WCSM Education Trust
Level 4 Diploma for Optical Technicians
(SMC Tech)

THE SYLLABUS
September 2010

Unit 1 - Mathematics for optical manufacturing

Unit Aim(s) - The candidate will have gained an understanding of all the mathematics required to carry out the tasks required in a typical optical workshop.

Use of the calculator – functions, arithmetical operations, use of memory, change sign, squares, square roots, exponential, priorities.
Solution of numeric expressions – numbers in standard form.
Squares and Square Roots.
Properties of triangles - definitions, inverse notation, Pythagoras' Theorem
Basic Geometry - angles and straight line geometry, angles in circles, circles, diameter, radius, circumference, chord, sector. Numerical value of π, properties of plane figures, similar triangles.
Algebra - add and subtract algebraic terms, use of brackets, simple equations, evaluating and transposing formulae.
Area and volume.
Constructing triangles.
Percentages and discount calculations.
Charts and graphs.

Unit 2 - The eye and the principles of optics

Unit Aim(s) - The candidate will have gained an understanding of the basic optical systems of the eye, the properties of light, including refraction, reflection, optical aberrations and the behaviour of light at curved surfaces.

2.1 The eye & introduction to refractive errors

Gross anatomical structure and function.
Emmetropia.
Hypermetropia.
Myopia.
Astigmatism.
Presbyopia.
The correction of ametropia

2.2 Light

Nature of light — wave theory, velocity, frequency and wavelength.
Electromagnetic Spectrum — significance of ultra-violet and infra-red, the visible spectrum.
Fundamental laws of geometrical optics
Reflection, absorption and transmission

2.3 Refractive index, laws of reflection and refraction

Refractive index - absolute and relative.
Laws of reflection – reflection at a plane surface, reflection at two plane mirrors.
Laws of refraction – Snell's Law, refraction at plane surfaces, apparent displacement, real and apparent depth, critical angle, ray tracing through prisms, minimum deviation.
Refraction at a curved surface – first and second focal length, curvature and vergences, optical sign convention, power of a curved surface, formation of images.
Reflection at a curved surface – power, focal length and radius of curvature.
Thin lenses – graphical construction of images formed by thin lenses, object and image vergences, use of the fundamental paraxial equation, magnification.
Chromatic aberration – Abbé number, dispersion, calculation of longitudinal chromatic aberration.

Unit 3 - The properties of ophthalmic lenses Part 1

Unit Aim(s) - The candidate will have gained an understanding of spherical and astigmatic lenses and the importance of prism, lens thickness and decentration effects for these lenses.

3.1 Spherical lenses

Power and focal length, Cartesian sign convention and application to optics, the Dioptre.
Optical Centre, elementary consideration – relevance – comparison to geometrical centre.
Surface power and form – lens maker equations, refractive index, base curve (spherical lenses).
The Thin Lens.

3.2 Astigmatic lenses

Surface power and form (Plano Cylinder, Toroidal Surfaces).
Power and Focal length.
Axis.
Standard Axis Notation.
Writing a prescription.
Sphere / Cyl Transposition.
Principal powers.
Lens surface calculation (Practical Toric Transposition).

3.3 Lens thickness considerations.

Sag Formulae, determination of exact and approximate sag equations. Use of these equations and application to lens forms.
Lens Measure – theory, use with various lens media. The Sagometer – application and use.

Thickness Calculation (Round Lens) – spherical and astigmatic, use of formulae and sag tables.

3.4 Prisms

Terms of Reference.
Plano prisms.
Prism action.
Prism power and measurement – the prism Dioptre, interpretation of prism units.
Base settings.
Thickness Difference, calculation and use of tables.
Compounding and Resolving – conversion of vertical and horizontal prisms to single resultant oblique prisms (and the reverse) angles.

3.5 Prismatic effects of decentration

Lens power and prismatic effect (use of formulae), Prentice rule, prism base direction.
Minimum sized uncut, stock and surfaced lenses.
Working prism to produce decentration - prism to cut - (Spherical or simple astigmatic lenses only).

Unit 4 - The theory of lens surfacing

Unit Aim(s) - The candidate will have gained an understanding of the surface generation of spherical and toroidal lenses and the processes and standards involved.

4.1 Lens surfacing

The control of curvature, thickness, centration and axis direction.
The principles of spherical and toroidal generation – including numerically controlled generators.
Working procedures and equipment.
Diamond laps, abrasives, polishing compounds and methods of application, cooling methods for slurries.
Material and surface faults – identification and inspection.
Surfacing tools and pads.
Radius of curvature.
Pad compensation.
Toric laps.
Common faults – orange peel, holes, bubbles.

4.2 Standards

Standards used to surface ophthalmic lenses.

4.3 Miscellaneous

The progress of prescription orders through a lens production process.

Unit 5 - The properties of ophthalmic lenses – Part 2

Unit Aim(s) - The candidate will have gained an understanding of the essential design principles of spectacle lenses and how these relate to processes used in spectacle manufacture.

5.1 Vertex distance and spectacle power

Vertex distance and focal power.
Change in vertex distance (testing / fitting).
Vertex distance and 'far point'.

5.2 Vertex power and lens thickness

Vertex power allowance.
Accurate transposition.

5.3 Properties of single vision (S/V) lenses

Physical properties of S/V lenses, inc. high-powered lenses.
Optical properties of S/V lenses, inc. high-powered lenses.

5.4 Properties of multifocal lenses

History and Development.
Method of Manufacture – to include components, depression curves and compatible flint series. Shaped segments and how these are manufactured.
Progressive power lenses (PPLs) –surface markings, measuring/checking points and prism thinning.
Optical and physical properties and comparison of bifocals, trifocals and progressive lenses.
Calculation of prismatic effects in the reading portion – due to sphere, cylinder and segment; use of relevant tables.
Prism controlled bifocals – types; uses; calculations (to include [Franklin] split, prism segment solids, unequal segments, bi-prism (slab off) and cemented segments); methods of manufacture.

5.5 Prismatic effects and decentration

Decentration required to produce prism.
Prismatic effects at any point on a lens (to include oblique cylinders).
Prism-to-cut.

5.6 Thickness and surface power

Surfacing ticket writing.

5.7 Principles of lens design

The Far Point and effective power.
Back Vertex Power.
Front Vertex Power.
Accurate Transposition.
Vertex Power Allowance.
Thick Lenses – vertex power and the focimeter.
Implications of aberrations in lens design.
Progressive power lens design: history and development, concept (principles of design – distance, *intermediate* corridor and reading area),
Aspherical and atoroidal surfaces.
Ordered and compensated prescriptions

Unit 6 - Spectacle lens materials

Unit Aim(s) – The candidate will understand the properties of spectacle lens materials and what makes them suitable for manufacture and the wearer.

Optical and physical properties of spectacle lens materials
Higher refractive index media – glass and resin.
High power lenses for myopia and aphakia.
Abbé number.
Transverse chromatic aberration.
Optical and mechanical implications to the spectacle wearer of using materials with differing properties for a given spectacle prescription.

Unit 7 - The properties of spectacle frames and glazing

Unit Aim(s) – The candidate will have gained an understanding of the properties, applications and the process of manufacture of spectacle frames and the glazing techniques available to the technician.

7.1 Spectacle frame components and terms

Frame types.
Description of spectacle frame components.
Handling and characteristics.

7.2 Frame measurements

Measurements and specifications.
Lens shapes.
Soldering and repairs to metal frames.
Assembly and manipulation of non-metal and metal frames, including rimless.
Repairs to non-metal frames.

7.3 Properties of frame materials

7.4 Frame repairs and manipulation

Types of repair.

Precautions when manipulating frames.
Adaption of frames for special applications.

7.5 Glazing

Precautions when glazing.
Glazing methods for metal and non-metal frames and mounts.

7.6 Spectacle frame manufacture and materials

Types of material, methods of material manufacture and methods of frame manufacture, CE marking.

7.7 Special optical appliances

Types of optical appliances
Construction and components.
Applications of special optical appliances

Unit 8 - Optical workshop tasks and glazing spectacle frames

Unit Aim(s) – The candidate will be able to complete a full range of tasks in an optical workshop, and perform routine and non-routine glazing.

Frame adjustments and measurements.
Adaptations and repairs to metal and non-metal frames.
Glazing to a given specification:

- Former making and formerless edging
- Automatic bevel edging, types of bevel.
- Automatic flat edging.
- Hand bevel edging and chamfering, automatic chamfering.
- Springing in and fitting to plastic frames.
- Differences in procedure for glass and plastics materials.
- Hand bevel edging to metal and metal combination frames.
- Edging, and fitting lenses to supras and rimless mounts.
- Facetting.
- Final set up.

Verification of spectacles against a written order using British and European Standard tolerances.
Specifications for replication of given spectacles.

Unit 9 - Optical workshop tasks and surfacing spectacle lenses

Unit Aim(s) – The candidate will be able to complete a full range of tasks in an optical workshop, and perform routine and non-routine surfacing.

Frame adjustments and measurements.
Adaptations and repairs to metal and non-metal frames.
Laying-off lenses for glazing.
Surface a lens to a given specification, including developing surfacing instructions:

- Marking up, taping/varnishing, blocking — prior to spherical and toroidal surfacing.
- Thickness calibration and control.
- Generating spherical and toroidal surfaces, control of stock removal.
- Smoothing spherical and toroidal surfaces.
- Polishing spherical and toroidal surfaces.
- Lens removal (deblocking), cleaning and inspection.
- Marking of single vision, bifocal, trifocal and progressive power blanks for surfacing.
- Care of surfacing tools.

Differences in procedure between surfacing of glass and plastic lens materials.
Verification of spectacles against a written order using British and European Standard tolerances.
Specifications for replication of given spectacles.

Unit 10 - Spectacle lens treatments

Unit Aim(s) - In this unit the candidate will have gained an understanding of the theory, advantages and practical application of spectacle coating and tinting and ISO Standards.

Anti-reflection coating – single and multi layer; theory and methods of application and handling.
Reasons for; methods of manufacture, application and handling of:

- Hard coatings
- Hydrophobic coatings
- Anti-mist coatings
- Stacked coatings
- Impact coatings

Transmittance, reflectance and luminous transmittance,
Relative visual attenuation coefficients.
Filters – absorptive and reflecting.
Types – Vacuum coated, bonded, dyed, solid, photochromic, polarised, UV and IR, special filters.
The restrictions on tinting materials.
ISO Standards for tinted lenses.

Unit 11 - The spectacle industry and standards

Unit Aim(s) - The candidate will have gained an understanding of the UK optical industry, standards and profession, the organiations involved and how the processes work to produce high standards for the UK consumer

11.1 The ophthalmic profession

The roles, qualification paths and scope of practice of ophthalmic professionals

11.2 The ophthalmic manufacturing industry

Types of manufacturing organisations.
Organisation of – including flow charts.
Stock control.
Utilisation of consumables.
The use of computers.

11.3 Optical agencies and Standards

Regulatory bodies, professional and trade associations.

11.4 British and European Standards

Key standard numbers and scope of standards.
Use of standards in optical manufacturing.

11.5 Protective eyewear

Standards relating to protective eyewear.
Hazards in the workplace.
Methods of protection against mechanical hazards – lenses (glass and plastics) and frames (to include industrial eye protection).
Types of protective eyewear.

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