National Testing Agency

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Introduction to Quantum Physics and its Applications

Group Number :	1
Group Id :	28860718
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Show Attended Group? :	No
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Break time:	0
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Introduction to Quantum Physics and its Applications

Section Id :	28860718
Section Number :	1
Section type :	Online
Mandatory or Optional:	Mandatory
Number of Questions:	15
Number of Questions to be attempted:	15
Section Marks:	90

Sub-Section Number:	1
Sub-Section Id:	28860718
Question Shuffling Allowed :	Yes

Question Number : 1 Question Id : 2886071701 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

From the Planck's formula of blackbody radiation, the energy density of the radiation is linearly dependent of the temperature T for

(A) all values of frequencies

(B) values of frequencies satisfying $h\nu \ll kT$

(C) values of frequencies satisfying $h\nu \approx kT$

(D) values of frequencies satisfying $h\nu \gg kT$

Here h is the Planck's constant and k is the Boltzmann's constant.

Options :

2886076794. 1

2886076795. 2

2886076796. 3

2886076797. 4

Question Number : 2 Question Id : 2886071702 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

In a photo-electric experiment, a metal is exposed to a radiation of frequency f and intensity I and a photo-current is observed. We can assume that one electron in the metal absorbs one incident photon. Which of the following statements is true?

(A) The photocurrent is independent of f and increases if I is increased.

(B) The photocurrent increases if f is increased and is independent of I

(C) The photocurrent increases if f is increased and increases if I is increased

(D) The photocurrent is independent of both f and I.

Options :

2886076798. 1

2886076799. 2

2886076800. 3

2886076801. 4

Question Number : 3 Question Id : 2886071703 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Consider Balmer series of photon emissions in a Hydrogen atom. Let λ_1 be the shortest wavelength in this series and λ_2 be the longest wavelength. The ratio λ_2/λ_1 is [SEP]

(A) 1.2

(B) 1.4

(C) 1.6

(D) 1.8

Options :

2886076802. 1

2886076803. 2

2886076804. 3

2886076805. 4

Question Number : 4 Question Id : 2886071704 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Consider the square pulse of the form,

$$f(x) = 0 \quad for\ -\infty < x < a$$

$$= 1 \quad for\ a < x < 3a$$

$$= 0 \quad for\ 3a < x < \infty$$

The Fourier transform of this function is

(A) $(2a)\dfrac{\sin(ka)}{ka}$

(B) $(2a)e^{2ika}\dfrac{\sin(ka)}{ka}$

(C) $(2a)\dfrac{\sin(2ka)}{ka}$

(D) $(2a)e^{2ika}\dfrac{\sin(2ka)}{ka}$

Options :

2886076806. 1

2886076807. 2

2886076808. 3

2886076809. 4

Question Number : 5 Question Id : 2886071705 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Consider a potential V(x) which is finite for all values of x. A function $f(x)$ defined to be

$$f(x) = 0 \quad for \quad -\infty < x < -a$$
$$= a - |x| \quad for \quad -a < x < a$$
$$= 0 \quad for \quad a < x < \infty$$

This function can not be a wave function of a bound state of V(x) because

(A) it can not be normalized

(B) it is not continuous

(C) its first derivative is not defined at all points

(D) all of the above reasons

Options :

2886076810. 1

2886076811. 2

2886076812. 3

2886076813. 4

Question Number : 6 Question Id : 2886071706 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

A one dimensional potential barrier is of the form

$$V(x) = 0 \quad for \ -\infty < x < 0$$
$$= V_0 \quad for \ 0 < x < \infty$$

where V_0 is positive. A stream of electrons of kinetic energy 100 eV is directed to this barrier from $-\infty$. It is found that 80% of these electrons are reflected back. The mass of electron, in energy units, is 500, 000 eV. The approximate value of V_0 (in eV) is

(A) 99.75

(B) 99.0

(C) 90.0

(D) 80.0

Options :

2886076814. 1

2886076815. 2

2886076816. 3

2886076817. 4

Question Number : 7 Question Id : 2886071707 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Consider a one dimensional infinite potential well from x = 0 to x = L. A particle in this well is in the n = 3 state (the second excited state). The probability of finding the particle between x = L/6 and x = 2L/3 is

(A) 5/6

(B) 2/3

(C) 1/2

(D) 1/3

Options :

2886076818. 1

2886076819. 2

2886076820. 3

2886076821. 4

Question Number : 8 Question Id : 2886071708 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

A one dimensional, finite potential barrier has the form

$$V(x) = 0 \quad for \; -\infty < x < 0$$

$$= V_0 \quad for \; 0 < x < L$$

$$= 0 \quad for \; L < x < \infty$$

where V_0 is a positive constant. A beam of particles with kinetic energy $0<E<V_0$ is incident on the barrier from $x = -\infty$. The probabilitity of a particle tunneling through the barrier is P. Which of the following statements is correct?

(A) P is larger if L is larger and is larger if V_0 is larger

(B) P is larger if L is smaller and is larger if V_0 is larger

(C) P is larger if L is larger and is larger if V_0 is smaller

(D) P is larger if L is smaller and is larger if V_0 is smaller

Options :

2886076822. 1

2886076823. 2

2886076824. 3

2886076825. 4

Question Number : 9 Question Id : 2886071709 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Consider a three dimensional infinite potential well, extending from $0 \leq x \leq L, 0 \leq y \leq L$ and $0 \leq z \leq L$. A particle in this well has energy $\frac{(51\pi^2\hbar^2)}{(2mL^2)}$. The number of distinct states this particle can occupy are

(A) 1

(B) 3

(C) 6

(D) 9

Options :

2886076826. 1

2886076827. 2

2886076828. 3

2886076829. 4

Question Number : 10 Question Id : 2886071710 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

A certain thermodynamic system has the non-degenerate energy levels, with energies 0, E, 3E, 5E, 9E. Suppose that there are four identical bosons, with total energy 10E. The number of possible distributions of these particles is

(A) 4

(B) 3

(C) 2

(D) 1

Options :

2886076830. 1

2886076831. 2

2886076832. 3

2886076833. 4

Question Number : 11 Question Id : 2886071711 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

The Fermi energy of Cu is 7 eV. The mass of electron, in energy units, is 500.000 eV. The de Broglie wavelength of the conducting electrons in Cu, in units of Angstroms, will be (approximately)

(A) 0.8

(B) 1.6

(C) 4.7

(D) 6.5

Options :

2886076834. 1

2886076835. 2

2886076836. 3

2886076837. 4

Question Number : 12 Question Id : 2886071712 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

A non-relativistic particle of mass m is held in a circular orbit around the origin by an attractive force $f(r) = -kr$ where k is a positive constant Assuming the Bohr quantization of the angular momentum of the particle, quantized energy of the particle is

(A) $E = n^2\hbar\left(\frac{k}{m}\right)^{1/2}$

(B) $E = n\,\hbar\left(\frac{k}{m}\right)^{1/2}$

(C) $E = n^{1/2}\,\hbar\left(\frac{k}{m}\right)^{1/2}$

(D) $E = n^{1/3}\hbar\left(\frac{k}{m}\right)^{1/2}$

Options :

2886076838. 1

2886076839. 2

2886076840. 3

2886076841. 4

Question Number : 13 Question Id : 2886071713 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Inter-atomic spacing in most solids is about one angstrom. To measure such spacing in a diffraction experiment, usually high energy X-rays, (with energy of thousands of eV) are used. But such measurements can also be done with low energy neutrons. Mass of neutron, in energy units, is 940 million eV. If a neutron is used in a diffraction experiment to measure an inter-atomic spacing of one angstrom, its kinetic energy (in eV) is

(A) 0.082

(B) 0.041

(C) 0.026

(D) 0.013

Options :

2886076842. 1

2886076843. 2

2886076844. 3

2886076845. 4

Question Number : 14 Question Id : 2886071714 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

Given a wave function $\psi(x) = \frac{N}{x^2+a^2}$, the normalization constant (N) is

(A) $\left(\frac{2a^3}{\pi}\right)^{1/2}$

(B) $\left(\frac{a^3}{\pi}\right)^{1/2}$

(C) $\left(\frac{a^3}{2\pi}\right)^{1/2}$

(D) $\left(\frac{a^3}{8\pi}\right)^{1/2}$

Options :

2886076846. 1

2886076847. 2

2886076848. 3

2886076849. 4

Question Number : 15 Question Id : 2886071715 Question Type : MCQ Option Shuffling : No
Correct Marks : 6 Wrong Marks : 0

Question Label : USEFUL INFO: hc = 12400 Angstrom-eV

A particle of mass m is trapped in a one dimensional potential given by $V(x) = m\omega^2x^2/2$. At a time $t = 0$, the state of the particle is described by the wave function $\psi(x) = \frac{1}{\sqrt{2}}[\psi_1 + \psi_2]$, where $\psi_1(x)$and $\psi_2(x)$ are the normalized ground and first excited states for the oscillator. The probability density $|\psi(x),t|^2$ oscillates with angular frequency

(A) 8ω

(B) 5ω

(C) 3ω

(D) ω

Options :

2886076850. 1

2886076851. 2

2886076852. 3

2886076853. 4