Student Number: _____

North Sydney Boys High School

Science Faculty

Year 11 Physics 2025

Yearly Examination

General Instructions:

Reading time – 5 minutes
Working time – 120 minutes

- Attempt all questions
- Written answers **MUST** be in black or blue pen
- Draw diagrams using a pencil
- NESA-approved calculators may be used
- This paper has three sections
- Write your student number at the top of this page
- A NESA data sheet will be provided.
- Write clearly. Illegible answers may not be marked.
- Use the extra writing pages at the end before asking for a separate booklet.

Total Marks - 70 marks

Section A: Multiple Choice
- Questions 1 to 20
- 20 marks

Section B: Working Scientifically
- Questions 21 to 22
- 17 marks

Section C: Extended Response KU
- Questions 23 to 28
- 36 marks

Section A	20	
Section B	17	
Section C	36	
WS	23	
KU	50	
Total Marks	**73**	

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Part A - Multiple Choice (20 marks)
Attempt Questions 1 - 20
Circle the correct answer. If you change your answer, indicate your answer clearly.

Q1. Which word best describes the motion of the medium as a mechanical wave passes?

- **A.** Displaced
- **B.** Oscillated
- **C.** Refracted
- **D.** Superposed

Q2. Beat frequencies are heard because of the:

- **A.** Superposition of sound waves.
- **B.** Doppler effect in sound waves.
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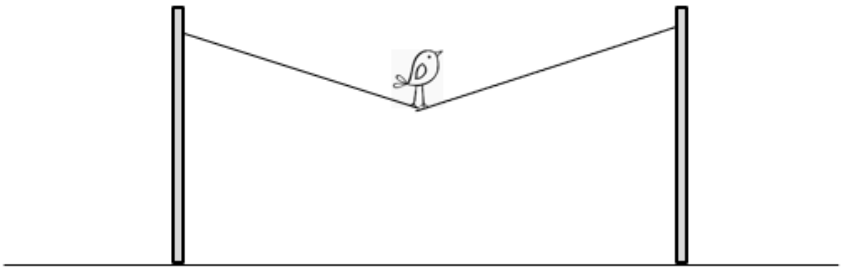
Q3. Which statement best describes the magnetic field surrounding a long, straight, current-carrying conductor?

- **A.** Circular around the wire, decreasing in strength inversely proportional to the perpendicular distance from the wire.
- **B.** Spiral in shape around the wire in the direction of the current flow in the wire.
- **C.** Directed radially outwards from the wire, perpendicular to the wire.
- **D.** Parallel to the wire, decreasing in strength inversely proportional to the distance from the wire.

Q4. A bird is sitting on a wire as shown.



Assuming the mass of the wire to be negligible and inextensible, which statement is correct?

A. The tension in the wire is equal to the weight of the bird.

B. The tension in the wire equals half the weight of the bird.

C. The tension in the wire is greater than the weight of the bird.

D. The tension in the wire is less than the weight of the bird.

Q5. A cyclist rides at a velocity of 8.0 ms^{-1} south before turning a corner to travel west while maintaining the same speed. If the vector for south is down the page, which of the following vectors represents the change in velocity of the cyclist?

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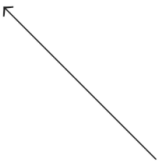
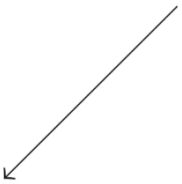
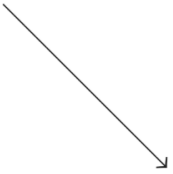
B.



C.



D.



Q6. An athlete completed a 5.00 km race with an average speed of 5.81 ms^{-1}. How long did it take the athlete to complete the race?

A. 29.1 s

B. 861 s

C. 2910 s

D. 29 050 s

Q7. In a parallel circuit with identical resistors, which of the following is true?

A. The current is not the same through all branches.

B. The total resistance is greater than any individual resistor.

C. The voltage across each resistor is the same.

D. The battery voltage is divided between branches.

Q8. A taxi driver, moving at 36 km/h North, sees an ambulance approaching, driving at 72 km/h South. Part of the siren signal is emitted at 900 Hz.

What frequency would the taxi driver detect that part of the signal?

A. 820 Hz

B. 880 Hz

C. 930 Hz

D. 980 Hz

Q9. A person with a mass of 70.0 kg stands on a scale in an elevator accelerating upward at 2.00 ms^{-2}. What does the scale read?

A. 560 N

B. 686 N

C. 140 N

D. 826 N

Q10. A person standing at the beach sees a flash of lightning strike the ocean. 4.5 seconds later, the person hears the thunder from the lightning. The time for light to reach the person and their approximate distance from where the lightning struck the water are respectively:

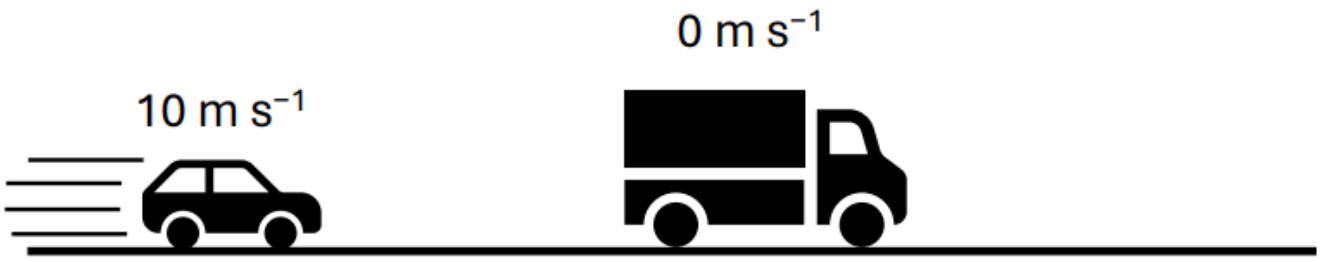
A. t = 4. 5 s, d = 1.35 km

B. t = 1. 5 $\times$ 10^{-5}s, d = 4.5 km

C. t = 5.1 $\times$ $10^{-6}s$, d = 1.53 km

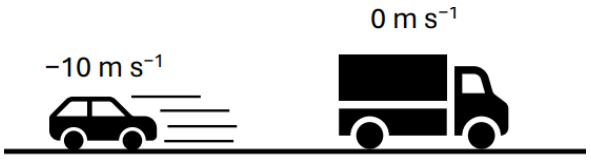
D. t = 3.7 $\times$ $10^{-3}s$, d = 1.44 km

Q11. A 500 kg car collides with a stationary 4500 kg truck as shown in the diagram below.



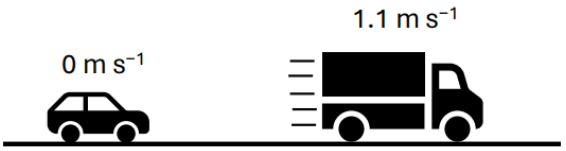
Which of the outcomes below shows an elastic collision?

A.

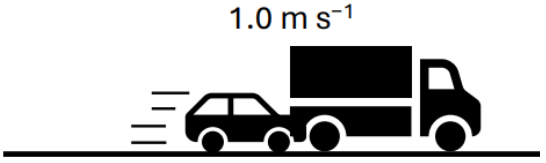


B.

C.

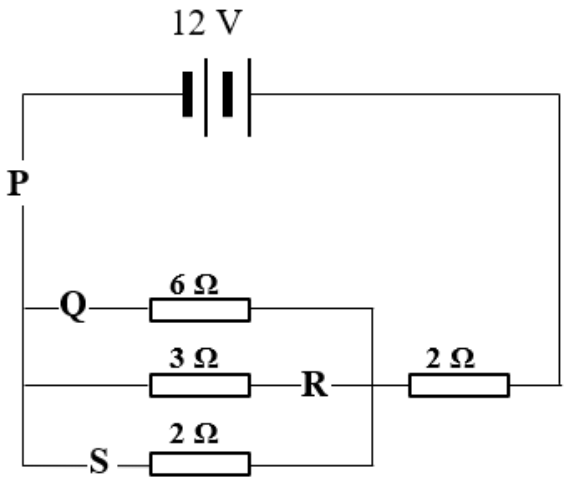


D.



Assessment continues on the next page

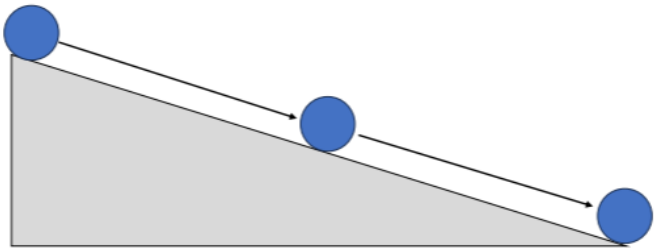
Q12. A circuit is constructed using a 12 volt battery and several resistances, as shown.



In which position in the circuit shown will a globe be using the most amount of electrical energy per second?

A. Position P
B. Position Q
C. Position R
D. Position S

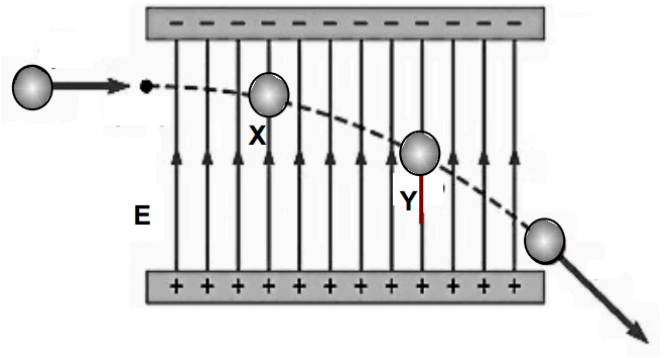
Q13. A ball rolls down a ramp of length L from rest with no friction, air resistance or any forces that impede motion. When the ball is half-way down the ramp it has a velocity of $v_{1/2}$. At the bottom of the ramp its velocity is v_f . Its average velocity is v_{avg} . The time it takes to roll down the ramp is t and it has a constant acceleration of a.



Which of the following statements are correct?

A. $v_f = 2 \times v_{1/2}$
B. $v_f = 2 \times v_{avg}$
C. $L = v_f \times t$
D. $a = v_{avg} \div t$

Q14. The diagram shows a charged particle moving through an electric field. Two positions, X and Y, of the particle on its passage through the field are labelled.



Which statement about this situation is correct?

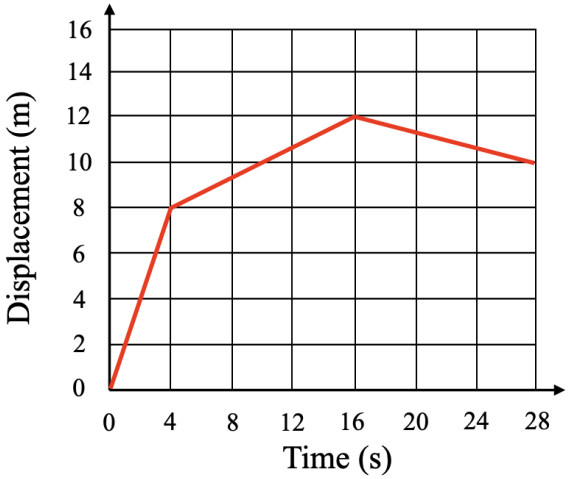
A. The particle is negatively charged and the force on it at X is less than the force on it at Y.

B. The particle is positively charged and the force on it at X is less than the force on it at Y.

C. The particle is negatively charged and the force on it at X is the same as the force on it at Y.

D. The particle is negatively charged and the force on it at X is greater than the force on it at Y.

Q15. The graph below shows an object's displacement over time.



What is the average velocity of the object during this time?

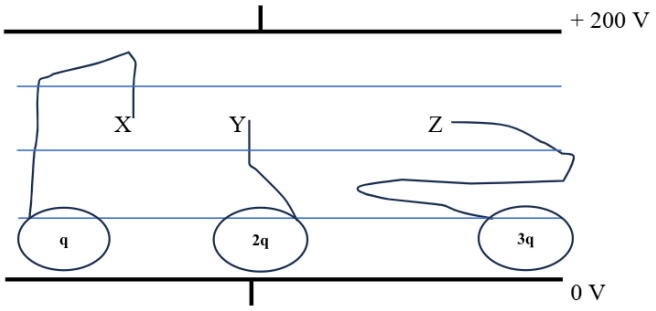
A. $0.36\ ms^{-1}$

B. $0.50\ ms^{-1}$

C. $0.58\ ms^{-1}$

D. $0.72\ ms^{-1}$

Q16. Three differently charged particles (X, Y and Z) of equal mass are moved against a uniform electric field, along random paths to a new position, as shown below:



Which of the following statements is true?

A. The most work is done on particle X because it moves through a greatest potential difference.

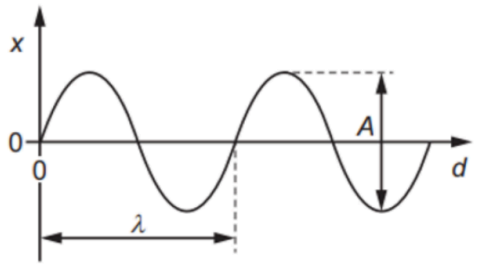
B. They all end up at the same equipotential, so the work done is the same for all three charged particles.

C. Less work is done to move particle Y because its path is the shortest.

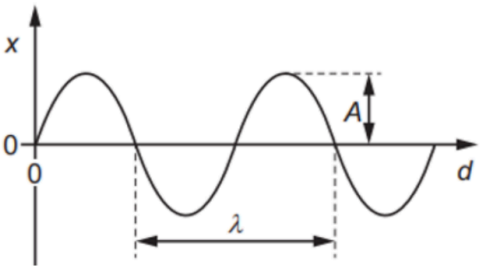
D. More work is done to move particle Z because it has the greatest charge.

Q17. Which of the following graphs correctly shows a wave with period T, wavelength λ, and amplitude A?

A.



B.



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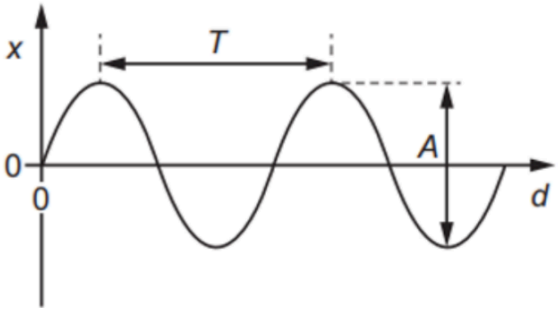
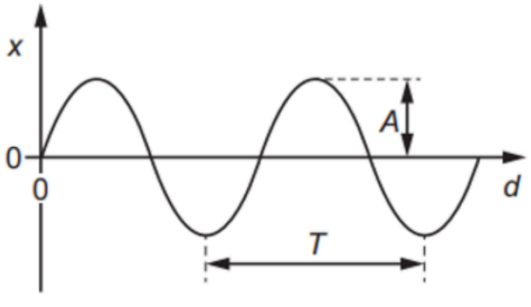
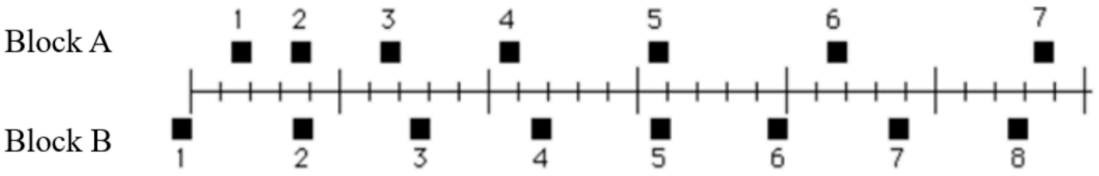


D.



Q18. The positions of Block A and Block B at successive 0.20 second time intervals are represented by the numbered squares in the figure below. The blocks are moving towards the right.



When do blocks A and B travel at the same speed throughout the journey?

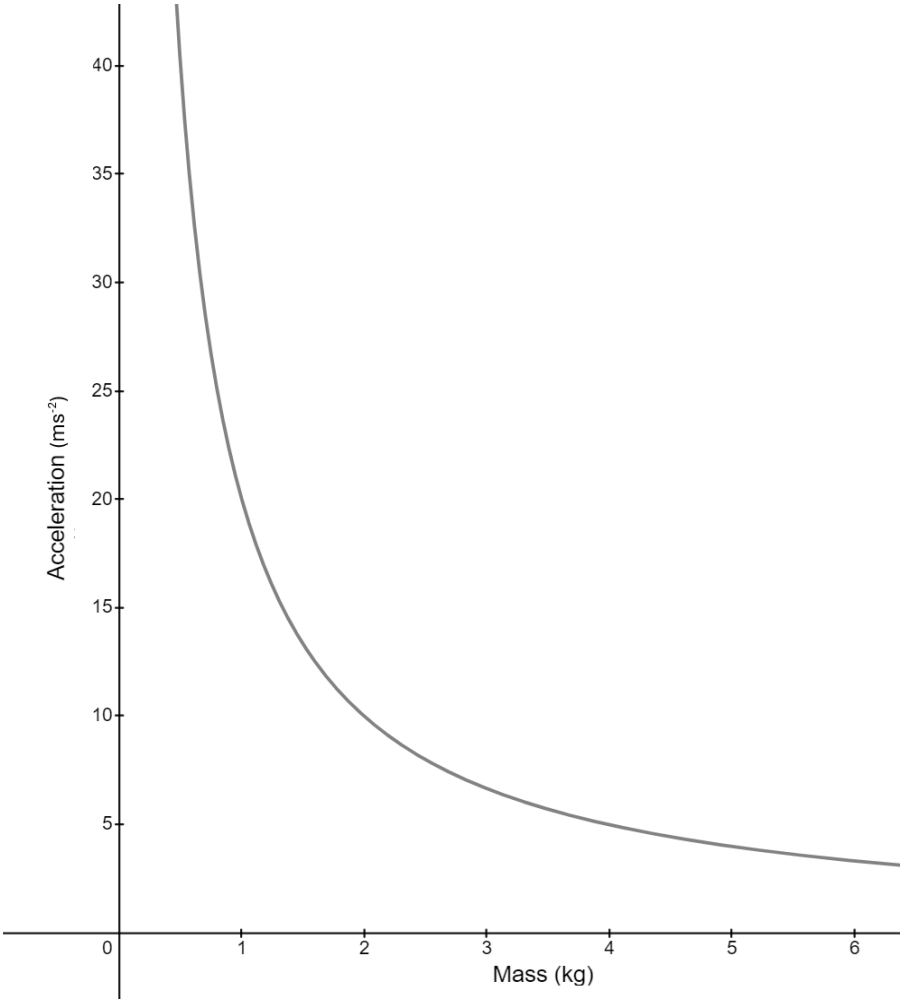
A. Between intervals 3 and 4.

B. Between intervals 4 and 5.

C. Between intervals 5 and 6.

D. Between intervals 6 and 7.

Q19. Consider the following relationship.



Given that the force being applied in this relationship is constant, determine the magnitude of the applied force.

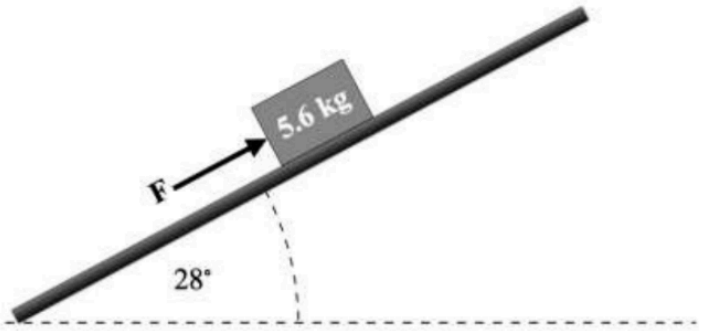
A. 15 N

B. 20 N

C. 25 N

D. 30N

Q20. The diagram below shows a block on a slope being held in place by the smallest possible force.



If the coefficient of friction between the slope and the block is 0.5, determine the force of friction acting on the box.

A. 26.0 N up the slope.

B. 11.5 N down the slope.

C. 27.5 N down the slope.

D. 24.0 N up the slope.

End of Part A.

Part B continues on the next page.

Part B - Working Scientifically Skills (17 marks)
Attempt Questions 21 - 22
Use the space provided to answer the questions.

Q21. A student is timing a remote-controlled car moving along a straight track **2**

A. The car starts from rest and accelerates uniformly to 4.0 ms^{-1} over a distance of 8.0m.

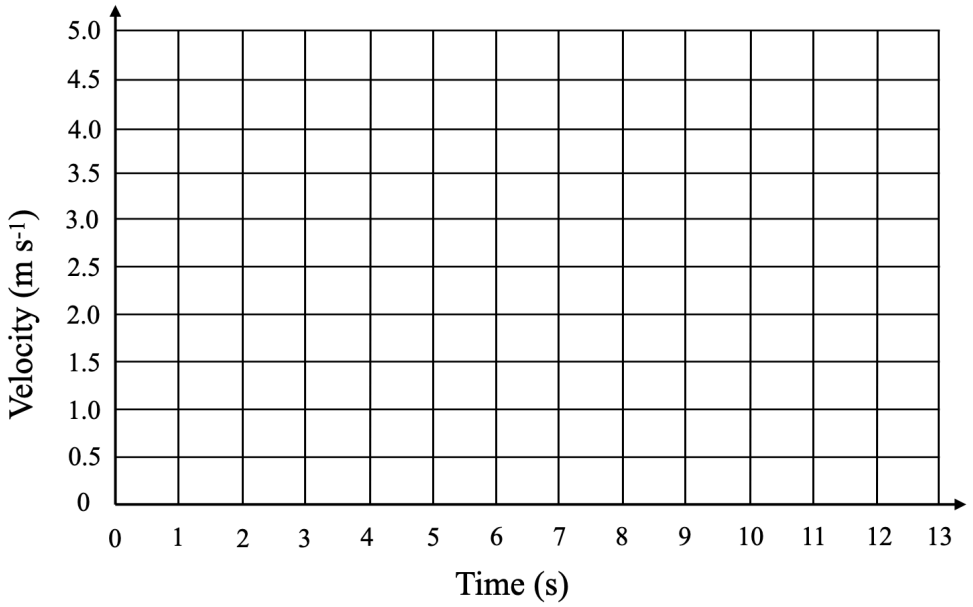
Calculate the car's acceleration.

B. The student plots a velocity-time graph for the motion in part A above to determine displacement. The student notices discrepancies between the calculated displacement from the graph and the measured displacement using a metre ruler. **3**

Identify two possible errors in the measurement and explain how each affects the validity of the experiment.

C. After reaching 4.0 ms^{-1}, the car continues at this speed for 5.0 seconds, then suddenly decelerates uniformly to a stop over 2.0 seconds. **3**

On the graph below, sketch a velocity-time graph of the entire motion from start to stop.



D. Calculate the total displacement of the journey in the first 10 seconds. Assume all values in the graph are 2 significant figures. **2**

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Q22. Design an investigation to explore the relationship between the average power required to move a dynamics trolley up an inclined plane at varied angles (15°, 30°, & 60°). In your response, provide an indication of the relevant formulas, variables and ways to ensure the results are accurate and reliable. Ensure to include a sample calculation of the average power in your response. **7**

Assessment continues on the next page

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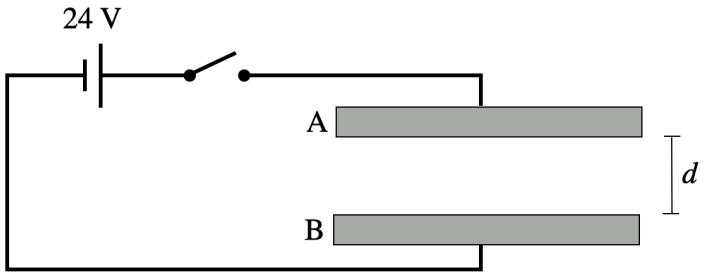
Part C - Knowledge and Understanding (36 marks)
Attempt Questions 23 - 28
Use the space provided to answer the questions.

Q23. Below shows two parallel plates, A and B, connected to a power supply and switch. Plate A sits horizontally above plate B. **4**



A single electron is placed between the plates. When the switch is closed, the electron is observed to accelerate at $4.2 \times 10^{12}\ ms^{-2}$ towards plate A. (Assume gravitational effects are negligible).

Determine the distance between the two plates.

Q24.

A. Compare the characteristics and behaviour of mechanical and electromagnetic waves. Provide one example of each wave. **4**

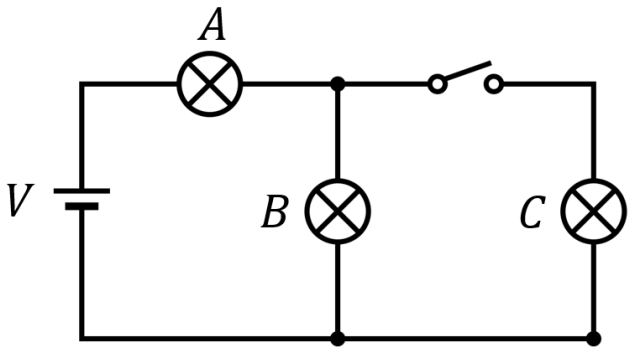
B. Explain how sound waves produce beats. Use a labelled diagram in the box provided to support your answer. **4**

Q25. Two cars collide on a straight road. Car A has a mass of 987.76 kg and is moving at $15.0\ ms^{-1}$. Car B has a mass of 1271.24 kg and is stationary. After the collision, the two cars lock together and move as one. **4**

Determine the kinetic energy lost during the collision.

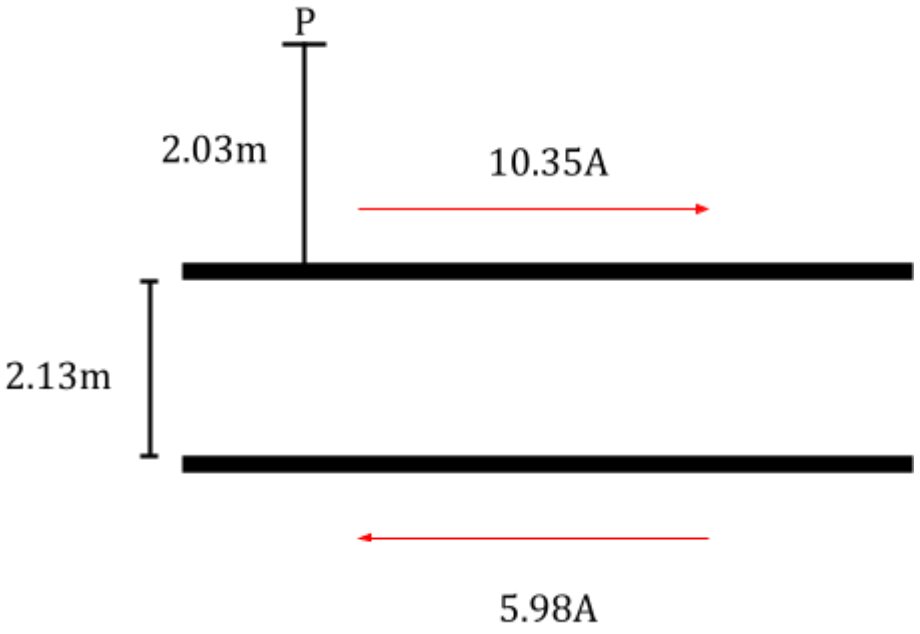
Q26.

A. The circuit below consists of 3 identical light bulbs, A, B, C connected to a voltage source, V and a switch. **2**



Compare qualitatively, the brightness of the bulbs A, B and C when the switch is closed.

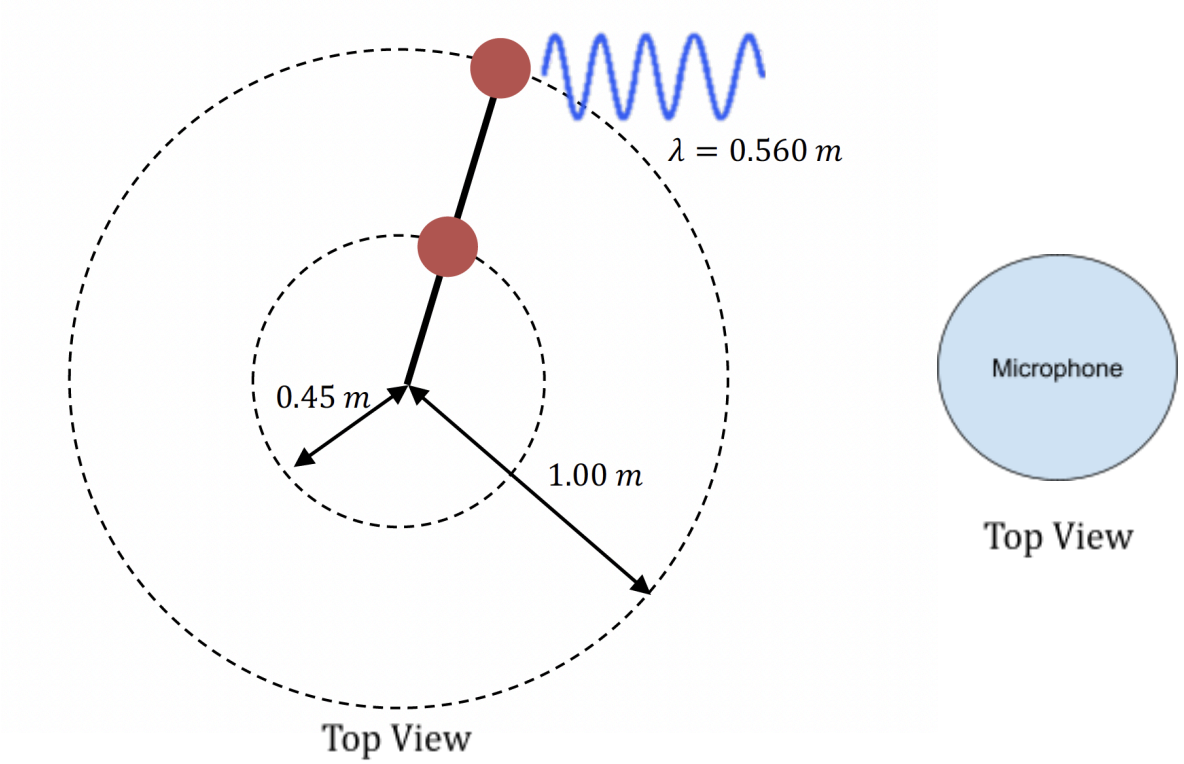
B. A straight current-carrying conductor is carrying a current of 10.35A and another conductor parallel to it carries a current of 5.98A in the opposite direction as shown below: **3**



Calculate the net magnetic field at the Point P

This has intentionally been left blank.

Q27. A student swings two sound emitters, attached to the same string, around in a horizontal motion so that they sweep out an anticlockwise circle with a constant velocity in uniform circular motion. Objects moving in uniform circular motion have a velocity that is tangential to the circle. The emitters are at a distance of 0.45 m and 1.00 m from the student's hand. Both emitters produce a sound wave with a wavelength of 0.560m. A microphone is placed a distance away from the student and measures the wavelengths of the emitted sound as the string is swung. Both emitters will swing with the same period. **2**



A. Draw a diagram that shows the position of the 1.00m emitter when the microphone measures:

i. A wavelength of 0.560m.	ii. The smallest wavelength produced

B. When the emitter at 1.00 m is turned on, the microphone measures a range of wavelengths varying between 0.536 m and 0.584 m. The emitter at 1.00 m is turned off and the emitter at 0.45 m is turned on. The student resumes swinging the string so that the 1.00 m emitter resumes moving at the same speed. The period for objects swinging in uniform circular motion can be calculated using the following formula: **5**

$$T = \frac{2\pi r}{v}$$ where:

T = Period (s)

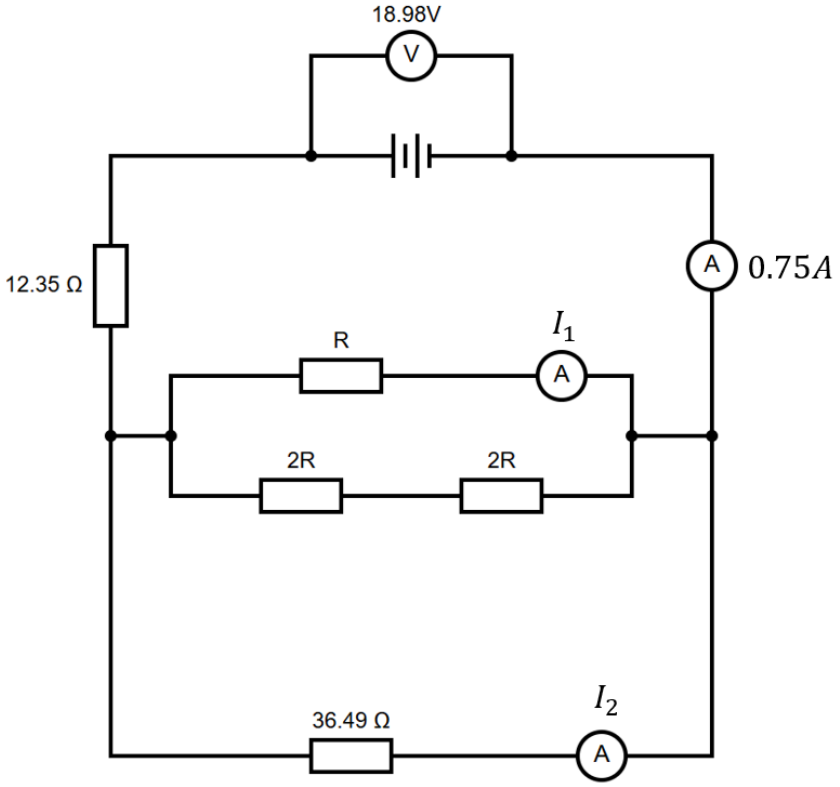
r = Radius of the circle (m)

v = velocity of the object (m/s)

Calculate the range of wavelengths the microphone will measure.

Q28 continues on the next page.

Q28. The circuit shown below consists of a power supply with negligible internal resistance, connected to three resistors of varying resistances. **8**



Calculate the values of I_1, I_2, R *and hence* R_{total} of the entire circuit. Show all relevant working.

End of Examination

Additional Writing Page. Indicate question number and part clearly.

Assessment continues on the next page

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Part A - Multiple Choice (20 marks)

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Circle the correct answer. If you change your answer, indicate your answer clearly.

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- **A.** Displaced
- **B.** Oscillated
- **C.** Refracted
- **D.** Superposed

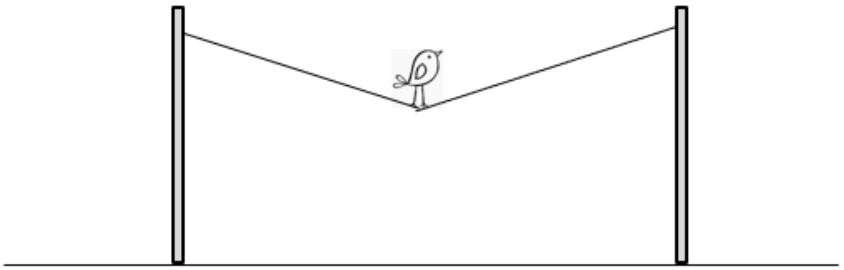
Q2. Beat frequencies are heard because of the:

- **A.** Superposition of sound waves.
- **B.** Doppler effect in sound waves.
- **C.** Refraction of sound waves.
- **D.** Difference in speeds of sound waves.

Q3. Which statement best describes the magnetic field surrounding a long, straight, current-carrying conductor?

- **A.** Circular around the wire, decreasing in strength inversely proportional to the perpendicular distance from the wire.
- **B.** Spiral in shape around the wire in the direction of the current flow in the wire.
- **C.** Directed radially outwards from the wire, perpendicular to the wire.
- **D.** Parallel to the wire, decreasing in strength inversely proportional to the distance from the wire.

Q4. A bird is sitting on a wire as shown.



Assuming the mass of the wire to be negligible and inextensible, which statement is correct?

A. The tension in the wire is equal to the weight of the bird.

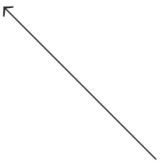
B. The tension in the wire equals half the weight of the bird.

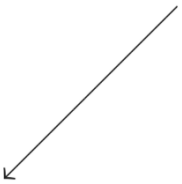
C. The tension in the wire is greater than the weight of the bird.

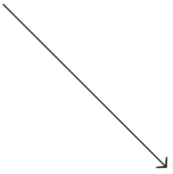
D. The tension in the wire is less than the weight of the bird.

Q5. A cyclist rides at a velocity of 8.0 ms^{-1} south before turning a corner to travel west while maintaining the same speed. If the vector for south is down the page, which of the following vectors represents the change in velocity of the cyclist?

A. 

B. 

C. 

D. 

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B. The total resistance is greater than any individual resistor.

C. The voltage across each resistor is the same.

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What frequency would the taxi driver detect that part of the signal?

A. 820 Hz

B. 880 Hz

C. 930 Hz

D. 980 Hz

Q9. A person with a mass of 70.0 kg stands on a scale in an elevator accelerating upward at 2.00 ms^{-2}. What does the scale read?

A. 560 N

B. 686 N

C. 140 N

D. 826 N

Q10. A person standing at the beach sees a flash of lightning strike the ocean. 4.5 seconds later, the person hears the thunder from the lightning. The time for light to reach the person and their approximate distance from where the lightning struck the water are respectively:

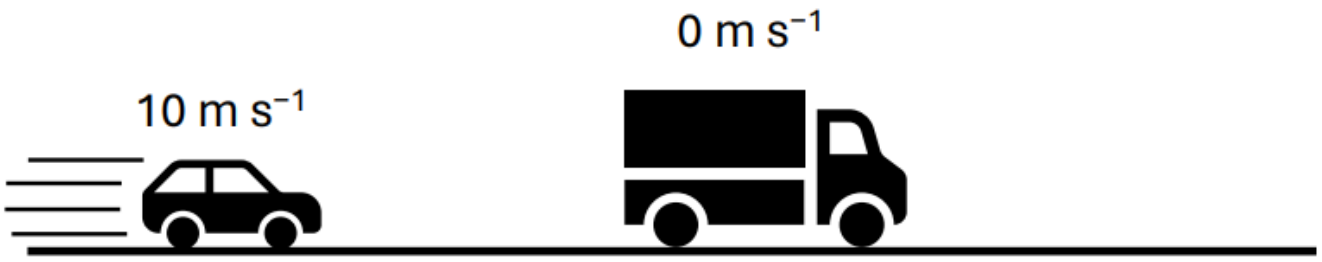
A. t = 4. 5 s, d = 1.35 km

B. t = 1. 5 $\times$ 10^{-5}s, d = 4.5 km

C. t = 5.1 $\times$ $10^{-6}s$, d = 1.53 km

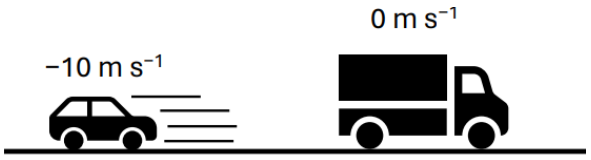
D. t = 3.7 $\times$ $10^{-3}s$, d = 1.44 km

Q11. A 500 kg car collides with a stationary 4500 kg truck as shown in the diagram below.



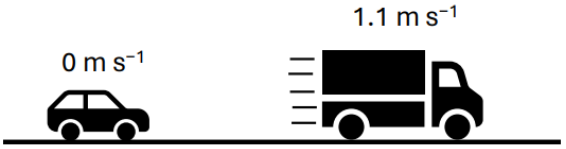
Which of the outcomes below shows an elastic collision?

A.

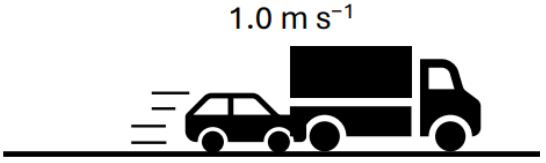


B.

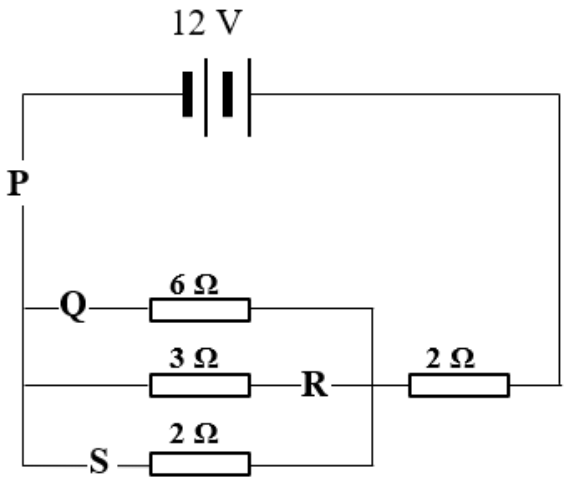
C.



D.



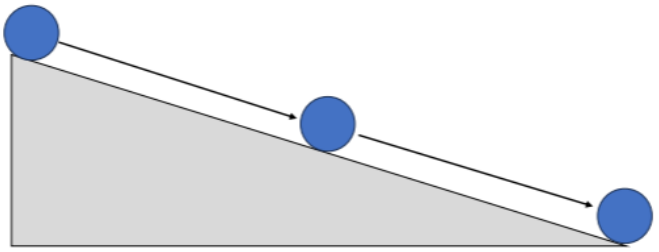
Q12. A circuit is constructed using a 12 volt battery and several resistances, as shown.



In which position in the circuit shown will a globe be using the most amount of electrical energy per second?

A. Position P
B. Position Q
C. Position R
D. Position S

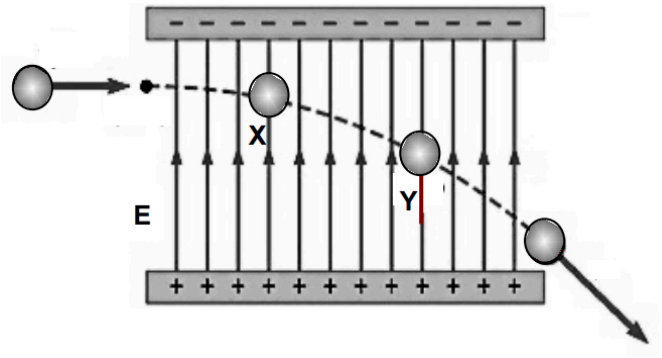
Q13. A ball rolls down a ramp of length L from rest with no friction, air resistance or any forces that impede motion. When the ball is half-way down the ramp it has a velocity of $v_{1/2}$. At the bottom of the ramp its velocity is v_f . Its average velocity is v_{avg} . The time it takes to roll down the ramp is t and it has a constant acceleration of a.



Which of the following statements are correct?

A. $v_f = 2 \times v_{1/2}$
B. $v_f = 2 \times v_{avg}$
C. $L = v_f \times t$
D. $a = v_{avg} \div t$

Q14. The diagram shows a charged particle moving through an electric field. Two positions, X and Y, of the particle on its passage through the field are labelled.



Which statement about this situation is correct?

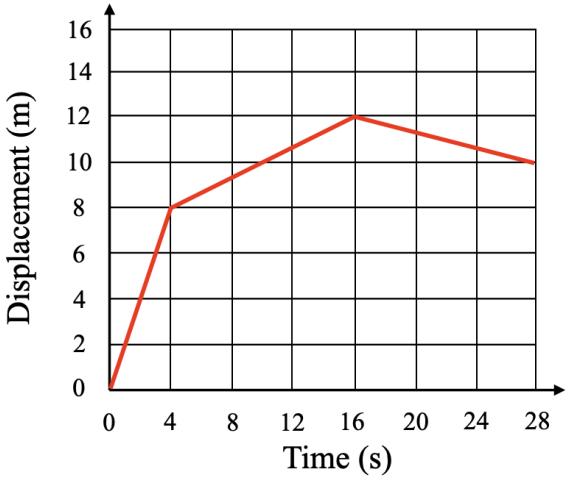
A. The particle is negatively charged and the force on it at X is less than the force on it at Y.

B. The particle is positively charged and the force on it at X is less than the force on it at Y.

C. The particle is negatively charged and the force on it at X is the same as the force on it at Y.

D. The particle is negatively charged and the force on it at X is greater than the force on it at Y.

Q15. The graph below shows an object's displacement over time.



What is the average velocity of the object during this time?

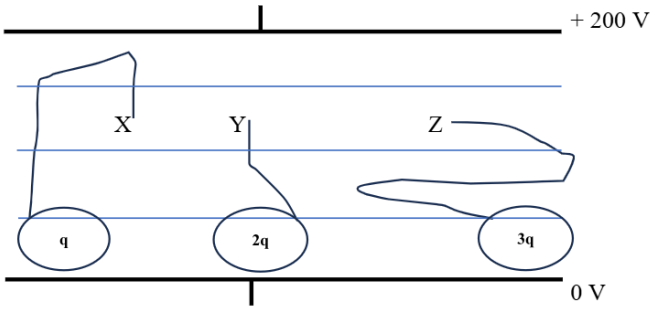
A. $0.36\ ms^{-1}$

B. $0.50\ ms^{-1}$

C. $0.58\ ms^{-1}$

D. $0.72\ ms^{-1}$

Q16. Three differently charged particles (X, Y and Z) of equal mass are moved against a uniform electric field, along random paths to a new position, as shown below:



Which of the following statements is true?

A. The most work is done on particle X because it moves through a greatest potential difference.

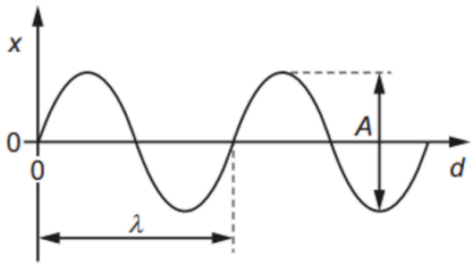
B. They all end up at the same equipotential, so the work done is the same for all three charged particles.

C. Less work is done to move particle Y because its path is the shortest.

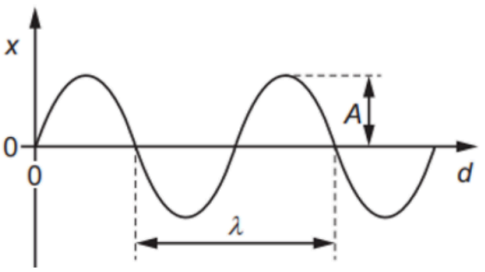
D. The most work is done on particle Z because it has the greatest charge.

Q17. Which of the following graphs correctly shows a wave with period T, wavelength λ, and amplitude A?

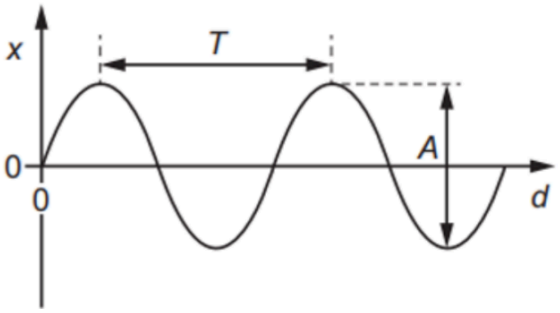
A.



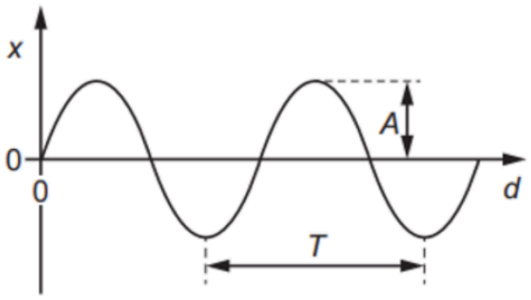
B.



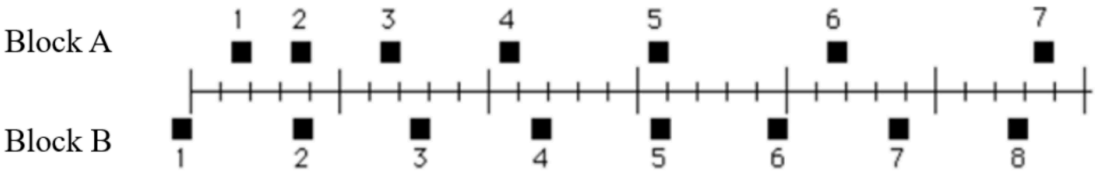
C.



D.



Q18. The positions of Block A and Block B at successive 0.20 second time intervals are represented by the numbered squares in the figure below. The blocks are moving towards the right.



When do blocks A and B travel at the same speed throughout the journey?

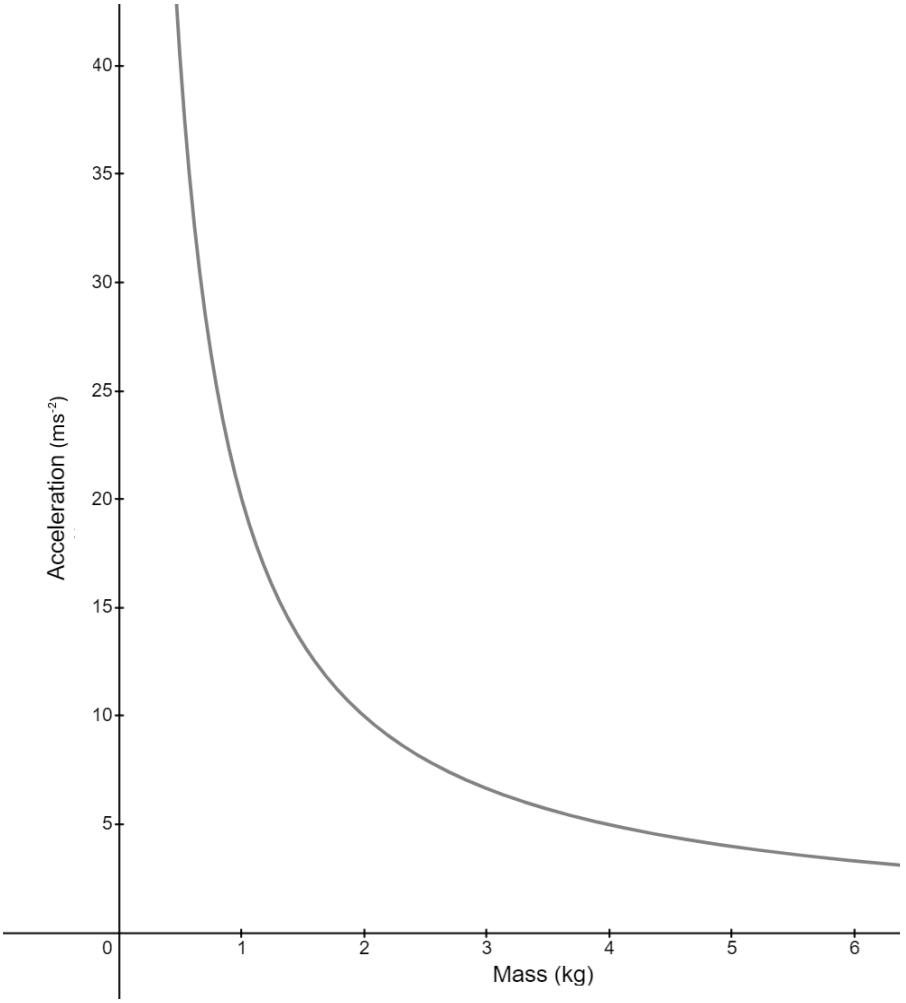
A. Between intervals 3 and 4.

B. Between intervals 4 and 5.

C. Between intervals 5 and 6.

D. Between intervals 6 and 7.

Q19. Consider the following relationship.



Given that the force being applied in this relationship is constant, determine the magnitude of the applied force.

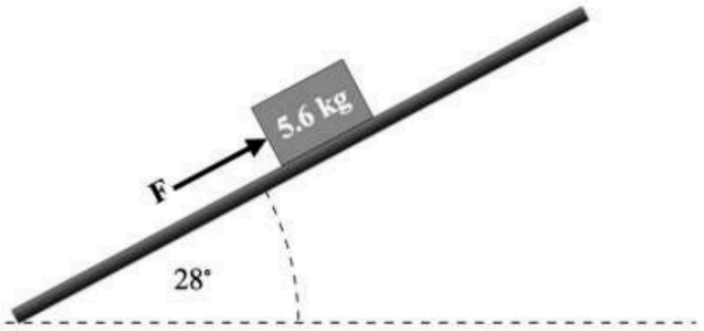
A. 15 N

B. 20 N

C. 25 N

D. 30N

Q20. The diagram below shows a block on a slope being held in place by the smallest possible force.



If the coefficient of friction between the slope and the block is 0.5, determine the force of friction acting on the box.

A. 26.0 N up the slope.

B. 11.5 N down the slope.

C. 27.5 N down the slope.

D. 24.0 N up the slope.

End of Part A.

Part B continues on the next page.

Part B - Working Scientifically Skills (17 marks)
Attempt Questions 21 - 22
Use the space provided to answer the questions.

Q21. **2**

A.

$v^2 = u^2 + 2as$

$a = \frac{v^2 - u^2}{2s} = \frac{4^2 - 0^2}{2 \times 8}$

$a = 1.0$ m s^{-2} in the forwards direction **- 2 marks (must include direction)**

Criteria	Marks
Correctly calculates the acceleration and includes direction.	2
Shows relevant working.	1

B. **3**

Criteria	Marks
Provides two valid errors for the discrepancy, and clearly identifies how each affects the validity.	3
Provides one valid and clearly explained reason, and partially explains how it affects validity. OR Provides two reasons with limited explanation.	2
Identifies one possible reason with minimal or unclear explanation.	1

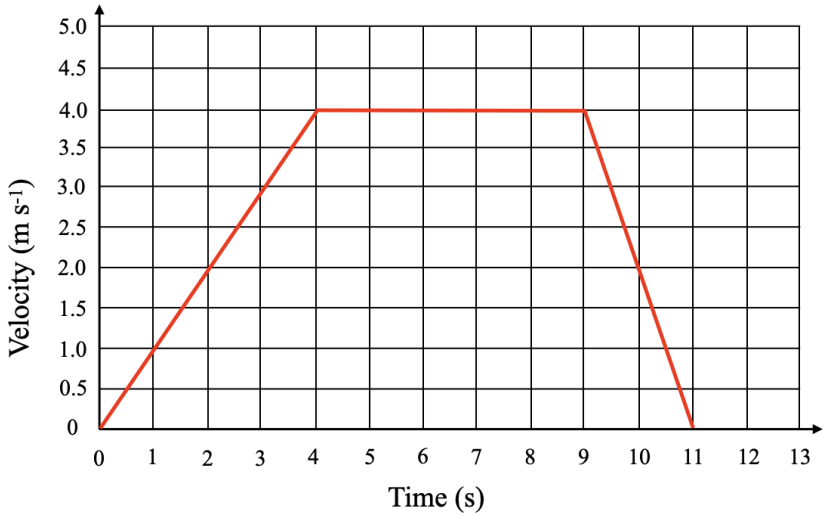
Sample Answer:

Validity of the experiment refers to whether the experiment is a fair test of the aim. It may be affected due to systematic errors due to a decrease in accuracy. Accuracy is defined as how close the measured values are to the true/ theoretical value. A possible error in the measurement may be due to parallax error and misalignment of the ruler when measuring displacement values. This may cause a systematic error which may reduce the accuracy of the measurements, which will reduce the validity of the experiment.

In addition, another error may be incorrectly reading or plotting points on the velocity-time graph. This systematic error may decrease the accuracy of the calculated displacement. Consequently, it will reduce the validity of the experiment as it is no longer a fair test of the aim.

Assessment continues on the next page

C. **3**



D. **2**

$A = \frac{4}{2}(9 + 5) + \frac{1}{2}(4 + 2) = 31m$ **- 2 marks**

7

Q22.

Variables - 3 marks

- Independent: Angle of the incline (15°, 30°, 60°)
- Dependent: Average power required to move the trolley up the incline
- Controlled: Mass of trolley, surface of ramp, string length, pulley type and distance travelled by the trolley

Method - 4 marks

1. Attach the trolley to a light, inextensible string passing over a pulley at the top of the

ramp, with a hanging mass of 0.25 kg on the other end. Ensure the back of the trolley is at the bottom of the ramp.

2. Set the ramp angle to 15° and mark a distance of 1.50 m along the incline. This is when the back wheels of the trolley would have travelled 1.50 m (from the bottom of the ramp to that mark).

3. Release the trolley so that the hanging mass pulls it up the ramp at constant speed. Adjust the mass if necessary to maintain steady motion.

4. Record the time for the trolley to travel the 1.50 m distance. Repeat three times and calculate the average.

5. Calculate average velocity: $v = \frac{s}{t} = \frac{1.5}{3} = 0.5ms^{-1}$

6. Calculate the pulling force: $F = m_{hang} \times g = 0.25 \times 9.8 = 2.45N$

7. Calculate average power: $P_{avg} = F \times v = 2.45 \times 0.5 = 1.23W$

8. Repeat steps 2–7 for ramp angles of 30° and 60°.

9. **Accuracy/reliability considerations:** Use a low-friction pulley, measure distances at eye level to avoid parallax, conduct at least three trials per angle to check for reliability, maintain constant trolley speed, and keep trolley mass and surface consistent across all trials.

Criteria	Marks
All variables correctly identified, the method fully describes investigation for all angles, includes sample calculation with correct formulas, and explains accuracy and reliability considerations.	7
Most variables correctly identified, method mostly complete for all angles, includes sample calculation and formulas, and includes some accuracy/reliability considerations. **OR: lacks detail in one area**	6
Variables mostly correct, method complete for some angles, sample calculation or formulas included, some accuracy/reliability considerations. **OR: lacks detail in two areas**	5
Some variables identified, method partially described, sample calculation or formula included, limited accuracy/reliability considerations **OR: only partially addresses multiple elements**.	4
One or two variables identified, method outlined vaguely, limited or no	3

calculation/formula, minimal reference to accuracy/reliability **OR: only addresses one element clearly.**	
One variable identified, method minimal, no calculation/formula, minimal relevance to accuracy/reliability **OR: largely incomplete across multiple elements**.	2
Something relevant is written	1

Marker's comments:

- Poor handwriting and formatting overall.
- **Read the question carefully.** Some students wrote methods where the trolley is travelling DOWN the ramp. Many students didn't indicate variables.
- Identifying the dep variable as "time taken…" cf. "avg power…" were not penalised since it's still a measurable variable impacted by the indep variable. Recall that a dep variable is one that we can either test (power) or measure (time), and that an experiment can have more than one.
- In "Method" (4 marks), if any of these sections are lacking will be penalised: formulas (1), accuracy AND reliability improvements (1), method (1), sample calculation (1).
- In "Variables" (3 marks), marks lost due to incorrect/vague/none variables identified.
- Some students were designing unrealistic and unscientific methods. e.g. "applying 100N on a dynamics trolley" is unrealistic. Some students also provided vague steps e.g. apply force without specifying the equipment required.
- Some misuse of formulas. Remember that in $P = mg\Delta h/t$, this is only relevant when the object is moving at a constant velocity and the work is done against gravity only, otherwise KE needs to be considered. In $P = Fvcos\theta$, this is the angle made by F and v, not the angle of inclination of the ramp. Carry on error from incorrect formulas to sample calculations unless reasoning provided is incorrect also.
- Many students need to revise on accuracy vs reliability. Some redundant mentions of validity. Recall that repeating trials doesn't increase reliability but checks for it. Well done to those who correctly defined reliability and accuracy.
- Human error is not a source of experimental error so it's irrelevant. Errors (or sources of error) can never be completely removed, it can only be minimised and mitigated.

Part C - Knowledge and Understanding (36 marks)
Attempt Questions 23 - 28
Use the space provided to answer the questions.

Q23. **4**

$F_{net} = F_E - F_g\ (F_g\ is\ negligible)$

$F_{net} = F_E$ **- 1 mark**

$ma = qE$ **- 1 mark**

$ma = q \times \frac{V}{d}$ **- 1 mark**

$\frac{V}{d} = \frac{ma}{q}$

$\therefore d = \frac{qV}{ma} = \frac{1.602\times10^{-19}\times24}{9.109\times10^{-31}\times4.2\times10^{12}} = 1.0m\ (2sf)$ **- 1 mark**

Marker's comments

- Poor handwriting and sequencing of working- many papers were illegible. Additionally it is good practice to not have more than one equal sign per line.
- Many students lost the first mark (i.e. first two lines of working above), and the second mark (3rd line).
- If students equated $qE = ma$ directly (i.e. they subbed in qE for ma in the next line), it is not penalised this time however it is important to communicate to the marker why you are subbing in values. Some students were able to provide clear derivations, some subbed in equalities with no context provided. If there are too many steps skipped, it has been penalised.
- Some students used the work equation successfully to solve this question.

Q24.

4

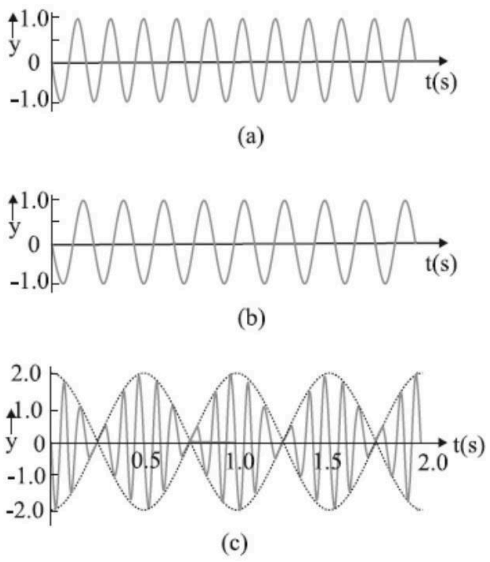
Mechanical and electromagnetic waves both transfer energy, but they differ in their formation and the way oscillations occur. Mechanical waves are created by the vibration of particles in a medium, and these particles oscillate either perpendicular to the direction of energy propagation in transverse waves or parallel in longitudinal waves. In contrast, electromagnetic (EM) waves consist of oscillating electric and magnetic fields at right angles to each other and to the direction of wave propagation, and they do not require a medium, allowing them to travel through space. Despite these differences, both mechanical and EM waves can exist as transverse waves and share the fundamental property of energy transfer. Examples of mechanical waves include water waves and sound waves, while examples of electromagnetic waves are visible light and radio waves.

Criteria	Marks

Provide similarities and differences Describes the composition, structure and behaviour of both mechanical and EM waves	4
Provides a similarity and difference Outlines the composition, structure and/or behaviour of both mechanical and EM waves	3
Compares two features of mechanical and EM waves	2
Provides some relevant information	1

A. **4**

Beats are produced when two sound waves of slightly different frequencies are superimposed. Because the frequencies are closely spaced, the waves periodically align in phase, resulting in constructive interference, and periodically oppose each other, resulting in destructive interference. During constructive interference, the resultant wave exhibits an increased amplitude, producing a louder sound, whereas during destructive interference, the amplitude is reduced, producing a softer sound. Consequently, the intensity of the sound alternates between loud and soft, a phenomenon referred to as beats. The frequency of the beats is equal to the absolute difference between the frequencies of the two original sound waves: $f_{beat} = |f_1 - f_2|$



a) Wave of frequency f1
b) Wave of frequency f2
c) Resultant wave due to areas of constructive and destructive interference, causing beating pattern

Criteria	Marks
Clear explanation of how two sound waves superimpose to form beats Relate amplitude to volume of sound Incorporates clear labelled diagram in answer	4
Sound explanation of beats Includes labelled diagram	3
Basic description of beats Attempts to use a diagram to show formation of beats	2
Provides some relevant information	1

Q25. **4**

$\Sigma p_{before} = \Sigma p_{after}$ **- 1 mark**

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2 \quad (u_2 = 0,\ v_1 = v_2)$

$987.76 \times 15 + 1271.24(0) = v\,(987.76 + 1271.24)$

$v = \frac{987.76 \times 15}{987.76 + 1271.24} = 6.56 ms^{-1}\ in\ the\ forwards\ direction$ **- 1 mark**

$\Delta K = K_f - K_i$

$\Delta K = (\frac{1}{2} \times (987.76 + 1271.24) \times 6.56^2) - (\frac{1}{2} \times 987.76 \times 15^2)$ **- 1 mark**

$\Delta K = -62533.87 J$

62. 5 $kJ\ energy\ lost$ **- 1 mark**

Q26.

A. **2**

The brightness of a globe is directly proportional to the power dissipated by the lamp. As light bulbs B and C are identical, connected in parallel, they will have the same potential difference across lamps.

$$I_B = I_C$$

$$\therefore P_{loss} = I_B{}^2 R = I_C{}^2 R$$

As the current through B and C are identical, the power dissipated by both lamps will be the same, hence light bulb B and C will have the same brightness. **- 1 mark**

When the switch is closed, the relationship of current between light bulb A and B and C can be demonstrated through Kirchhoff's current law:

$$I_A = I_B + I_C$$
$$\therefore I_A = 2 \times I_B\ (as\ I_B = I_C)$$

As the current flowing through lamp A is twice as much as both lamps B and C, the power dissipated by lamp A will be 4 times higher than both lamps B and C:

For A:

$$P_{loss} = (2 \times I_B)^2 \times R = 4 \times I_B{}^2 \times R$$

$$\therefore P_{loss\ for\ A} = 4 \times P_{loss\ for\ B} = 4 \times P_{loss\ for\ C}$$

Hence, lamp A will be 4 times as bright as lamps B and C. **- 1 mark**

NB: Partial marks awarded for talking about voltage only.

3

Calculate the net magnetic field at the Point P

$B_{10A} = \frac{1.257\times10^{-6}\times10.35}{2\pi\times2.03} = 1.02 \times 10^{-6} T$ **- 1 mark**

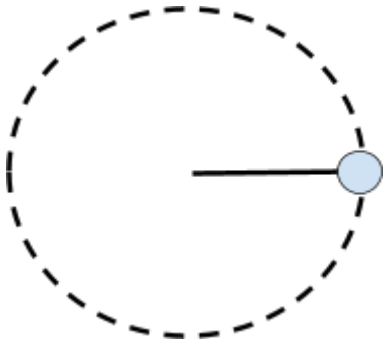
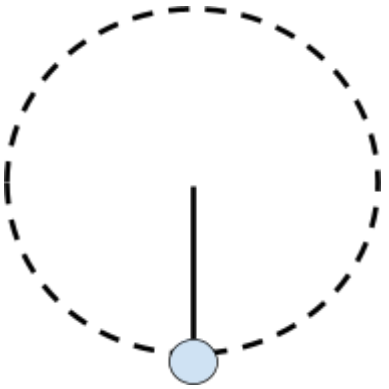
$B_{5A} = \frac{1.257\times10^{-6}\times5.98}{2\pi\times4.26} = 2.80 \times 10^{-6} T$ **- 1 mark**

$B_{net} = B_{10A} - B_{5A} = 1.02 \times 10^{-6} - 2.80 \times 10^{-6} = 7.4 \times 10^{-7} T$ **- 1 mark**

This has intentionally been left blank.

Q27. **2**

A. Draw a diagram that shows the position of the 1.00m emitter when the microphone measures:

i. A wavelength of 0.560m.	ii. The smallest wavelength produced
	

Notes: At the position nearest to the microphone, there is no doppler effect as there is no relative velocity. Also accepted the position on the left for i. At the bottom position, the velocity is towards the microphone, therefore the highest doppler shift and hence the smallest wavelength is produced.

B. **5**

$v = f\lambda$

$f = \frac{v}{\lambda}$

$f_0 = \frac{340}{0.560} = 607.14Hz$ **(original frequency) - 1 mark**

$f' = \frac{340}{0.536} = 634.33Hz$ **(observed frequency)**

$f' = f_0 \times \frac{(v_w + v_0)}{(v_w - v_s)}$

$634.33 = 607.14 \times \frac{340+0}{340-v_s}$

$\frac{634.33}{607.14} = \frac{340}{340-v_s}$

$-\ v_s = \frac{340\times607.14}{634.33} - 340$

$\therefore v_s = 14.57ms^{-1}$ **- 1 mark**

$T = \frac{2\pi\times1.00}{14.57} = 0.431...\ s$ **- 1 mark**

$T_{1.00m} = T_{0.45m} = 0.431s$

$v_{0.45m} = \frac{2\pi\times0.45}{0.431} = 6.56ms^{-1}$ **- 1 mark**

$\therefore 1.\ f' = 607.14 \times \frac{340+0}{340+6.56} = 595.66Hz$

$2.\ f' = 607.14 \times \frac{340+0}{340-6.56} = 619.08Hz$

$\therefore 1.\ \lambda = \frac{340}{619.08} = 0.55m\ \ 2.\ \lambda = \frac{340}{595.66} = 0.57m$ **- 1 mark**

Q28. The circuit shown below consists of a power supply with negligible internal resistance, connected to three resistors of varying resistances. **8**

Calculate the values of I_1, I_2, R *and hence* R_{total} of the entire circuit. Show all relevant working.

$$V_{12.35\Omega} = 12.35 \times 0.75 = 9.2625\Omega$$

By Kirchoff's Voltage Law:

$$V_{36.49\Omega} = 18.98 - 9.2625 = 9.7175V = V_{parallel}$$

$$I_2 = \frac{V_{parallel}}{R_{36.49\Omega}} = \frac{9.7175}{36.49}$$

$\therefore I_2 = 0.266A$ **(2 marks - Answer + working)**

By Kirchoff's Current Law:

$$I_{parallel} = 0.75A - 0.266 = 0.484A$$

$I_1 = \frac{4R}{R+4R} \times 0.484A = 0.387A$ **(2 marks - Answer + working)**

By Kirchoff's Voltage Law:

$$V_{parallel} = 9.7175V = V_R$$

$\therefore R = \frac{9.7175V}{0.387} = 25.11\ldots\Omega$ **(2 marks - Answer + working)**

For internal parallel component:

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{4R} = \frac{5}{4R}$$

$R_P = \frac{4 \times 25.11}{5} = 20.09\Omega$

For external parallel circuit:

$\frac{1}{R_P} = \frac{1}{20.09} + \frac{1}{36.49}$

$R_P = 12.956\Omega$

Total Circuit:

$R_T = 12.956 + 12.35 = 25.31\Omega$ **(2 marks - Answer + working)**

NB: Full marks were not awarded if you calculated total resistance first. The question explicitly asked for you to calculate the others and then calculate the total resistance.

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End of Examination

Additional Writing Page. Indicate question number and part clearly.

Additional Writing Page. Indicate question number and part clearly.

Assessment continues on the next page