 30°? (1)

Write only INCREASE, DECREASE or STAY THE SAME.

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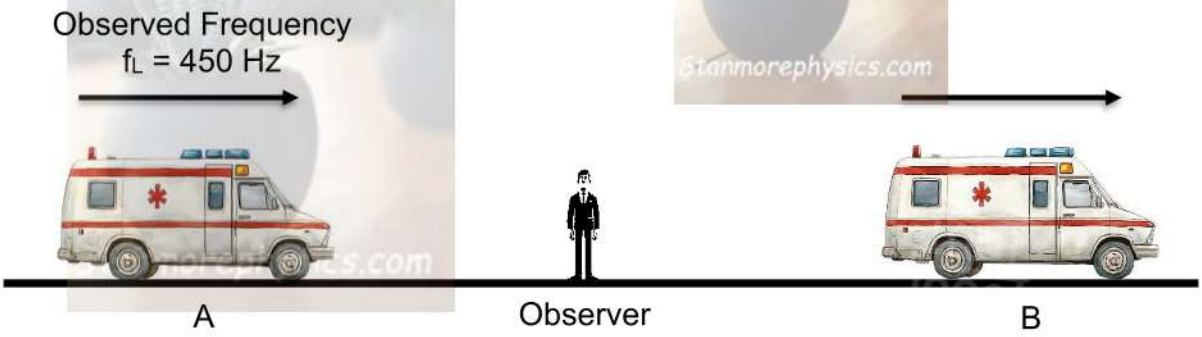
QUESTION 6 (Start on a new page)

An ambulance siren emits a sound wave with a frequency of 415 Hz. It moves at a constant speed on a horizontal path past an observer. The observer hears a frequency of 450 Hz as the ambulance moves towards him.

Take the speed of sound in air as 340 $m.s^{-1}$.



6.1 State the DOPPLER EFFECT in words. (2)

6.2 Calculate the observed frequency if the ambulance moves AWAY from the observer (at point **B**). (6)

6.3 Briefly explain why the two observed frequencies, at point **A** and point **B**, differ from each other. (2)

6.4 How would the following values change if the ambulance were to travel at 30 $m.s^{-1}$?

Write only INCREASE, DECREASE or STAY THE SAME.

6.4.1 Frequency of the ambulance siren. (f_S) (1)

6.4.2 Observed frequency as the ambulance travels TOWARDS the observer. (f_L at point A) (1)

6.4.3 Observed frequency as the ambulance moves AWAY from the observer. (f_L at point B) (1)

6.4.4 The DIFFERENCE between the two observed frequencies. (1)

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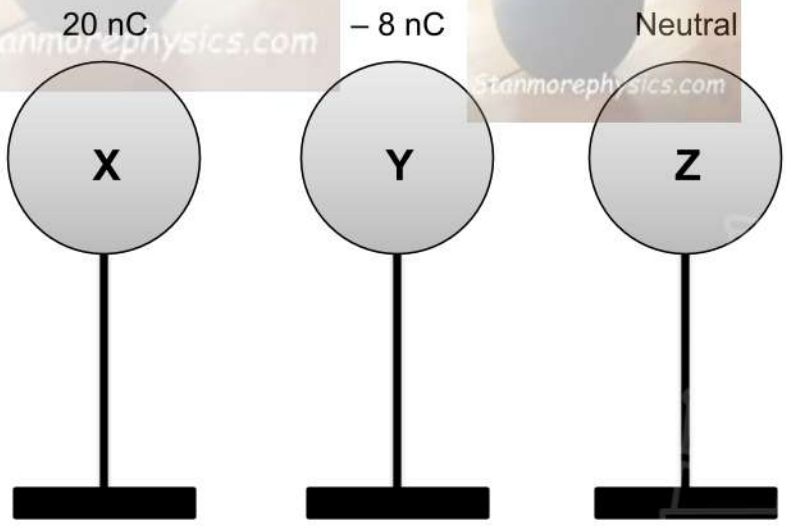
QUESTION 7 (Start on a new page)

Three identical metal spheres, **X**, **Y** and **Z**, are mounted on three insulated stands as shown in the diagram. Sphere **X** has a charge of 20 nC, sphere **Y** has a charge of – 8 nC and sphere Z is neutral.



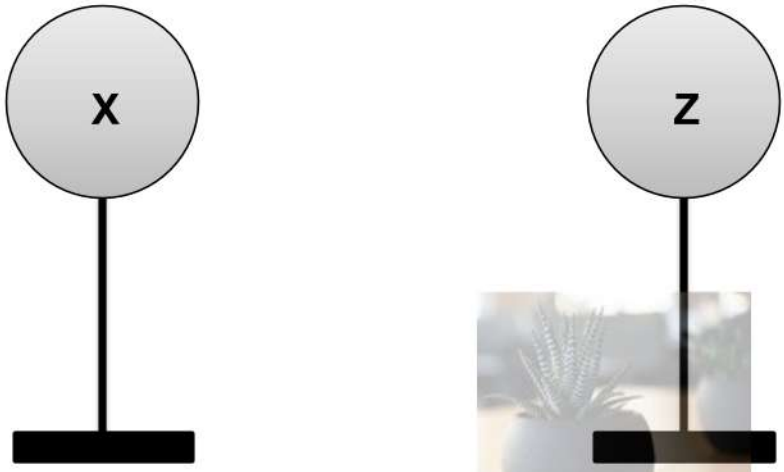
7.1 Give a reason why the metal spheres are mounted on insulated stands. (1)

7.2 Sphere **X** is picked up and first brought into contact with sphere **Y**. Then sphere **X** is brought into contact with sphere **Z**. Sphere **X** is then placed back in its original position.

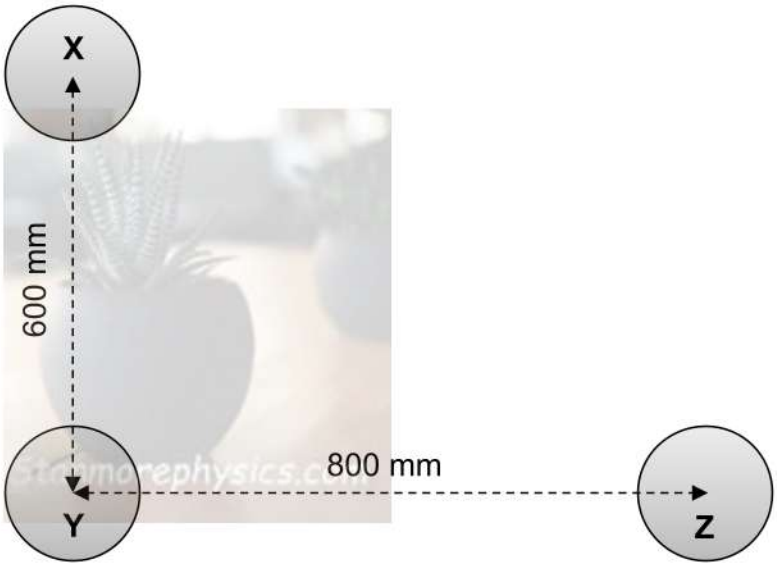
7.2.1 Calculate the net charge on sphere **X** after it is placed back in its original position. (4)

7.2.2 How many electrons did sphere **X** gain in total? (2)

7.3 Sphere **Y** is now completely removed. Draw the characteristic electric field pattern between sphere **X** and sphere **Z**. (3)



7.4 The three spheres, **X**, **Y** and **Z** are now placed so that they form a right angle as shown below. Note that the charges on each sphere are the values you calculated in question 7.2.1.



7.4.1 State Coulomb's Law in words. (2)

7.4.2 Draw a neatly labelled free-body diagram of the electrostatic forces acting on sphere **Y** due to the presence of spheres **X** and **Z**. (2)

7.4.3 Calculate the magnitude of the net electrostatic force acting on sphere **Y** due to the presence of spheres **X** and **Z**. (4)

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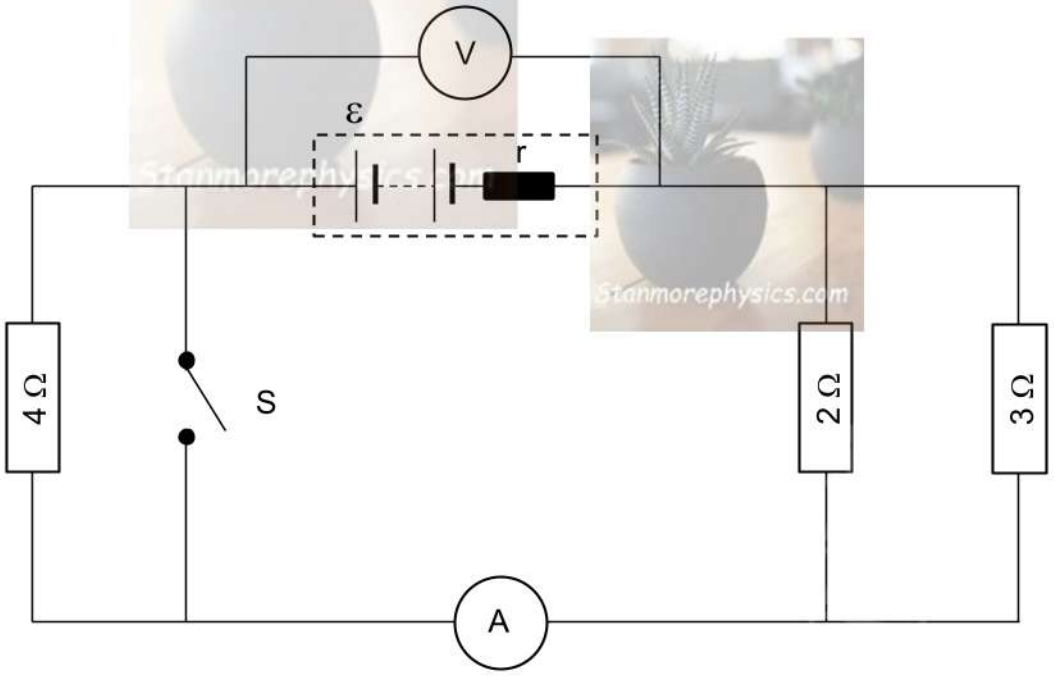
QUESTION 8 (Start on a new page)

A battery with an unknown emf (ε) and internal resistance (r) is connected in a circuit as shown in the diagram below. The ammeter and electrical conductors have negligible resistance and the voltmeter (V) has a high resistance.

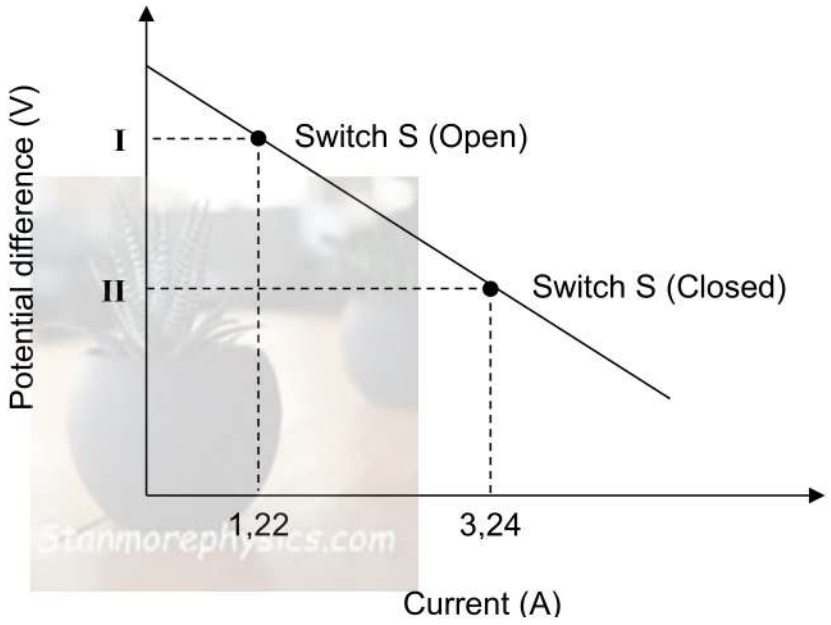


If switch S is CLOSED, the reading on the ammeter is 3,24 A.
If switch S is OPEN, the reading on the ammeter is 1,22 A.

8.1 Define the term: Emf (ε) of a battery. (2)

The readings on the voltmeter and ammeter, when the switch is opened and closed, are shown on the following graph.

The graph is not drawn to scale.



8.2 Calculate the values of the voltmeter reading on the vertical axis of the graph for:

8.2.1 **I** (5)

8.2.2 **II** (2)

8.3 Calculate:

8.3.1 The internal resistance (r) of the battery. (4)

8.3.2 The emf (ε) of the battery. (2)

8.4 When will the battery get warmer? (3)

If the switch is OPEN or CLOSED?

Explain your answer and refer to the change in the internal POWER in the battery in your answer.

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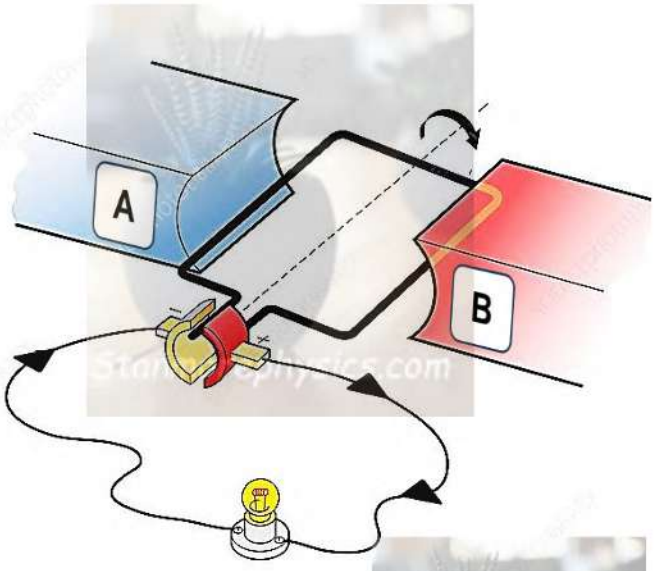
QUESTION 9 (Start on a new page)

The diagram below shows a simple generator with a light bulb in an external circuit. The light bulb in the circuit is marked (60 W; 220V).

The coil rotates clockwise to induce a potential difference that causes the bulb to shine at maximum power (60 W).



9.1 Define the term: rms Potential difference (2)

9.2 Is it a DIRECT CURRENT (DC) or ALTERNATING CURRENT (AC) generator? (1)

9.3 Name the component in the circuit that you identified to answer question 9.2. (1)

9.4 In which direction does the magnetic flux move between the two magnets? Write only A to B **or** B to A. (1)

9.5 Calculate:

9.5.1 The resistance of the light bulb. (3)

9.5.2 The peak voltage (V_{max}) that the generator must induce so that the light bulb can deliver a power of 60 W. (3)

9.6 What will happen to the light bulb if the rotation speed of the generator is doubled? Give a reason for your answer. (2)

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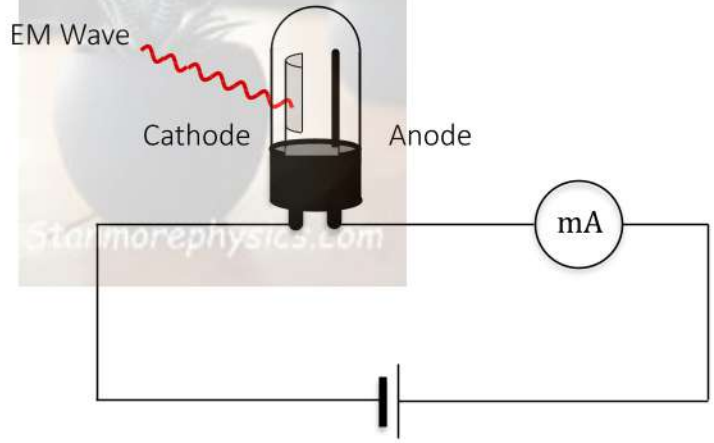
QUESTION 10 (Start on a new page)

Consider the following diagram of a photocell. The metal plate at the cathode has a work function of $7,57 \times 10^{-19}$ J.



10.1 Define the term: Work function (2)

10.2 Light with a wavelength of 200 nm is incident on the cathode. (6)

Calculate the maximum kinetic energy of the photoelectrons that are emitted.

10.3 Which ONE of the following changes to the incident light will increase the reading on the ammeter? (1)

Write only **A** or **B**.

A) Increase the intensity of the light beam.

B) Increase the frequency of the light beam.

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PHYSICAL SCIENCES PAPER 1
GRADE 12

MARKING GUIDELINES: SEPTEMBER 2026

MARKS: 150

TIME: 3 hours

These marking guidelines consist of 26 pages.

Please pay attention to the correct application of the following **MARKING RULES**:

1. Components of oblique forces and weight against an inclined plane are no longer accepted!
2. Answers left in fractional form will be marked incorrect. Candidates must give the final answer as a decimal fraction rounded to at least two places after the decimal.
3. Do not indicate the correct answer for the multiple choice questions while marking. This makes the moderation of the question difficult.
4. If the candidate gives more than one answer to the question, mark only the first option.

   The first option is the topmost answer (first attempt at an answer) or the answer furthest left on the page. Do not draw a red line through the candidate's alternative answer(s), just write the words **2nd ATTEMPT.**
5. For CALCULATIONS, marks will be awarded for: correct formula, correct substitution, correct answer WITH the correct SI unit.
6. No marks will be awarded where an incorrect or inappropriate formula is used, even if there are relevant symbols and relevant substitutions.

Memorandum:	Candidate's answer:
$F = k\frac{Q_1Q_2}{r^2}$ ✓	$E = k\frac{Q_1Q_2}{r^2}$ x
$= (9 \times 10^9)\frac{(2 \times 10^{-6})(5 \times 10^{-6})}{(0,1)^2}$ ✓	$= (9 \times 10^9)\frac{(2 \times 10^{-6})(5 \times 10^{-6})}{(0,1)^2}$
= 9 N ✓	= 9 N ↓ No marks

7. When an error is made during substitution in a correct formula, a mark will be awarded for the correct formula and for correct substitutions, but no further marks will be awarded.
8. If no formula is given, but all the substitutions are correct, the candidate loses one mark.
9. No penalty if zero values are not shown in calculations where the formula / principle is given correctly.
10. Mathematical manipulations and changing the subject of applicable formulas do not count for any marks, but if a candidate starts with the correct formula and then incorrectly changes the subject of the formula, the marks for the formula and correct substitutions will be awarded. The mark for the incorrect numerical answer is forfeited.

11. Marks are only awarded for a formula if an attempt at calculation has been made, i.e. substitutions have been made or a numerical answer has been given.

12. Marks can only be awarded for substitutions when values are entered into formulas and not for values listed before a calculation.

13. All calculations, when not specified in the question, must be done to a minimum of two decimal places.

14. If a final answer to a calculation is correct, full marks will not be automatically awarded. Markers will always ensure that the correct/appropriate formula is used and that operations, including substitutions, are correct.

15. Questions where a series of calculations are to be done (e.g. a circuit diagram question) do not necessarily have to be in the same order. FULL MARKS will be awarded provided that it is a valid solution to the problem. However, any calculation that does not bring the candidate closer to the answer than the original data will not count for any marks.

16. Candidates will only be penalized once for repeatedly using an incorrect unit in a question.

17. Units are only required in the final answer to a question.

18. Marks will be awarded for an answer only and not for a unit alone. Candidates will forfeit the mark for the answer in the following cases: (i) Correct answer + wrong unit, (ii) Wrong answer + correct unit, (iii) Correct answer + no unit.

19. If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, regardless of which one is correct. If two answers are required, only the first two will be marked, etc.

20. For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.

21. Separate compound units with a multiplication point and not with a period, for example $m \cdot s^{-1}$. For marking purposes, $m.s^{-1}$ and m/s will also be accepted.

22. Positive marking in relation to calculations will apply in the following cases: (i) Sub-question after sub-question: When a certain variable is calculated in one sub-question (e.g. 3.1) and then has to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, full marks will be awarded for the subsequent sub-question. ; (ii) A question with multiple steps in a sub-question: If a candidate e.g. calculates the current incorrectly in a first step due to a substitution error, the candidate loses the mark for the substitution as well as the final answer.

23. If the candidate writes something that doesn't carry any marks, just draw a squiggle to the right of it to show that you saw it.

24. The number of ticks on the page must match the total at the bottom of the page. The tick must indicate what the candidate is getting the mark for according to the marking guidelines.

25. If the answer has multiple options, it would be helpful for the moderator if the marker indicated in a square box which option the candidate used to answer the question.

26. Please note that you may have your own style of marking and your own way of drawing attention to something. For consistency, please note the following marking conventions:

    ✓ - If an answer is correct and a point is indicated on the marking guideline.

    x - If an answer is incorrect and a point is indicated on the marking guideline.

27. Positive marking applies from one sub-question to the next sub-question and not within a sub-question. A marker must indicate POSITIVE MARKING as shown in the example below.

Marking guideline:	**Candidate's answer:**
8.1.1 $Q = I\Delta t$ ✓ $120 = I(60)$ ✓ $I = 2$ A ✓	8.1.1 $Q = I\Delta t$ ✓ $120 = I(50)$ x $I = 2{,}4$ A x
8.1.2 Positive marking from 8.1.1	8.1.2 Positive marking from 8.1.1
$P = I^2R$ ✓ $= (2)^2(5)$ ✓ $= 20$ W ✓	$P = I^2R$ ✓ $= (2{,}4)^2(5)$ ✓ $= 12$ W ✓

28. Replacement marks are sometimes awarded, especially in an answer with more than one step. Replacement marks are indicated in the marking guidelines by solid arrows. A marker must indicate a replacement mark as shown below.

Marking guideline:	**Candidate's answer:**
8.1.1 $Q = I\Delta t$ ✓ $120 = I(60)$ ✓ $I = 2$ A	8.1.1 $Q = I\Delta t$ ✓ $120 = I(50)$ x $I = 2{,}4$ A
8.1.2	8.1.2
$P = I^2R$ ✓ $= (2)^2(5)$ ✓ $= 20$ W ✓	$P = I^2R$ ✓ $= (2{,}4)^2(5)$ ✓ $= 12$ W x

QUESTION 1

1.1	C	✓✓	(2)
1.2	D	✓✓	(2)
1.3	A	✓✓	(2)
1.4	B	✓✓	(2)
1.5	A	✓✓	(2)
1.6	C	✓✓	(2)
1.7	C	✓✓	(2)
1.8	C	✓✓	(2)
1.9	A	✓✓	(2)
1.10	B	✓✓	(2)

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Explanation of answers to **QUESTION 1**:

1.1	**C**	The upward vertical component of the applied force reduces the normal force exerted by the surface on the block.
1.2	**D**	$F_{net} = \frac{\Delta p}{\Delta t}$. The net force and contact time are inversely proportional to each other. As the contact time increases, the net force decreases.
1.3	**A**	By definition, an isolated system is a system where only conservative forces (e.g. gravitational force) do work. This happens when only conservative forces do work and no energy is lost through non-conservative forces.
1.4	**B**	Wavelength and pitch (frequency) are inversely proportional to each other. As the wavelength increases, the frequency (pitch) decreases.
1.5	**A**	$F = \frac{kQ_1Q_2}{r^2} \therefore \blacksquare F = \frac{kQ_1Q_2}{(2r)^2} \therefore \blacksquare F = \frac{kQ_1Q_2}{4r^2} \therefore \blacksquare = \frac{1}{4}$ According to Coulomb's law, the electrostatic force decreases rapidly as the distance between charges increases. When the distance is doubled, the force becomes four times smaller.
1.6	**C**	R is directly proportional to $V_{External}$. Bulbs in parallel reduce the external resistance. The difference between the emf and $V_{External}$ increases. When another bulb is added in parallel, the current increases. More voltage is lost within the battery, therefore the terminal voltage decreases.
1.7	**C**	According to Faraday's law, the induced EMF increases as the rate at which the magnetic field changes increases. A higher rotation speed causes a faster change and therefore a larger EMF.
1.8	**C**	The threshold wavelength is the maximum wavelength of light that still has enough energy to release photoelectrons from the metal. The longer the λ, the smaller the frequency.
1.9	**A**	The shortest wavelength is emitted when the largest energy difference between energy levels occurs. Electron A falls across the largest energy gap and therefore emits the most energetic photon.
1.10	**B**	The photoelectric effect shows that light acts as discrete energy packets that transfer energy to electrons. This proves the particle nature of light.

QUESTION 2

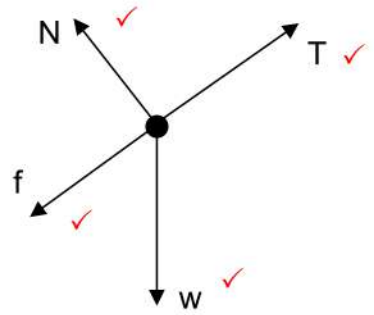
2.1 **Newton's 2nd Law of Motion:** When a resultant/net force acts on an object, the object accelerates in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object. ✓✓ (2)

OR

Newton's 2nd Law of Motion in terms of momentum: The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force. ✓✓

If any ONE of the underlined phrases is omitted = 1 mark If MORE than one of the underlined phrases is omitted = 0 marks

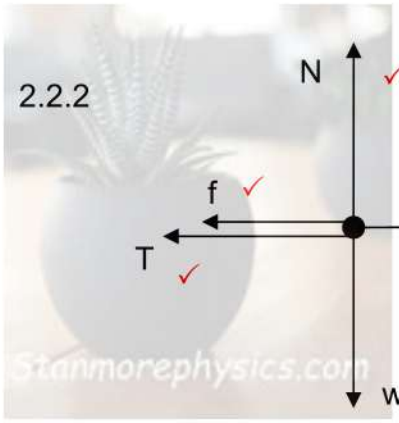
2.2.1



Key: (4)

N = Normal force
T = Tension
f = Friction
w = Weight

2.2.2



Key: (5)

N = Normal force
F = Applied force
f = Friction
T = Tension
w = Weight

For question 2.2.1 and 2.2.2:

- Penalize only once if vectors do not touch the dot.
- Penalize only once if extra forces are applied to the diagram that do not belong there. (– 1)
- Do not penalize for the length of the vectors.
- ONE mark is given for a vector WITH an arrowhead, correct unit and that is indicated in the correct direction.

Accepted symbols for both free-body diagrams:	
w	F_w / F_g / mg / Gravitational force / Weight
f	F_f / f_k / (Kinetic) friction
N	F_N / Normal force
F	F_A / Applied force / 20 N
T	F_T / Tension

2.3 **Block A:** (6)

$F_{net} = ma$ ✓

Any one of the following two extensions of F_{net}: ✓

$T - w_{//} - f = ma$

$T - w\sin30° - f = ma$

$T - (1,6)(9,8)\sin30° - f = (1,6)(0,5)$ ✓

$T - 7,84 - f = 0,8$

$T = f + 8,64$

Block B:

$F_{net} = ma$

$F - T - f = ma$ ✓

$20 - (\mathbf{f + 8,64}) - f = (1,6)(0,5)$ ✓

$20 - 8,64 - 2f = 0,8$

$f = 5,28$ N ✓

2.4 Any version of the equation: ✓ (3)

$f_k = \mu_k N$

$f_k = \mu_k(w\cos\theta)$

$5,28 = \mu_k(1,6)(9,8)\cos30°$ ✓

$\mu_k = 0,39$ ✓

20

QUESTION 3

3.1 **FREE FALL:** The MOTION during which the only force acting on an object is the force of gravity. ✓✓ (2)

3.2 Any wording that indicates that the candidate understands that the definition of a projectile does NOT apply to the drone. ✓ (1)

Please note: The fact that the drone is moving UPWARDS is not an acceptable reason.

- There is another force besides gravitational force that also acts on the drone.
- The drone moves at a CONSTANT SPEED.
- The upward force caused by the movement of the blades of the drone's propellers also acts on the drone.

3.3.1 8 $m.s^{-1}$ UPWARDS ✓ (1)

3.3.2 9,8 $m.s^{-2}$ DOWNWARDS ✓ (1)

3.4.1 **OPTION 1** (Upward movement of camera) (4)

$v_f^2 = v_i^2 + 2a\triangle y$ ✓
$(0)^2 = (8)^2 + 2(-9,8)\triangle y$ ✓
$\triangle y = 3,27$ m ✓
$\therefore h = 150 - 3,27 = 146,73$ m ✓

$v_f^2 = v_i^2 + 2a\triangle y$ ✓
$(0)^2 = (-8)^2 + 2(9,8)\triangle y$ ✓
$\triangle y = 3,27$ m ✓
$\therefore h = 150 - 3,27 = 146,73$ m ✓

OPTION 2 (Downward movement of camera)

$v_f^2 = v_i^2 + 2a\triangle y$ ✓
$(-8)^2 = (0)^2 + 2(-9,8)\triangle y$ ✓
$\triangle y = -3,27$ m ✓
$\therefore h = 150 - 3,27 = 146,73$ m ✓

$v_f^2 = v_i^2 + 2a\triangle y$ ✓
$(8)^2 = (0)^2 + 2(9,8)\triangle y$ ✓
$\triangle y = 3,27$ m ✓
$\therefore h = 150 - 3,27 = 146,73$ m ✓

OPTION 3 (Upward movement if candidate has worked out time)

$v_f = v_i + a\triangle t$
$(0) = (8) + (-9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$= (8)(0,82) + \frac{1}{2}(-9,8)(0,82)^2$ ✓
$= 3,27$ m ✓

$h = 150 - 3,27 = 146,73$ m ✓

$v_f = v_i + a\triangle t$
$(0) = (-8) + (9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$= (-8)(0,82) + \frac{1}{2}(9,8)(0,82)^2$ ✓
$= 3,27$ m ✓

$h = 150 - 3,27 = 146,73$ m ✓

OPTION 4 (Downward movement if candidate has worked out time)

$v_f = v_i + a\triangle t$
$(0) = (8) + (-9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$= (0)(0,82) + \frac{1}{2}(-9,8)(0,82)^2$ ✓
$= -3,27$ m ✓

$h = 150 - 3,27 = 146,73$ m ✓

$v_f = v_i + a\triangle t$
$(0) = (-8) + (9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$= (0)(0,82) + \frac{1}{2}(9,8)(0,82)^2$ ✓
$= 3,27$ m ✓

$h = 150 - 3,27 = 146,73$ m ✓

OPTION 5 (Upward movement if candidate has worked out time)

$v_f = v_i + a\triangle t$
$(0) = (8) + (-9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = \left(\frac{v_i+v_f}{2}\right)\triangle t$ ✓
$\triangle y = \left(\frac{8+0}{2}\right)(0,82)$ ✓
$\triangle y = 3,27$ ✓

$h = 150 - 3,27 = 146,73$ m ✓

$v_f = v_i + a\triangle t$
$(0) = (-8) + (9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = \left(\frac{v_i+v_f}{2}\right)\triangle t$ ✓
$\triangle y = \left(\frac{-8+0}{2}\right)(0,82)$ ✓
$\triangle y = -3,27$ ✓

$h = 150 - 3,27 = 146,73$ m ✓

If the unrounded value for $\triangle t = 0,8163265306$ is used, the answer is $\triangle y = 3,27$ m and $h = 146,73$ m

If the rounded value for $\triangle t = 0,82$ is used, the answer is $\triangle y = 3,28$ m and $h = 146,72$ m

OPTION 6 (Downward movement if candidate has worked out time)

$v_f = v_i + a\triangle t$
$(0) = (8) + (-9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = \left(\frac{v_i+v_f}{2}\right)\triangle t$ ✓
$\triangle y = \left(\frac{0-8}{2}\right)(0,82)$ ✓
$\triangle y = -3,27$ ✓

$h = 150 - 3,27 = 146,73$ m ✓

$v_f = v_i + a\triangle t$
$(0) = (-8) + (9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = \left(\frac{v_i+v_f}{2}\right)\triangle t$ ✓
$\triangle y = \left(\frac{0+8}{2}\right)(0,82)$ ✓
$\triangle y = 3,27$ ✓

$h = 150 - 3,27 = 146,73$ m ✓

If the unrounded value for $\triangle t = 0,8163265306$ is used, the answer is $\triangle y = 3,27$ m and $h = 146,73$ m

If the rounded value for $\triangle t = 0,82$ is used, the answer is $\triangle y = 3,28$ m and $h = 146,72$ m

3.4.2 Positive marking from 3.4.1 (4)

OPTION 1 (One complete trajectory)

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$(-146,73)$ ✓ $= (8)\triangle t + \frac{1}{2}(-9,8)\triangle t^2$ ✓
$4,9\triangle t^2 - 8\triangle t - 146,73 = 0$

$\triangle t = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$\triangle t = \frac{-(-8) \pm \sqrt{(-8)^2-4(4,9)(-146,73)}}{2(4,9)}$

$\triangle t = 6,35$ s ✓ en $\triangle t \neq -4,72$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$(146,73)$ ✓ $= (-8)\triangle t + \frac{1}{2}(9,8)\triangle t^2$ ✓
$-4,9\triangle t^2 + 8\triangle t + 146,73 = 0$

$\triangle t = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$\triangle t = \frac{-(8) \pm \sqrt{(8)^2-4(-4,9)(146,73)}}{2(-4,9)}$

$\triangle t = 6,35$ s ✓ en $\triangle t \neq -4,72$ s

OPTION 2 (Trajectory divided into three movements)

$v_f = v_i + a\triangle t$
$(0) = (8) + (-9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$(-146,73)$ ✓ $= (-8)\triangle t + \frac{1}{2}(-9,8)\triangle t^2$ ✓
$4,9\triangle t^2 + 8\triangle t - 146,73 = 0$

$$\triangle t = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$\triangle t = \frac{-(8) \pm \sqrt{(8)^2-4(4,9)(-146,73)}}{2(4,9)}$$

$\triangle t = 4,72$ s en $\triangle t \neq -6,35$ s

Total time = 4,72 + 2(0,82)
= 6,35 s / 6,36 s ✓

$v_f = v_i + a\triangle t$
$(0) = (-8) + (9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
$(146,73)$ ✓ $= (8)\triangle t + \frac{1}{2}(9,8)\triangle t^2$ ✓
$4,9\triangle t^2 + 8\triangle t - 146,73 = 0$

$$\triangle t = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$\triangle t = \frac{-(8) \pm \sqrt{(8)^2-4(4,9)(-146,73)}}{2(4,9)}$$

$\triangle t = 4,72$ s en $\triangle t \neq -6,35$ s

Total time = 4,72 + 2(0,82)
= 6,35 s / 6,36 s ✓

OPTION 3 (Trajectory divided into two movements)

$v_f = v_i + a\triangle t$
$(0) = (8) + (-9,8)\triangle t$
$\triangle t = 0,82$ s

$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
(-150) ✓ $= (0)\triangle t + \frac{1}{2}(-9,8)\triangle t^2$ ✓
$\triangle t = 5,53$ s

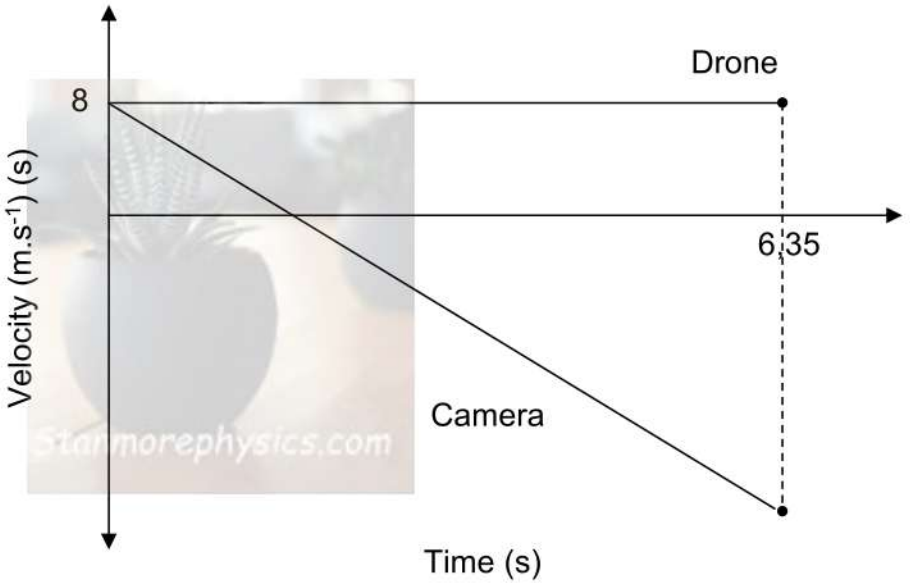
Total time = 5,53 + 0,82
= 6,35 s ✓

$v_f = v_i + a\triangle t$
$(0) = (-8) + (9,8)\triangle t$
$\triangle t = 0,82$ s

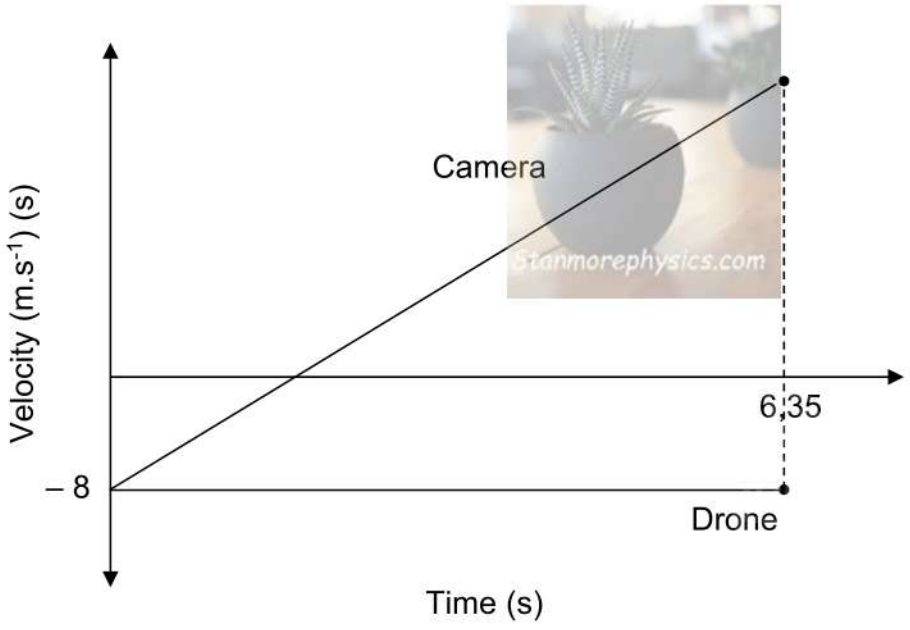
$\triangle y = v_i\triangle t + \frac{1}{2}a\triangle t^2$ ✓
(150) ✓ $= (0)\triangle t + \frac{1}{2}(9,8)\triangle t^2$ ✓
$\triangle t = 5,53$ s

Total time = 5,53 + 0,82
= 6,35 s ✓

3.5 Positive marking from 3.4.2 (4)



OR



Initial velocity for both graphs is 8 m.s^{-1}. ✓
Both graphs stop at 6,35 s. ✓
Graph for drone is a horizontal line. ✓
Graph for camera drawn correctly. ✓

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QUESTION 4

4.1 **INELASTIC COLLISION:** Collision during which the momentum of a system is conserved, but not the kinetic energy. ✓✓ (2)

4.2 Any version of the equation: ✓ (4)

$\Sigma p_{(Before)} = \Sigma p_{(After)}$

$mv_{i(A+B)} + mv_{i(C)} = mv_{f(A)} + mv_{f(B+C)}$

$(11)(2) + (2)(-5)$ ✓ $= (10)(0) + (3)v_{f(B+C)}$ ✓

$12 = (3)\ v_{f(B+C)}$

$v_{f(B+C)} = 4\ m.s^{-1}$ (To the right) ✓

4.3 **OPTION 1:** ($F_{net}\triangle t = \triangle p$) (3)

Any version of the equation: ✓

$F_{net}\triangle t = \triangle p$

$F_{net}\triangle t = mv_f - mv_i$

$F_{net}.(60) = (3)(0) - (3)(4)$ ✓

$F_{net} = -0,2$ N **or** 0,2 N ✓

OPTION 2: ($F_{net} = ma$)

$v_f = v_i + a\triangle t$

$(0) = (4) + a(60)$

$a = -0,067\ m.s^{-2}$

$F_{net} = ma$ ✓

$= (3)(-0,067)$ ✓

$= -0,2$ N **or** 0,2 N ✓

OPTION 3: ($W_{net} = \triangle E_K$)

$\triangle x = \left(\frac{v_f + v_i}{2}\right) \triangle t$

$= \left(\frac{0+4}{2}\right) (60)$

$= 120$ m

$\triangle x = v_i \triangle t + \frac{1}{2} a \triangle t^2$
$\triangle x = (4)(60) + \frac{1}{2}(-0{,}067)(60)^2$
$\triangle x = 120$ m

$v_f^2 = v_i^2 + 2a\triangle x$
$(0)^2 = (4)^2 + 2(-0{,}067)\triangle x$
$\triangle x = 120$ m

Any version of the equation: ✓

$W_{net} = \triangle E_K$

$f\triangle x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$f(120)\cos 180° = \frac{1}{2}(3)(0)^2 - \frac{1}{2}(3)(4)^2$ ✓

$f = 0{,}2$ N **or** $-0{,}2$ N ✓

4.4.1 STAY THE SAME ✓ (1)

4.4.2 INCREASE ✓ (1)

11

QUESTION 5

5.1 **THE WORK-ENERGY THEOREM:** The net work done on an object is equal to the change in kinetic energy of the object ✓✓ (2)

OR

THE WORK-ENERGY THEOREM: The work done on the object by a net force is equal to the change in kinetic energy of the object ✓✓

If any ONE of the underlined phrases is omitted = 1 mark If MORE than one of the underlined phrases is omitted = 0 marks

5.2 **OPTION 1:** ($W_{net} = \triangle E_K$)

Any version of the equation: ✓

$W_{net} = \triangle E_K$

$W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(3)(3,5)^2 - \frac{1}{2}(3)(10)^2$ ✓

$= -131,625$ J

$= -131,63$ J ✓

OPTION 2: ($W_{nc} = \triangle E_K + \triangle E_P$)

Any version of the equation: ✓

$W_{nc} = \triangle E_K + \triangle E_P$

$W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$

$W_f = \frac{1}{2}(3)(3,5)^2 - \frac{1}{2}(3)(10)^2 + (3)(9,8)(0) - (3)(9,8)(0)$ ✓

$= -131,625$ J

$= -131,63$ J ✓

5.3 **OPTION 1:** ($E_{M(Bottom)} = E_{M(Top)}$) (4)

Any version of the equation: ✓

$E_{M(Bottom)} = E_{M(Top)}$

$(E_K + E_P)_{Bottom} = (E_K + E_P)_{Top}$

$(\frac{1}{2}mv_i^2 + mgh_i)_{Bottom} = (\frac{1}{2}mv_f^2 + mgh_f)_{Top}$

$\frac{1}{2}(3)(3,5)^2 + (3)(9,8)(0)$ ✓ $= \frac{1}{2}(3)(0)^2 + (3)(9,8)(\mathbf{d}\sin 20°)$ ✓

$0,625 = \mathbf{d}\sin 20°$

$\mathbf{d} = 1,83$ m ✓

OPTION 2: ($W_{net} = \triangle E_K$ & Weight)

Any version of the equation: ✓

$W_{net} = \triangle E_K$

$W_f + W_{Weight} = \triangle E_K$

$f\triangle x\cos\theta + w\triangle x\cos\theta = \triangle E_K$

$f\triangle x\cos\theta + w\triangle x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(0) + (3)(9,8)(\mathbf{d})\cos 110° $ ✓ $= \frac{1}{2}(3)(0)^2 - \frac{1}{2}(3)(3,5)^2$ ✓

$\mathbf{d} = 1,83$ m ✓

OPTION 3: ($W_{net} = \triangle E_K$ & Parallel component of Weight)

Any version of the equation: ✓

$W_{net} = \triangle E_K$

$W_f + W_{Parallel\ component\ of\ Weight} = \triangle E_K$

$f\triangle x\cos\theta + w_{//}\triangle x\cos\theta = \triangle E_K$

$f\triangle x\cos\theta + w_{//}\triangle x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(0) + (3)(9,8)\sin 20°(\mathbf{d})\cos 180° $ ✓ $= \frac{1}{2}(3)(0)^2 - \frac{1}{2}(3)(3,5)^2$ ✓

$\mathbf{d} = 1,83$ m ✓

OPTION 4: ($W_{nc} = \triangle E_K + \triangle E_P$)

$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ ✓

$0 = \frac{1}{2}(3)(0)^2 - \frac{1}{2}(3)(3,5)^2$ ✓ $+ (3)(9,8)(\mathbf{d}\sin 20°) - (3)(9,8)(0)$ ✓

$\mathbf{d}\sin 20° = 0,625$

$\mathbf{d} = 1,83$ m ✓

5.4 DECREASE ✓ (1)

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QUESTION 6

6.1 **DOPPLER EFFECT:** The change in frequency (or pitch) of sound observed by a listener because the sound source and the listener have different speeds relative to the medium in which the sound is propagated. ✓✓ (2)

OR

DOPPLER EFFECT: The change in observed frequency/pitch due to relative motion between the sound source and the listener. ✓✓

If any ONE of the underlined phrases is omitted = 1 mark If MORE than one of the underlined phrases is omitted = 0 marks

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ ✓ (6)

Ambulance moves TOWARDS the observer:

(450) ✓ $= \frac{(340) + (0)}{(340) - v_s} (415)$ ✓

$V_S = 26{,}44\ m.s^{-1}$ ✓

Ambulance moves AWAY from the observer:

$f_L = \frac{(340) - (0)}{(340) + (26{,}44)} (415)$ ✓

$f_L = 385{,}06\ Hz$ ✓

6.3 Any one of the following two explanations.The candidate must refer to the change in wavelength (λ)✓ and the change in number of waves (wavefronts) observed per unit time. ✓ (2)

If the ambulance (source) moves TOWARDS the observer, a buildup of waves (waves with shorter wavelengths) occurs and the observer observes MORE waves per unit of time.

If the ambulance (source) moves AWAY from the observer, a "stretching" of waves (waves with longer wavelengths) occurs and the observer observes FEWER waves per unit of time.

6.4.1 STAY THE SAME ✓ (1)

6.4.2 INCREASE ✓ (1)

6.4.3 DECREASE ✓ (1)

6.4.4 INCREASE ✓ (1)

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QUESTION 7

7.1 Acceptable explanation: ✓ (1)

The spheres are insulated to prevent electrons from being exchanged with the surface / the sphere's charge changes because it is in contact with the ground / to prevent the sphere from being grounded.

7.2.1 **Contact between X and Y:** (4)

$$Q_f = \frac{Q_X + Q_Y}{2}$$

$$Q_f = \frac{(20) + (-8)}{2}$$ ✓

$$Q_f = 6\ nC$$ ✓

$$Q_f = \frac{Q_X + Q_Y}{2}$$

$$Q_f = \frac{(20 \times 10^{-9}) + (-8 \times 10^{-9})}{2}$$

$$Q_f = 6 \times 10^{-9}\ C$$

Contact between X and Z:

$$Q_f = \frac{Q_X + Q_Z}{2}$$

$$Q_f = \frac{(6) + (0)}{2}$$ ✓

$$Q_f = 3\ nC$$ ✓

$$Q_f = \frac{Q_X + Q_Z}{2}$$

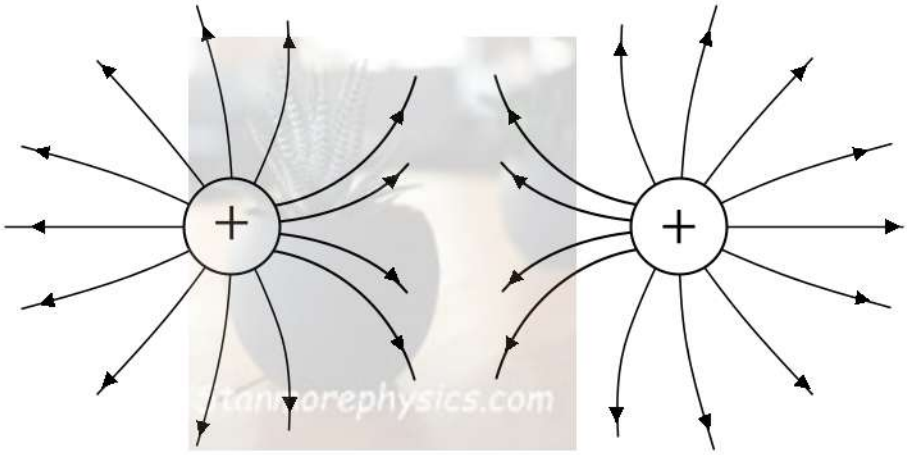
$$Q_f = \frac{(6 \times 10^{-9}) + (0)}{2}$$

$$Q_f = 3 \times 10^{-9}\ C$$

7.2.2 $\Delta n = \frac{\Delta Q}{q_e} = \frac{Q_f - Q_i}{q_e}$ (2)

$\Delta n = \frac{(3 \times 10^{-9}) - (20 \times 10^{-9})}{(-1,6 \times 10^{-19})}$ ✓ $= 1,0625 \times 10^{11}$ electrons ✓

7.3 (3)



The direction of the electrostatic field is correctly indicated. ✓

Characteristic pattern between spheres & outside the spheres drawn correctly. ✓

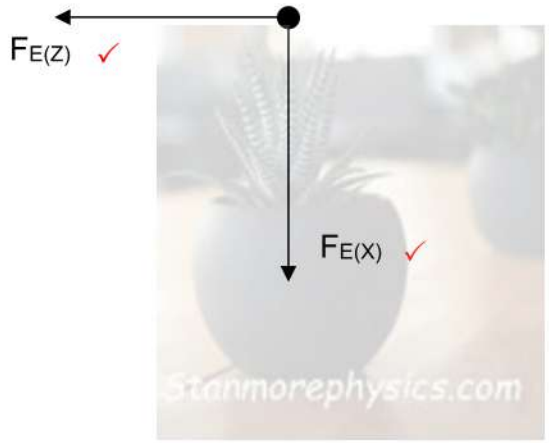
All conventions of electrical fieldlines adhered to: ✓

7.4.1 **COULOMB'S LAW:** (2)

The magnitude of the **electrostatic force** exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them. ✓✓

If any ONE of the underlined phrases is omitted = 1 mark If MORE than one of the underlined phrases is omitted = 0 marks IF THE CANDIDATE REFERS TO THE PRODUCT OF MASS AND THEREFORE IS REFERRING TO NEWTON'S UNIVERSAL LAW OF GRAVITY THE CANDIDATE GETS = 0 marks

7.4.2 (2)



Key:

$F_{E(Z)}$ = Electrostatic force due to Z / Also accept F_Z
$F_{E(X)}$ = Electrostatic force due to X / Also accept F_X

7.4.3 Positive marking from 7.2.1 (4)

$F_{E(Z)} = \frac{kQ_YQ_Z}{r^2}$ ✓

$F_{E(Z)} = \frac{(9x10^9)(6x10^{-9})(3x10^{-9})}{(0,8)^2}$ ✓

$F_{E(Z)} = 2,53125 \times 10^{-7}$ N

$F_{E(X)} = \frac{kQ_YQ_X}{r^2}$

$F_{E(X)} = \frac{(9x10^9)(6x10^{-9})(3x10^{-9})}{(0,6)^2}$ ✓

$F_{E(X)} = 4,5 \times 10^{-7}$ N

$F_{net}^2 = (2,53125 \times 10^{-7})^2 + (4,5 \times 10^{-7})^2$

$F_{net} = 5,16 \times 10^{-7}$ N ✓

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QUESTION 8

8.1 **EMF:** The maximum energy a battery delivers per unit charge flowing through it. ✓✓ (2)

8.2.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{3}$ ✓ $= \frac{5}{6}$ (5)

$\therefore R_P = 1{,}2\ \Omega$

$\therefore R_T = 4 + 1{,}2 = 5{,}2\ \Omega$ ✓

$V = IR$ ✓ $= (1{,}22)(5{,}2)$ ✓ $= 6{,}344\ V \approx 6{,}34\ V$ ✓

8.2.2 $V = IR = (3{,}24)(1{,}2)$ ✓ $= 3{,}888\ V \approx 3{,}89\ V$ ✓ (2)

8.3.1 Positive marking from 8.2.1 and 8.2.2

OPTION 1: (Formula) (4)

$\varepsilon = I(R + r)$ ✓

$\varepsilon = 1{,}22(5{,}2 + r)$ ✓

$\varepsilon = I(R + r)$

$\varepsilon = 3{,}24(1{,}2 + r)$ ✓

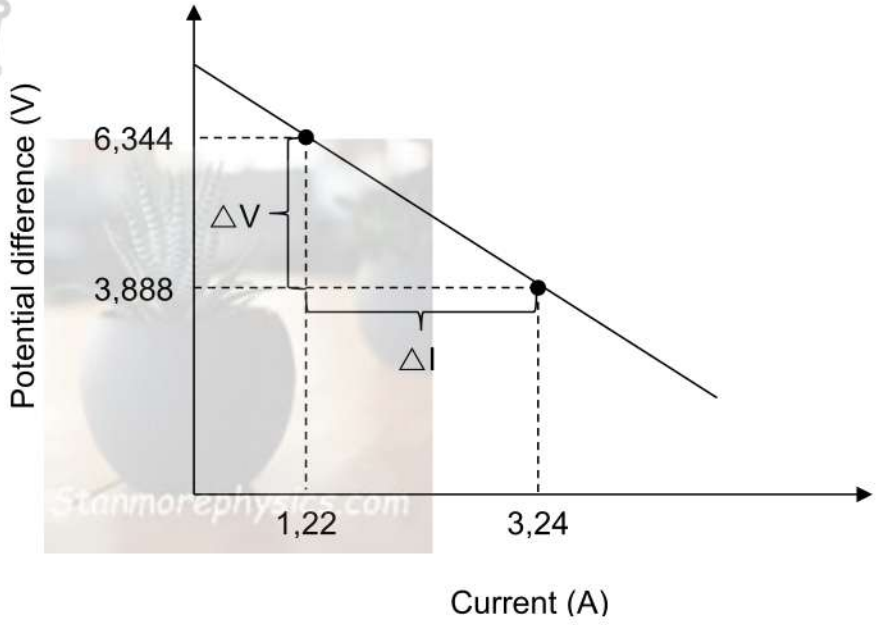
$1{,}22(5{,}2 + r) = 3{,}24(1{,}2 + r)$

$6{,}344 + 1{,}22r = 3{,}888 + 3{,}24r$

$2{,}456 = 2{,}02r$

$r = 1{,}22\ \Omega$ ✓

OPTION 2: (Graph)



$$r = \frac{\Delta V}{\Delta I} \checkmark = \frac{6,344-3,888}{1,22-3,24} \checkmark = \frac{2,456}{-2,02} \checkmark = -1,22\ \Omega \checkmark$$

8.3.2 Positive marking from 8.2.1 and 8.2.2 and as a result from 8.3.1

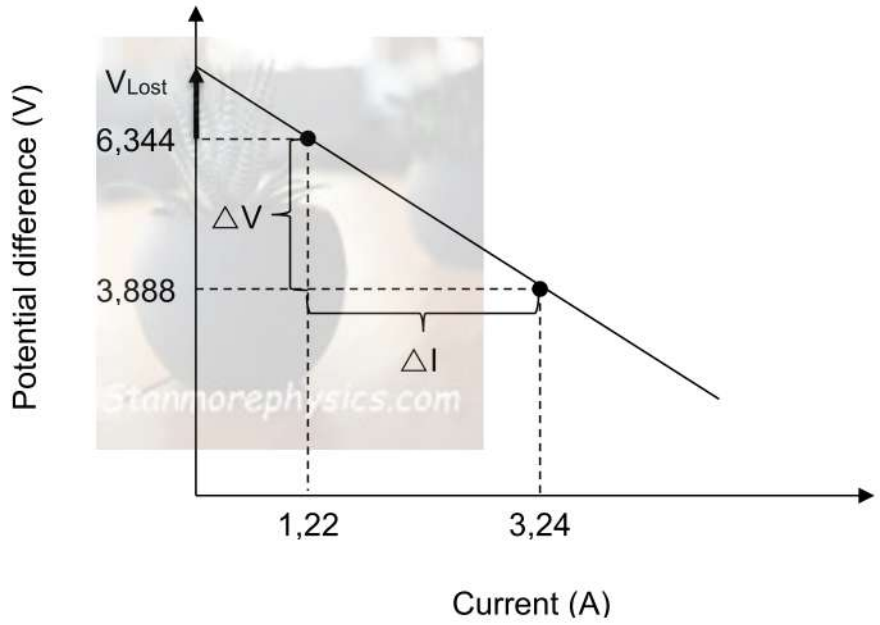
OPTION 1: (Formula) (2)

$\varepsilon = 1,22(5,2 + r) = 1,22(5,2 + 1,22) \checkmark = 7,83\ V \checkmark$

OR

$\varepsilon = 3,24(1,2 + r) = 3,24(1,2 + 1,22) \checkmark = 7,83\ V\ (7,84\ V) \checkmark$

OPTION 2: (Graph)



$r = \frac{V_{Lost}}{I}$

$1,22 = \frac{V_{Lost}}{1,22}$

V_{Lost} = 1,4884

ε = 6,344 + 1,4884 ✓

ε = 7,83 V ✓

$r = \frac{V_{Lost}}{I}$

$1,22 = \frac{V_{Lost}}{3,24}$

V_{Lost} = 3,9528

ε = 3,888 + 3,9528 ✓

ε = 7,84 V ✓

8.4 If the switch is CLOSED. ✓ (3)

TWO MARKS if a candidate understands the heating of a battery in terms of an increase in power (P) ✓ and that the power increases as the current increases. ✓

E.g.:

- When S is closed, the current increases from 1.22 A to 3.24 A.
- The heat developed in the battery's internal resistance is given by: $P = I^2r$
- Because the current is greater when S is closed, the internal power (and therefore heat development) is greater. Therefore, the battery gets warmer when the switch is closed.

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VRAAG 9

9.1 **RMS POTENTIAL DIFFERENCE:** The RMS potential difference is the AC potential difference that consumes/transfers the same amount of energy as an equivalent DC potential difference. ✓✓ (2)

9.2 DIRECT CURRENT ✓ (1)

9.3 Split ring commutator ✓ (1)

9.4 A to B ✓ (1)

9.5.1 $P_{average} = \frac{V_{rms}^2}{R}$ ✓ (3)

$(60) = \frac{(220)^2}{R}$ ✓

$R = 806{,}67\ \Omega$ ✓

9.5.2 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ (3)

$(220) = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = 311{,}13\ V$ ✓

9.6 The light bulb will suddenly shine very brightly and then burn out. ✓ (2)

Any one of the following two statements: ✓

- The induced peak voltage will increase (double).
- The Power of the bulb will increase ($P_{avearge} \propto V_{rms}^2$)

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QUESTION 10

10.1 **WORK FUNCTION:** The minimum energy required to release an electron from the surface of a metal. ✓✓ (2)

10.2 $E = h\frac{c}{\lambda}$ ✓ (6)

$E = (6{,}63x10^{-34})\frac{(3x10^{8})}{(200x10^{-9})}$ ✓

$E = 9{,}945 \times 10^{-19}$ ✓

$E = W_0 + E_{K(max)}$ ✓

$(9{,}945 \times 10^{-19}) = (7{,}57 \times 10^{-19}) + E_{K(max)}$ ✓

$E_{K(max)} = 2{,}375 \times 10^{-19}$ J ✓

10.3 A ✓ (1)

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