2022

Higher School Certificate

Year 11 Yearly Examination

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board approved calculators may be used
- Write using black pen
- A data sheet, formulae sheets and periodic table are provided
- Draw diagrams using pencil
- A ruler is required

Write your NESA number in the spaces provided in the written section of the paper

Total marks – 75

Section I – Pages 3-12
20 marks
Attempt Questions 1–20
Allow 35 minutes for this section
Write your answers on the multiple choice grid on page 13 of writing booklet

Section II – Pages 13– 27
55 marks
Attempt Questions 21–34
Allow 1 hour and 25 minutes for this section

This paper MUST NOT be removed from the examination room

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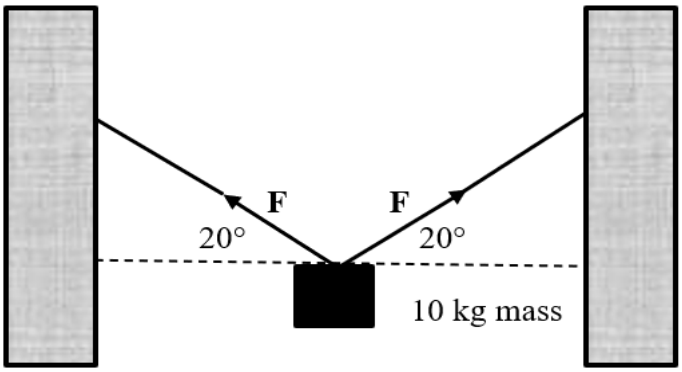
1. A 10 kg mass is suspended by two strings, as shown below.



The force applied to the mass by each of the strings, **F** is closest to:

(A) 98 N

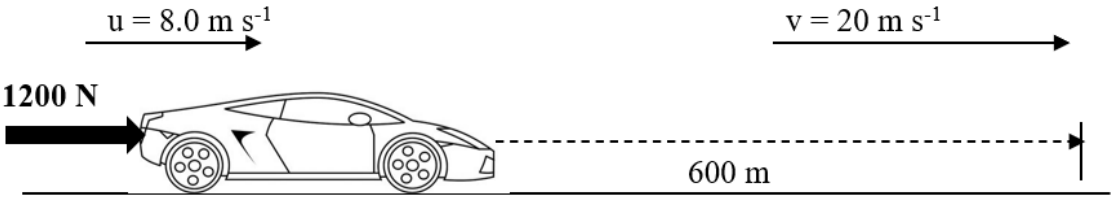
(B) 143 N

(C) 52 N

(D) 72 N

2. A 1500 kg car has a 1200 N force acting on it in the same direction as its motion. The car moves a distance of 600 m over horizontal ground while the force is acting.

The car's initial speed is 8.0 m s^{-1} and its final speed is 20 m s^{-1}.



From these data, it can be concluded that:

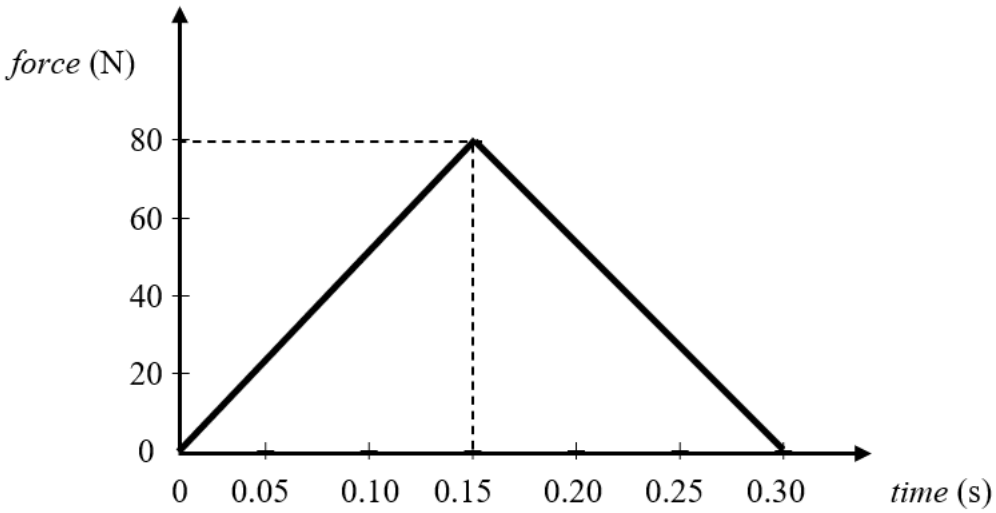
(A) the car's kinetic energy doubled.

(B) the work done on the car by the 1200 N force was (1200 × 12) J.

(C) the car's acceleration was 12 m s^{-1}.

(D) the work done on the car by the 1200 N force was (1200 × 600) J.

3. The force applied to a 0.200 kg ball is plotted against time, as shown below.



The magnitude of the change in the velocity of the ball caused by the application of this force is:

(A) 12 m s^{-1}

(B) 120 m s^{-1}

(C) 60 m s^{-1}

(D) 24 m s^{-1}

4. Which statement correctly identifies the role of the medium in the propagation of mechanical waves?

(A) The oscillations in the medium can only be longitudinal for a mechanical wave.

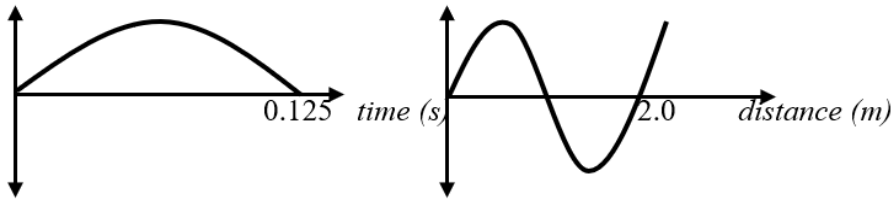
(B) The oscillations in the medium can only be transverse for a mechanical wave.

(C) The oscillations of the particles of the medium act to transfer the energy of the wave.

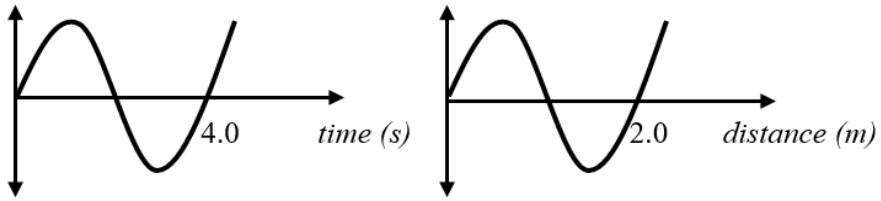
(D) The oscillations of the particles of the medium are slower than the frequency of the wave itself.

5. Which pair of graphs depicts a wave with a velocity of 10 m s^{-1}?

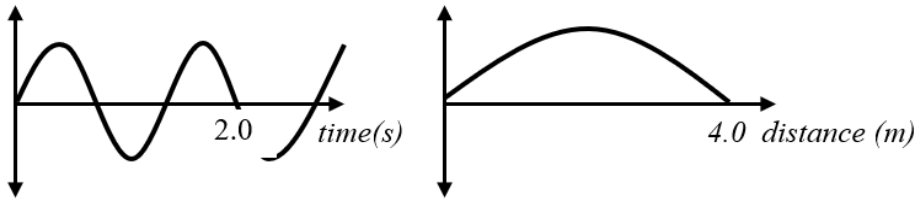
(A)



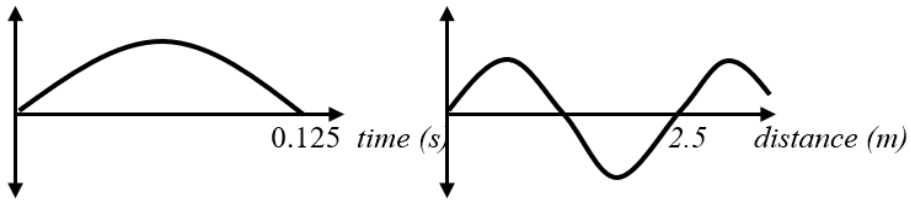
(B)



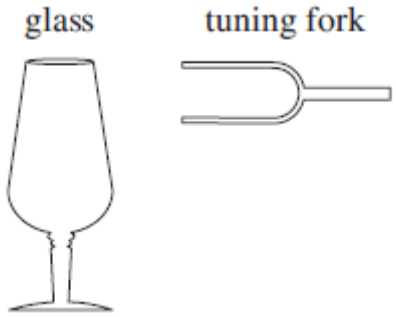
(C)



(D)



6. A glass and tuning fork are shown.



When the tuning fork is struck and brought very close to the top of the glass, a loud sound is heard.
Which of the following wave behaviours is responsible for this effect?

(A) diffraction

(B) resonance

(C) dispersion

(D) refraction

7. At a shooting range, a gun is fired and the bullet bounces off the top of a boulder. As the bullet hit the boulder, it exerted a force on the boulder, though the boulder did not move. At the same time, the boulder exerted a force on the bullet, resulting in the bullet slowing down and changing direction.

Which statement correctly describes this interaction?

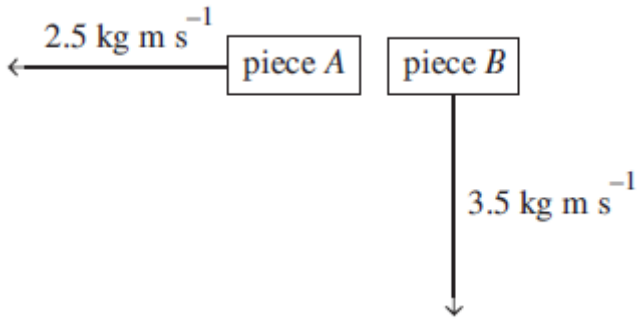
(A) The force of the bullet on the boulder is greater in magnitude than the force of the boulder on the bullet, resulting in the bullet slowing down and changing direction.

(B) The force of the bullet on the boulder is less in magnitude than the force of the boulder on the bullet, resulting in the boulder not moving.

(C) The force of the bullet on the boulder is greater in magnitude than the force of the boulder on the bullet, though the boulder has much more inertia and, therefore, does not move.

(D) The force of the bullet on the boulder is equal in magnitude to the force of the boulder on the bullet, and their mass difference accounts for their subsequent motion.

8. A stationary explosive with a mass of 5.5 kg is detonated and separates into three individual pieces, *A*, *B* and *C*. The momentum of piece *A* is 2.5 kg m s^{-1} west and the momentum of piece *B* is 3.5 kg m s^{-1} south as shown in the diagram.



What is the magnitude and direction of the momentum of piece *C*?

(A) 2.5 kg m s^{-1} N54°E

(B) 4.3 kg m s^{-1} N36°E

(C) 5.5 kg m s^{-1} N54°E

(D) 6.0 kg m s^{-1} N36°E

9. An object is placed in front of a concave mirror at a point beyond the centre of curvature.

The image created will be

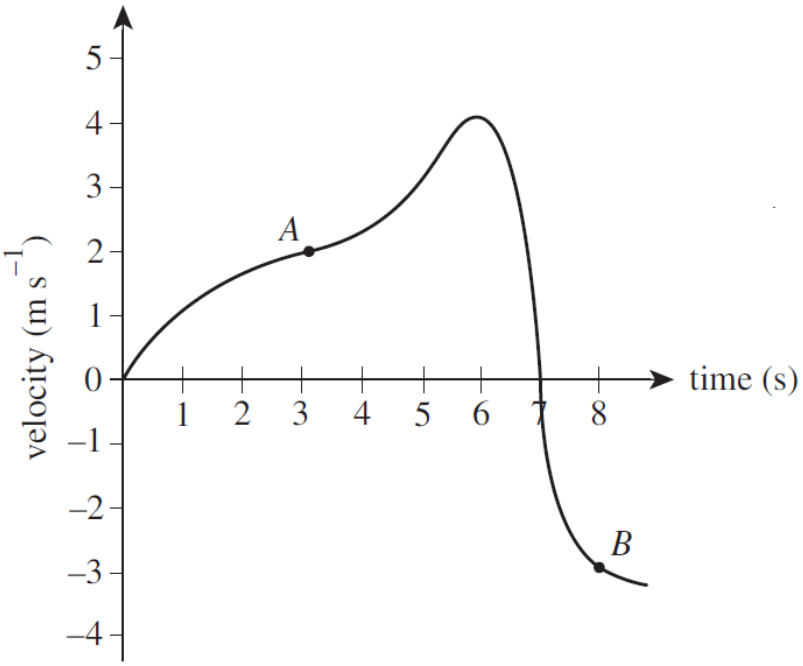
(A) diminished and inverted.

(B) magnified and inverted.

(C) diminished and upright.

(D) magnified and upright.

10. The velocity–time graph for an object is shown.



What is the average acceleration of the object between points *A* and *B*?

(A) –5 m s $^{-2}$

(B) –1 m s $^{-2}$

(C) 1 m s $^{-2}$

(D) 5 m s $^{-2}$

11. An electron experiences a force of 4×10^{-15} N when placed between two charged parallel plates that are 1 mm apart.

What is the potential difference between the plates?

(A) 1.602×10^{-22} V

(B) 4.39×10^{12} V

(C) 0.67 V

(D) 25.0 V

12. Which of the following is NOT an action–reaction force pair?

(A) the force a hammer exerts on a nail and the force the nail exerts on the hammer

(B) the normal force and the force of gravity acting on an object on the Earth's surface

(C) the gravitational forces that attract the Earth and the Moon to one another

(D) the repulsive forces that repel two like charges

13. Which statement is true whenever refraction is observed as light moves from one medium into another?

(A) Total internal reflection will occur if the angle of incidence is suitable.

(B) The light will bend towards the normal.

(C) The wavelength of the light will change.

(D) The speed of light will remain constant.

14. A landing strip is being built in Antarctica. It must be sufficiently long so that a plane can reach its take-off speed of 70 m s^{-1} after accelerating at 3.0 m s^{-2} from rest.

What is the minimum length of this landing strip?

(A) 550 m

(B) 723 m

(C) 817 m

(D) 945 m

15. A man yells 'Cooee!' at a distance of 3.0 km from a flat cliff face.
How long would it take for the man to hear the echo that reflects off the cliff face?

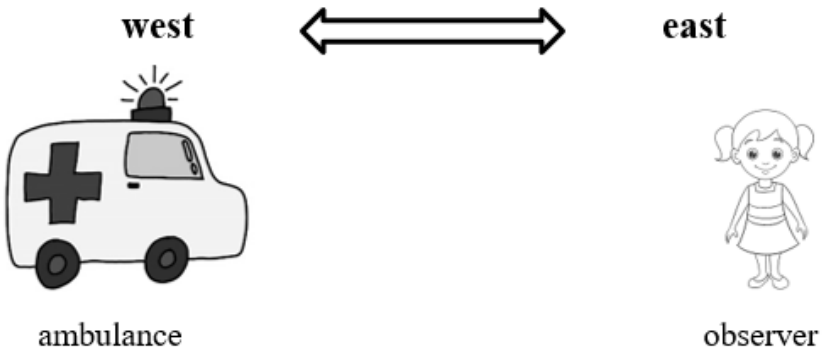
(A) 3.10 s

(B) 8.82 s

(C) 17.6 s

(D) 20.1 s

16. An ambulance with its siren on is moving relative to an observer.



Under which conditions will the siren have the highest observed pitch?

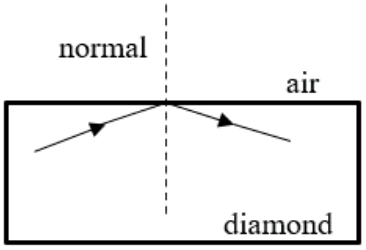
	Velocity of ambulance ($m\ s^{-1}$)	Velocity of observer ($m\ s^{-1}$)
(A)	25 (west)	10 (east)
(B)	stationary	28 (west)
(C)	30 (east)	stationary
(D)	25 (east)	10 (west)

17. Which diagram shows the path of the ray of light **incorrectly**?

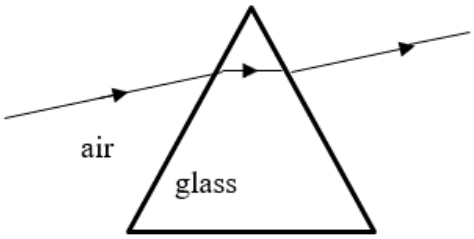
(A)

solid glass tube in air

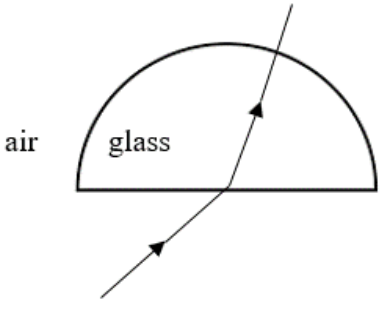
(B)



(C)

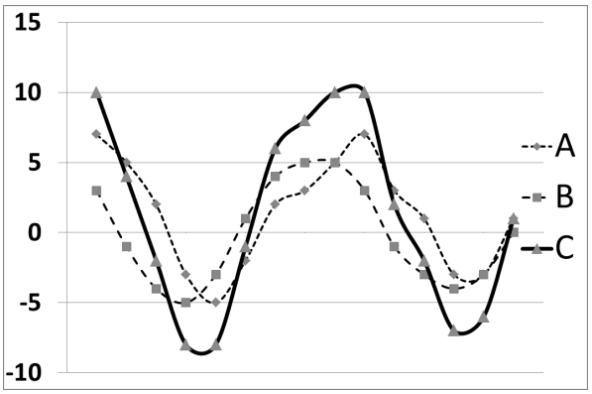


(D)

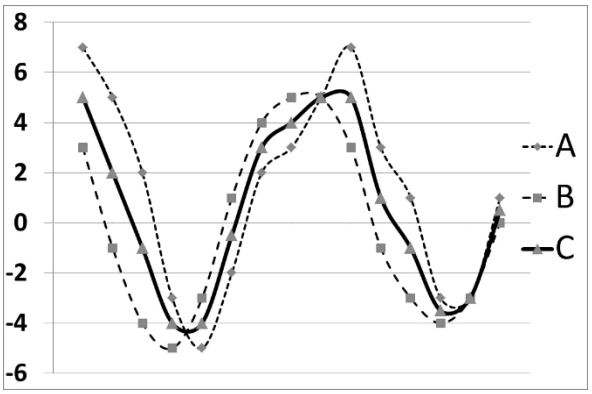


18. Of the following, which diagram correctly shows the principle of superposition, where wave C is the resultant of waves A and B?

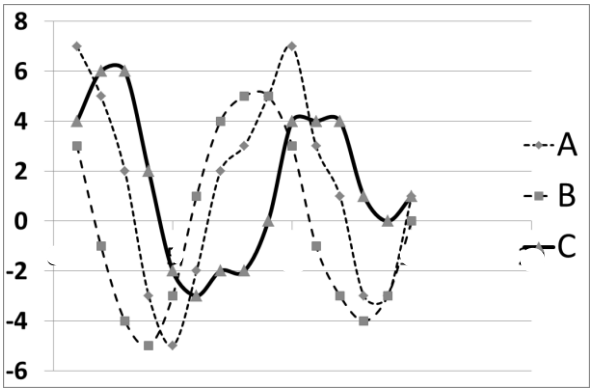
(A)



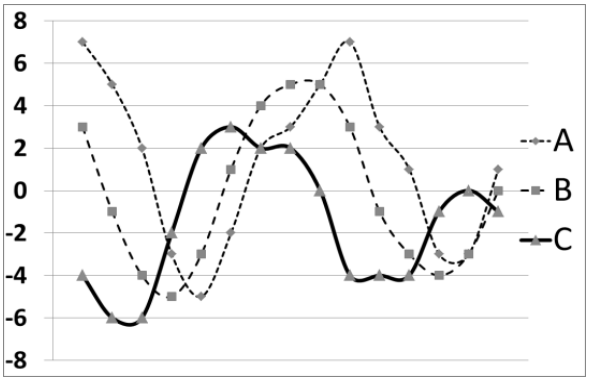
(B)



(C)



(D)



19. Which wave has the shortest wavelength?

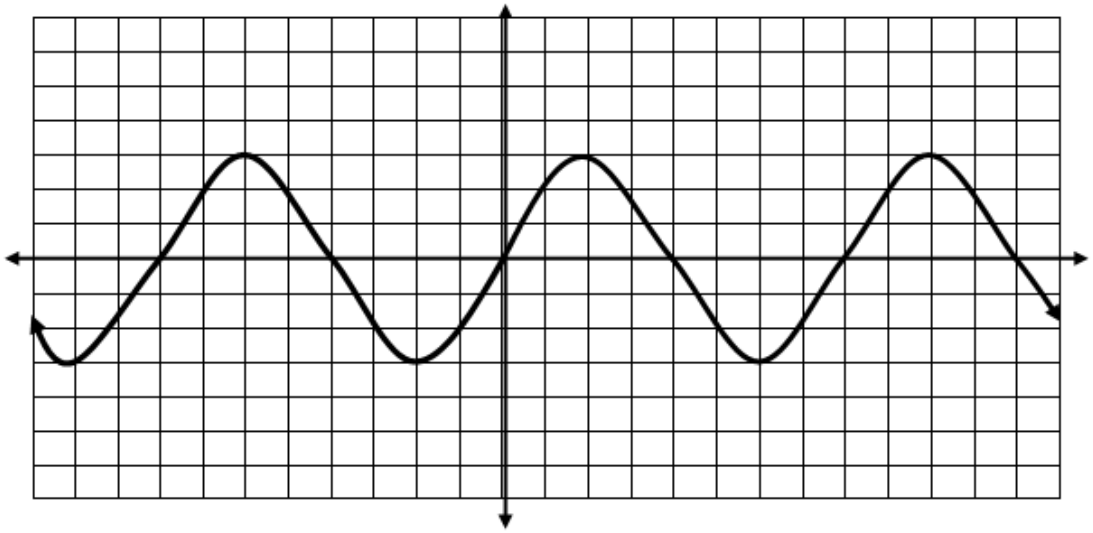
(A) An infra-red wave with a frequency of 6.0×10^{10} Hz.

(B) A sound wave of frequency 20 kHz.

(C) A water wave with a frequency of 0.5 Hz travelling at 5.0 ms^{-1}.

(D) A 100 MHz radio wave.

20. The following wave trace was made on the screen of a CRO when the sweep time was set to 2.0 ms per division.



The period of this wave is:

(A) 6 ms

(B) 12 ms

(C) 16 ms

(D) 4 ms

Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
1				
2				
3				
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9				
10				

	A	B	C	D
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Outcome	Questions	Mark
Knowledge and Understanding	MCQ(20), Q21(3), Q24(4), Q29(4), Q32(7)	$\overline{38}$
Working Scientifically	Q22(4), Q23(4), Q25(3), Q26(2), Q27(5), Q28(4), Q30(2), Q31(3), Q33(6), Q34(4)	$\overline{37}$

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Section II

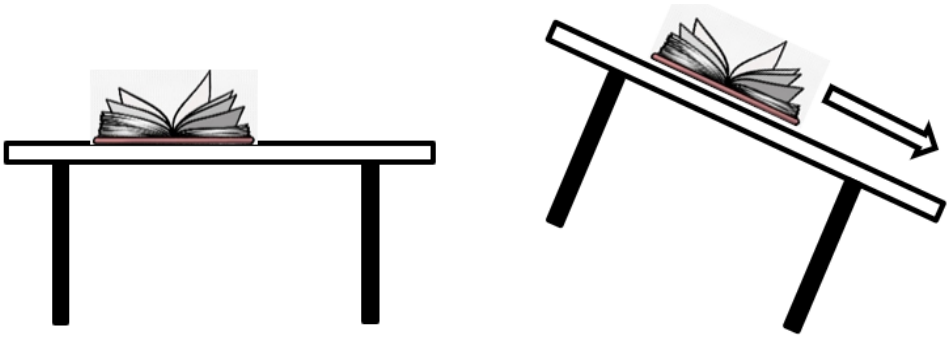
55 marks
Attempt Questions 21–34
Allow about 1 hour and 25 minutes for this section

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 21 (3 marks) **Marks**

In an investigation into the motion of objects sliding down inclined planes, a book was placed on a desk. The desk was then gradually tilted until at a certain angle, the book just began to slide.



It was observed that the book accelerated as it slid down the tilted desk, even though the desk was not tilted any further.

(a) What can be concluded about the direction of the net force acting on the book as it slides down the tilted desk? **1**

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(b) From the time it started to move, the book took 1.25 s to slide 80 cm.

What was its acceleration during this time? **2**

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Question 22 (4 marks) **Marks**

Two identical 1400 kg cars travelling at 90 km h^{-1} in opposite directions collide head-on and then re-bound with exactly half of their original speeds.

(a) Is this collision elastic or inelastic? Give your reasons. **2**

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(b) Given that the cars were in contact with each other for a total of 0.40 s, calculate the average force that acts on each car whilst they are in contact. **2**

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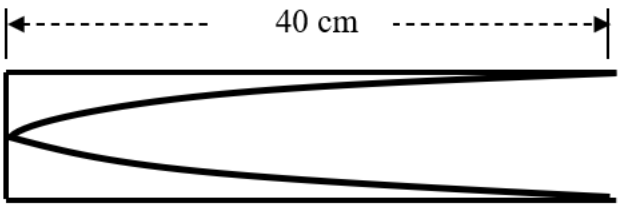
Question 23 (4 marks) **Marks**

The diagram below shows an open air column with the shape of the fundamental standing sound wave.



(a) On the same diagram, sketch the shape of the 2nd harmonic (1st overtone) standing wave. **2**

(b) State the frequencies of the fundamental and the 2nd harmonic (1st overtone) resonances. **2**

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Question 24 (4 marks) **Marks**

(a) Calculate the work done in moving a +3.60 mC charge through a potential difference of 160 V. **2**

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(b) The same +3.60 mC charge now experiences a force of 5.40×10^{-6} N due to the proximity of another charge 50.0 mm away.

What is the magnitude of this other charge? **2**

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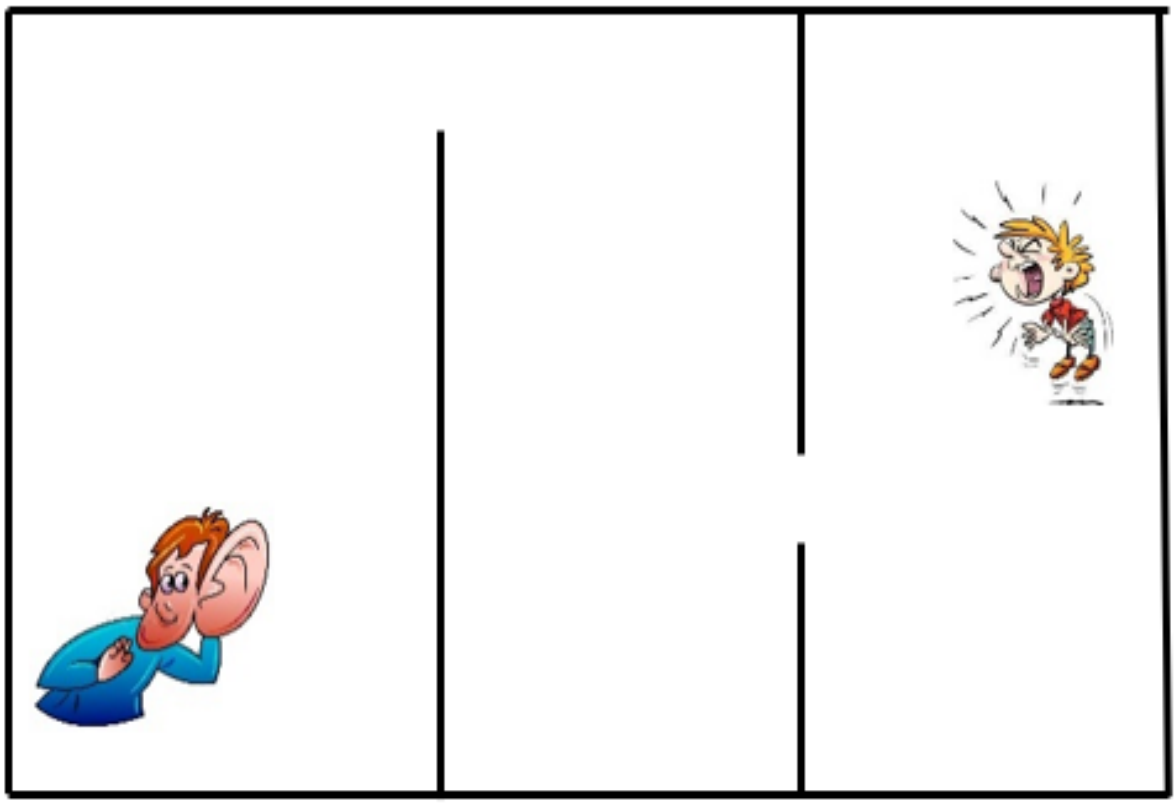
Question 25 (3 marks) **Marks**

The diagram below is the plan of part of a house where a person is talking and another person in a different part of the house is able to hear what is being said.

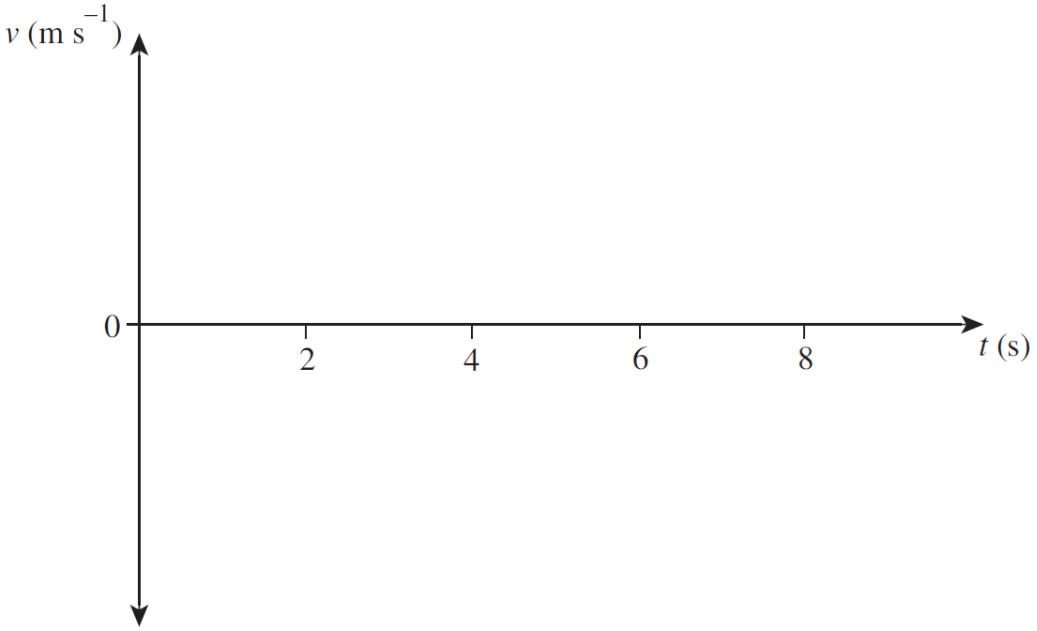


By drawing a sketch on the diagram, show how the sound can travel from the talking person to the other person. Label one instance of both reflection and diffraction. **3**

Question 26 (2 marks) **Marks**

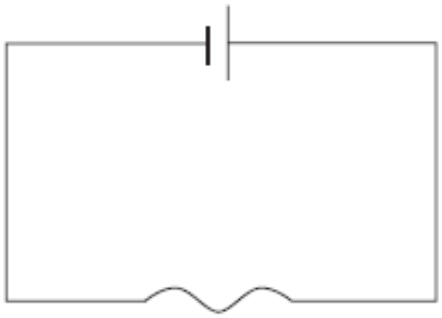
A basketball is thrown directly up into the air from the ground with an initial velocity at $t = 0$ s. The ball returns to the ground at $t = 4$ s.

On the axes below, plot the basketball's velocity for the duration of its journey. Take the upwards direction as positive and ignore air resistance. **2**



Question 27 (5 marks) **Marks**

Louise has a piece of resistance wire, which is ohmic. She wants to investigate how its resistance varies with length. She sets up a circuit as shown. Louise also has access to a voltmeter, an ammeter and a ruler.



Describe how Louise would obtain the data that she requires for this investigation. **5**

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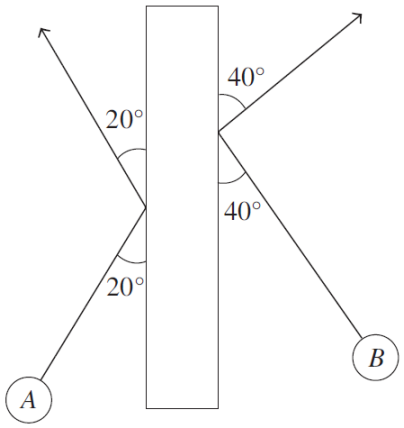
Question 28 (4 marks) **Marks**

Two balls, *A* and *B*, are rolled towards a wall as shown.



Initially, ball A travels at a constant speed of 12 m s^{-1} and ball B travels at a constant speed of 15 m s^{-1}.

What is the velocity of ball A relative to ball B after colliding with the wall? Include a diagram in your response. **4**

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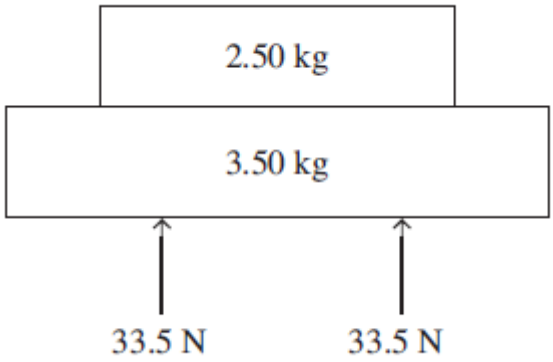
Question 29 (4 marks) **Marks**

Simon is delivering two packages to a client. He stacks the lighter package on top of the heavier package. He then lifts the packages by applying a 33.5 N vertical force from each of his hands to the bottom of the heavier package as shown.



(a) What is the magnitude of the acceleration of the packages? **2**

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(b) The magnitude of the force that the 3.50 kg package applies to the 2.50 kg package is greater when the packages are accelerating than when they are at rest. Explain why. **2**

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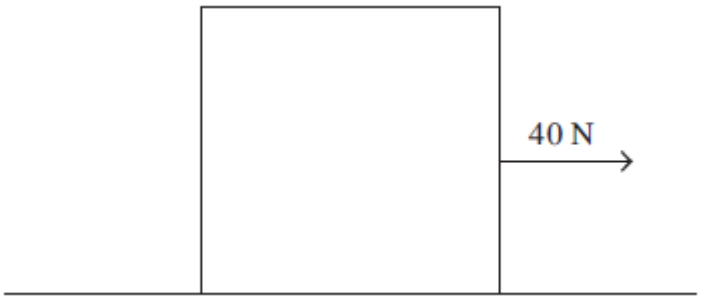
Question 30 (2 marks) **Marks**

A box, initially at rest, is pushed across a horizontal, frictionless surface with a constant force of 40 N for 10 seconds, as shown in the diagram. During this time, the box accelerates at a rate of 2.0 m s^{-2}.



How much power is exerted on the box? **2**

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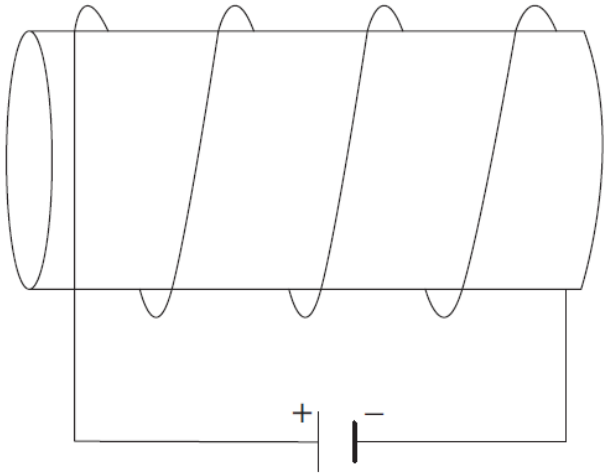
Question 31 (3 marks) **Marks**

A solenoid is a type of electromagnet that consists of wire wrapped around a core.



(a) On the diagram, draw the magnetic field that occurs when the solenoid is connected to a battery. Include at least THREE field lines. **1**

(b) Identify THREE ways that the magnetic field strength of the solenoid could be increased and explain why with reference to the relevant formula. **2**

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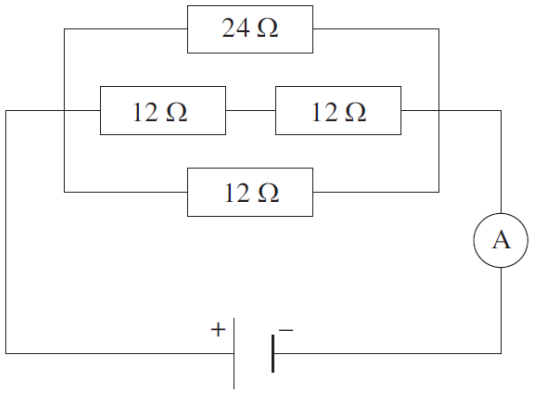
Question 32 (7 marks) **Marks**

A large spotlight is made up of four smaller light bulbs, which can be modelled as ohmic resistors. The spotlight is powered by a 12 V battery, as represented in the circuit.



(a) Calculate the reading on the ammeter. **3**

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(b) How much energy will the spotlight consume over one hour? **2**

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(c) Explain how the spotlight's intensity will change as an observer moves away from it. **2**

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Question 33 (6 marks) **Marks**

An experiment was performed to calculate the refractive index of a rectangular Perspex prism. The results are given in the table below.

angle of incidence (degrees)	angle of refraction (degrees)				
	trial 1	trial 2	trial 3		
10	7	7	6		
20	14	13	13		
30	22	21	20		
40	24	25	27		
50	34	31	29		
60	37	37	31		

(a) Complete the columns in the results table and plot the data on the grid below, including a line of best fit. **5**

(b) Using the information from the graph, determine the refractive index of Perspex. **1**

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Question 34 (4 marks) **Marks**

(a) Describe the conditions necessary for total internal reflection to occur. **2**

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(b) A ray of light travelling in air enters a transparent substance which halves the speed of the light.

If the angle of incidence of the ray of light is 30°, find the angle of refraction. **2**

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END OF EXAMINATION

Additional writing space

Marking Criteria Year 11 Yearly Examination 2022

Multiple Choice

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
B	D	C	C	D	B	D	B	A	B	D	B	C	C	C	D	C	A	A	C

Question 21

a.

Marking Criteria	Marks
● Correct answer provided	**1**

Net force is in the same direction as the acceleration of the book – i.e. down the incline parallel to the desktop

b.

Marking Criteria	Marks
● Correct answer provided	**2**
● Appropriate data used but with an error	**1**

Use u = 0; s = 0.80 m; t = 1.25 s and $s = ut + 1/2at^2$

$0.80 = 0 + 1/2a \times 1.25^2$

$a = 0.80/(0.5 \times 1.25^2)$

$a = 1.0 \text{ m s}^{-2}$ down the slope

Marker's comments

- some student used $v = u + at$ but substituted v with average velocity instead of final velocity

Question 22

a.

Marking Criteria	Marks
● Correct answer with calculations and clear, correct reasoning given	**2**
● Identifies that kinetic energy is not conserved or provides correct calculation	**1**

The sum of the KEs of the cars after the collision is less than before the collision, so KE is lost collision is inelastic, as KE is not conserved. Total KE before = 1250 kJ and KE after = 312.5 kJ

b.

Marking Criteria	Marks
● Calculations and working shown ● Correct answer provided	**2**
● A correct step or several steps taken towards obtaining correct answer. Must recognise that there is a change in velocity	**1**

Use $I = Ft$

$Ft = \Delta P$

$= m\Delta v$

$F = (m\Delta v)/t$

$= (1400 \times 25 - -12.5)/0.40$ as $90 \text{ km h}^{-1} = 25 \text{ m s}^{-1}$

$= 1.31 \times 10^5$ N on each car, in the direction of their change in motion

OR

$v = u + at$

$-12.5 = 25 + a \times 0.4$

$a = -93.75\ ms^{-2}$

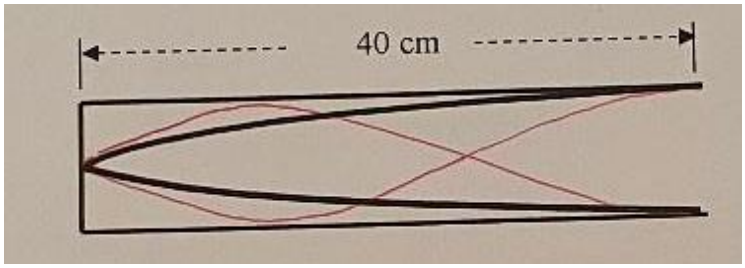
$F = ma = 1400 \times -93.75 = -1.31 \times 10^5\ N$

Teacher's comment
- Students must recognise that there is a change in velocity
- Initial velocity is 90 km/h or 25 m/s NOT 0

Question 23

a.

Marking Criteria	Marks
● Correct wavelength/shape shown	**2**
● Node and antinode placed correctly but error in shape/wavelength	**1**



b.

Marking Criteria	Marks
● Both frequencies calculated correctly (error carry from pt a is OK)	**2**
● One frequency found correctly OR ● both frequencies calculated but same single error made	**1**

Fundamental: $\lambda/4 = 40$ cm

$\lambda = 1.60$ m

$f = v/\lambda$

$f = 340/1.6$

$f = 212.5$ Hz

1st overtone: $f = 3 \times 212.5$

$= 637.5$ Hz

Question 24

a.

Marking Criteria	Marks
● Correct answer provided	**2**
● Correct equation attempted	**1**

Use $W=qV$

$= 3.60 \times 10^{-3} \times 160$

$= 5.76 \times 10^{-1}$ J (or 0.576 J)

b.

Marking Criteria	Marks
● Correct answer provided	**2**
● A correct step taken towards obtaining a correct answer	**1**

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

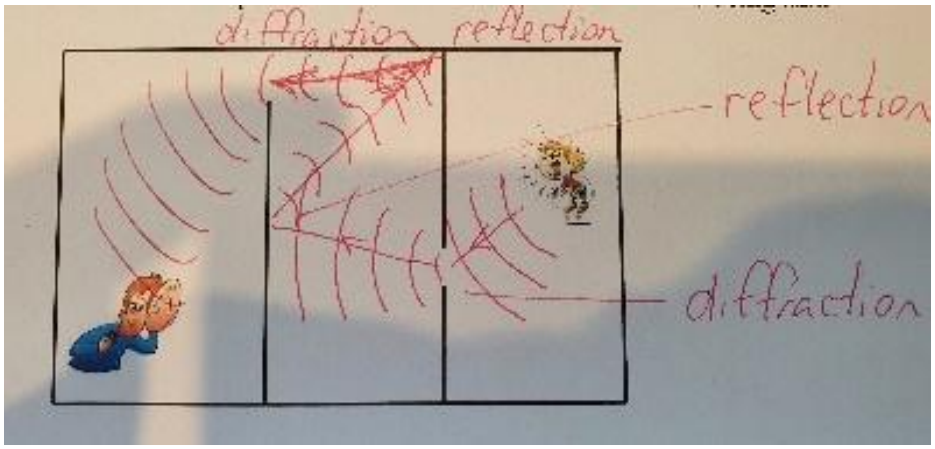
$$q_2 = \frac{Fr^2 \times 4\pi\varepsilon_0}{q_1}$$

$$= \frac{(5.40\times10^{-6})\times 0.0500^2 \times 4\pi \times 8.854\times10^{-12}}{3.60\times10^{-3}}$$

Use: $= 4.17\times10^{-16}$ C

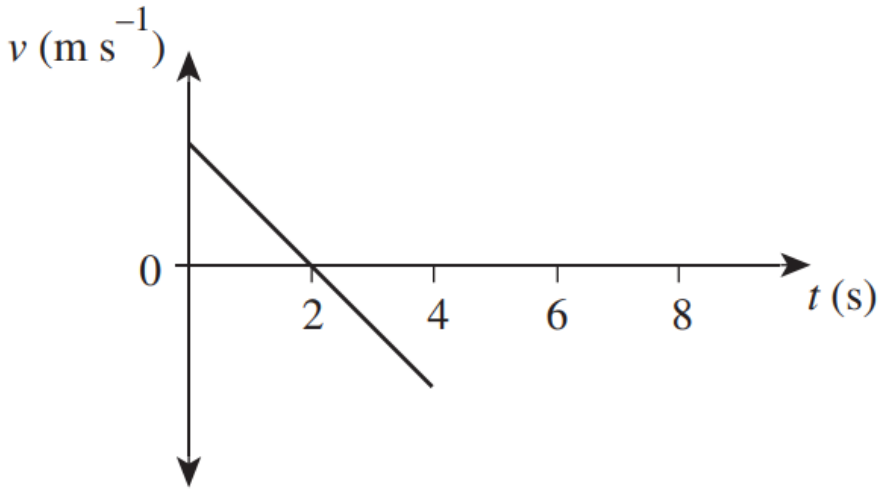
Question 25

Marking Criteria	Marks
• Diagram provided shows reflection and diffraction where appropriate with labels	**3**
• Diagram shows reflection and diffraction with an error or omission in diagram or labelling	**2**
• Some aspect of diffraction and/or reflection is evident	**1**



Question 26

Marking Criteria	Marks
• Draws graph with correct shape AND shows the x-intercept at 2 seconds	**2**
• Any ONE of the above points	**1**



Question 27

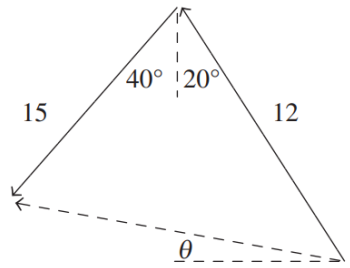
Louise should measure the length of the piece of resistance wire using a ruler. After switching on the power supply at a set voltage, she should measure and record the amount of current within the circuit using the ammeter. She should also measure and record the voltage drop across the wire using the voltmeter. Using Ohm's Law ($V = IR$), she should then calculate the resistance of the wire. Louise should then repeat these steps with varied lengths of resistance wire and plot her final results in a graph (resistance against length) to determine the relationship between resistance and length.	Mod 4 Electricity and Magnetism PH11–1, 11–7, 11–11 Bands 3–6 • Identifies that the length of wire should be varied and how each length of wire should be measured. AND • Outlines how the current and voltage should be measured. AND • Outlines how resistance should be calculated. AND • Identifies how the relationship between resistance and length will be determined. AND • Identifies a relevant controlled variable. . . . . .5 • Any FOUR of the above points . . . .4 • Any THREE of the above points . . .3 • Any TWO of the above points. . . . .2 • Any ONE of the above points 1	a b c d e

Question 28

Let the final relative velocity be v_{AB}.

$v_{AB} = v_A - v_B$

This difference can be represented diagrammatically as follows.



$$v_{AB_x} = -15\sin 40 - 12\sin 20$$
$$= -13.746055\ldots$$

In the y direction:

$$v_{AB_y} = 12\cos 20 - 15\cos 40$$
$$= -0.21435519\ldots$$

For magnitude:

$$v_{AB} = \sqrt{13.746^2 + 0.214^2}$$
$$= 13.7$$

For direction:

$$\tan\theta = \left(-\frac{0.214}{13.746}\right)$$
$$\theta = \tan^{-1}\left(-\frac{0.214}{13.746}\right)$$
$$= -89.19°$$

Therefore, $v_{AB} = 13.7$ m s^{-1} at bearing S89°W.

Mod 1 Kinematics
PH11–8 Bands 3–5

- Draws a correct diagram that represents v_{AB}.

AND

- Correctly calculates the magnitude of the relative velocity vector.

AND

- Correctly calculates the direction of the relative velocity vector 4

- Any TWO of the above points. 3

- Any ONE of the above points 2

- Shows some understanding of relative velocity OR vector addition. 1

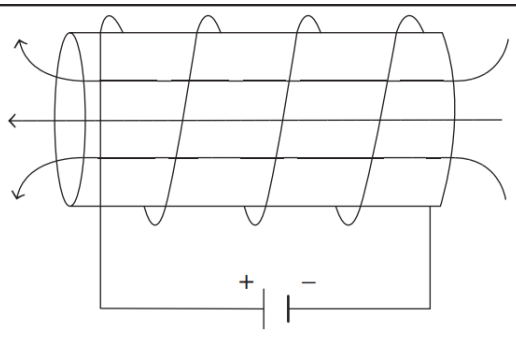
Question 29

(a) F_{net} = total upwards force – weight $= (2 \times 33.5) - (6 \times 9.8)$ $= 8.2$ N $\vec{a} = \frac{\vec{F}_{net}}{m}$ $= \frac{8.2}{6}$ $= 1.3667$ ≈ 1.37 m s^{-2}	Mod 2 Dynamics PH11–9 Bands 4–5 • Calculates the net force. AND • Calculates the magnitude of the acceleration . . . . . .2 • Any ONE of the above points 1
(b) When the packages are at rest, the force applied by the 3.50 kg package to the 2.50 kg package must be equivalent to the weight of the 2.50 kg package. When the packages are accelerating upwards, there must be an *additional* force applied to the 2.50 kg package by the 3.50 kg package for this motion to occur.	Mod 2 Dynamics PH11–6, 11–9 Bands 4–5 • Explains that the force applied by the 3.50 kg package to the 2.50 kg package at rest is equivalent to the weight of the 2.50 kg package. AND • Explains that there must be an additional force applied by the 3.50 kg package to the 2.50 kg package for the system to accelerate upwards. . . . . .2 • Any ONE of the above points 1

Question 30

$P = Fv$ $= F\left(\frac{at}{2}\right)$ $= 40\left(\frac{2 \times 10}{2}\right)$ $= 400$ W	Mod 1 Kinematics Mod 2 Dynamics PH11–8, 11–9 Bands 2–4 • Calculates the power exerted on the box . . . . . .2 • Provides some relevant working . . .1

Question 31

(a) 	Mod 4 Electricity and Magnetism PH11–11 Bands 2–3 • Correctly draws the magnetic field 1

(b)	The magnetic field strength of a solenoid is given by the equation $B = \frac{\mu_0 NI}{L}$, where B is the magnetic field strength, μ_0 is the magnetic permeability constant, N is the number of coils, L is the length of the solenoid and I is the current through the wire. From this formula, we can deduce that increasing the terms of the numerator will increase the magnetic field strength. Increasing the number of coils of wire around the solenoid and increasing the current through the wires will both increase the magnetic field strength of the solenoid. Adding a ferromagnetic material such as iron to the core will also increase the magnetic field strength of the solenoid.	Mod 4 Electricity and Magnetism PH11–11 Bands 2–4 • Identifies THREE ways of increasing the magnetic field strength. AND • Explains with reference to the relevant formula. . . . . 2 • Identifies TWO ways of increasing the magnetic field strength. OR • Identifies ONE way of increasing magnetic field strength AND explains with reference to the relevant formula. 1

Question 32

(a)	Combining the resistors in series: $R_{series} = 12 + 12$ $= 24\ \Omega$ Combining the resistors in parallel: $\frac{1}{R_{circuit}} = \frac{1}{12} + \frac{1}{24} + \frac{1}{24}$ $= \frac{1}{6}$ $= 6\ \Omega$ As the ammeter is connected in series, its reading will be the circuit current, so we can apply Ohm's law to the resistors to obtain: $I_{circuit} = \frac{V_{circuit}}{R_{circuit}}$ $= \frac{12}{6}$ $= 2\ \text{A}$	Mod 4 Electricity and Magnetism PH11–11 Bands 3–6 • Calculates the ammeter reading. . . . 3 • Calculates the total equivalent resistance of the circuit . . . . . 2 • Gives some relevant information. . . 1

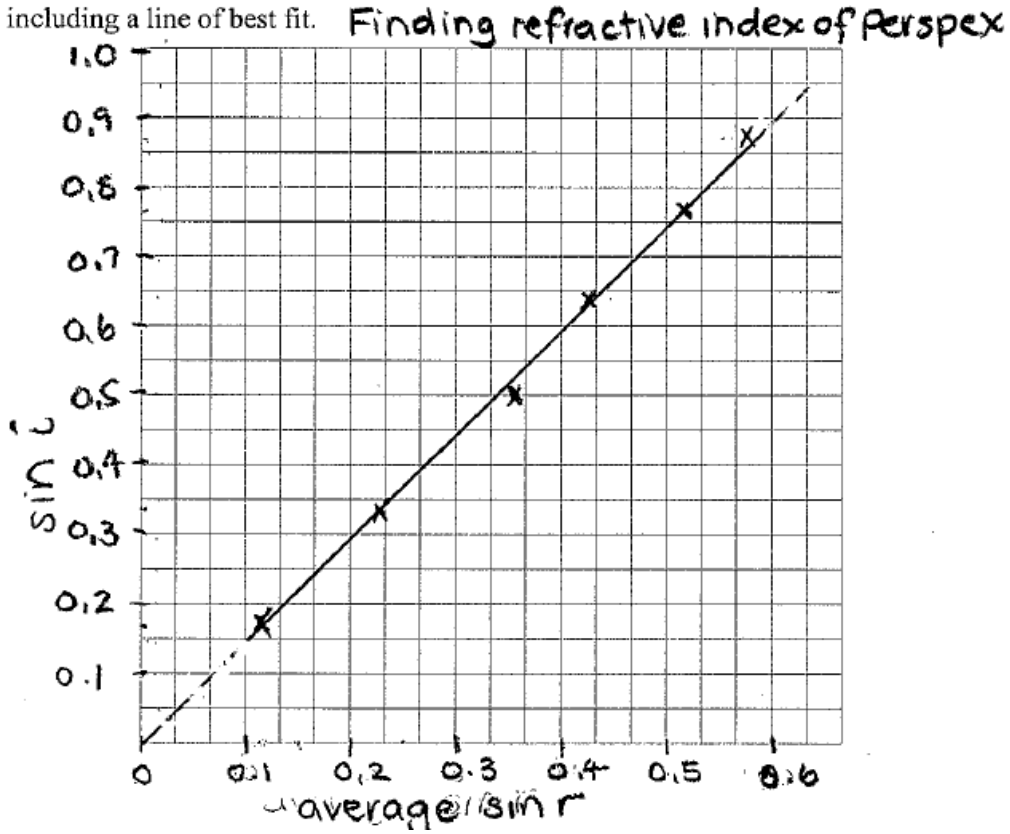
(b) $P = IV$ $= I^2R$ $= 2^2 \times 6$ $= 24$ W $P = \frac{\Delta E}{\Delta T}$ $\Delta E = P\Delta T$ $= 24 \times 60^2$ $= 86.4$ kJ	Mod 4 Electricity and Magnetism PH11–11 Bands 5–6 • Calculates the energy consumed by the spotlight . . . . . 2 • Calculates the power consumed by the spotlight. OR • Equivalent merit 1
(c) *For example:* As an observer moves further away from the spotlight, the light rays it produces will be dispersed further and further apart. Subsequently, a lower concentration of light energy will reach the area where the observer is, resulting in the spotlight's intensity decreasing as the observer moves away. *Note: Answers could also include a suitable reference to the formula* $I_1R_1^2 = I_2R_2^2$.	Mod 3 Waves and Thermodynamics PH11–10 Bands 4–5 • Explains how the spotlight's intensity changes as an observer moves away from it . . . . . 2 • Gives some relevant information. . . 1

Question 33

Marking Criteria	Marks
• Correct headings and full calculations for table of results (must be sin i and sin r values) AND correct plotting of points, correctly labelled axes, correct scale and correct line of best fit	**5**
• Calculates and plots sin i and sin r data correctly with one mistake	**4**
• Correctly calculates average and graphs with correct line/curve of best fit	**3**
• Plots i and r values correctly with correct labelled axes (may be missing unit in brackets) and correctly averages r values in table	**2**
• Some correct plotting or completion of columns in results table	**1**

angle of incidence (degrees)	angle of refraction (degrees)			**sin i**	**average sin r**
	trial 1	trial 2	trial 3		
10	7	7	6	**0.174**	**0.116**
20	14	13	13	**0.342**	**0.231**
30	22	21	20	**0.500**	**0.358**
40	24	25	27	**0.643**	**0.428**
50	34	31	29	**0.766**	**0.520**
60	37	37	31	**0.866**	**0.574**

including a line of best fit.



b)

Marking Criteria	Marks
• Correct answer provided using points that lie on the line of best fit from graph (not points from the table)	**1**

Refractive index of Perspex = $\frac{sin\,i}{sin\,r} = \frac{rise}{run} = \frac{0.74-0.29}{0.5-0.2} = \frac{0.45}{0.3} = 1.5$

Question 34

a.

Marking Criteria	Marks
• At least two appropriate conditions given and named specifically	**2**
• One necessary condition given	**1**

e.g. 1. Light must be moving from a more optically dense medium into a less optically dense medium;
2. The angle of incidence must be greater than the critical angle for the boundary between the two mediums

b

Marking Criteria	Marks
• Correct answer calculated (error carry from previous question is OK)	**2**
• An answer provided with an error made	**1**

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2}$$

$$= \frac{0.5}{2}$$

$$\theta_2 = \sin^{-1}(0.25)$$

$$= 14.5°$$