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Future Perspective on Jute Fiber *Corchorus capsularis* in South Salmara-Mankachar District, Assam

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Abstract: ***The use of synthetic products in day-to-day life is causing huge pollution of environment. Jute being a natural fiber can be a good alternative to the synthetic materials. This paper deals the mechanical properties of local jute variety and how it can be improved. It is found that this variety of Jute has highest number of aliphatic groups (CH2-CH2) and ester and fatty acids groups (C=O) i.e.83.4% and 86.8% which is good for making reinforced materials like woven fabrics and thermoplastics. Secondly the tensile strength of Jute fibre of three different spans (5, 15, 35mm) is calculated. The increase in length of span is directly proportional to the Young's modulus which means more the length of span less will be the strain to failure.***

Keywords: jute fiber, sustainable materials, mechanical properties, tensile strength, environmental pollution

1. Introduction

The Jute being a natural fibre is considered best for development of Fiber-reinforced polymer, Micro crystalline crystal (MCC) etc. (1) (Liang et al, 2023) In south-west Assam in South Salmara Mankachar district weather is very suitable for production of *Corchorus capsularis.* as the average rainfall is 114.8 inch and temperature being 32-45 ˚C. (2)

Cultivation and Extraction of Fibre:
Jute plants are grown in grassy soil with 125-150mm of rainfall per month. Once the plant matures, they are cut and allowed to undergo the process of Retting i.e. leaving the plants in slow running water for example in the banks of rivers tied at some point or in clear ponds. This process is called retting which helps the fibre to come out of the mature plant. The Jute fibers are then dried and marketed for further processing (M.S. Rahman 2010(3), Ullah et al. 2017(4). Yarn is then produced from fiber and from this yarn is used to produce fabrics. Jute is also treated with chemicals to increase its mechanical properties (Kayser M.A. et al. 17-19, 2021) (5). The main objectives of the current work are to characterize various natural fibres and determine mechanical properties of the fiber.

The fibers are extracted from matured stem and seen through Fourier Transform infra-red spectroscopy (FTIR) to obtain an infra- red spectrum of absorption or emission of the solids present in it.

Following is the result of the findings

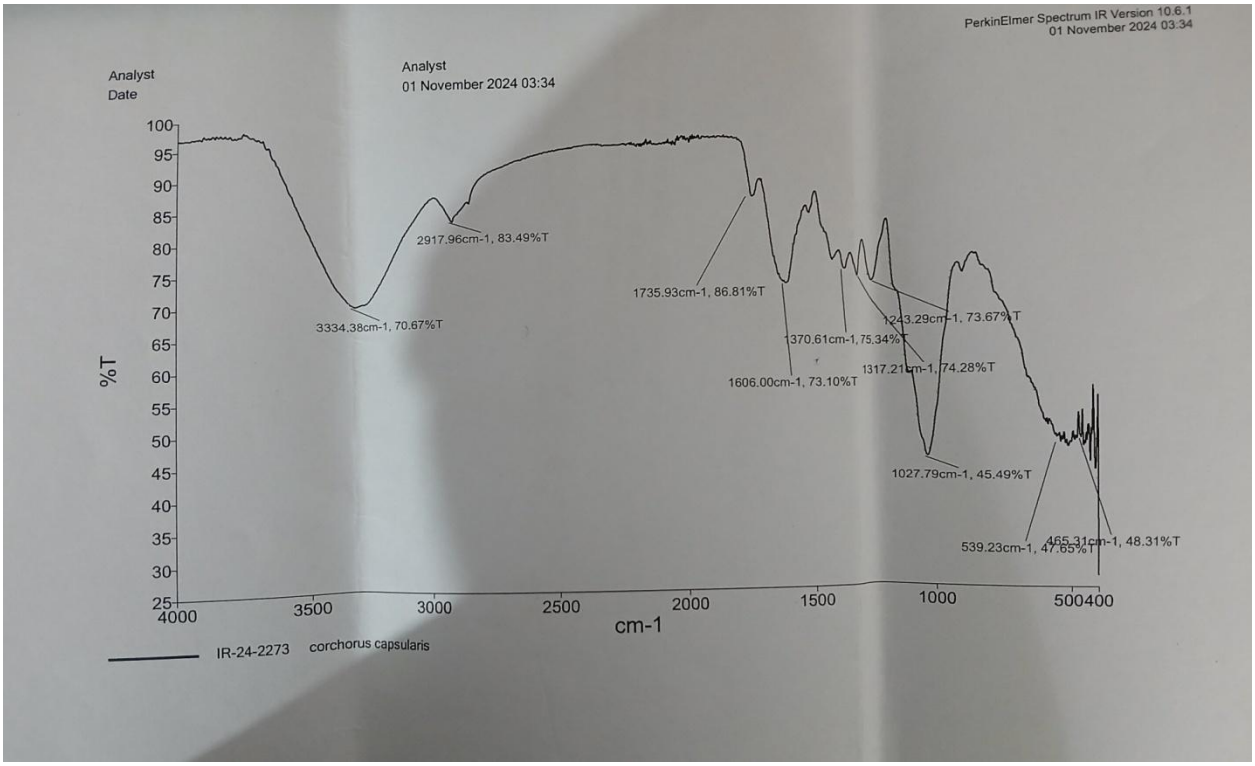

Figure 1: FTIR of Corchorus capsularis (6)

Result of FTIR:

There is peak in ester fatty acid bonds(c=O) 86.8%T (1735.93 $cm^{-1)}$ which suggests the vast presence of ester bonds. This feature helps to make polyester fabrics. There is also a peak in 3334.38cm^{-1}, 2917.96cm^{-1} corresponding to –OH (Alcohol) and C-H (Aliphatic hydrocarbon) vibrations. Saha *et. al,* (2010) (7) conducted X-RD and FTIR analysis of Jute fibers. The authors concluded that Jute fibers displayed cellulose crystallites justified by X-Ray diffractograms and Jute fiber FTIR spectra showed a strong peak at 3200-3600 cm^{-1} reflecting the hydrogen bonding(-OH) bonds stretching. All these things suggests that this jute fiber can be easily bent or folded.

The next finding of this research work is to find the tensile property of the Jute variety. The specific objective is to determine the actual Young's modulus and strain to failure from obtained experimental results.

2. Experimental Procedure for Tensile Strength

Method

Tensile testing of Jute single fibres(span length of 5mm, 10mm, 15mmand 35mm) with a crosshead speed and Load cell of 5mm/min and 5N was performed by using mini-Tensile testing machine. The same was conducted by Shahinur *et al.* 2015, (8) using an Instron^{TM} universal testing machine (Norwood, MA, USA)

Specimen preparation and measurement

The Jute fibre is cut to a random length and weight was taken. The fibers are then glued between two paper frames for good grip and straight positioning in the clamp of the machine. (9)(Biswas, S. 2011). Diameter of Jute fiber is measured by optical microscope and the cross-head speed used for Jute is 0.5mm/min. Then 5 N load cells are used.

Tensile strength was calculated by using the formula

$$\sigma = \frac{F_{max}}{A}$$

Where σ is tensile strength, F_{max} is maximum force and A is cross-sectional area.

$A = \pi r^2$ Where r is radius

Correction for Tensile properties

a. $\alpha_i = \frac{\Delta L_{total}}{F} - \frac{L_0}{E_0 \times A_i}$

b. $\frac{\Delta L_{total}}{F} = \frac{\varepsilon \times L_0}{\sigma \times A_i} = \frac{1 \times L_0}{E \times A_i}$

c. $\frac{\Delta L_{grip}}{L_0} = \frac{\alpha_i \times A_i \times \sigma}{L_0}$

d. $\frac{\Delta L_{(corrected)}}{L_0} = \frac{\Delta L_{total}}{L_0} - \frac{\Delta L_{grip}}{L_0}$

Where α_i is machine displacement for each fiber, L_0 is the original length span, E is the Young's modulus for each fiber, E_0 is the extrapolated Young's modulus, A_i is the cross-sectional area for each fiber, F is the Force, ε is the Strain and σ is the Stress.

Following is the table showing the comparision between corrected and uncorrected Young's Modulus and Strain to failure of Jute fiber with different span length

Span length	Young's modulus	Strain to failure (%)	Corrected Young's Modulus (GPa)	Corrected Strain to failure (%)
5mm	8.68± 3.05	4.83 ± 1.15	29.00 ± 15.24	1.50 ± 0.76
10mm	14.43± 3.85	2.90 ± 0.73	29.72 ± 9.8	1.45 ± 0.39
15mm	17.95 ± 5.30	2.14 ± 0.59	27.23 ± 8.27	1.37 ± 0.46
25mm	21.68 ± 5.45	1.48 ± 0.21	26.44 ± 6.07	1.29 ± 0.17
35mm	27.2 ± 8.50	1.22 ± 0.32	28.80 ± 9.5	1.16 ± 0.32

3. Results

The Stress/Strain curves of jute of 25 mm span are shown in fig 3. The uncorrected and corrected extrapolated curves (1/span vs the Young's modulus and strain to failure and Tensile strength for span 5mm, 10mm, 15mm ,25mm and 35mm of jute is shown in fig4. It is seen that with increase in span length the youngs modulus also increased. It is also found that strain to failure and machine displacement (α) decreased with increase in span length. The tensile strength of this variety is very high i.e. 360Mpa which suggests that the fiber can be easily made into yarn.

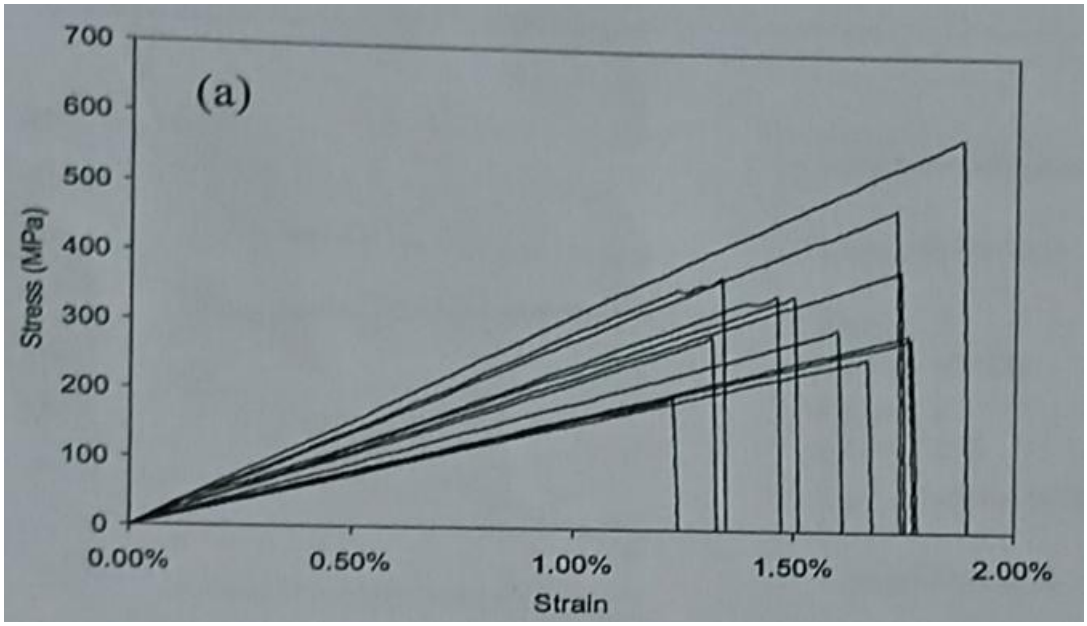

Figure 2: Stress/Strain curves of jute of 25 mm span

4. Conclusion

From this paper we can conclude that Jute present in the area is a good variety with high quality to be a fabric and it can be used in making reinforced materials with other materials like plastics.

References

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HS 2nd Year (Botany)
Action plan

Class No.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teaching Aid
1.	1.	Reproduction in Organisms	Asexual Reproduction	Explanation and discussion	Blackboard, Chalk and Duster.
2.	1.		Asexual Reproduction	Explanation and discussion	Blackboard, Chalk and Duster.
3.	1.		Natural vegetative propagation and Usefulness of asexual reproduction	Notes are provided	Blackboard, Chalk and Duster
4.	1.		Artificial vegetative reproduction	Explanation and discussion	Blackboard, Chalk and Duster
5.	1.		Micropropagation	Explanation and discussion	Blackboard, Chalk and Duster.
6.	1.		Tissue Culture	Notes are provided	Blackboard, Chalk and Duster.
7.	1.		Apomixis	Notes are provided	Blackboard, Chalk and Duster.
8.	1.		Sexual Reproduction: Basic processes	Explanation and discussion	Powerpoint presentation
9.	1.		Pre-Fertilization events	Explanation and discussion	Powerpoint presentation
10.	1.		Fertilization and post- fertilization methods	Explanation and discussion	Powerpoint presentation
11.	1.		Sexual Dimorphism	Notes are provided	Blackboard, Chalk and Duster.
12.	1.		Whole chapter	Class test	Blackboard, Chalk and Duster
13.	2.	Sexual reproduction in Flowering Plants	Flower-the organ of reproduction	Explanation and discussion	Blackboard, Chalk and Duster
Class No.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teaching Aid
14.	2.	Sexual reproduction in Flowering Plants	Structures of Pollen grains	Explanation and discussion	Blackboard, Chalk and Duster
15.	2.		Microsporogenesis	Explanation and discussion	Blackboard, Chalk and Duster
16.	2.		Pistil, Ovule and Embryo-sac	Notes are provided	Blackboard, Chalk and Duster
17.	2.		Ovule and Megasporogenesis	Explanation and discussion	Blackboard, Chalk and Duster
18.	2.		Development of male gametophyte	Explanation and discussion	Blackboard, Chalk and Duster
19.	2.		Development of female gametophyte	Explanation and discussion	Blackboard, Chalk and Duster
20.	2.		Pollination and types	Notes are provided	Blackboard, Chalk and Duster
21.	2.		Mechanisms of pollination	Explanation and discussion	Blackboard, Chalk and Duster
22.	2.		Advantages and disadvantages of Self-Pollination	Explanation and discussion	Blackboard, Chalk and Duster
23.	2.		Advantages and disadvantages of Cross-Pollination	Notes are provided	Blackboard, Chalk and Duster
24.	2.		Pollen-Pistil interaction, Artificial Hybridisation	Explanation and discussion	Blackboard, Chalk and Duster
25.	2.		Fertilization process, Double fertilization and Triple fusion	Powerpoint presentation	Blackboard, Chalk and Duster, Projector
26.	2.		Post- Fertilization Changes and formation of seed	Powerpoint presentation	Blackboard, Chalk and Duster, Projector
27.	2.		Formation of Fruit, Structure of Fruit	Explanation and discussion	Blackboard, Chalk and Duster
Classno.	Chapter No.	Chapter Name/Topic	Sub-Topic	Teacher's Activity	Teacher's Aid
28.	2.	Sexual reproduction in Flowering Plants	Apomixis and Polyembryony	Notes are provided	Blackboard, Chalk and Duster
28.	2.		Whole chapter	Class test	Blackboard, Chalk and Duster
29.	7.	Origin of Life and Evolution	History of Earth and Origin of Life	Explanation and discussion	Blackboard, Chalk and Duster
30.	7.		Chemical origin and Experiment of Miller and Urey	Explanation and discussion	Blackboard, Chalk and Duster
31.	7.		Biological origin	Notes are provided	Blackboard, Chalk and Duster
32.	7.		Evolution of Photosynthetic organisms	Explanation and discussion	Blackboard, Chalk and Duster
33.	7.		Organic Evolution	Explanation and discussion	Blackboard, Chalk and Duster
34.	7.		Evidences from Anatomy and morphology,Embryology	Explanation and discussion	Blackboard, Chalk and Duster
35.	7.		Evidences from Palaeontological records, Geological Time- Scale	Explanation and discussion	Blackboard, Chalk and Duster
36.	7.		Theories of Organic Evolution	Explanation and discussion	Blackboard, Chalk and Duster
37.	7.		Theory of Natural Selection	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
38.	7.		Mutation Theory	Explanation and discussion	Blackboard, Chalk and Duster
39.	7.		Adadtive Radiation and Common ancestry	Explanation and discussion	Blackboard, Chalk and Duster
40.	7.		Hardy-Weinberg's Principle	Explanation and discussion	Blackboard, Chalk and Duster

Class No.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teaching Aid
41.	7.	Origin of Life and Evolution	Natural selection and survival of Fittest	Explanation and discussion	Blackboard, Chalk and Duster
42.	7.		Origin and Evolution of Man	Notes are provided	Blackboard, Chalk ,Duster
48.	9.	Strategies for Enchancement in food production	Animal husbandry	Explanation and discussion	Blackboard, Chalk and Duster
49.	9.		Dairy management	Explanation and discussion	Blackboard, Chalk ,Duster
50.	9.		Poultry farm management	Explanation and discussion	Blackboard, Chalk and Duster
51.	9.		Animal Breeding	Notes are provided	Blackboard, Chalk ,Duster
52.	9.		Controlled breeding experiments	Notes are provided	Blackboard, Chalk and Duster
53.	9.		Bee- keeping	Notes are provided	Blackboard, Chalk ,Duster
54.	9.		Fisheries and maintainence of fishery farms	Explanation and discussion	Blackboard, Chalk and Duster
55.	9.		Plant breeding and crop- improvement	Explanation and discussion	Blackboard, Chalk ,Duster
56.	9.		Plant breeding for disease resistance	Explanation and discussion	Blackboard, Chalk and Duster
57.	9.		Single Cell protein	Explanation and discussion	Blackboard, Chalk ,Duster
58.	9.		Tissue culture	Explanation and discussion	Blackboard, Chalk and Duster
59.	9.		Nutrient Fortification	Notes are provided	Blackboard, Chalk ,Duster
60.	9.		Whole chapter	Class-test	Blackboard, Chalk ,Duster
Classno.	Chapter No.	Chapter Name/Topic	Sub-Topic	Teacher's Activity	Teacher's Aid
61.	10.	Microbes in Human welfare	Microbes in household products	Explanation and discussion	
62.	10.		Use of microbes in industries	Explanation and discussion	
63.	10.		Steps and pre-requisites in industrial fermentation	Explanation and discussion	
64.	10.		Production of Ethanol and fermented beverages	Notes are provided	
65.	10.		Antibiotic production	Explanation and discussion	
66.	10.		Microbial production of chemicals and bioactive substances	Notes are provided	
67.	10.		Sewage microbiology	Explanation and discussion	
68.	10.		Biogas production	Explanation and discussion	
69.	10.		Microorganisms as biocontrol agent	Explanation and discussion	
70.	10.		Biofertilizer	Notes are provided	
71.	10.		Non-symbiotic nitrogen fixing microbes	Notes are provided	
72.	10.		Whole chapter	Class test	
73.	11.	Biotechnology: Principles and processes	Biotechnology and its principles	Explanation and discussion	
74.			Methods in Genetic Engineering/ Recombinant technology	Explanation and discussion	
75.			Prospects of genetic engineering and applications	Explanation and discussion	
76.			Tools of Recombinant technology- Enzymes and Vehicle DNA	Explanation and discussion	
77.			Recognition sequence and isolation of DNA	Explanation and discussion	
Class no.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teacher's Aid
78.	11.	Biotechnology: Principles and processes	Gel Electrophorosis	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
79.			Cloning, Gene cloning	Explanation and discussion	Blackboard, Chalk and Duster
80.			Cloning vectors, Selectable markers	Explanation and discussion	Blackboard, Chalk and Duster
81.			Cloning sites	Explanation and discussion	Blackboard, Chalk and Duster
82.			Vectors for cloning, Plasmid	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
83.			Isolation and Fragmentatation of DNA,	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
84.			Polmerase Chain Reaction (PCR)	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
85.			Recombinant DNA into host cells.	Explanation and discussion	Blackboard, Chalk and Duster
86.			Mass production	Notes are provided	Blackboard, Chalk and Duster
87.			Bioreactor	Notes are provided	Blackboard, Chalk and Duster
88.			Whole Chapter	Class-test	Blackboard, Chalk and Duster

89.	12.	Biotechnology and its applications	Applications in Agriculture	Explanation and discussion	Blackboard, Chalk and Duster
			Genetically modified organisms (GMO)	Explanation and discussion	Blackboard, Chalk, Duster
Class no.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teacher's Aid
90.	12.	Biotechnology and its applications	Bt plants and cry gene	Notes are provided	Blackboard, Chalk, Duster
91.	12.		Medical Biotechnology, GM insulin	Explanation and discussion	Blackboard, Chalk and Duster
92.			Gene therapy	Explanation and discussion	Blackboard, Chalk and Duster
93.			Molecular Diagnosis	Explanation and discussion	Blackboard, Chalk and Duster
94.			Enzyme linked Immuno Sorbent Assay (ELIZA)	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
95.			Flourescent Antibody technique, Widal test	Power-point presentation, Explanation and discussion	Blackboard, Chalk and Duster, Projector
96.			Autoradiography	Explanation and discussion	Blackboard, Chalk and Duster
97.			Transgenic animals	Explanation and discussion	Blackboard, Chalk and Duster
98.			Ethical issues	Notes are provided	Blackboard, Chalk, Duster
99.			Intellectual Property right (IPR) and Biopiracy	Notes are provided	Blackboard, Chalk, Duster
100.			Whole chapter	Class test	Blackboard, Chalk, Duster
101.	13.	Organisms and Populations	Organisms and Environment	Explanation and discussion	Blackboard, Chalk and Duster
102.	13.		Factors affecting habitats	Explanation and discussion	Blackboard, Chalk and Duster
103.	13.		Biotic facors	Explanation and discussion	Blackboard, Chalk and Duster
104.	13.		Abiotic factors	Explanation	Blackboard, Chalk, Duster
Class no.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teaching Aid
105.	13.	Organisms and Populations	Abiotic facors	Explanation and discussion	Blackboard, Chalk and Duster
106.	13.		Response to Abiotic factors	Explanation and discussion	Blackboard, Chalk and Duster
107.	13.		Adaptation	Explanation and discussion	Blackboard, Chalk and Duster
108.	13.		Population Attribute	Explanation	Blackboard, Chalk, Duster
109.	13.		Population Growth	Notes are provided	
110.	13.		Carrying capacity, Exponential and logistic growth	Explanation and discussion	Blackboard, Chalk and Duster
111.	13.	Organisms and Populations	Life history variation	Explanation and discussion	Blackboard, Chalk and Duster
112.	13.		Population interaction: Mutualism, Competition	Explanation and discussion	Blackboard, Chalk and Duster
113.	13.		Population interaction: Predation, Commensalism, Amensalism	Notes are provided	Blackboard, Chalk, Duster
114.	13.		Whole chapter	Class test	Blackboard, Chalk, Duster
115.	14.	Ecosystems	The concept of ecosystem		
116.			Component of ecosystem		
117.			Types of ecosystem		
118.			Ecosystem: Structure and Function		
119.			Productivity of ecosystem		
120.			Decomposition		
Class no.	Chapter No.	Chapter Name/ Topic	Sub- Topic	Teacher's Activity	Teacher's Aid
121.		Ecosystem	Energy flow	Explanation and discussion	Blackboard, Chalk and Duster
122.			Trophic level in ecosystem	Explanation	Blackboard, Chalk, Duster
123.			Food chain and ecological pyramid	Notes are provided	Blackboard, Chalk, Duster
124.			Ecological succession of plants	Explanation and discussion	Blackboard, Chalk, Duster
125.			Biogeochemical cycling	Explanation and discussion	Blackboard, Chalk, Duster
126.			Ecosystem service	Notes are provided	Blackboard, Chalk, Duster
127.			Whole chapter	Class test	Blackboard, Chalk, Duster