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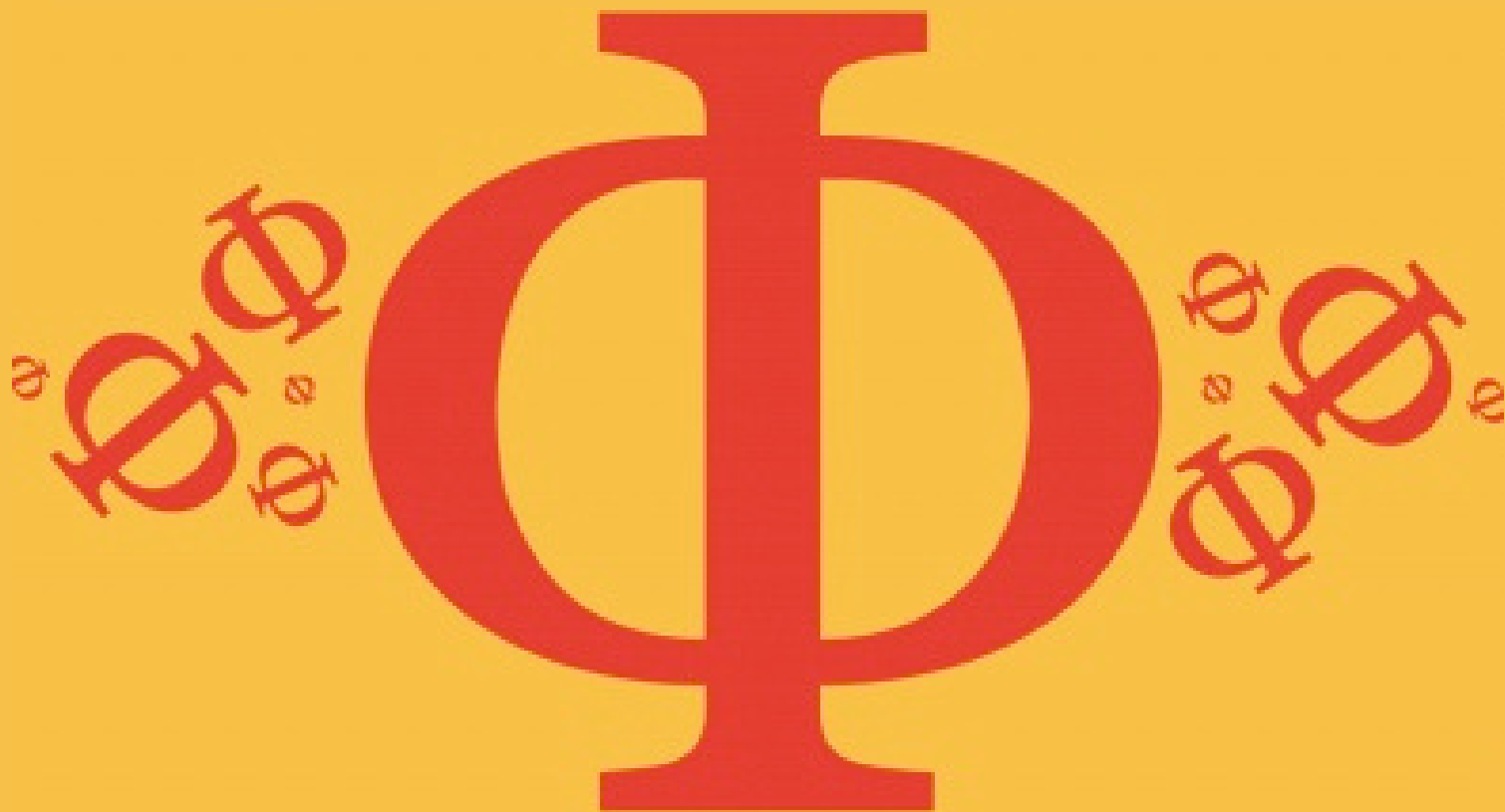
Detailed mark scheme

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thoroughly prepare you

12.1 The Interaction of Matter with Radiation

Medium



PHYSICS

IB HL

12.1 The Interaction of Matter with Radiation

Question Paper

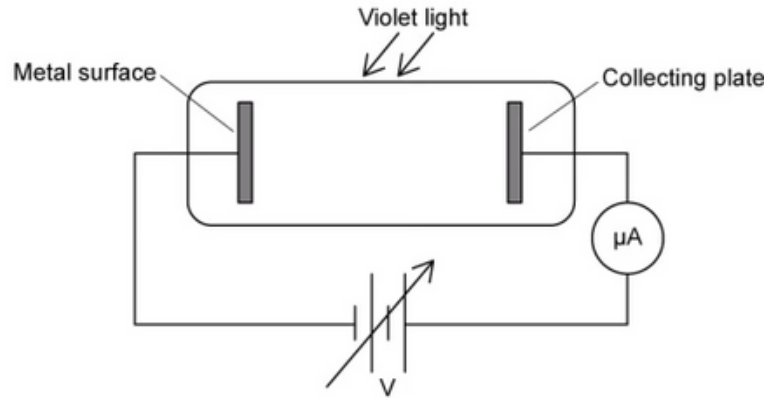
Course	DP IB Physics
Section	12. Quantum & Nuclear Physics (HL only)
Topic	12.1 The Interaction of Matter with Radiation
Difficulty	Medium

EXAM PAPERS PRACTICE

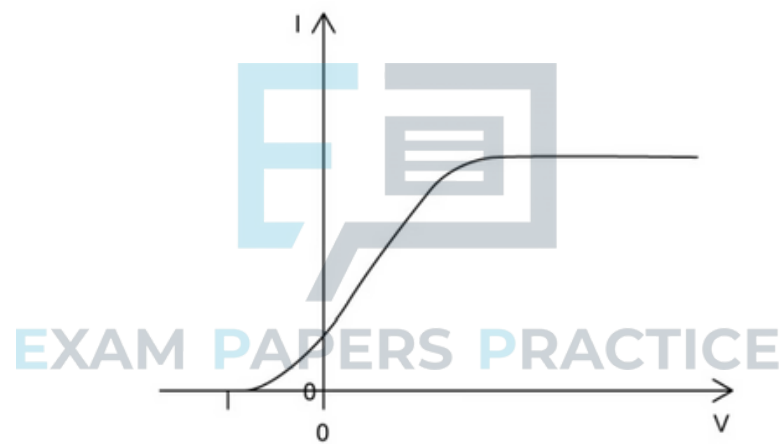
Time allowed: 20
Score: /10
Percentage: /100

Question 1

Violet light is incident on a metal surface, producing photoelectrons.



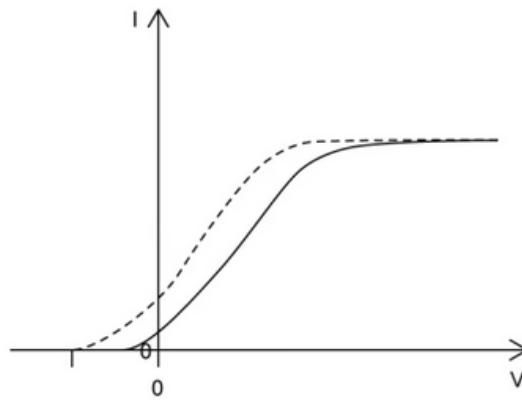
The variation of photocurrent I with potential difference V is shown.



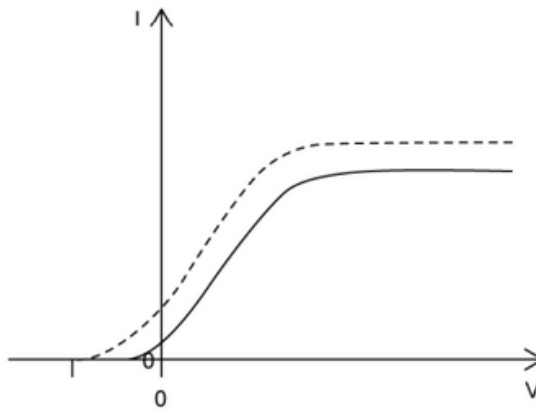
The light source is changed to red light of the same intensity as the violet light. Which graph shows the variation of photocurrent I with potential difference V for the red light? The results for the violet light are shown as a dashed line.



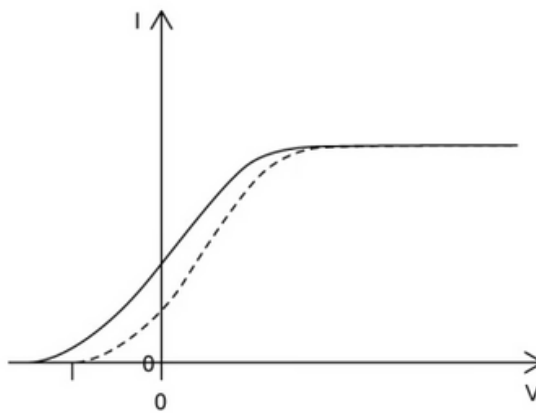
A.



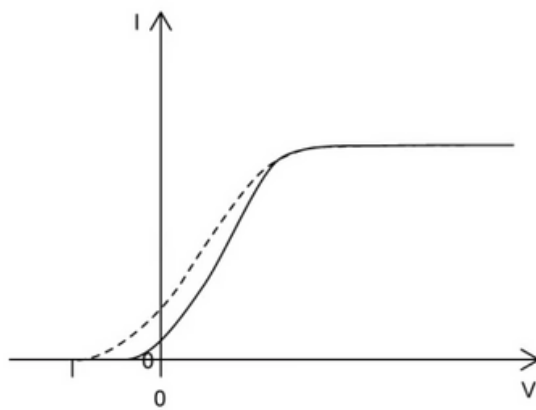
B.



C.



D.



[1 mark]



Question 2

A subatomic particle of mass m has an uncertainty in its position r , denoted by Δr . What is the uncertainty in its velocity, Δv ?

- A. $\frac{hm}{4\pi\Delta r}$
- B. $\frac{h}{4\pi\Delta r}$
- C. $\frac{h}{4\pi m\Delta r}$
- D. $\frac{h}{4\pi}$

[1 mark]

Question 3

Which expression is proportional to the probability of finding an electron in a particular region of space?

- A. The magnitude of the wave function
- B. The square of the magnitude of the wave function

C. $\frac{h}{4\pi \times \text{uncertainty in momentum}}$

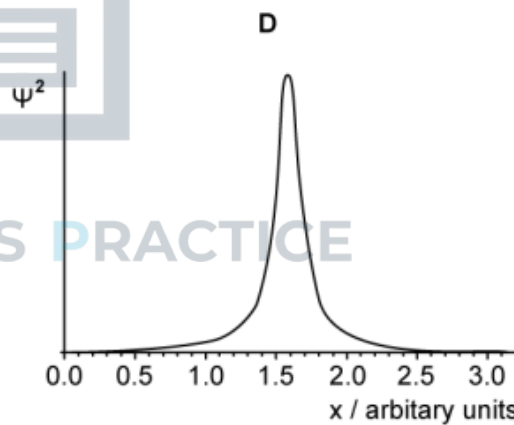
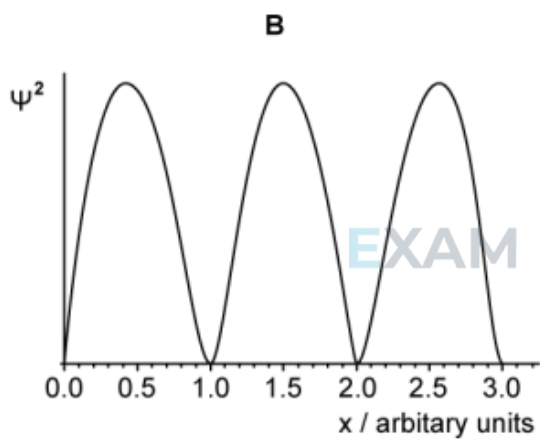
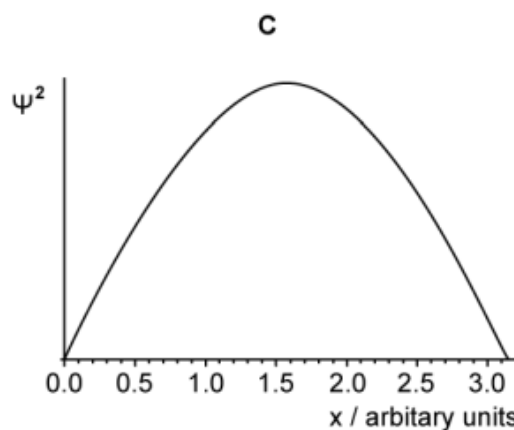
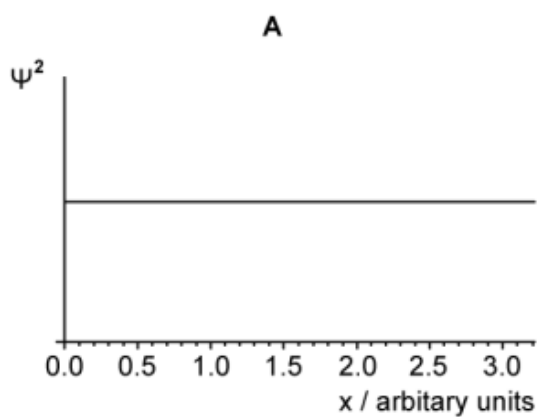
D. $\frac{h}{4\pi \times \text{uncertainty in energy}}$

[1 mark]



Question 4

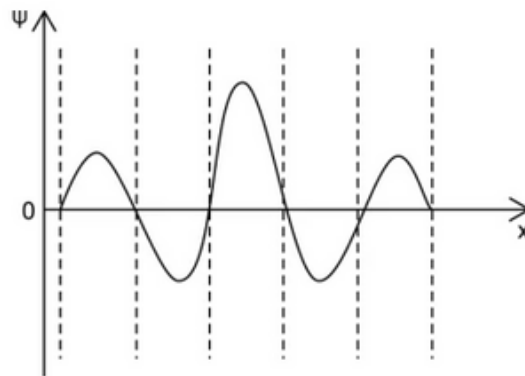
The graphs show the variation with distance x of the square of the magnitude of the wave function, ψ^2 , of a particle. Which graph corresponds to a particle with the largest uncertainty in momentum?



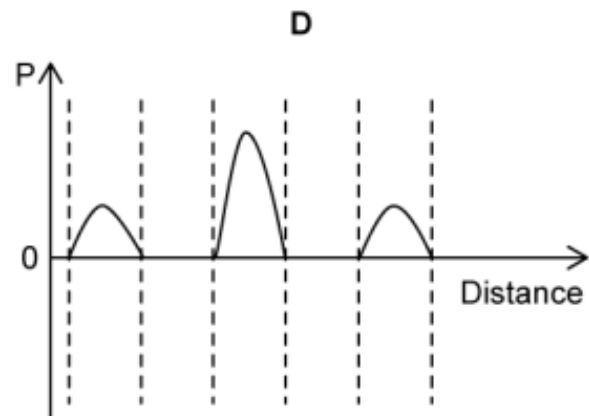
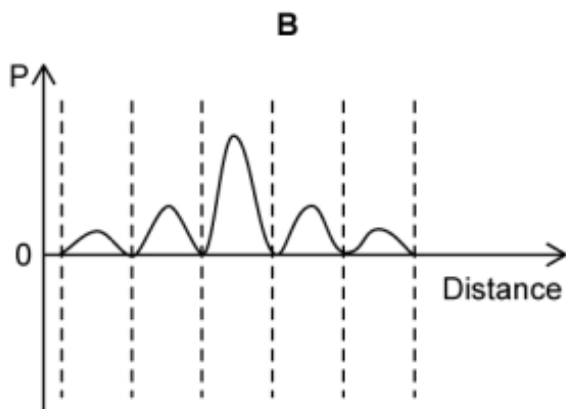
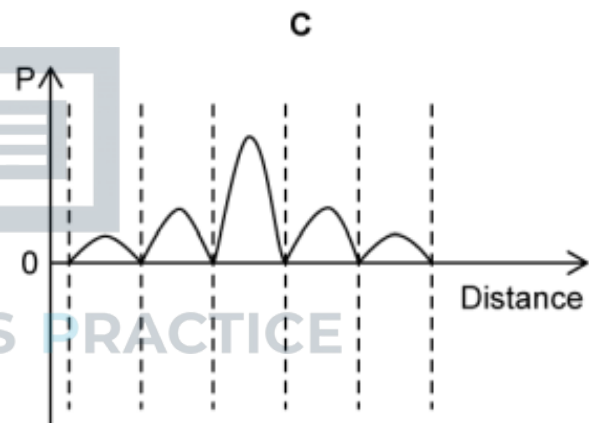
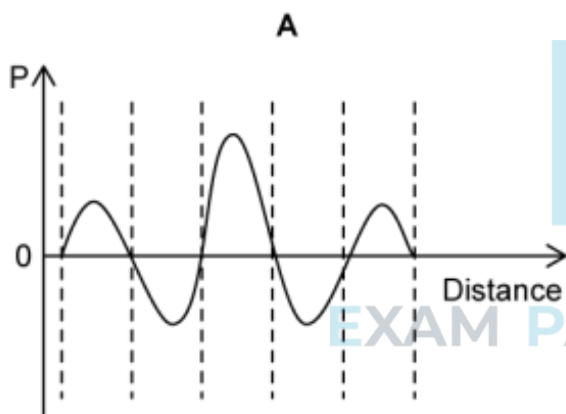


Question 5

The graph shows how the wave function ψ of an electron varies with distance x .



Which of the following graphs shows the probability P of finding the electron at each position along the distance x ?





Question 6

According to Heisenberg's uncertainty principle, conjugate quantities are pairs of quantities that cannot be known simultaneously with unlimited precision. What unit represents the product of two conjugate quantities?

- A. $\text{kg}^2 \text{m s}^{-1}$
- B. $\text{kg m}^2 \text{s}$
- C. $\text{kg m}^2 \text{s}^{-1}$
- D. $\text{kg m}^2 \text{s}^{-2}$

[1 mark]

Question 7

Alpha particles of mass m are accelerated from rest through a potential difference ΔV . Which of the following gives the de Broglie wavelength of the alpha particles as a result of the acceleration?

Use the following data:

- Planck's constant is h
- The magnitude of charge on an electron is e

A. $hm\Delta V$

B. $\sqrt{2hm\Delta Ve}$

C. $\sqrt{\frac{h}{m\Delta V}}$

D. $\frac{h}{\sqrt{4m\Delta Ve}}$

[1 mark]



Question 8

Which expression evaluates the de Broglie wavelength of an electron of mass m and charge e in the $n = 2$ state of hydrogen?

A. $\frac{h}{\sqrt{2me}}$

B. $\frac{h}{\sqrt{3.4me}}$

C. $\frac{h}{\sqrt{6.8me}}$

D. $\frac{h}{\sqrt{13.6me}}$

[1 mark]

Question 9

The electron wave function ψ is a function of position and time. Which expression evaluates the probability of discovering the electron in some volume ΔV ?

A. ψ

B. ψ^2

C. $|\psi|^2$

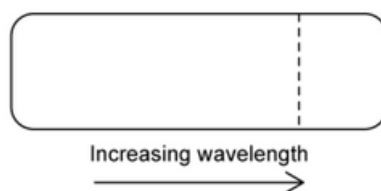
D. $|\psi|^2 \Delta V$

[1 mark]

Question 10

According to the Bohr model for hydrogen, visible light is emitted when electrons make transitions from excited states down to the state with $n = 2$.

The dotted line in the diagram represents such a transition, from $n = 3$ to $n = 2$, in the spectrum of hydrogen.



Which of the following diagrams could represent the visible light emission spectrum of hydrogen?

