```
5 CLS SCREEN0
10 LOCATE 5.10: PRINT "(1) Travelling Wave"
2.0 LOCATE 6,10: PRINT "(2) Wave Packets (Position Representation)"
30 LOCATE 7,10: PRINT "(3) Fourier Transforms (Momentum Representation"
40 LOCATE 8,10: PRINT "(4) Square Well Potential"
50 LOCATE 9,10: PRINT "(5) Barrier Potential (Tunneling)"
60 LOCATE 10,10: PRINT "(6) Rutherford Scattering Experiment"
70 LOCATE 1 I, IO: PRINT "(7) Harmonic Oscillator"
80 LOCATE 12,10: PRINT "(8) Exit"
90 LOCATE 14,9: INPUT CH$
100 IF (CH$ > "8") OR (CH$ < "1") THEN GOT0 5
1 IO IF (CH$ = "I") THEN GOT0 1000
120 IF (CH$ = "2") THEN GOT0 2000
130 IF (CH$ = "3") THEN GOT0 3000
140 IF (CH$ = "4") THEN GOT0 4000
150 IF (CH$ = "5") THEN GOT0 5000
160 IF (CH$ = "6") THEN GOT0 6000
170 IF (CH$ = "7") THEN GOT0 7000
180 IF (CH$ = "8") THEN END


1000 REM TRAVELLING WAVES
1010 REM ***** SET UP GRAPHICS CHARACTERISTICS *****
1020 SCREEN 2: CLS : XO = 320: YO = 100: SX = 1.5: SY = SX / 2.25
1050 REM **** SPECIFY INITIAL CONDITIONS *****
1060 L = 60
1070 A1 = 50
1080 V = IO
1090 GOSUB 9000

1150 SC = IO: REM SCALE FOR SCREEN IN METERS
1160 SX = 10 * SX / SC: SY = SX / 2.25
1170 LOCATE 4, 32: PRINT "ONE UNIT ="; SC; "m"
1175 LOCATE 1, 32: PRINT "Travelling Waves"

1200 REM ***** CALCULATE VALUES AND PLOT FUNCTION *****
1205 FOR T = 0 TO 2 STEP 1
1210 FOR Xl = -100 TO 100 STEP .1
1220 Yl = Al * COS(6.28 * (Xl - V * T) / L)
1230 GOSUB 1900
1240 NEXT Xl
1250 NEXT T
1255 CH$ = INPUT$(1)
1300 GOTO 5

1900 REM ***** PLOTTING SUBROUTINE *****
1910 XS = XO + SX * X1: YS = YO - SY * Y1: PSET (XS, YS)
1920 RETURN


2000 REM WAVE PACKETS ( POSITION REPRESENTATION )
2100 REM ***** SET UP GRAPHICS CHARACTERISTICS *****
2110 SCREEN 2: CLS : X0 = 320: YO = 100: SX = 1.5: SY = SX / 2 25
2 150 REM ***** SPECIFY INITIAL CONDITIONS *****
2155 DEF FNSI (X) = 5 * EXP(-X * X / 5) * COS(6.28 * X / L)
2156 REM DEFINE EIGENFUNCTION SI(X) MUST BE AN EVEN FUNCTION
2160 L = 1: REM WAVELENGTH IN METERS
2165 N = 4.5: REM NUMBER OF WAVES IN WAVE PACKET
```

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2170 P = L * N: REM LENGTH OF WAVE PACKET IN METERS
2180 DX = ,005
2190 DK = .2
2200 GOSUB 9000

2450 SC = 1: REM SCALE FOR SCREEN GRID IN METERS
2460 SX = 10 * SX / SC: SY = SX / 2.25
2470 LOCATE 4, 32: PRINT "one unit = "; SC; "m"
2475 LOCATE 1, 22: PRINT "Wave Packets (Position Representation)"

2500 REM ***** CALCULATIONS AND PLOTTING *****
2510 FOR X = -P / 2 TO P / 2 STEP DX
2520 Y = FNSI(X)
2530 GOSUB 2900
2550 NEXT x
2555 CH$ = INPUT$(1)
2600 GOTO 5

2900 REM ***** PLOTTING SUBROUTINE *****
2910 XS = XO + SX * X: YS = YO - SY * Y: PSET (XS, YS)
2920 RETURN


3000 REM FOURIER TRANSTORMS ( MOMENTUM REPRESENTATION )
3100 REM ***** SET UP GRAPHICS CHARACTERISTICS *****
3110 SCREEN 2: CLS : XO = 320: YO = 100: SX = 1.5: SY = SX / 2.25
3150 REM ***** SPECIFY INITIAL CONDITIONS *****
3 155 REM DEF FNSI (X) = 5 * EXP(-X * X / 5) * COS(6.28 * X / L)
3 156 REM DEFINE EIGENFUNCTION SI(X) MUST BE AN EVEN FUNCTION
3 160 L = 1: REM WAVELENGTH IN METERS
3165 N = 4: REM NUMBER OF WAVES IN WAVE PACKET
3 170 P = L * N: REM LENGTH OF WAVE PACKET IN METERS
3 180 DX = .005
3190 DK = .025
3200 GOSUB 9000

3450 SC = 1: REM SCALE FOR SCREEN GRID IN METERS
3460 SX = 10 * SX / SC: SY = SX / 2.25
3470 LOCATE 4, 32: PRINT "one unit = "; SC; "(l/m)"
3475 LOCATE 1,20: PRINT "Fourier Transforms (Momentum Representation)"

3500 REM ***** CALCULATIONS AND PLOTTING *****
3510 FOR K = 0 TO 12.5 STEP DK
3520 AK = 0
3530 FOR X = -P / 2 TO P / 2 STEP DX
3540 AK = AK + FNSI(X) * COS(K * X) * DX
3550 NEXT x
3560 GOSUB 3900
3570 NEXT K
3575 CH$ = INPUT$(1)
3600 GOTO 5

3900 REM *****PLOTTING SUBROUTINE *****
3910 XS = XO + SX * K: YS = YO - SY * AK: PSET (XS, YS)
3920 RETURN


4000 REM SQUARE WELL POTENTIAL
```

```
4100 REM     ***** SET UP GRAPHICS CHARACTERISTICS *****
4110  SCREEN 2: CLS XO = 320 YO = 100: SX = 1.5: SY = SX / 2.25
4150 REM     ***** SPECIFY INITIAL CONDITIONS *****
4160  M= 9.100001 *10^-31: REM MASS OF ELECTRON
4170  HB= 1.055 * 10 ^ -34: REM H/2*PI
3180  E = -3.37 * 1.6 * 10 ^ -19: REM ENERGY OF ELECTRON
4 190 Y =  1: REM AMPLITUDE OF EIGENFUNCTION WITH EVEN PARITY
4200 D = 0: REM SLOPE OF EIGENFUNCTION WITH EVEN PARITY
4210  DX = 10 ^ -12
4220  GOSUB 9000

4450  SC = 10 ^ -10
4460  SX = 10 * SX / SC- SY = 100 / 2.25
4470  LOCATE 4, 32. PRINT "one unit ="; SC; "m"
4475  LOCATE 1, 3 1: PRINT "Square Well Potential"

4500  REM     ***** CALCULATIONS AND PLOTTING *****
4510 FOR X = (I TO IO * 10 ^ -10 STEP DX
4520  V = -10 * 1.6 * 10 ^ -19: REM POTENTIAL FUNCTION
4530 DY = D + (2 * M / HB) * ((V - E) * Y / HB) * DX
4540 Y1 = Y + DY * DX
4550  GOSUB 4900
4560 D = DY: Y = Y1
4570 NEXT X
4610 FOR X = 10 * 10 ^ -10 TO 20 * 10 ^ -10 STEP DX
4620 V = 0: REM POTENTIAL FUNCTION
4630 DY = D + (2 * M / HB) * ((V - E) * Y / HB) * DX
4640  Yl = Y + DY * DX
4650 GOSUB 4900
4660 D = DY: Y = Y1
4670 NEXT X
4675  CH$ = INPUT$( 1)
4700 GOTO 5

4900  REM     *****PLOTTING SUBROUTINE *****
4910 XS = XO + SX * X: YS = YO - SY * Y: PSET (XS, YS)
4920    RETURN


5000 REM    THE BARRIER POTENTIAL (TUNNELING)
5100 REM     ***** SET UP GRAPHICS CHARACTERISTICS *****
5110  SCREEN 2: CLS : XO = 320: YO = 100: SX = 1.5: SY = SX / 2.25
5150 REM     ***** SPECIFY INITIAL CONDITIONS *****
5155  W = .2 * 10 ^ -10. REM WIDTH OF POTENTIAL BARRIER
5160 M = 9.100001 * 10 ^ -31
5170  HB = 1.055 * 10 ^ -34
5180 E=  10 * 1.6 * 10 ^ -19
5182  V = O *  1.6 * 10 ^ -19
5185 K = SQR(2) * SQR(M) * SQR(E - V) / HB
5190  YR = 1: D 1 =  0: REM INITIAL INTERCEPT AND SLOPE FOR REAL TERM
5200  YI = 0: D2 = K: REM INITIAL INTERCEPT AND SLOPE FOR IMAGINARY TERM
5210  DX = 10 ^ -12
5220  GOSUB 9000

5300  SC = 10 ^ -10
5310  SX=IO*SX/SC    SY = 100 / 2.25
5340  LOCATE 24, 32: PRINT "one unit ="; SC; "m"
5350  LOCATE 1,25 : PRINT "The Barrire Potential (Tunneling)"
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5400 REM  ***** CALCULATIONS AND PLOTTING *****
5410 FOR X = 0 TO 10 * 10 ^ -10 STEP DX
5420 V = 0
5430 DR = D1 + (2 * M / HB) * ((V - E) * YR / HB) * DX
5440 YR = YR + DR * DX
5460 DI = D2 + (2 * M / HB) * ((V - E) * YI / HB) * DX
5470 YI = YI + DI * DX
5490 P = YI ^ 2 + YR ^ 2: Y = P
5494 GOSUB 5900
5496 Dl = DR: D2 = DI
5500 NEXT x
5506 YR = 1: D1 = 0: REM INITIAL SLOPE AND INTERCEPT OF REAL TERM
5508 Yl = 0: D2 = K: REM INITIAL SLOPE AND INTERCEPT OF IMAGINARY TERM
5510 FOR X = 0 TO -W STEP -DX
5520 V = 20 * 1.6 * 10 ^ -19: REM HEIGHT OF POTENTIAL BARRIER
5530 DR = D1 + (2 * M / HB) * ((V - E) * YR / HB) * (-DX)
5540 YR = YR + DR * (-DX)
5560 DI = D2 + (2 * M / HB) * ((V - E) * YI / HB) * (-DX)
5570 Yl = YI + DI * (-DX)
5585 P = YI ^ 2 + YR ^ 2: Y = P
5590 GOSUB 5900
5600 Dl = DR: D2 = DI
5605 NEXT X
5610 FOR X = -W TO -10 * 10 ^ -10 STEP -DX
5620 V = 0
5630 DR = D1 + (2 * M / HB) * ((V - E) * YR / HB) * (-DX)
5640 YR = YR + DR * (-DX)
5660 DI = D2 + (2 * M / HB) * ((V - E) * YI / HB) * (-DX)
5670 YI = YI + DI * (-DX)
5685 P = YI ^ 2 + YR ^ 2: Y = P
5690 GOSUB 5900
5700 D1 = DR: D2 = DI
5705 NEXT x
5707 CH$ = INPUT$(1)
5710 GOT0 5

5900 REM  ***** PLOTTING SUBROUTINE *****
5910 XS = XO + SX * X: YS = YO - SY * Y: PSET (XS, YS)
5920 RETURN


6000 REM  THE RUTHERFORD SCATTERING EXPERIMENT
6100 REM  ***** SETUP GRAPHICS CHARACTERISTICS *****
6110 SCREEN 2: CLS : XO = 320: YO = 100: SX = 1.5: SY = SX / 2.25
6150 REM  ***** SPECIFY INITIAL CONDITIONS *****
6160 E = 1.6 * 10 ^ -19
6170 M = 4 * 1.67 * 10 ^ -27
6180 K = 9 * 10 ^ 9
6190 Z = 53
6200 VX = 1.4 * 10 ^ 7
6210 VY=O
6220 X = -10 * 10 ^ -14
6230 Y = 2 * 10 ^ -14
6240 DT = 10 ^ -22
6250 GOSUB 9000

6450 SC = 10 ^ -14
6460 SX = 10 * SX / SC: SY = SX / 2.25
```

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6470 LOCATE 4, 32: PRINT "one unit =", SC; "m"
6475 LOCATE I. 23 PRINT "The Rutherford Scattering Experiment"

6500 REM  ***** CALCULATIONS AND PLOTTING *****
6510 FOR T = 0 TO 2 * 10 ^ -20 STEP DT
6520 V1 = VX + ((K * Z * E * E / M) / (X ^ 2 + Y ^ 2)) * (X / (X ^ 2 + Y ^ 2) ^ 5) * DT
6530 XI =X + VX * DT
6540 V2 = VY + ((K * Z * E * E / M) / (X ^ 2 + Y ^ 2)) * (Y / (X ^ 2 + Y ^ 2) ^ .5) * DT
6550 Y1 = Y + VY * DT
6560 GOSUB 6900
6570 VX = V1: X = X1
6580 VY = V2  Y = Y1
6590 NEXT T
6595 CH$ = INPUT$(1)
6600 GOT0 5

6900 REM  ***** PLOTTING SUBROUTINE *****
6910 XS = XO + SX * X: YS = YO SY * Y: PSET (XS, YS)
6920 RETURN


7000 REM  THE HARMONIC OSCILLATOR
7100 REM  ***** SET UP GRAPHICS CHARACTERISTICS *****
7110 SCREEN 2: CLS : XO = 320: YO = 100: SX = 1.5: SY = S X / 2.25
7150 REM  ***** SPECIFY INITIAL CONDITIONS *****
7160 M = 9.100001 * 10 ^ -31: REM MASS OF ELECTRON
7170 HB = 1.055 * 10 ^ -34: REM H/2*PI
7180 E = 3.80155 * 1.6 *  10 ^ -19: REMENERGY OFELECTRON
7190 Y = 0: REM INITIAL AMPLITUDE FOR EIGENFUNCTION WITH ODD PARITY
7200 D = .8 *10 ^ 10: REM INITIAL SLOPE OF EIGENFUNCTION WITH ODD PARITY
7210 K= I
7220 DX= 10 ^ -12
7230 GOSUB 9000

7450 SC = 10 ^ -10
7460 SX = 10 * SX / SC: SY = 100 / 2.25
7470 LOCATE 4, 32: PRINT "one unit =", SC; "m"
7475 LOCATE I. 30 : PRINT "The Harmonic Oscillator"

7500 REM  ***** CALCULATIONS AND PLOTTING *****
7510 FOR X = 0 TO 20 * 10 ^ -10 STEP DX
7520 V = .5 * K * X * X: REM POTENTIAL FUNCTION
7530 DY = D + (2 * M / HB) * ((V - E) * Y / HB) * DX
7540 Y1 = Y + DY * DX
7550 GOSUB 7900
7560 D = DY: Y = Y1
7570 NEXT x
7575 CH$ = INPUT$(1)
7600 GOT0 5

7900 REM  *****PLOTTING SUBROUTINE *****
7910 XS = XO + SX * X: YS = YO - SY * Y: PSET (XS, YS)
7920 RETURN


9000 REM  ***** SET UP SCREEN DISPLAY ****
9010 Y 1 = 0: REM DRAW HORIZONTAL AXIS
9020 FOR X1 = -110 TO 110 STEP 2
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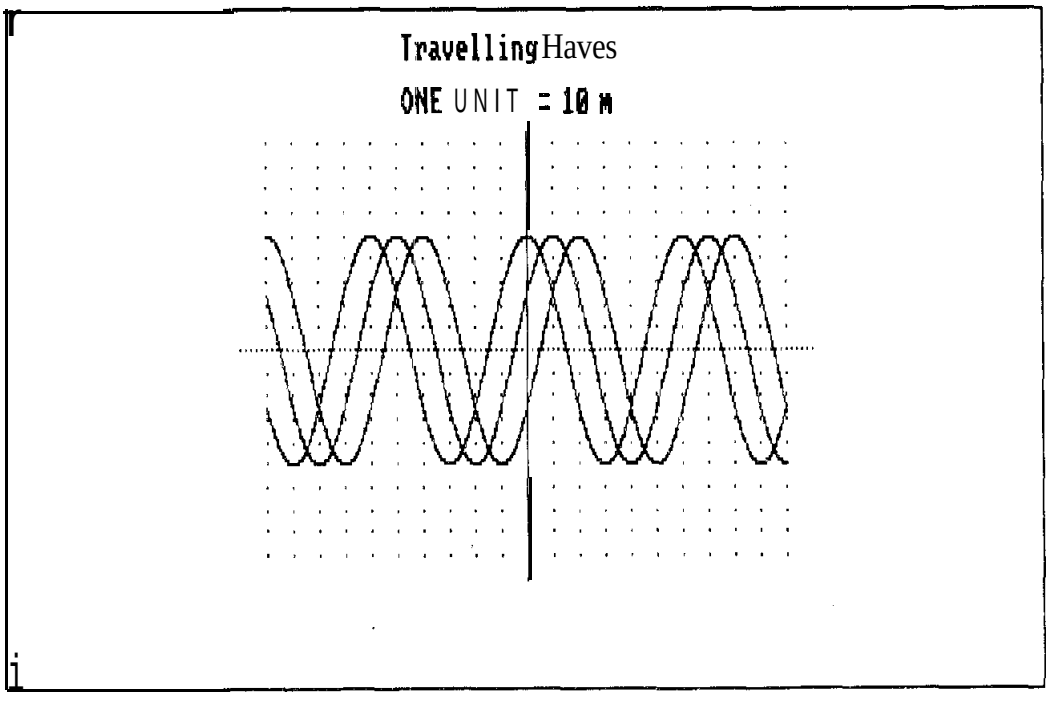
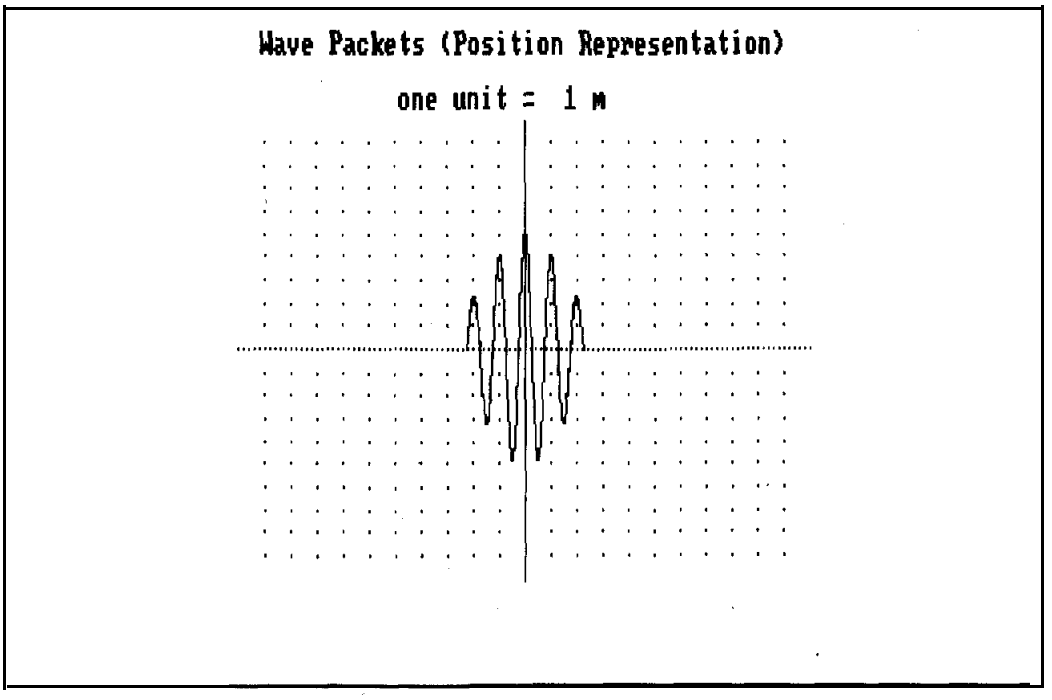
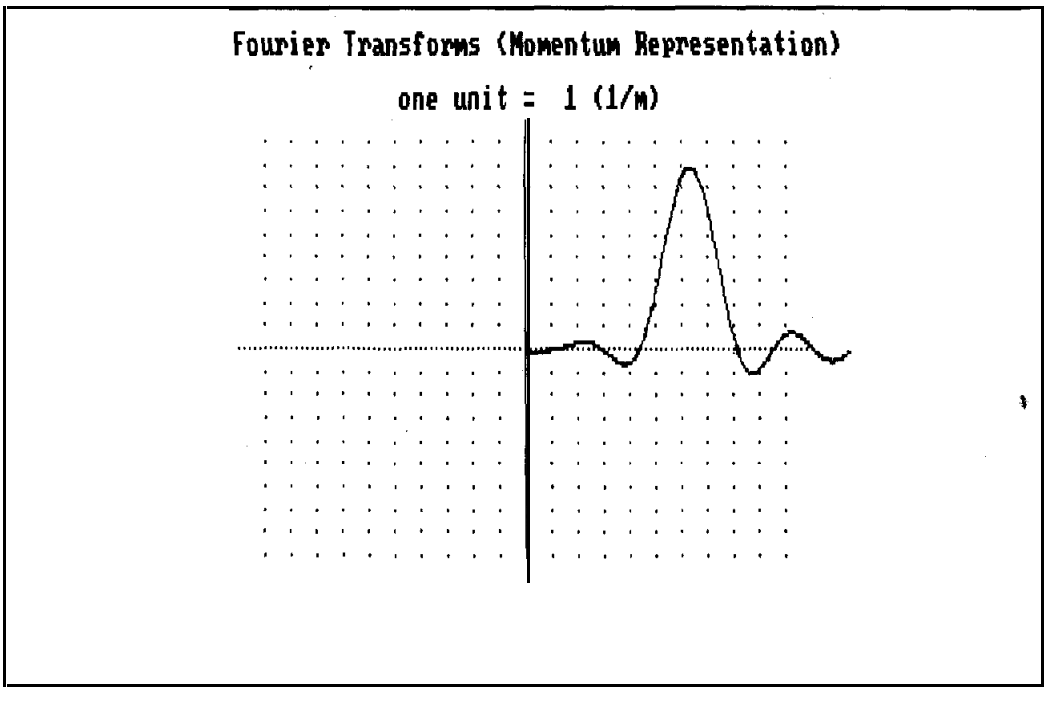
```
9030 XS = XO + SX * X1: YS = YO - SY * Y1: PSET (XS, YS)
9040 NEXT X1
9050 Xl = 0: REM DRAW VERTICAL AXIS
9060 FOR Y1 = -100 TO 100 STEP 1.5
9070 XS = XO + SX * Xl: YS = YO - SY * Y1: PSET (XS, YS)
9080 NEXT Y1
9090 REM DRAW COORDINATE GRID
9100 FOR Xl = -100 TO 100 STEP 10
9110 FOR Y1 = -90 TO 90 STEP 10
9120 XS = XO + SX * Xl: YS = YO - SY * Y1: PSET (XS, YS)
9130 NEXT Y1
9140 NEXT X1
9150 RETURN
```

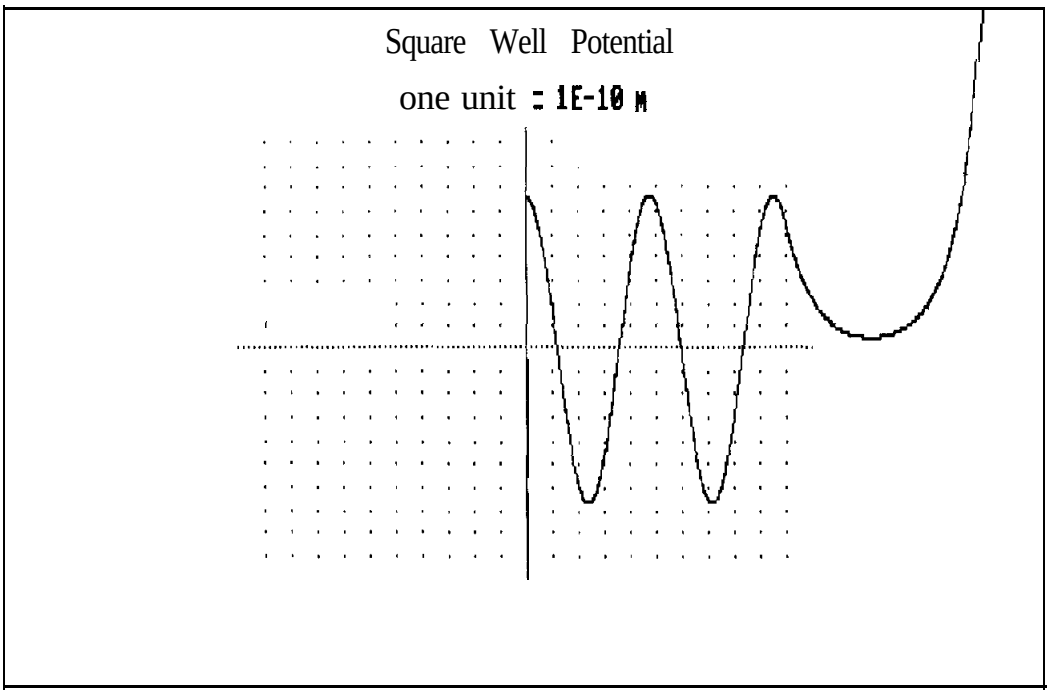
(1) Travelling Wave
(2) Wave Packets (Position Representation)
(3) Fourier Transforms (Momentum Representation
(4) Square Well Potential
(5) Barrier Potential (Tunneling)
(6) Rutherford Scattering Experiment
(7) Harmonic Oscillator
(8) Exit

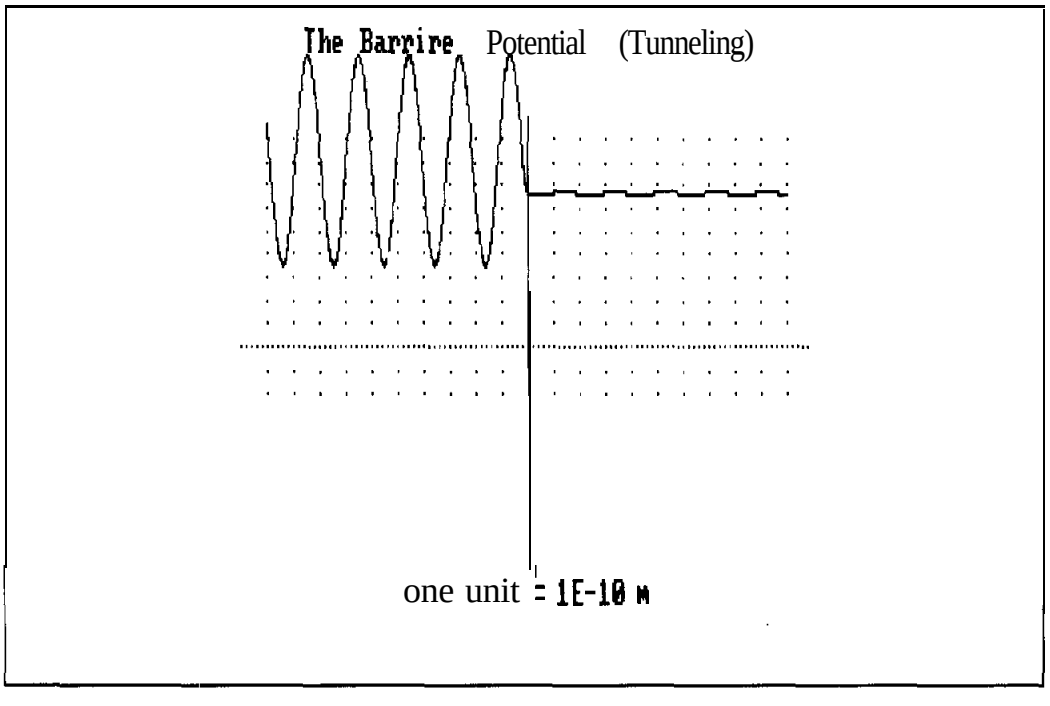
?

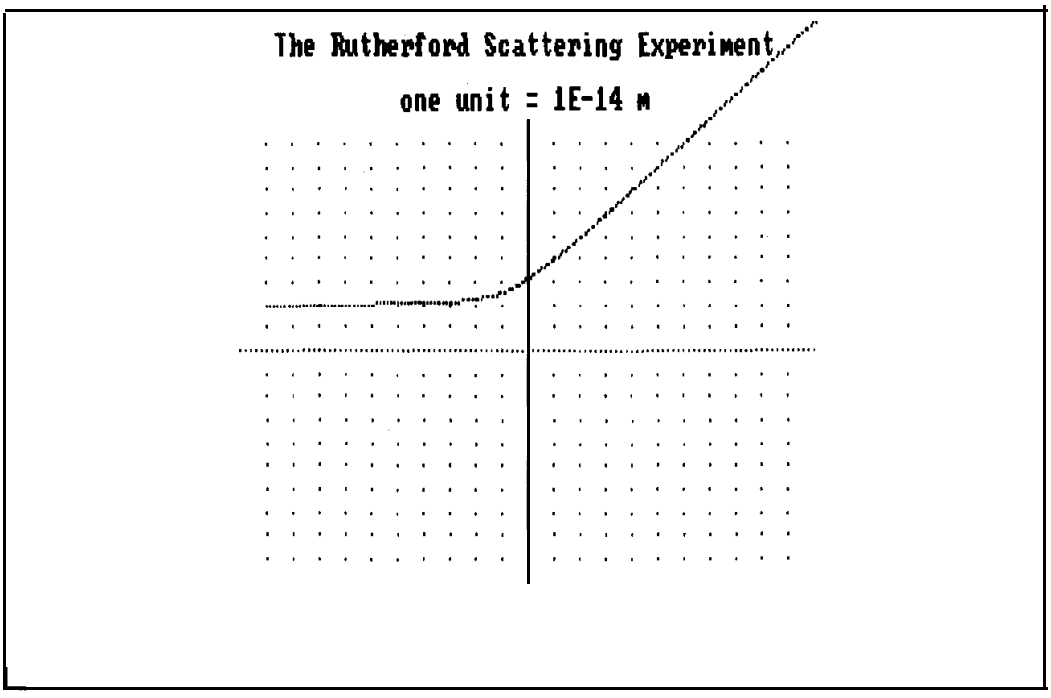


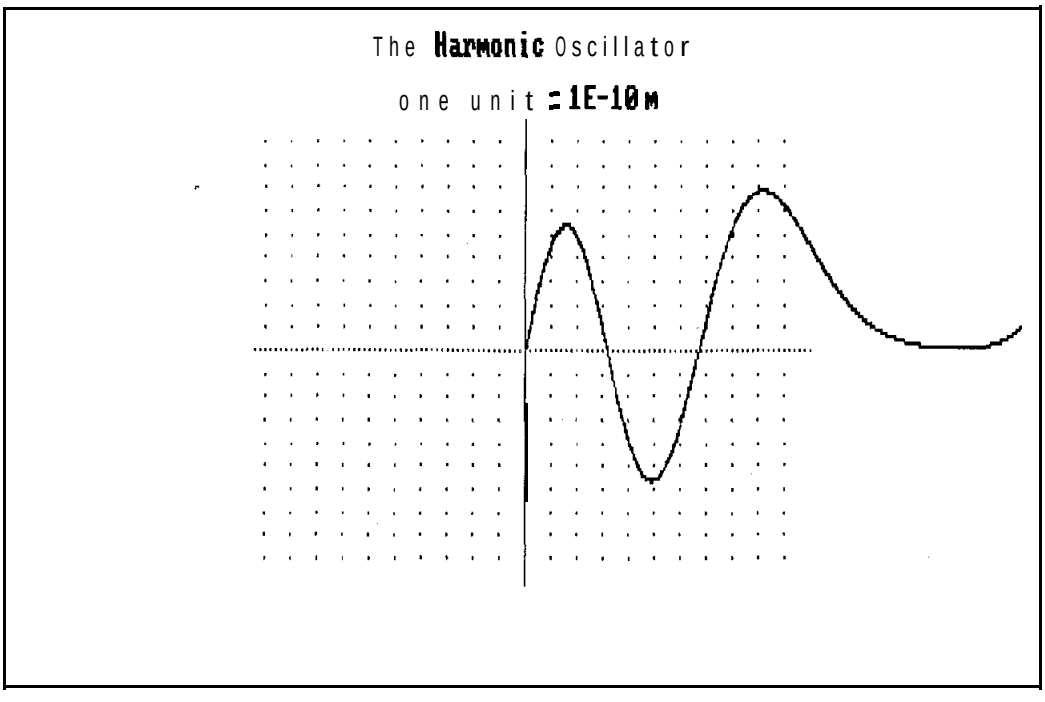

Wave Packets (Position Representation)
one unit = 1 m


Fourier Transforms (Momentum Representation)
one unit = 1 (1/m)


Square Well Potential
one unit = 1E-10 m


The Barrire Potential (Tunneling)
one unit = 1E-10 m


The Rutherford Scattering Experiment
one unit = 1E-14 m


The Harmonic Oscillator
one unit = 1E-10 m