Code No.	V – 2351

Entrance Examination for Admission to the P.G. Courses in the Teaching Departments, 2025

CSS

PHYSICS WITH SPECIALIZATION IN (APPLIED ELECTRONICS/SPACE PHYSICS/RENEWABLE ENERGY/NANO SCIENCE)

For office use only

General Instructions

1. The Question Paper is having 100 Objective Questions, each carrying one mark.
2. The answers are to be (✓) 'tick marked' **only** in the "**Response Sheet**" provided.
3. **Negative marking** : **0.25 marks** will be deducted for each wrong answer .

Time : 2 Hours **Max. Marks : 100**

To be filled in by the Candidate									
Register Number	in Figures								
	in words								

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Choose appropriate answer from the options in the questions.

(100 × 1 = 100 marks)

1. A solid sphere is rolling without slipping on a horizontal surface. The ratio of rotational kinetic energy to total kinetic energy is:

   A. 2/7

   B. 5/7

   C. 3/5

   D. 2/5

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2. A particle is moving under a potential $U(x) = ax^4 - bx^2$. The points of stable equilibrium are at :

   A. $x = 0$ B. $x = \pm\sqrt{b/2a}$ A

   C. $x = \pm\sqrt{b/a}$ D. None of these

3. Work-energy theorem states that net work done by all forces is equal to:

   A. Change in total energy

   B. Change in potential energy

   C. Change in momentum

   D. Change in kinetic energy

4. A force is conservative if:

A. Work done depends on path

B. Work done is zero

C. Work done is positive

D. Work done is independent of path

5. For a rotating rigid body, which of the following statement is correct?

A. Angular velocity is the same for all particles

B. Linear velocity is the same for all particles

C. Angular momentum is uniform in all directions

D. Moment of inertia is constant for any axis

6. What happens to the time period T of a simple pendulum when it's length L is reduced to one quarter:

A. T/4 B. 4T

C. 2T D. T/2

7. Work done in twisting a wire by an angle θ is proportional to:

A. θ B. θ^3

C. θ^2 D. $\sqrt{\theta}$

8. A wire is stretched such that its length increases by 0.2%. If Poisson's ratio is 0.25, then the percentage decrease in its diameter is approximately:

A. 0.025% B. 0.05%

C. 0.10% D. 0.15%

9. A droplet of water breaks into 8 smaller droplets. The total surface energy increases by a factor of:

A. 2 B. 4

C. $8^{1/3}$ D. $8^{2/3}$

10. The thermal conductivity of a bad conductor is best determined using:

A. Searle's apparatus

B. Lee's disc method

C. Parallel flow method

D. Wiedemann-Franz method

11. Wiedemann-Franz Law relates:

A. Specific heat and conductivity

B. Electrical and thermal conductivity

C. Temperature and entropy

D. Thermal resistance and heat transfer

12. According to Stefan's law, if the temperature of a body is doubled, the radiated energy increases by a factor of:

A. 2 B. 4

C. 8 D. 16

13. In an isothermal process, the work done 'W' by the system is given by:

A. $W = P \Delta V$ B. $W = nC_v \Delta T$

C. $W = nRT \ln \frac{V_f}{V_i}$ D. $W = \Delta Q$

Where P is pressure, ΔV is volume change. C_v is specific heat at constant volume, n is number of moles, T is temperature. ΔQ is heat, V_i and V_f is initial and final volume respectively.

14. The latent heat of fusion of ice at 0°C is 3.42×10^5 J/kg. The change in entropy when 400 gm of ice melts reversibly at 0°C is around:

A. 1220 J/K B. 1000 J/K

C. 500 J/K D. 620 J/K

15. A reversible heat engine absorbs 800 J of heat at 600 K and rejects 200 J at temperature T_{LT}. The temperature T_{LT} of the cold reservoir is:

A. 300 K B. 150 K

C. 200 K D. 450 K

16. Calculate approximately the change in internal energy when 2 moles of an ideal monoatomic gas when heated from 300 K to 400 K at constant volume.

A. 2500 J
B. 4000 J
C. 1500 J
D. 0 J

17. Which of the following statements about entropy change in an ideal Carnot cycle is true?

A. Entropy increases over the complete cycle
B. Entropy decreases over the complete cycle
C. Entropy remains constant over the complete cycle
D. Entropy is zero only during adiabatic processes

18. The electric field at a point varies as r^{-1} for

A. a point charge
B. spherically symmetric charge distribution
C. a plane infinite sheet of charge
D. a line charge of infinite length

19. The electric displacement vector in a linear dielectric is related to by:

A. $\vec{D} = \varepsilon_0 \vec{E}$
B. $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$
C. $\vec{D} = \vec{E} - \vec{P}$
D. $\vec{D} = \vec{P} / \varepsilon_0$

20. A charge *Q* is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

A. Be doubled
B. Increase four fold
C. Be reduced to half
D. Remains the same

21. Maxwell introduced the concept of displacement current to modify:

A. Faraday's law
B. Gauss's law
C. Ampère's law
D. Coulomb's law

22. Eight electric dipoles of charges of magnitude *e* are placed inside a cube of edge length *L*. The total electric flux coming out of the cube will be

A. $8e/\varepsilon_0$
B. $16e/\varepsilon_0$
C. Zero
D. $8e/(6\varepsilon_0)$

23. A point charge '+2q' is placed at a distance 'd' above an infinite grounded conducting plane. The total induced charge on the plane is:

A. $+q$ B. $+2q$

C. $-q/2$ D. $-2q$

24. The Q-factor of a series LCR circuit at resonance is defined as:

A. $Q = \dfrac{1}{\omega_0 RC}$ B. $Q = \omega_0 RC$

C. $Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$ D. $Q = \dfrac{R}{\sqrt{LC}}$

Where R, C, L, ω_0 denotes resistance, capacitance, inductance and resonance frequency respectively.

25. A point charge $+q$ is placed at origin. A second point charge $+9q$ is placed at (d, $d/2$, 0) in Cartesian coordinate system. The neutral point is at

A. ($d/4$,$d/8$,0) B. (0,$d/2$,0)

C. ($d/2$,0,0) D. ($d/2$,$d/4$,0)

26. The conservation of linear momentum is a consequence of:

A. Rotation invariance B. Time homogeneity

C. Spatial uniformity D. Galilean invariance

27. Which of the following is not conserved in a general collision in lab frame?

A. Linear momentum B. Angular momentum

C. Total kinetic energy D. Total energy

28. The number of degrees of freedom of a rigid body in 3D is:

A. 3 B. 6

C. 5 D. 9

29. Which of the following systems cannot be described using Lagrangian mechanics?

A. Conservative B. Holonomic

C. Non-conservative D. Constrained

30. A particle of mass m moves in a circular path under a central force $F = -\frac{k}{r^2}$.

What is the expression for angular momentum?

A. $L = \sqrt{mkr}$ B. $L = \sqrt{mk/r}$

C. $L = mkr$ D. $L = \sqrt{mk}$

31. In the Atwood machine (masses m_1 = 5 kg, m_2 = 3 kg), the acceleration of the system is:

A. $g/2$ B. 0

C. $g/4$ D. $3g/10$

Where g is acceleration due to gravity.

32. A rocket of rest mass 500 kg moves at 0.8c. What is its total energy in MeV?

A. 7.5×10^{19}J B. 4.5×10^{19}J

C. 2.25×10^{19}J D. 3.735×10^{19}J

33. What is the mass equivalent of the energy from an antenna radiating 10,000 watt for 12 hours?

A. 4.8×10^{-10} kg B. 4.8×10^{-9} kg

C. 4.8×10^{-7} kg D. 9.6×10^{-6} kg

34. A rod of length 10 m moves at a speed of 0.6c relative to an observer. What is its length in the observer's frame?

A. 9 m B. 6 m

C. 10 m D. 8 m

35. The de-Broglie wavelength of a charge q and accelerated through a potential difference V volts is

A. $\lambda = h/\sqrt{mqV}$ B. $\lambda = hm/\sqrt{qV}$

C. $\lambda = h/\sqrt{2mqV}$ D. $\lambda = h/mqV$

36. Which one of the following pairs of phenomenon illustrates the particle aspect of wave particle duality

A. Compton-effect and Bragg's law

B. Photoelectric effect and Compton-effect

C. Compton-effect and Pauli's principle

D. Bragg's law and photoelectric effect

37. If E_0 is the zero-point energy of a harmonic oscillator of frequency v then its energy in the n=2 excited state will be

A. $E_0 + hv$ B. $2E_0 + 1/2hv$

C. $4E_0$ D. $E_0 + 2hv$

38. The value of A for an allowed wave function $\psi(x) = A\cos^2 x$ for $-\frac{\pi}{2} < x < \frac{\pi}{2}$ is

A. $\sqrt{\frac{8}{3\pi}}$ B. $\sqrt{\frac{3}{8\pi}}$

C. $\sqrt{\frac{1}{2\pi}}$ D. $\sqrt{\frac{3}{2\pi}}$

39. Which one of the following is correct in respect of an electron and a proton having same de Bragile wavelength of 0.5 nm?

A. Both have same kinetic energy

B. The kinetic energy of proton is more than that of electron

C. Both have same velocity

D. Both have same momentum

40. If the quantum mechanical operators of two observable of a system do not commute, then

A. Total energy of the system must be negative.

B. Parity of the wave functions will be odd.

C. Observable must be time independent

D. It is impossible to know the exact values of the observable simultaneously

41. A particle is confined in a 1D infinite potential well of width 'a'. What is the expectation value of position <x> in the ground state?

A. $a/4$ B. $a/2$

C. 0 D. $a/8$

42. Which of the following wave functions is not physically acceptable for a free particle in one dimension?

A. $\psi(x) = A\sin(kx)$ B. $\psi(x) = Ae^{ikx}$

C. $\psi(x) = A\delta(x - x_0)$ D. $\psi(x) = Ae^{x}$

where k is a real number.

43. For a free electron gas, the number density electron is increased eight folds. Then the Fermi energy of the electron gas:

A. Increases by four times

B. Decreases by four times

C. Does not change

D. Increases by eight times

44. Maxwell-Boltzmann statistics assumes:

A. Particles are indistinguishable and non-interacting

B. Particles are distinguishable and non-interacting

C. Particles follow quantum rules

D. Pauli exclusion principle applies

45. The Fermi-Dirac distribution function becomes the Heaviside step function at

A. Very high temperatures

B. Absolute zero

C. Room temperature

D. Low pressure

46. A two-level system with energies 0 and $\in$ is in thermal equilibrium. The ratio of populations $\frac{N_{\in}}{N_o}$ is:

A. $e^{\in/kT}$

B. $\frac{\in}{kT}$

C. $e^{-\in/kT}$

D. $\frac{1}{1+e^{-\in/kT}}$

47. Bose-Einstein statistics allows:

A. Only one particle per quantum state

B. At most two particles per quantum state

C. Multiple particles to occupy the same quantum state

D. Only charged particles to be considered

48. For three distinguishable particles in two energy levels (E_0 and E_1), how many microstates correspond to the macrostate: (two in E_0, one in E_1)?

A. 3

B. 2

C. 1

D. 6

49. A particle is confined to a 1D box of length 2 m with momentum varying between 0 and 2×10^{-24} kg.m/s. What is the phase space volume?

A. 1×10^{-24} kg. m^2/s
B. 0.5×10^{-24} kg. m^2/s
C. 2×10^{-24} kg. m^2/s
D. 4×10^{-24} kg. m^2/s

50. The mean internal energy of a one-dimensional harmonic oscillator in equilibrium with a heat bath of temperature T is

A. $\frac{1}{2} k_B T$
B. $k_B T$
C. $\frac{3}{2} k_B T$
D. $3 k_B T$

51. The Thevenin equivalent resistance is found by:

A. Shorting all voltage sources and opening all current sources
B. Opening all voltage sources and shorting all current sources
C. Removing all voltage sources
D. Measuring voltage across terminals

52. An op-amp has a differential gain of 100 and a CMRR of 80 dB. What is the common mode gain?

A. 1
B. 0.001
C. 0.01
D. 10

53. An AM signal has a carrier power of 10 W and modulation index m = 0.6. What is total transmitted power?

A. 12 W
B. 10 W
C. 11.8 W
D. 13.6 W

54. A Zener diode regulator has a Zener voltage of 5.6V. What is the output voltage if the input is 12 V and the series resistor drops 6.4 V?

A. 5.6 V
B. 6.4 V
C. 12 V
D. 0 V

55. An opamp has open loop gain of 200,000 and unity gain frequency of 5 MHz. A negative feedback network is connected to make it work as a non-inverting amplifier of gain 1000. What will be its band width?

A. 5000 Hz
B. 200 Hz
C. 500 Hz
D. 5 Hz

56. The purpose of the potential divider biasing method in a BJT amplifier is to:

A. Vary the emitter resistance

B. Increase power gain

C. Provide stable bias independent of transistor parameters

D. Improve frequency response

57. Which oscillator uses a tapped inductor for feedback?

A. RC phase shift

B. Colpitt's

C. Hartley

D. Wien-bridge

58. A diode is forward biased using a 5 V power supply. When a voltmeter is placed across a forward-biased diode, it will read a voltage approximately equal to

A. The bias battery voltage of 5 V

B. 0 V

C. The diode barrier potential

D. The total circuit voltage

59. The Stark effect refers to the splitting of spectral lines in the presence of:

A. Magnetic field

B. Electric field

C. Gravitational field

D. Radiation field

60. The number of allowed values for the magnetic quantum number for m_l for $m_l = 2$ is

A. 2

B. 10

C. 4

D. 5

61. The spectral lines of sodium's D-lines are due to

A. Rotational transitions

B. Spin-orbit coupling

C. Nuclear transitions

D. Raman scattering

62. What is the energy (in cm^{-1}) of the J = 2 level for a diatomic molecule with a rotational constant B=2.0 cm^{-1}

A. 4 cm^{-1}

B. 6 cm

C. 8 cm^{-1}

D. 12 cm^{-1}

63. For a diatomic molecule with vibrational frequency v = 2500 cm^{-1} , what is the energy difference (in cm^{-1}) between vibrational states v = 3 and v = 2 states assuming a harmonic oscillator?

A. 2500 cm^{-1}

B. 5000 cm^{-1}

C. 1250 cm^{-1}

D. 7500 cm^{-1}

64. Calculate the orbital magnetic dipole moment (in Bohr magnetons) for an electron in an orbital with quantum number $l = 2$.

A. $\sqrt{2}\mu_B$ B. $\sqrt{3}\mu_B$

C. $2\ \mu_B$ D. $\sqrt{6}\mu_B$

65. Which of the following is not a requirement for Mössbauer effect?

A. Recoilless emission and absorption

B. Presence of gamma-ray photons

C. High-pressure environment

D. Solid lattice to absorb recoil

66. Hyperfine structure in atomic spectra is caused by the interaction between:

A. The electron's spin and orbital angular momentum

B. The magnetic dipole moment of the electron and the magnetic dipole moment of the nucleus

C. Different electronic configurations

D. The Stark effect due to internal electric fields

67. The Miller indices (hkl) represent:

A. Atomic number B. Types of bonding

C. Orientation of crystal planes D. Crystal symmetry

68. The first Brillouin zone is defined as:

A. The largest unit cell in reciprocal space

B. The shortest reciprocal vectors

C. The Wigner-Seitz cell in reciprocal space

D. The crystal symmetry center

69. The interplanar spacing d in a cubic crystal with lattice constant a = 0.4 nm for the (3, 4, 0) plane is

A. 0.02 nm B. 0.04 nm

C. 0.01 nm D. 0.08 nm

70. Using Bragg's law, find the angle of deflection of X-ray for first-order diffraction (n = 1) from a crystal with spacing d = 0.1 nm and X-ray wavelength $\lambda = 0.1\ nm$.

A. 60° B. 45°

C. 30° D. 15°

71. If the Fermi energy of a metal is 3.45 eV, what is the Fermi temperature?

A. 10,000 K
B. 64,000 K
C. 20,000 K
D. 40,000 K

72. The Hall coefficient of a material is $R_H = 3 \times 10^{-4} m^3/C$. The carrier concentration is approximately:

A. $2 \times 10^{22}\ m^{-3}$
B. $4 \times 10^{23}\ m^{-3}$
C. $2 \times 10^{19}\ m^{-3}$
D. $2 \times 10^{20}\ m^{-3}$

73. In a dielectric material, if an electric field of 200 V/m causes a polarization $P = 8.85 \times 10^{-9}\ C/m^2$, what is the electric susceptibility χ_e?

A. 0.04
B. 0.4
C. 4.0
D. 5.0

74. The electrical conductivity σ of a metal is $5.12 \times 10^7 S/m$. If the electron density n = 18.2 in $10^{28}/m^3$, then the relaxation time τ estimated using Drude's model is

A. $2.5 \times 10^{-14}\ S$
B. $4.8 \times 10^{-14}\ S$
C. $1 \times 10^{-13}\ S$
D. $1 \times 10^{-14}\ S$

75. For a paramagnetic material, susceptibility χ varies with temperature as

A. $\chi \propto T$
B. $\chi \propto T^2$
C. $\chi \propto T^{-1}$
D. χ is constant

76. The fundamental conservation law that explains the stability of protons in free space is:

A. Conservation of mass
B. Conservation of lepton number
C. Conservation of charge
D. Conservation of baryon number

77. The binding energy of a nucleus with mass defect $\Delta m = 0.2\ u$ is:

A. 102 MeV
B. 186 MeV
C. 200 MeV
D. 220 MeV

78. A radioactive sample decays to 25% in 10 days. What is the half-life?

A. 7.5 days
B. 10 days
C. 2.5 days
D. 5 days

79. The binding energy per nucleon is maximum for nuclei around mass number

A. 1 B. 56

C. 4 D. 238

80. When a radioactive element decay by gamma radiation

A. Its mass number will decrease by one unit with no change in atomic number

B. Its mass number will not be change but the atomic number will increase by one unit

C. Both mass number and atomic number of the element change

D. There will be no change in either mass number or atomic number of the element

81. An alpha particle and a proton enter a cyclotron with the same kinetic energy and are accelerated under same perpendicular magnetic field. The ratio of the radii of their paths in the magnetic field is

A. 1 B. 2

C. $\sqrt{2}$ D. $1/\sqrt{2}$

82. When a neutron is converted into proton

A. only an electron is produced

B. one electron and a neutrino are produced

C. one electron and an anti-neutrino are produced

D. one electron and a photon are produced

83. The ratio of the sizes of the $^{208}_{82}$Pb and $^{26}_{12}$ Mg nuclei is approximately

A. 2 B. 4

C. 7 D. 8

84. Rayleigh's criterion for resolution is based on:

A. The maximum of one coinciding with the minimum of the other

B. Intensity difference

C. Angular separation

D. Polarization angle

85. The resolving power of a grating increases with:

A. Decrease in order of spectrum

B. Increase in wavelength

C. Increase in number of lines

D. Decrease in incident light intensity

86. In a double slit experiment, the distance between the slits is 0.2 mm, and the screen is 2 m away. If the wavelength of light is 600 nm the fringe width is:

A. 3 mm B. 4.5 mm

C. 6 mm D. 9 mm

87. If the cavity length of a laser is 0.5 m with a refractive index of 1, what is the mode spacing (Δv)?

A. 1.5 MHz B. 200 MHz

C. 300 MHz D. 3 GHz

88. Numerical aperture of a fiber with core refractive index n_1 = 1.5 and cladding n_2 = 1.4 is approximately:

A. 0.3 B. 0.5

C. 0.6 D. 0.7

89. In Malus's law, if the angle between the polarizer and analyzer is 30°, what is the transmitted intensity as a percentage of the initial?

A. 25% B. 50%

C. 75% D. 100%

90. The angle of incidence at which light is completely polarized on reflection from glass (μ = 1.5) is :

A. 45º B. 56º

C. 62º D. 90º

91. In Newton's rings experiment, the diameter of the 10^{th} dark ring is 4 mm. If the radius of curvature of the lens is 1 m, what is the wavelength of light used?

A. 400 nm B. 500 nm

C. 600 nm D. 700 nm

92. In Michelson interferometer, when the mirror is moved by 0.05 mm, 200 fringes are observed. What is the wavelength of light?

A. 300 nm B. 400 nm

C. 500 nm D. 750 nm

93. What is the 6-bit representation of 2's complement of decimal 20?

A. 101100 B. 010100

C. 100100 D. 110110

94. Which logic gate produces high output only when inputs are different?

A. AND B. OR

C. XOR D. NOR

95. The binary representation of a decimal 10.625 is:

A. 1010.110 B. 1100.100

C. 1010.101 D. 1010.111

96. The Boolean expression, $\overline{\overline{AB} + \overline{A} + AB}$ is equivalent to

A. $\overline{A}$ B. A

C. 1 D. Zero

97. If a memory chip size is 256 × 1 bits, what is the number of chips required to make up 1 kbyte of memory

A. 32 chips B. 64 chips

C. 128 chips D. 256 chips

98. Number of flip-flops needed to divide the input frequency by 1024 is

A. 5 B. 4

C. 10 D. 8

99. The expression $(A + B)(A + C)$ can be simplified to:

A. $A + BC$ B. $AB + AC$

C. $A + B + C$ D. $A + BC + AC$

100. Which addressing mode in 8085 uses the operand directly in the instruction?

A. Direct B. Immediate

C. Register D. Indirect

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RESPONSE SHEET

1	A	B	C	D	E	26	A	B	C	D	E	51	A	B	C	D	E	76	A	B	C	D	E
2	A	B	C	D	E	27	A	B	C	D	E	52	A	B	C	D	E	77	A	B	C	D	E
3	A	B	C	D	E	28	A	B	C	D	E	53	A	B	C	D	E	78	A	B	C	D	E
4	A	B	C	D	E	29	A	B	C	D	E	54	A	B	C	D	E	79	A	B	C	D	E
5	A	B	C	D	E	30	A	B	C	D	E	55	A	B	C	D	E	80	A	B	C	D	E
6	A	B	C	D	E	31	A	B	C	D	E	56	A	B	C	D	E	81	A	B	C	D	E
7	A	B	C	D	E	32	A	B	C	D	E	57	A	B	C	D	E	82	A	B	C	D	E
8	A	B	C	D	E	33	A	B	C	D	E	58	A	B	C	D	E	83	A	B	C	D	E
9	A	B	C	D	E	34	A	B	C	D	E	59	A	B	C	D	E	84	A	B	C	D	E
10	A	B	C	D	E	35	A	B	C	D	E	60	A	B	C	D	E	85	A	B	C	D	E
11	A	B	C	D	E	36	A	B	C	D	E	61	A	B	C	D	E	86	A	B	C	D	E
12	A	B	C	D	E	37	A	B	C	D	E	62	A	B	C	D	E	87	A	B	C	D	E
13	A	B	C	D	E	38	A	B	C	D	E	63	A	B	C	D	E	88	A	B	C	D	E
14	A	B	C	D	E	39	A	B	C	D	E	64	A	B	C	D	E	89	A	B	C	D	E
15	A	B	C	D	E	40	A	B	C	D	E	65	A	B	C	D	E	90	A	B	C	D	E
16	A	B	C	D	E	41	A	B	C	D	E	66	A	B	C	D	E	91	A	B	C	D	E
17	A	B	C	D	E	42	A	B	C	D	E	67	A	B	C	D	E	92	A	B	C	D	E
18	A	B	C	D	E	43	A	B	C	D	E	68	A	B	C	D	E	93	A	B	C	D	E
19	A	B	C	D	E	44	A	B	C	D	E	69	A	B	C	D	E	94	A	B	C	D	E
20	A	B	C	D	E	45	A	B	C	D	E	70	A	B	C	D	E	95	A	B	C	D	E
21	A	B	C	D	E	46	A	B	C	D	E	71	A	B	C	D	E	96	A	B	C	D	E
22	A	B	C	D	E	47	A	B	C	D	E	72	A	B	C	D	E	97	A	B	C	D	E
23	A	B	C	D	E	48	A	B	C	D	E	73	A	B	C	D	E	98	A	B	C	D	E
24	A	B	C	D	E	49	A	B	C	D	E	74	A	B	C	D	E	99	A	B	C	D	E
25	A	B	C	D	E	50	A	B	C	D	E	75	A	B	C	D	E	100	A	B	C	D	E

ROUGH WORK

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ROUGH WORK