The quantum mechanical tunneling across a potential barrier or a potential step is commonly studied topics that is covered in most courses on quantum mechanics (see for example [82, 83]). The transmission probability of a quantal particle across a barrier when its incident energy is less than the barrier height is often used to distinguish between the classical situation where tunneling is not possible and the corresponding quantal situation which is due to the wave aspect of the quantum particle. Even in classical wave theory, tunneling is well understood and hence similar behavior for a quantal particle described by the
Schrödinger wave equation becomes comprehensible.

In most of the treatments of quantum mechanical tunneling, only the relative importance of transmission and reflection is investigated using a real potential barrier and the role of possible absorption in the barrier region is not given adequate attention. The subtle inter-relationship between the barrier problem and the corresponding well problem is not widely known in particular when absorption is present. In many problems of interest in non-relativistic quantum mechanics like nuclear scattering in 3D and coherent resonant tunneling through one dimensional systems, the role of absorption is very important [21, 84–86]. Therefore a good illustrative treatment of transmission, absorption and reflection across one-dimensional well and barrier with absorption will give a good basis for understanding the subtleties involved in this problem and hence give a more complete picture of the problem of quantum tunneling and transmission.

It is well known that absorption can be simulated in quantum mechanics by invoking a complex potential with negative imaginary part even though such a potential makes the hamiltonian for the system non-hermitian. But if it is interpreted as simulation of a collision problem where the incident flux is absorbed and injected to other non-elastic channels [87], the description of such a situation using the single-particle Schrödinger equation for complex potentials becomes quite meaningful. As is well known, complex potentials are widely used in the analysis of nuclear scattering and is referred to as the nuclear optical model [64, 88]. Since the nucleus is a many-body system, in nucleon-nucleus or nucleus-nucleus scattering, in general, a large number of channels are opened for different reaction processes like elastic scattering,
in-elastic scattering and various types of reactions. In order to generate the inelastic and reaction process, the incident flux has to be absorbed from the elastic channel and injected into all open non-elastic channels. If one is interested mainly in the total reaction cross section contributed from all channels as well as the elastic scattering cross section, it is possible to obtain these phenomenologically by treating the nucleon-nucleus or nucleus-nucleus problem as a two-body problem having a complex potential with negative imaginary part. In this model, the region around the scattering centre acts like a partially absorptive sphere. The absorption accounts for the reduction in the incident flux due to various reaction channels. In one dimension the attenuation of the incident flux by an imaginary attractive potential implies that the incident flux is distributed among the transmitted, reflected and absorbed fluxes. These quantities can be determined using the appropriate Schrödinger equation and boundary conditions. The use of optical potential is very much similar to the use of a complex refractive index for describing the passage of light waves through an absorbing material.

The attenuation is also found when the flux with below barrier energy enters the real barrier affecting its transmission. Hence a careful study of the coefficients of reflection $R$, absorption $A_b$ (we use the symbol $A_b$ in order to distinguish it from the coefficient $A$ used for the amplitude of incident wave) and transmission $T$ for complex potential and their comparison with the $T$ and $R$ generated by real potentials is desirable to highlight the subtleties involved in complex potential scattering in general and 1D transmission in particular. In this connection it is pointed out that Lyngdoh et al [85] in their previous work have examined closely related problem of resonances in an absorptive well lo-
cated in between the barriers. In our study of quantum transmission across an absorptive medium [23] we analyzed the special features which are not dealt in their work.

In 1D quantum transmission across an absorptive potential, the imaginary part of the potential causes the absorption of the flux. This make one to think that the increase in absorptive potential strength $W_0$ will lead to monotonic increase in absorption making the transmission and reflection insignificant. We examined this for the transmission across an 1D absorptive domain for a given energy and found that at a given energy as $W_0$ is increased, the absorption coefficient $A_b$ increases reaches a maximum value for a particular value of $W_0$ and then decreases gradually and tends to zero as $W_0 \to \infty$. Since $A_b$ for a given energy approaches zero as $W_0 \to \infty$, we expect that transmission will approach zero and reflection will go to unity. This behavior is similar to the transmission across a real barrier of infinitely large height for a fixed energy, in which $T$ will go to zero and $R$ to unity. Does this similar dependence imply that an infinitely large absorptive well is equivalent in some way to an infinitely high potential barrier? Further we find that there is critical value of $W_0$ for a given energy and similarly a critical value of $E$ for a given $W_0$ for absorption to be maximum. We examine these results in detail.

In section 5.1 we give the mathematical preliminaries to deduce the relation between transmission, reflection and absorption coefficient generated by a rectangular absorptive potential and mathematical analysis of absorption coefficient $A_b$ as a function of $W_0$. In section 5.2 we study the transmission across a real barrier and the corresponding well and in section 5.3 we study the variation of transmission, reflection and absorption coefficient across an absorptive bar-
rier and well as a function of energy. In section 5.4 we analyze the significance of absorption strength $W_0$ on transmission, absorption and reflection coefficient across a purely absorptive domain for a given energy $E$, and to study the correlation between $W_0$ and $E$ we study the variation of transmission, absorption and reflection coefficient as a function of energy $E$ for a given absorption strength $W_0$ and then we analyze the variation of absorption strength $W_0(E)$ where absorption peak occurs for energy $E$ as a function of energy $E$. For all these calculations we use rectangular potentials. Section 5.5 contains the summary of the main conclusions of our study.

### 5.1 Transmission $T$, reflection $R$ and absorption $A_b$ across an absorptive potential

Consider the transmission across a complex barrier given by:

$$V(x) = \begin{cases} 
0, & x < 0, \\
V_0 - iW_0, & V_0 > 0, W_0 > 0, \quad 0 < x < a, \\
0, & x > a \text{ or } x < 0.
\end{cases} \quad (5.1)$$

This potential represents a real barrier when $V_0 > 0, W_0 = 0$, a real well when $V_0 < 0, W_0 = 0$, an absorptive well when $V_0 < 0, W_0 > 0$ and an absorptive barrier when $V_0 > 0, W_0 > 0$.

As usual we start with the 1D time independent Schrödinger wave equation:

$$\frac{d^2}{dx^2}\phi(x) + (k^2 - V(x))\phi(x) = 0. \quad (5.2)$$
In this and the next chapter we use fermi \((fm)\) as the unit of length and \(fm^{-2}\) as the unit of energy \(E\) in our numerical calculations. Defining:

\[
\alpha^2 = k^2 - V_0 + iW_0,
\]

(5.3)

the solution \(\phi(x)\) can be written as:

\[
\phi(x) = e^{ikx} + Be^{-ikx}, \ x < 0,
\]

\[
\phi(x) = Ce^{i\alpha x} + De^{-i\alpha x}, \ 0 < x < a,
\]

(5.4)

\[
\phi(x) = Fe^{ikx}, \ x > a,
\]

where the incident wave amplitude is assumed to be unity and \(B, C, D,\) and \(F\) are functions of \(k\). Algebraic expression for \(B, C, D\) and \(F\) is found by matching these wave functions and their derivatives at \(x = 0\) and \(x = a\). These equations are then solved to obtain an expression for reflection amplitude \(B\) and transmission amplitude \(F\):

\[
B = \frac{(1 - \frac{k^2}{\alpha^2})(1 - e^{-2ia})}{\left((1 + \frac{\alpha}{a})^2 e^{-2ia} - (1 - \frac{\alpha}{a})^2\right)}
\]

(5.5)

\[
F = \frac{(1 - \frac{\alpha}{a})^2 - (1 + \frac{\alpha}{a})^2}{e^{i(k+\alpha)a}\left(1 - \frac{\alpha}{a}\right)^2 - e^{i(k-\alpha)a}\left(1 + \frac{\alpha}{a}\right)^2}
\]

(5.6)

The corresponding reflection coefficient \(R = |B|^2\) and transmission coefficient \(T = |F|^2\). For an absorptive potential, \(R + T < 1\), and absorption coefficient \(A_b = 1 - R - T\). 

111
5.1.1 **Mathematical expression for absorption coefficient**

An expression for $A_b$ can be obtained by solving the Schrödinger Eq.(5.2) and its complex conjugate. Taking the complex conjugate of Eq.(5.2), we get:

$$
\frac{d^2}{dx^2} \phi^*(x) + \left(k^2 - V^*(x)\right) \phi^*(x) = 0.
$$  \hspace{1cm} (5.7)

Form Eq.(5.2) and Eq.(5.7), we get:

$$
\phi^*(x) \frac{d^2}{dx^2} \phi(x) - \phi(x) \frac{d^2}{dx^2} \phi^*(x) = 2i \text{Im} (V(x)) |\phi(x)|^2,
$$  \hspace{1cm} (5.8)

$$
\left[ \phi^*(x) \frac{d}{dx} \phi(x) - \phi(x) \frac{d}{dx} \phi^*(x) \right]_0^a = 2i \int_0^a \text{Im} (V(x)) |\phi(x)|^2 \, dx,
$$  \hspace{1cm} (5.9)

$$
\left[ \phi^*(x) \frac{d}{dx} \phi(x) - \phi(x) \frac{d}{dx} \phi^*(x) \right]_0^a = -2iW_0 \int_0^a |\phi(x)|^2 \, dx. \hspace{1cm} (5.10)
$$

Substituting the value of $\phi(x)$ and $\frac{d\phi(x)}{dx}$ at $x = 0$ and $x = a$ in Eq.(5.10), we get:

$$
2ik \left(|B|^2 + |F|^2 - 1\right) = -2iW_0 \int_0^a |\phi(x)|^2 \, dx,
$$  \hspace{1cm} (5.11)

$$
or \hspace{1cm} 1 - \left(|B|^2 + |F|^2\right) = \frac{W_0}{k} \int_0^a |\phi(x)|^2 \, dx. \hspace{1cm} (5.12)
$$

The left side of the Eq.(5.12) is just the absorption coefficient $A_b$. Hence,

$$
A_b = \frac{W_0}{k} \int_0^a |\phi(x)|^2 \, dx. \hspace{1cm} (5.13)
$$
It should be noted that the energy and $W_0$ dependence arises indirectly through $|\phi(x)|$. We examine the detailed behavior of $A_b$ by substituting the expression for $\phi(x)$ in the range $0 < x < a$ in the right side of Eq.(5.12) and get:

$$A_b = \frac{W_0}{k} \left| \frac{|C|^2 (e^{-2\alpha_i a} - 1)}{(-2\alpha_i)} + \frac{|D|^2 (e^{2\alpha_i a} - 1)}{(2\alpha_i)} + \frac{CD^* (e^{2\alpha_r a} - 1)}{(2i\alpha_r)} + \frac{C^* D (e^{-2\alpha_r a} - 1)}{(-2i\alpha_r)} \right|, \quad (5.14)$$

where $\alpha_r$ and $\alpha_i$ are real and imaginary parts of $\alpha$. In the case of real potential ($W_0 = 0$), $\alpha$ is real for real barrier if $E > V_0$ and purely imaginary when $E < V_0$. Similarly, for real attractive well ($V_0 < 0$), $\alpha$ is real for all $E > 0$. But for an absorptive potential $W_0 > 0$, $\alpha$ is complex for all real $E$ in general.

To analyze the behavior of $A_b$ as a function of absorption strength $W_0$ mathematically, we determined $C$ and $D$ in terms of $F$ and obtained:

$$C = \frac{1}{2} \left( 1 + \frac{k}{m} \right) Fe^{-ika} e^{-i\alpha a}, \quad (5.15)$$

$$D = \frac{1}{2} \left( 1 - \frac{k}{m} \right) Fe^{ika} e^{i\alpha a}. \quad (5.16)$$

By using Eqs.(5.6), (5.15) and (5.16), it is found that:

$$W_0|C|^2 \frac{(e^{-2\alpha_i a} - 1)}{(-2\alpha_i)} \xrightarrow{W_0 \to \infty} O\left(W_0^{-1/2}\right), \quad (5.17)$$

$$W_0|D|^2 \frac{(e^{2\alpha_i a} - 1)}{(2\alpha_i)} \xrightarrow{W_0 \to \infty} O\left(W_0^{-1/2}e^{-2\sqrt{W_0}}\right), \quad (5.18)$$

$$\left| W_0CD^* \frac{(e^{2\alpha_r a} - 1)}{(2i\alpha_r)} \right| \xrightarrow{W_0 \to \infty} O\left(W_0^{-1/2}e^{-2\sqrt{W_0}}\right), \quad (5.19)$$
Thus we find:

\[
A_b \xrightarrow{W_0 \to \infty} O\left(W_0^{-1/2}\right).
\] (5.21)

On the other hand, as \(W_0 \to 0\), \(A_b \to 0\). This shows that in the range \(0 < W_0 < \infty\), \(A_b\) must have at least one maximum. If there are more than one unequal maxima, one of them will be largest. Thus we conclude that there is at least one critical \(W_0\) at which absorption is largest for a given \(E\). We expect that this statement is valid even for the case of a smooth absorptive potential governed by a strength parameter \(W_0\). Our heuristic reasoning is as follows: for a smooth complex barrier the wave function inside the barrier can be approximated using WKB approach as (Ref. [87]):

\[
\frac{C}{\sqrt{K(x)}} e^{i \int K(x) dx} + \frac{D}{\sqrt{K(x)}} e^{-i \int K(x) dx},
\] (5.22)

where \((K(x))^2 = k^2 - V_0 f(x) + iW_0 g(x)\). The function \(f(x)\) and \(g(x)\) denote the form factors of real and imaginary potentials with respective strengths \(V_0\) and \(W_0\). Therefore, the exponential terms in Eq.(5.22) will not alter the general asymptotic behavior \(O(W_0^{-1/2})\) of \(A_b\) as a function of \(W_0\). In addition, the term \(K(x)\) in the denominator of \(C\) and \(D\) can only make the asymptotic decrease of \(A_b\) with increasing \(W_0\) more rapid.
5.2 Transmission across real barrier and the corresponding well

The problem of transmission of a beam of particles of energy $E < V_0$ across a real barrier is a quantal phenomena which has no classical analogue. This makes one to think that if the barrier is replaced by well, then there would be full transmission without reflection. But quantum transmission is a wave phenomena, hence transmission and reflection are present for all most all potentials whether attractive or repulsive. To demonstrate this we compared the transmission and reflection across a real barrier with the real well. The details of the resonances generated by the well and barrier have already been described in chapter 3 [11].

In the case of well, the transmission at below barrier energies is substantially larger than the corresponding barrier, but it is less than unity. This implies that the well can cause substantial reflection which is less than the corresponding value for the barrier in most of the domain. However, at above barrier energies the transmission across barrier becomes quite close to that of the well even though marginal difference persists. But in the limit $E/V_0 \gg 1$, $T(B)$ and $T(W)$ will be very close to each other, where $T(B)$ is the transmission across barrier and $T(W)$ is the transmission across well. Figure 5.1 demonstrates all these salient features in a comprehensive way.
Figure 5.1: Variation of $T$ and $R$ across a rectangular barrier (indicated by B) ($V_0 = 5, a = 2$) and corresponding well (W) as a function of $E$. In this and rest of the figures potential strengths and $E$ are in $fm^{-2}$ units and $a$ in $fm$ units.


5.3 Transmission, reflection and absorption across an absorptive barrier and well

We study the relative role of absorption $A_b$ in an absorptive barrier ($V(x) = V_0 - iW_0$, $0 < x < a$) versus absorptive well ($V(x) = -V_0 - iW_0$, $0 < x < a$) with $V_0 > 0$. The results are shown in Figure 5.2. We have taken the parameters $V_0 = 5$, $W_0 = 5$ and $a = 1.5$. The symbol $AW$ and $AB$ in this figure refer to absorptive well and absorptive barrier respectively. The variation of transmission $T(AW)$ across an absorptive well and the corresponding $T(AB)$ as a function of $E$ are more or less as expected and transmission $T(AW) > T(AB)$. Similarly the reflections $R(AW)$ and $R(AB)$ also show the variations as one anticipates. However more interesting behavior is the variation of absorption $A_b$ with energy. In the case of absorptive well the peak in absorption $A_b(AW)$ occurs at much lower energy than the corresponding absorptive barrier case. Further one finds that in most of the above barrier region of energy $A_b(AB)$ is more predominant than $A_b(AW)$. This can be explained as follows:

Consider the case of an absorptive well. As the particle crosses the well domain $0 < x < a$, since total energy $E$ is conserved the kinetic energy increases. Due to this the particle (/wave) system spends relatively less time in the well domain resulting in relatively less absorption as a function of energy. The argument works other way in the case of an absorptive barrier at above barrier energies. In this case, kinetic energy decreases in the barrier domain $0 < x < a$. This facilitates the system to spend more time in the barrier region facilitating higher absorption. Due to this as $E$ increases above $V_0$ one has $A_b(AB) > A_b(AW)$. Similarly, in most of the range having $E < V_0$,
Figure 5.2: Comparative behaviour of coefficient of transmission ($T$), reflection ($R$) and absorption ($A_b$) as a function of energy ($E$) in the case of an absorptive barrier ($V_0 = 5, W_0 = 5, a = 1.5$) and absorptive well ($V_0 = -5, W_0 = 5, a = 1.5$).

$A_b(AW) > A_b(AB)$ because, in this case it is more difficult for the system to penetrate into the barrier region than into the well region. Based on this physical picture one can similarly interpret the variation of pairs of variables $T(AW)$, $T(AB)$ and $R(AW)$, $R(AB)$. Hence $T(AW) > T(AB)$ and $R(AW) < R(AB)$ at below barrier energies.

### 5.4 Transmission, reflection and absorption across a purely absorptive domain

We now examine the transmission across an absorptive domain to analyze the physical significance of absorption strength $W_0$ and energy $E$ on absorption,
reflection and transmission coefficient. The purely absorptive potential is given by:

$$V(x) = \begin{cases} 
0, & x < 0, \\
-iW_0, & W_0 > 0, \ 0 < x < a, \\
0, & x > a.
\end{cases} \tag{5.23}$$

This is useful in exploring the features generated by a purely absorptive domain when no real potential ($V_0$) is present.

### 5.4.1 Effect of Absorption strength $W_0$ on $T$, $R$ and $A_b$

We study $R$, $T$ and $A_b$ at a given energy $E$ as a function of $W_0$. Naively, one would expect that at a given $E$ when $W_0$ increases indefinitely absorption would steadily dominate over reflection and transmission. However we show that there will be critical $W_0$ at which absorption is maximum for a given $E$ and $A_b \to 0$ as $W_0 \to \infty$. In Figure 5.3 we show the variation of $R$, $T$ and $A_b$ as a function of $W_0$ for a fixed energy $E = 3$. It is clear from this figure that the transmission rapidly vanishes with the increase in $W_0$. However absorption shows interesting behaviour, expected mathematically. It rapidly raises with the increase in $W_0$ reaches a maximum and then starts slowly falling as $W_0$ is further increased. This means that at a given energy there is a critical absorption strength $W_0$ where $A_b$ is maximum and increasing it further does not lead to additional increase of $A_b$. On the other hand $R$ increases steadily with $W_0$. This gives rise to question whether $R$ will approach unity as $W_0$ goes to infinity. The answer is in affirmative. By examining the behaviour of $B$ as a function of $W_0$, we can see that $R \to 1$ as $W_0$ goes to infinity. In Eq.(5.5) when $W_0 \to \infty$, $k/\alpha \to 0$ and hence $B \to -1$ and hence $R \to 1$ as $W_0 \to \infty$. However this
rise of $R$ to unity is very slow as compared with a real barrier case. In the latter case when $V_0$ increases significantly above $E$, $R$ rapidly rises to unity and $T$ exponentially falls. Thus, we may find that even though rapidly increasing $W_0$ tends to increase $R$, because of slow decrease of $A_b$ the rise of $R$ to unity is also quite slow. In Figure 5.4 we display the relative contribution of $T$, $R$ and $A_b$ as a function of $W_0$ over a much wider range for a fixed energy, to indicate the relative values of $R$, $T$ and $A_b$ as absorption strength $W_0$ becomes very much larger than $E$. From this figure it is clear that above critical $W_0$, $R$ exceeds $A_b$ and increases steadily towards unity. As $W_0$ becomes large, the penetrability of the wave out of the absorptive region becomes smaller and hence $T$ rapidly drops and $R$ rises steadily. As $W_0$ initially increases, $A_b$ increases, indicating that the wave function is significantly present in the absorption region. As $W_0$ becomes very large, there is no significant amount of wave present in the absorption region and hence $A_b$ drops after reaching a peak. Eqs.(5.13) and (5.21) demonstrate this behavior mathematically.
Figure 5.3: The variation of the absorption $A_b$, transmission $T$, and reflection $R$ coefficients as a function of absorption strength $W_0$ for energy $E = 4$ indicating the gradual dominance of $R$ for large $W_0$ for $E = 3$. 

\[ E = 3, \ a = 1, \ V_0 = 0 \]
Figure 5.4: The variation of the absorption $A_b$, transmission $T$, and reflection $R$ coefficients as a function of the absorption strength $W_0$ for energy $E = 4$ indicating the gradual dominance of $R$ for large $W_0$. For $E = 4$, $T$ becomes practically zero when $W_0 > 12$. 

$E = 4$, $a = 1.5$, $V_0 = 0$
5.4.2 Variation of $T$, $R$ and $A_b$ with energy

The numerical results of the variation of $T$, $R$ and $A_b$ for a given absorption strength $W_0$ as a function of energy $E$ is shown in Figure 5.5. Figure shows that as $k \to \infty$ the transmission goes to unity, absorption $A_b$ initially increases reaches a maximum value at critical energy $E$ and then decreases gradually to zero and the reflection goes to zero rapidly. This behavior is mathematically confirmed by the Eqs.(5.5) and (5.6), which shows that for fixed $V_0$ and $W_0$, $|B| \to 0$ and $|F| \to 1$ as $k \to \infty$. The decrease of $A_b$ as $k \to \infty$ is due to the fact that with an increase in $E$ the importance of the finite range potential gradually decreases and hence, transmission dominates and goes to unity. Near the threshold energy the potential becomes highly reflective because of the drastic attenuation of the wave function in the potential region even though from Eq.(5.13) it may superficially appear that $A_b$ will go to infinity as $k \to 0$. The correct threshold behavior of $A_b$ can be verified mathematically. From Eq.(5.6) we find that as $k \to 0$, $F \to 0$ linearly. Hence, by using Eqs.(5.15) and (5.16) in Eq.(5.13), it is clear that the integrand varies as $k^2$ as $k \to 0$ and hence $A_b \to 0$ as $k \to 0$. This point is important because, as we will discuss later, the corresponding behavior of the absorption cross section in 3D is very different [24].

5.4.3 Correlation between the absorption strength $W_0$ and energy $E$

From the results in Figures.(5.4) and (5.5), it is found that there is a critical value of $W_0$ for a given energy $E$ and critical energy $E$ for a given $W_0$ for $A_b$
Figure 5.5: Variation of the coefficients $A_b$, $T$, and $R$ as a function of the energy $E$ for an absorptive potential with $V_0 = 0, W_0 = 3, a = 1.5$. The lowest value of the energy is $E = 0$.

to be maximum. So it is interesting to see the correlation between $E$ and $W_0$, which corresponds to the maximum absorption $A_b$. This correlation is examined by looking at the variation of $W_0(E)$ as a function of $E$, where $W_0(E)$ specifies the value of $W_0$ that gives the absorption maximum at $E$. A typical set of the results for $W_0(E)$ as a function of $E$ is shown in Figure. 5.6. The crowding together of the $W_0(E)$ versus $E$ curves as the range parameter $a$ increases can be understood as follows: Because of the rapid attenuation of the wave function in the potential region, most of the absorption is completed at some critical range depending on $W_0$; beyond this range the absorptive potential’s importance gradually decreases. Hence, any further increase in the range parameter $a$ results in similar $W_0(E)$ versus $E$ curves.
Figure 5.6: Variation of the absorption strength $W_0(E)$ where the absorption peak occurs as a function of energy $E$. The lowest value of the energy is $E = 1$.

5.5 Summary

- From the study of transmission and reflection across a rectangular barrier and well without absorption, we found that at below barrier energies $T$ across well is greater than the $T$ across barrier. At energies $E/V_0 \gg 1$, the $T$ across barrier and well is very close to each other, as expected.

- Transmission across an absorptive barrier and absorptive well shows that at below barrier energies reflection by absorptive barrier is more than the corresponding well, hence absorption of incident flux by absorptive well is more than that of the corresponding barrier. At above barrier energies, the absorption by absorptive barrier is more than the corresponding well because the kinetic energy of the particle is less in the potential domain resulting in significant absorption of incident flux and hence $A_b(AB) > A_b(AW)$. 
• In the study of variation of $T$, $R$ and $A_b$ across a purely absorptive domain for a given energy $E$ as a function of absorption strength $W_0$ we found that $A_b$ has maximum value at a particular $W_0$ where $W_0$ is close to given energy $E$ and with further increase in $W_0$ it decreases and tends to zero as $W_0 \to \infty$. On the other hand $R \to 1$ and $T \to 0$. This shows that as $W_0 \to \infty$, the absorptive domain behaves like an infinitely high repulsive barrier.

• Then we studied the variation of $T$, $R$ and $A_b$ across a purely absorptive domain for a given $W_0$ as a function of $E$ we found that $A_b$ has maximum value at a particular $E$ where $E$ is close to given $W_0$ and for $E > W_0$, $A_b$ decreases and tends to zero as $E \to \infty$, whereas $R \to 0$ and $T \to 1$.

• From the variation of $A_b$ as a function of $W_0$ and $E$, we found that there is a critical value of $W_0$ for a given energy $E$ and critical energy $E$ for a given $W_0$ for $A_b$ to be maximum. Hence we studied variation of absorption strength $W_0(E)$ that corresponds to maximum $A_b$ at particular energy as a function of energy $E$ for different absorptive domains. We found that there is critical absorption range and within that region rapid attenuation of the incident flux occurs. Beyond that region the absorptive potential’s importance decreases, resulting in similar behavior of $W_0(E)$ versus $E$ curve with the increase in range parameter $a$.

• This study together with the ref.[85] provide a comprehensive study of absorption, transmission, reflection and resonance phenomenon in 1D quantum mechanical transmission problems.