INSTRUCTIONS:

- Fill in your student details on the cover page
- Use the spaces provided to answer the questions.
- Corrections must be made clearly and neatly.
- For all solutions, show
 - ✓ every step you have taken.
 - ✓ all formulae used.
 - ✓ that you are following the rules of physics and measurement.

Question 1 Quantum Physics (14 marks)	
1.1. An electron has 1 300 eV of energy. What is its de Broglie wavelength $(1 \text{ eV} = 1.60 \times 10^{-19} \text{ J})$? (5)
(10) 1:00 : 10	
stays for a very short time (its lifetime) before it falls back to a lower en emitting a photon (de-excitation). Electrons in one such laser have a lifetime of 10 ⁻⁸ s. What is the uncer of the photon emitted during de-excitation of these electrons?	

1.3. In view of the uncertainty principle, can you measure a position with low uncertainty (with high precision)? Explain.	(1) (3)

Question 2 Fluid Mechanics (14 marks) 2.1. The large piston of a hydraulic lift is 0.300 m in diameter. What pressure (in atmospheres) must be applied at the small piston in order to lift a car of mass 1.20 × 10 ³ kg?	(6)
2.2. A slab of ice floats on a freshwater lake. What minimum mass must the slab have for a 45.0 kg person to be able to stand on the floating ice slab without getting their feet wet?	(8)

	marks) and whose level is at the human threshold of pain at an intensity of 1.0 pW m ⁻² .	(4
undergoes simple harmonic motion with	a spring with a spring constant of 6.50 N/m and an amplitude of 10.0 cm. When the block is halfwaynt of maximum displacement, its speed is measured the block.	(5
5.3. Show that wave function $y(x, t) = e^{b(x-b)}$ below) where b is a constant.	$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}$	(5

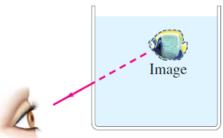
Question 4 Thermodynamics (14 marks) 4.1. A copper pot with a mass of 0.500 kg contains 0.170 kg of water, and both are at a temperature of 20.0 °C. A 0.250 kg block of iron at 85.0 °C is dropped into the pot. Find the final temperature of the system, assuming no heat loss to the surroundings.		
	(6)	
4.2. Describe how a refrigerator cycle works. Include a well labelled block diagram illustrating the cycle.	(5) (3)	

Question 5 Optics (14 marks)

5.1. A person is looking into an aquarium containing a fish. One ray of light coming from the fish is shown in the diagram (bold line). As illustrated by the dotted line, that ray makes the fish appear to be in the position shown.

In the same diagram, indicate with a clear and visible 'dot', the approximate actual position of the fish inside the aquarium.





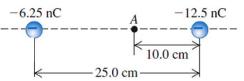
Briefly justify your answer.		
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A shaving or makeup mirror is d by a factor of 1.40 when your fac What type of mirror is this and d	ce is placed 20.0 cm in front of the mirror.	l

5.3. At what angle will 510 nm light produce a second-order maximum when falling on a grating whose slits are 1.35×10^{-3} cm apart?	(4)

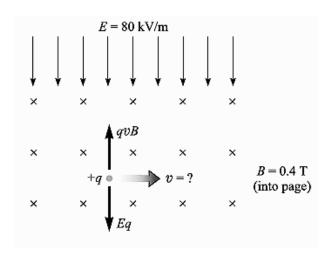
(6)

Question 6 Electricity and Magnetism (14 marks)

6.1. Two point charges are separated by 25.0 cm. What is the net electric field they produce at point A?



6.2. As shown in the diagram below, a particle of charge q enters a region where an electric field is uniform and directed downward. Its value is E = 80 kV/m. Perpendicular to \vec{E} and directed into the page is a magnetic field of magnitude B = 0.4 T. If the speed of the particle is properly chosen, the particle will not be deflected by the combined fields (electric and magnetic). Determine such a speed in this scenario? (5)



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6.3. Define the unit 'Ampere'				(3)
Question 7 Nuclear Physic	es (16 i	marks)		
7.1 The helf life of radium 2	06 in 1 6'	2 × 103 200	rs. How many radium atoms decay in 1.00 s	
in 1.00 g sample of radium	20 18 1.02 n? [1	year = 365	.25 days]	(8)

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7.2. W	7.2. What is the 'binding energy' and 'binding energy per nucleon' for			
7.2.1.	⁴ He?	(4)		
7.2.2.	²³⁸ U?	(4)		