ProjectAcademy

2018 | PROJECT **EXAMINATION**

C

Prelim Physics

Student #:

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper

Total marks: 100

Section I – 75 marks

This section has two parts, Part A and Part B

Part A - 20 marks

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

Part B - 55 marks

- Attempt Questions 21-34
- Allow about 2 hours and 25 minutes for this part

Comments:

Marker: **Date:**

Section I
75 marks

Part A - 20 Marks
Attempt Questions 1–20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet for Questions 1–20.

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1 Triple J Sydney has a frequency of 105.7MHz. What is the wavelength of the radiowave emitted by the Triple J broadcasting station?

(A) 2.838×10^6 m

(B) 3.52 m

(C) 2.838 m

(D) 0.3523 m

2 The wavelength of a transverse wave can be determined by finding:

(A) The distance between two troughs.

(B) The distance between two crests.

(C) The distance between equilibrium and maximum displacement.

(D) A and B.

3 A light ray is measured to travel through a piece of perspex at 2.00×10^8 m/s. What is the refractive index of the perspex?

(A) 1.25

(B) 1.50

(C) 0.667

(D) 1

4 Which of the statements are true?

(A) Electromagnetic waves always travel at the same speed, regardless of the medium.

(B) Infrared waves are more energetic than radio waves.

(C) The period of a gamma ray will be greater than the period of an X-ray

(D) None of the above

Use the following information to answer questions 5 and 6.

Bodacious Bridgett and Admirable Alexander are standing 7m and 9m respectively away from a light source. The light which reaches Bridgett has an intensity of 100 lux.

5 Calculate the intensity of light which reaches Alexander

(A) 165 lx

(B) 77.8 lx

(C) 129 lx

(D) 60.5 lx

6 How far would Bridgett have to move for the intensity to drop 25 lx?

(A) 7 m

(B) 9 m

(C) 14 m

(D) 21 m

7 A wave is sent through a slinky into a fixed wall. Which of the following statements is correct?

(A) The wave reflects and is upright, but flipped laterally.

(B) The wave reflects and is upright, and remains the same laterally.

(C) The wave reflects and is inverted, but flipped laterally.

(D) None of the above.

8 Total internal reflection occurs when:

(A) Light travels from a less dense to more dense medium and $\theta_i > \theta_c$

(B) Light travels from a more dense to less dense medium and $\theta_i > \theta_c$

(C) Light travels from a less dense to more dense medium and $\theta_i < \theta_c$

(D) Light travels from a more dense to less dense medium and $\theta_i < \theta_c$

9 A light ray entering a more dense medium from a less dense medium will:

(A) Bend away from the medium.

(B) Bend towards the normal.

(C) Pass straight through.

(D) Bend away from the normal.

Use the following information to answer question 10 and 11.

A ray of light travels from water to air, which has refractive indexes of 1.33 and 1.000273 respectively.

10 Calculate the angle of refraction if the angle of incidence is equal to 28°.

(A) 0.368°

(B) 48.7°

(C) 38.6°

(D) 20.7°

11 Calculate the critical angle of the light ray.

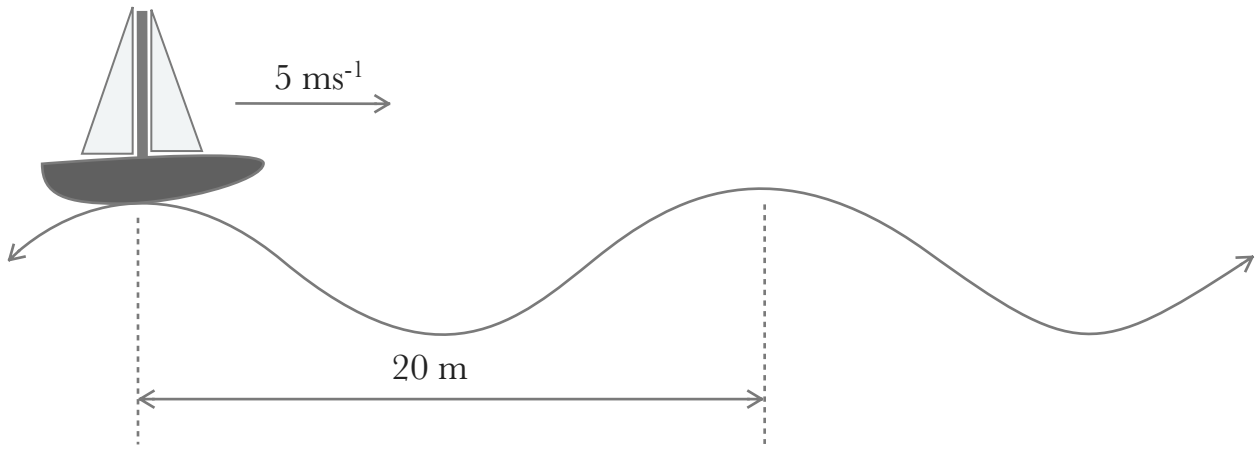
(A) 34.2°

(B) 75.0°

(C) 48.8°

(D) None of the above

12 A windsurfer moves at 5 m/s while staying on the crest of a wave, as shown below.



What is the frequency of the the waves if the distance between the two wave crests is 20 m?

(A) 0.25 Hz

(B) 0.5 Hz

(C) 2.5 Hz

(D) 4 Hz

13 To determine weather two flutes instruments are in tune, an orchestra conductors listens to the beat frequency of two instruments playing the same note. If first flute is playing a note at 746 Hz and the second flute is playing a note at 754 Hz, what is the beat frequency that the orchestra conductor hears?

(A) -8 Hz

(B) 8 Hz

(C) 1500 Hz

(D) -1500 Hz

14 Which of the following best explains how electromagnetic waves travel?

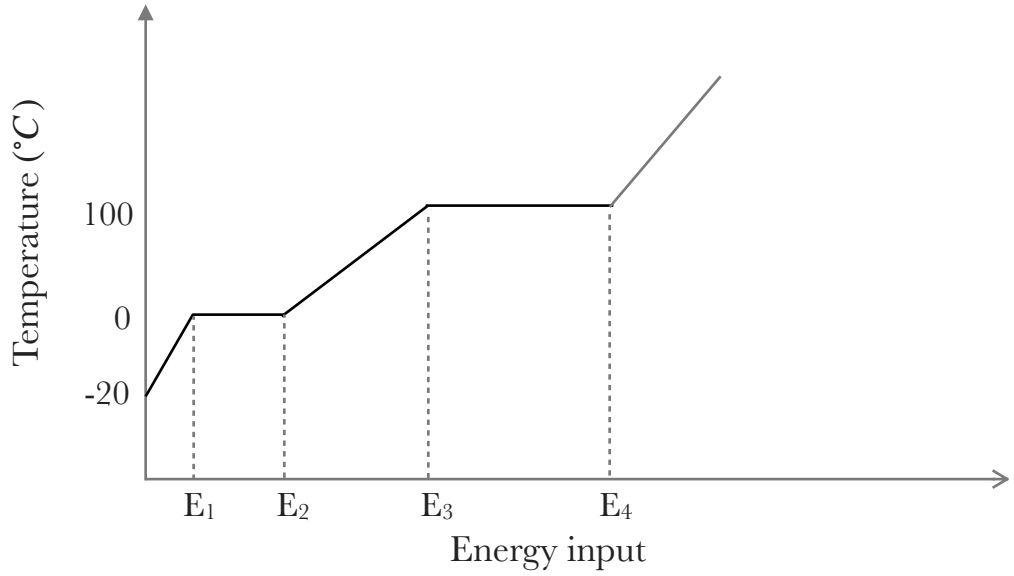
(A) An electric field propagates a magnetic field, which propagates in a vacuum.

(B) Disturbances in pressure in air allow electromagnetic waves to propagate.

(C) Particles in a medium transfer their kinetic energy to each other, propagating energy.

(D) Propagation of electric field which induce magnetic fields, and magnetic fields which induce electric fields. This interaction transfers energy.

15 A glass beaker containing super-cooled ice is heated up using a bunsen burner. The temperature of the glass beaker vs energy input of the bunsen burner is graphed below:



The larger energy input from E_1 to E_2 when compared to the energy input from E_3 to E_4 is best explained by:

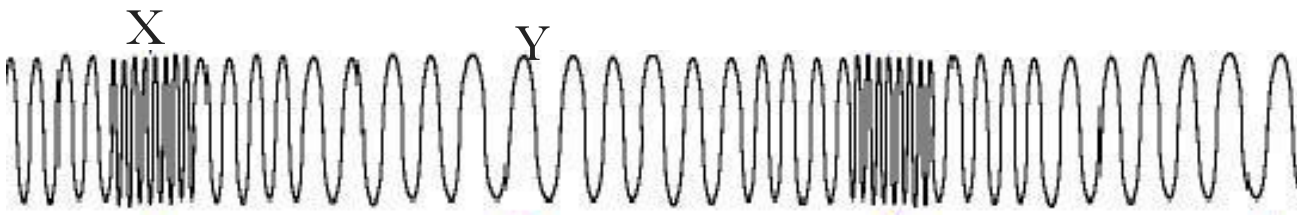
(A) The latent heat of fusion is greater than the latent heat of vaporization.

(B) A temperature of 0 degrees Celsius holds less energy.

(C) The latent heat of vaporization is greater than the latent heat of fusion.

(D) A temperature of 0 degrees Celsius holds more energy.

16 Intrigued Isuru conducted an experiment to observe properties of a longitudinal wave using a slinky.



The distance between X and Y represents:

(A) $\frac{1}{2}\lambda$

(B) λ

(C) Amplitude.

(D) Period

17 What is the speed of a wave in a string with a mass per unit length of 0.030kg/m and tension of 30N?

(A) 1000 ms^{-1}

(B) 0.032 ms^{-1}

(C) 18 ms^{-1}

(D) 32 ms^{-1}

18 Impulse is equal to:

(A) Fs

(B) $\triangle p$

(C) $\frac{1}{2}mv^2$

(D) mv

19 The loudness of a sound is related to its:

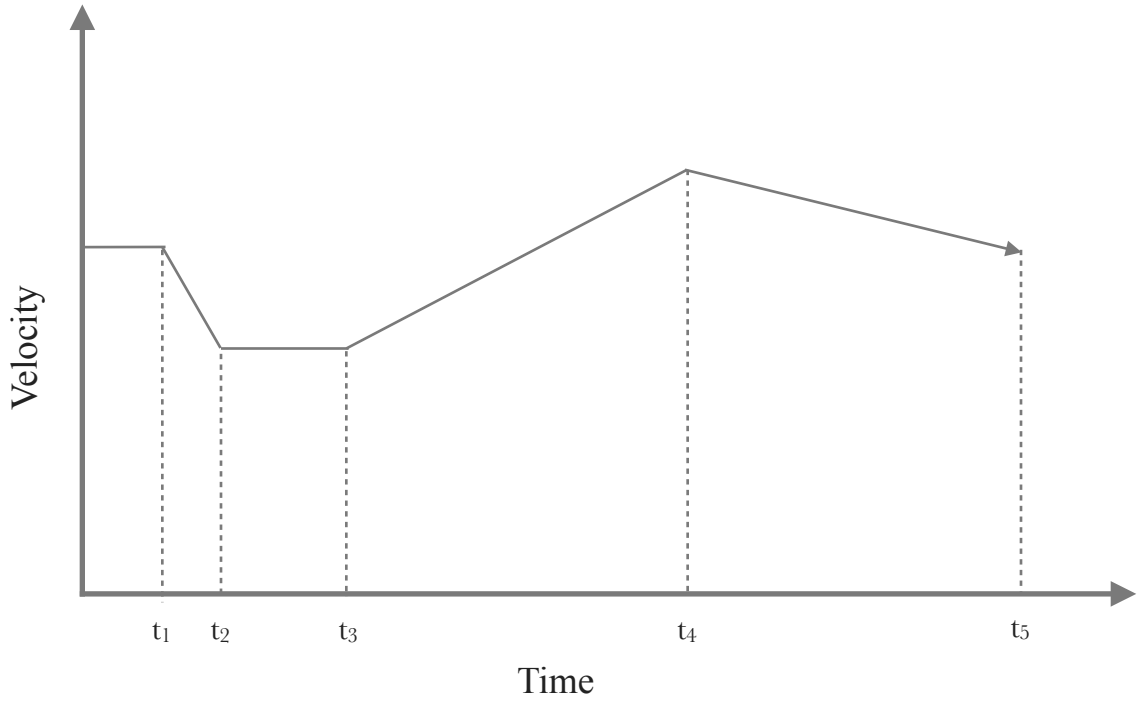
(A) Amplitude

(B) Frequency

(C) Wavelength

(D) Period

20 The velocity-time graph of an object is shown below.



What period of time does the object have the largest magnitude of acceleration?

(A) t_1 - t_2

(B) t_2 - t_3

(C) t_1 - t_4

(D) t_4 - t_5

Section I (continued)

Part B - 80 Marks
Attempt ALL Questions
Allow about 2 hours and 20 minutes for this part

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.

Extra writing space is provided at the end of the section. If you use this space:
• clearly indicate which question you are answering, AND
• write '*continued*' in the space originally allocated for the question

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Please turn over

Question 21 (5 marks) **Marks**

Swimming Shaun is floating in the water at the beach. He moves up and down 3 times in 30 seconds due to the motion of the waves.

(a) Calculate the period of the ocean waves. **1**

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(b) Calculate the frequency of the ocean waves. **1**

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The speed of the ocean wave is 10 ms^{-1}

(c) Find the wavelength and draw a displacement-position diagram of the above situation, showing how the wavelength can be measured on the diagram. **3**

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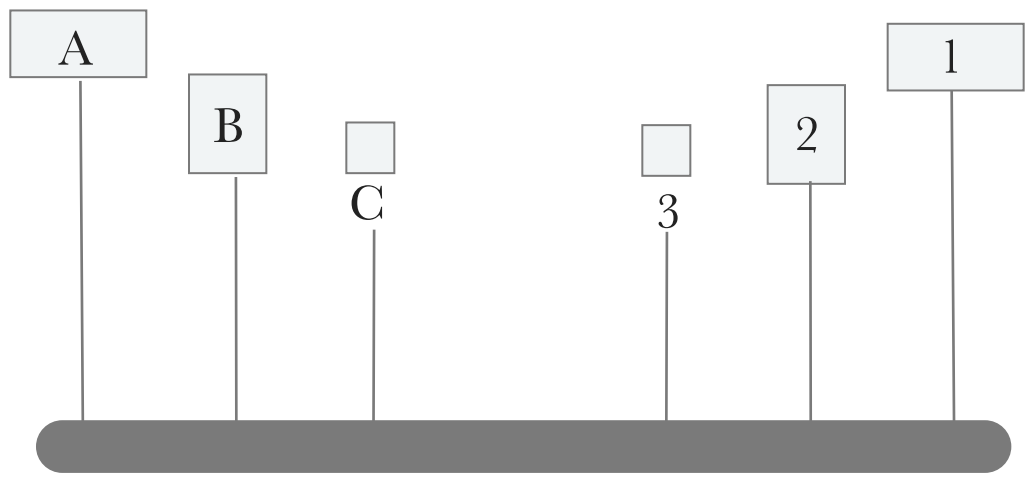
Question 22 (5 marks) **Marks**

Knowledgable Karen performed an experiment with a set of weighted bobs on a metal plate to investigate the concepts of natural frequency, driving frequency, resonance, and forced vibration. The experimental is shown below.

Bobs A/1, B/2 and C/3 are identical pairs



(a) When Karen pulls and releases bob A, it vibrates at its 'natural frequency'. What is meant by this term? **1**

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(b) After releasing bob A, she observes bob 1 to vibrate at the same frequency, whilst the other bobs vibrate sporadically. Explain the results of her experiment using the concepts of driving frequency, forced vibration, and resonance. **4**

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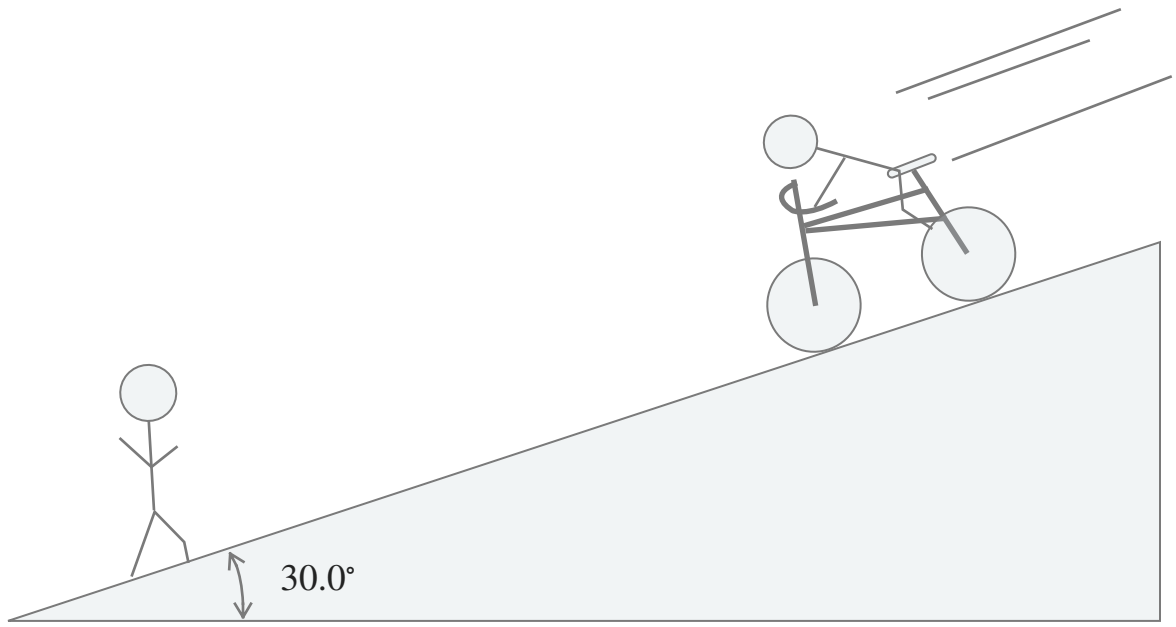
Question 23 (9 marks) **Marks**

Speedy Shawn, who weighs 60.0kg, rides his bike down a hill at an angle of 30.0 degrees to the horizontal towards Academic Aayushma, who is stationary. At $t = 0.00s$, Shawn is stationary at the top of the hill.



(a) Calculate the acceleration of Speedy Shawn as he rides down the hill, assuming there is no air resistance. **2**

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(b) Thus, find the velocity of Shawn at $t = 3.00\ s$. **3**

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At some point down the hill, Shawn is traveling at 20 m/s towards Aayushma. To avoid running over Aayushma, Shawn rings his bell which at a rest frame of reference, rings at a frequency of 720 Hz.

Take the speed of sound to be 340 ms^{-1}

(c) What frequency does Shawn hear his bell ring? **1**

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(d) What frequency does Aayushma hear the bell ring? **3**

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Question 24 (9 marks) **Marks**

Jazzy Jayden is playing a saxophone in a musical band. His saxophone can be modeled as a half open pipe, where the mouthpiece is the closed side, and the bell is the open side. His mouthpiece holds a reed, which produces air pressure variations when blown through and thus sound.

The length of his saxophone is 85cm.

(a) Determine the wavelength of the fundamental frequency played by Jayden. **1**

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(b) If the speed of sound in air is 340 ms^{-1}, find the fundamental frequency. **1**

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(c) Jayden wishes to play a two octaves higher. This can be interpreted as producing the 3rd harmonic. **2**

In the space below, draw a diagram of the 3rd harmonic standing wave, labelling nodes and antinodes.

(d) What is the wavelength of the 7th harmonic? **2**

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In the same band, Musical Michelle plays a flute, which can be modeled as an open pipe. She bets Jayden that she can calculate the length of the flute without the need for a ruler. **3**

Using a pitch recorder, she calculates the 2nd harmonic to be 520 Hz.

(e) What is the length of Michelle's flute if the speed of sound is 340 ms^{-1}?

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Question 25 (5 marks) **Marks**

In your studies, you performed an investigation to demonstrate the properties of mechanical and electromagnetic waves.

(a) Describe the methodology of the experiment you performed, including a table of results. **3**

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(b) Discuss the validity of your experiment **2**

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Question 26 (3 marks) **Marks**

Explain how the speed of sound in air varies with air temperature **4**

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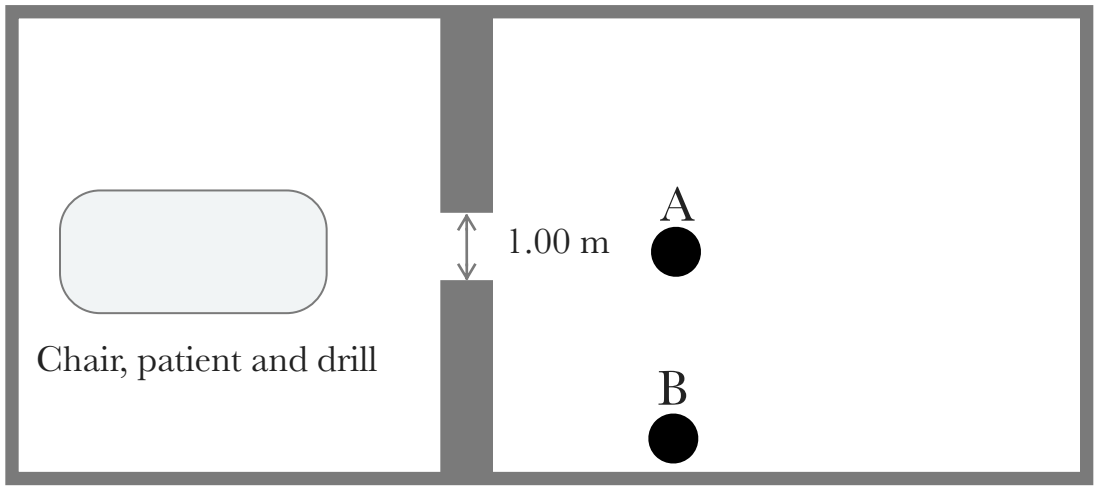
Question 27 (7 marks) **Marks**

The figure below shows the design of a dentist's waiting room and surgery.



There are two people sitting in the waiting room at points A and B. The door to the surgery is open and has a width of 1.00 m. A drill is operating and produces a sound of 5000 Hz frequency. The patient groans at a frequency of 200 Hz. Assume the speed of sound is 340 ms^{-1}, and both the sound of the drill and patient's groans are emitted with the same sound power.

(a) Define diffraction **2**

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(b) What is the wavelength of the patient's groans? **1**

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(c) What difference, if any, is there in the sound intensity levels heard at points A and B from dentist drill and groans? Justify your answer. **4**

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Question 28 (4 marks)

Jayden is trying to make a musical instrument that replicates a guitar. To do this, he ties a string with a mass per unit length of 3.55g/m on two fixed ends 60.0 cm apart, with a screw to adjust the tension. What tension does he have to set the string to achieve the A note (110 Hz) ?

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Question 29 (8 marks) **Marks**

Countryman Clayton is practicing his aim with a rifle. Using a light-gate, he measures the exit speed of the 20g bullet to be 352 ms^{-1} to the left. After firing the bullet, Clayton feels the 2.2kg rifle recoil backwards into his shoulder.

(a) Use Newton's third law of motion to explain why the rifle recoils backwards. **2**

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(b) Calculate the velocity in which the rifle initially recoils back. **2**

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(c) The rifle's rightwards recoil is absorbed into Clayton's shoulder and rebounds off his shoulder with a velocity of 0.5 ms^{-1} to the left. Calculate the impulse that the Clayton's shoulder delivers to the rifle **4**

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Question 30 (8 marks) **Marks**

Gordon Ramsay is trying to cook half boiled eggs in hot water, which requires the eggs to be cooled in a cold water bath immediately after cooking. The heat capacity of an egg and water is 3700 J kg^{-1} K^{-1} and 4184 J kg^{-1} K^{-1} respectively. The weight of each egg is 58 g.

(a) He initially needs to cook the eggs. To achieve this, he must have the eggs at the optimal cooking temperature of $83°C$. The eggs are initially taken out of the fridge at a temperature of $4°C$. **2**

How much thermal energy is required to bring the eggs to this optimal cooking temperature?

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(b) Gordon notices that the cooked egg at $83°C$ is slightly larger in size compared to the original egg from the fridge. Using the kinetic theory of matter, explain why this is the case. **2**

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After the eggs have been cooking at this optimal temperature for 2 minutes, Gordon transfers the eggs into a 400 mL cold water bath with water at an initial temperature of $7°C$.

The density of water is 1.00 kg/L

(c) Eventually, the eggs and cold water bath will reach the same temperature. Identify what principle this demonstrates. **1**

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(d) Find the final temperature of the egg and water system after they reach the same temperature. **4**

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Question 31 (6 marks) **Marks**

Existential-crisis Eddy is staring out of a 90cm x 90cm glass window in a house that is heated to 24 C. The outside temperature is -5 C and the glass pane is 10 mm thick.

Note: The thermal conductivity constant of glass is 0.27 W m C

(a) Explain why heaters are typically placed on the floor of the house rather than the ceiling. **3**

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(b) Find the rate of at which heat is transferred through the glass pane **3**

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Question 32 (4 marks) **Marks**

Amused Alexander is enjoying a day at Luna park, when he walks in front of a concave mirror with centre of curvature of 2 meters away from the vertex.

He notices that is reflection is upside-down until he gets to within a certain distance in front of the mirror.

(a) Draw a ray diagram of when Alexander sees an upside-down reflection of himself, and thus determine the length of this certain distance, and the type of image formed. **4**

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Question 33 (7 marks)

Scientist Saf is baking cookies in an oven when he accidentally burns himself on the hot oven tray. He exclaims "Owch! This oven tray contains a lot of heat".

(a) Assess the validity of his statement in relation to the definitions of temperature and heat. **5**

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(b) Explain, using the kinetic theory of matter, how his skin is burnt when he touches the hot oven tray. **2**

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END OF EXAM

Section 1 Part B Extra Writing Space

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Section 1 Part B Extra Writing Space

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