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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Home Economics
5561/6561 Unit 7 Textiles Science and Technology

Mark Scheme
2005 examination – June series

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GCE Home Economics

Textiles Science and Technology HEC7

Each question carries 25 marks. Answer two questions only

Question 1

(a) **Melt spinning –**
Principle - production of continuous filaments by forcing molten polymer through the tiny holes in a spinnerette.(1)

Polymer thermosplasticity – only those polymers which melt and are stable at the melting point can be melt spun. (1)

The size and shape of the spinnerette determines the properties of the continuous filaments produced. (1)

The important textile fibres produced by melt spinning are polyester, polyamide polypropylene and acrylics. (2)

(5 marks)

(b) **Fibre-reactive dye -**
These are a unique class of dyes specially developed in order to r4efuce dye loss during washing i.e. to significantly improve dye-fastness and therefore prevent dye loss. (1)

All other dye types are held on to fibres mainly by physical forces and often they bleed during high-temperature washing and often affect white garments being washed at the same time. (1)

Fibre-reactive dyes actually form strong (covalent) chemical bonds with the fibres being dyed resulting in very good dye-fastness. (2)

These dyes are extensively used on wool and cotton but cannot be used on synthetic Fibres such as polyester or polyamide. (1)

(5 marks)

(c) **Worsted yarns -**
These are used to make fine, high quality worsted cloth which is used in suits, overcoats, jackets etc. (1)

Only long, fine wool fibres are used especially from merino fleece. (1)

During yarn manufacture the process of combing removes short coarse wool fibres which would adversely affect the fabric fineness. (1)

Worsted fabrics and garments tend to be expensive but are well known for being of high-quality. (1)

Worsted fabrics can be used in garments which are worn at all times of the year not only during the winter when traditionally wool has been worn. (1)

(5 marks)

(d) **Non-woven fabric –**
These fabrics are produced without using weaving or knitting processes. (1)
These fabrics consist essentially of webs of fibres bonded together by physical or thermal methods. (1)
Any fibre types can be used and there is great potential for using recycled fibres in the production of non-wovens. (1)

Their use has dramatically increased in the past 20 years especially in disposable textile products such as disposable nappies, incontinence pads, kitchen cloths etc. (1)

They are fairly cheap and easy to produce but do not have the good qualities of woven or knitted fabrics. (1) *(5 marks)*

(e) **Fleece fabric –**
The name fleece is derived from the wool industry6 but most fleece fabrics used today are not made from wool, polyester is the most widely used fibre in fleece fabrics. (1)

Fleece fabrics are used mainly for outdoor clothing such as jackets and hats. (1)

They are warm because the fibres in the surface of the fabric are brushed and consequently raised from the fabric surface trapping air. (1)

These fabrics are quite tough and durable, they are colourfast and do not shrink during washing. (1)

(5 marks)

Question 2

(a) **Linear density**
This is the relationship between fibre thickness and fibre length and the term is unique to textiles. (1)

Two units are used today to describe the linear density of textile yarns and fibres tex and denier. (2)

Tex is the mass in grammes of 1 kilometre (1000 metres) of fibre yarn or filament. (1)

Denier is the mass in grammes of 9000 metres of fibre, yarn or filament. (1)

(5 marks)

(b) **Linear density calculation**
500 metres of yarn weighed 500 milligrammes – using the definition in (a) above, the tex value for this polyamide yarn is **1**. *(3 marks)*

(c) (i) **Percentage extension calculation**
100 centimetres of yarns becomes 110cm when stretched
% extension = 10/100 x 100 = **10%** *(3 marks)*

(ii) **Percentage elastic recovery calculation**
Removal of the 50 gramme weight caused the yarn to recover to 102 cm
% elastic recover = **80%** *(3 marks)*

(d) (i) Standard moisture regain (SMR) is the percentage increase in weight when a bone-dry fibre is allowed to come to equilibrium in air at a temperature of 21° C and a relative humidity of 65%. (1)

Wool **SMR** = 5.20 – 4.53/4.53 x 100 = **14.79%** (1)

Polyamide **SMR =** 6.40 – 6.11/6/11 x 100 = **4.75%** (1)

(3 marks)

(ii) Standard moisture content (SMC) is the percentage of moisture present in a Fibre which has been allowed to come to equilibrium in air at a temperature of 21° C and a relative humidity of 65%. (1)

Wool **SMC** = 5.40 – 4.53/4.53 = **19.20%** (1)

Polyamide **SMC =** 6.60 – 6.11/6.11 = **8.02%** (1)

(3 marks)

(e) Zero value for the SMR of polypropylene

Polypropylene fibres are based on a polymer containing carbon and hydrogen only (1)

There are not sites on the polymer for water molecules to become attached to via hydrogen bonding (1)

Unlike cotton and wool where there are many sites for water to hydrogen bond to polypropylene fibres are extremely hydrophobic (water-hating) and as a result the fibres simply do not attract water from the air onto the fibres. (2)

This very low value for the SMR of polypropylene means that garments containing polypropylene fibres are quick to dry but can be uncomfortable to wear especially when the garment is close to the skin.(1)

(5 marks)

Question 3

(a) **Proban**

A flame-retardant finish for use with 100% cotton textiles. (1)

Proban is added to cotton during finishing and it is a permanent finish which does not wash out (1)

The finish contains phosphorus compounds which during heating produce phosphoric acids and it is these acids of phosphorus which react with cotton cellulose and prevent them from igniting and burning. (1)

The treated fabrics tend to form lots of char and they do not burn. (1)

The Proban finish is used when fabrics have to meet special flammability regulations such as upholstered furniture, childrens nightwear, military uniforms etc. (1)

(5 marks)

(b) **DMDHEU**

This is a crease-resistant finish used for cotton and polyester/cotton fabrics. (1)

The finish was developed in the USA in the 1960's mainly for white 100% cotton shirts and blouses which were very popular at the time. As well as preventing creasing and wrinkling DMDHEU had another important property because it prevented cotton from shrinking. (2)

DMDHEU is applied to cotton during finishing and the finish is fixed (cured) on the fabric at high temperatures. The chemical compound forms a chemical bond with cotton cellulose and it is said to 'cross-link' and stabilise cellulose fibres. (1)

It is still very widely used today for both 100% cotton and those polyester/cotton blends with a high proportion of cotton present. (1)

(5 marks)

(c) **Mordants**

Some types of dyes are applied to textile fibres in the presence of a chemical compound, mainly metal oxides, which 'fix' the dye on the fibres. (1)

Although mordants are not so extensively used today as they were in the past, they are still used for dyeing some textiles which must be totally dye-fast. (1)

The mordant acts like a bridge between fibre and dye thus preventing dye loss from occurring during washing. (1)

Different metal oxides are used. Today mainly chromium for polyamides and cobalt, aluminium, nickel and copper for the natural fibres cotton and wool. (2)

(5 marks)

(d) **PTFE**

This compound polytetrafluoroethylene is used in textiles mainly as a stain and water repelling finish, Scotchgard is a typical example. (1)

Fluorocarbon finishes are usually applied to textiles where eater and oil staining can be a problem. Workwear, carpets and upholstered furniture are typical examples. (1)

When the finish is applied to textile fibres it changes considerably the physical Properties of the fibres. Fibres which are usually hydrophilic e.g. cotton and wool can be made virtually uneatable by both water and oil-based stains. (2)

Unfortunately the finish is not permanent and has to be reapplied during the lifetime of the fabric. (1)

(5 marks)

(e) **Hydrogen peroxide**

This substance is used as mild bleaching agent in textile processing. (1)

It acts by producing 'active oxygen' which attacks stains and coloured impurities in fabrics. (1)

Bleaching has been carried out since very early times for white cotton and linen bur hydrogen peroxide-based bleaches have only recently been used. (1)

Delicate fibres and fabrics can be damaged by traditional chlorine-based bleaches so the prevent damage from occurring hydrogen peroxide is used. (1)

Hydrogen peroxide is normally used at a pH of about 10 in order to maximise the bleaching effect. (1)

(5 marks)

Question 4

(a) **Cotton, cellulose acetate and cellulose triacetate – differing moisture regain values**

The tree cellulose-based fibres have different values for SMR because, although they are based on the cellulose structure, they have different functional groups present which have different abilities to absorb water which in turn affect SMR values. (2)

Cotton (SMR = 8.5%) has the cellulose structure with three – OH groups present in each repeat unit in the polymer so it readily absorbs water. (1)

Cellulose secondary acetate has fewer – OH groups present in the repeating unit with the result that the SMR value for this fibre is only 6.5%. (1)

Cellulose triacetate has no – OH groups present so that it absorbs even less water than secondary acetate, its SMR value is only 4.5%. (1)

(5 marks)

(b) **Cotton and nylon have different physical properties**

Cotton fibres are not very extensible (EAB = 5 – 10 %) whereas polyamide fibres are much more extensible (EAB (nylon) = 25 – 55 %). Because of these differing elasticity properties the two fibres behave quite differently when they are made into clothing, woven cotton fabrics have little elasticity and do not give, while garments containing polyamide fibres are very elastic. (1)

Nylon is thermoplastic cotton is not, cotton is absorbent, nylon is not. These important difference in physical properties affects the types and characteristics of clothing which are made from the two fibres. (1)

Cotton shirts and blouses are very attractive to wear because, when ironed or pressed these garments have a very smart and neat appearance, ideal for professionals, nylon shirts and blouses are much more elastic and are not really suited for formal wear. (1)

The excellent stretch and recovery properties of polyamide fibres gives them a unique application which cannot be provided by any other fibre. Nylon tights and foundation garments for women contain high levels of nylon and now that a little elastane can be added they are almost perfect for this use. (1)

(4 marks)

(c) **Linen is difficult to blend with other fibres**

Like cotton, linen consists largely of cellulose, but 25% of the total material present consists of pectin and waxes, this gives linen fabric a lustre not present in cotton. Linen is very inelastic and rather stiff (EAB = 2- 5%) and the individual fibres are very much longer than cotton often 30 to 50cm in length. (1)

Because of these properties linen is difficult to blend with most fibres. (1)

The waxy coating on lines makes it difficult to dye (unlike cotton). (1)

Also, unlike cotton, linen is very expensive and this adds to the costs. (1)

(4 marks)

(d) **Wool and silk both protein fibres with very different properties**

Both of these natural fibres are protein based, wool is mainly keratin while silk is fibroin. Unlike wool silk has no sulphur containing amino-acids present. Wool is much more complex than silk. (1)

Silk filaments are smooth while wool fibres are scaly. (1)

Both fibres are absorbent and comfortable to wear but each fibre has its own disadvantages and problems, Wool tends to shrink easily while silk cannot cope with excess perspiration. *(1)*

Both fibres are expensive and each fibre has very different uses. (1)

(4 marks)

(e) **Uncomfortable 100% polyamide woven fabric**

Because of their make-up polyamides have rather low SMR values and they cannot cope with excessive amounts of moisture. This can be a problem especially in the summer and tightly woven 100% polyamide blouses can be very uncomfortable in conditions of high temperature and high humidity. (1)

The fabric cannot absorb the excess perspiration produced on the skin and 'wet patches' are produced. (1)

The body uses the evaporation of water as the main cooling mechanism, so if water cannot be evaporated from the skin, body temperature will rise and the wearer will feel uncomfortable. (1)

If knitted polyamide fabrics are worn in the summer there are more comfortable than woven fabrics because there is plenty of space between the yarns for the water to easily escape into the air. (1)

(4 marks)

(f) **Detergents without enzymes present do not remove protein-based stains**

Biological or enzyme-containing detergent products were introduced to enable the consumer to achieve good cleaning even when difficult protein-based stains were present. Rather like the protein digesting enzymes present in our digestive processes, these

biological detergents contain very stable protein-digesting systems which will survive the rigours of high temperatures and severe chemical environments. (2)

The protein-active enzymes present in washing powders act in a similar way as our own. They were developed from human enzymes in such a way that they would function at temperatures much higher than body temperature and in highly alkaline conditions. (1)

Unfortunately some consumers have found that they are sensitive to the residues of these protein-digesting systems left on clothing after washing and can only use non-biological products. (1)

(4 marks)