

Communications for the Transmission of Messages.

Ballooning.—General considerations.

Observatories.—Object, requirements, method of construction of various kinds.

PLATES.—IV. Project for a military railway bridge.

FAIR NOTES—On lectures during the term.

EXERCISES—Report on project.

SUBJECT OF EXAMINATION—JUNE—The whole subject.

MARKS—For work during the the term..... 400

For examination, June 600

Total..... 1,000

ENGINEERING DRILL.

3RD TERM—TOTAL MARKS, 500.

FIELD FORTIFICATION.

Preliminary.

Carrying tool drill and extending working parties. Field Geometry.

Obstacles.

Abattis ordinary. German bough abattis. Shallow military pits. Irregular pits with wire entanglement stretched over. Wire entanglement. Palisades. Fraises. Chevaux-de-Frise.

COVER FOR TROOPS.

Infantry.

Shooting Line.—Shelter pits and rifle pits. Shelter trench exercise. Blinded shelter trenches, defensible hedges, walls and snake fences. Log, hurdle and plank parapets. Stockades of various kinds.

Supports.—Deep shelter trenches. Blinded shelter trenches. Field casemates of various kinds.

Reserves.—Lean-to shed covered with earth.

Artillery.

Guns and Detachment.—Gun pits. Gun epaulements. Gunner pits.

Ammunition. Ammunition recesses in above.

Limbers.—Limber pits.

Use of brushwood.

Making pickets, gabions, fascines and hurdles.

Revetments.

Made of the following materials:—Gabions, casks, fascines, logs, planks, hurdles, continuous hurdle work, sand-bags, bricks, stone, miscellaneous.

Field Redoubt.

Tracing, profiling and defilading full size. Executing in model. The redoubt to contain splinter proofs, traverses and occasionally gun-banks.

Attack of Fortresses.

First Artillery position.—Execution in model of suitable battery.

Up to 1st Parallel.—Common trench work for parallels and approaches.

Second Artillery position.—Tracing of full size siege-gun battery and execution in model with magazines, screen, platforms and approaches

Up to 2nd Parallel.—Flying trench work.

Up to 3rd Parallel.—Single sap shallow and deep.

Advance to covered way.—Circular portions. Double saps. Blinded saps. Crowning the covered way.

Breaking into enceinte.—Batteries in lodgment on covered way. Descent into the ditch. Passage of ditch, (1) when dry, (2) when wet. Occupation of breach.

Marks:—

For the term..... 250

4TH TERM.

Attack of Fortresses—(Con.)

Mining.—Sinking shafts with cases and frames. Driving galleries with cases and frames. Preparing charge for mine.

Use of Explosives.

Preparing Charges and cutting through timber and iron with gun-cotton or dynamite, firing the charges by slow or quick match and by electricity.

Electrical testing.—Testing source of electricity, as regards strength and internal resistance. Testing line wire for continuity and insulation and detaching position of faults. Testing completed circuit for resistance, pricker test to locate a fault (methods of testing to be those detailed in theoretical part of Syllabus for Obligatory course).

PIONEER DUTIES.

SIGNALLING.

Flag drill. Practice with flags. Lamp drill with dummy lamps. Practice with lamps. Practice with heliograph. Selecting stations. Transmission of messages.

BRIDGING.

Preliminary.—Reconnaissance of site. Measuring width, taking sections (boring and levelling). Knotting. Lashing spars. Making Derricks, Shears and Gyns. Trussed beams.

Frame Bridges.—Single lock, Double lock, Single sling.

Trestle Bridges.—Making two legged, three legged and four legged trestles with various materials. Forming up into bridge.

Miscellaneous.—Points of support formed by gabions, casks, crib piers, &c.

Water Bridging.—Barrel pier drill. Making timber rafts. Preparing boats. Forming the above into bridge.

CAMP DUTIES.

Bivouacs. Field kitchens and ovens. Latrines.

MARKS:—

For the term (N. C. officers only)..... 250

Practice of imparting Drill Instruction..... 170

APPENDIX F. 3.

SYLLABUS OF ARTILLERY.

Both courses occupy the second and third years, and are carried on simultaneously..... *Total Marks, 400.*

2ND TERM—MARKS, 200—(OBLIGATORY.)

Field gun drill with 6 pr. M.L. and 9 pr. M.L.R. Heavy gun drill on garrison standing carriage 7 inch B. L. R. on traversing platform.

Mortar drill with 8 in. and 10 in.

Manceuvres and evolutions of a field battery of four guns (6 pr. M. L.)

Mounting and dismounting field guns; changing the wheel of a disabled gun carriage.

Firing with blank ammunition.

3RD TERM—MARKS, 200—(OBLIGATORY.)

Filling shell and making up ammunition.

Practice with 9 pr. M. L. R.

Practice with 8 in. mortar.

Knotting and splicing.

Elementary shifts of ordnance, such as par-buckling; raising a gun off the ground; running a gun through a sally-port on rollers; slewing the trunnions; rowing a gun; raising a gun out of the trunnion holes; mounting and dismounting by plank and roller, or by a single stud, &c. Shifting from one carriage to another by plank and roller or by lifting and slewing to a carriage placed alongside.

Gyn drill.

Evolutions of a field battery.

Practice of drill instruction (N. C. Officers only).....*Marks, 160.*

SYLLABUS OF INSTRUCTION IN THEORY AND CONSTRUCTION OF ARTILLERY.

Total Marks. { Obligatory... 3,000.
Voluntary... 1,000.

The instruction is carried on chiefly by means of printed notes extracted by Major Fairtlough, R.A., from the text books of the various departments in the Royal Arsenal, Woolwich. These notes are supplemented by lectures and kept up to date from the monthly list of "Changes in War Material."

Sladen's "*Principles of Gunnery*" is studied by a few advanced cadets in the Voluntary Course.

A limited number of War Office lithograms are provided for issue to such cadets as may desire them.

Text Books.

Manual of Siege and Garrison Artillery, 1879.

Printed Notes on Artillery, by Major Fairtlough, R.A.

Principles of Gunnery, by Major Sladen, R.A.

Tracts on Mechanics containing Problems on Artillery Machines, by Crofton & Kensington.

Manuals of Drill for Canadian Artillery, by Col. Strange, R.A.

Tables of Ordnance and Ammunition by R. A. Institution.

Books of Reference.

Owen's Modern Artillery (Superseded as text book).

Treatise on Construction of Ordnance, R. G. F. Woolwich.

Treatise on Ammunition, R. Laboratory, Woolwich.

Treatise on Military R. C. Department, Woolwich.

Current numbers of R. A. Institution proceedings.

A selection of Sections, Models and Lithograms are available for purposes of instruction.

OBLIGATORY COURSE.

3RD CLASS—1,500 MARKS.

AMMUNITION.—*Explosives* in common use in the service, including gunpowder, gun-cotton and fulminate of mercury; their composition; the outlines of their manufacture; their physical and chemical properties; their uses, classification and storage; precautions to be taken for their safety.

Cartridges; necessary qualities of the material for the bag; distinctive characteristics of cartridges for S.B.; R.B.L.; R.M.L. guns. Lubricator, paper cylinder, &c., used with R.B.L. guns.

Battering, Service and reduced charges; their respective uses.

Filling cartridges; storing filled cartridges; precautions to be taken in handling powder.

Projectiles S. B. Shot, solid, grape and case; Shell, common, naval, diaphragm shrapnel, mortar, &c.; Carcasses, light balls, &c.; their distinctive characteristics and uses.

Fuzes for S. B. Ordnance, including the common, diaphragm and mortar fuzes; Pettman's G. S. and L. S. Percussion fuze; their several applications and uses.

Projectiles R. Palliser shot and shell; Common and Double shell; Segment shell Boxer shrapnel; Battering shell; Case shot; Star shell. Their uses and comparative advantages.

Fuzes for R. Ordnance. The various time fuzes R. M. L. and R. B. L. Royal Laboratory fuze Marks I, II; Sensitive fuze; Delay action fuze; Pettman's G. S. percussion fuze; Armstrong's plain percussion fuze. Brief description of these fuzes with diagrams and sections; their uses and purposes.

Rockets; their history, use, construction and general management.

Gas check, ordinary; the driving gas-check; their history, description and uses.

Wedge wad.

Filling shell and storing filled shell. Premature explosions and how to guard against them. The causes of blind shell.

Means for firing ordnance. The various descriptions of tubes; portfires; quick match; slow match.

ORDNANCE S. B. A short description of the natures still in use.

ORDNANCE R. Guns; Howitzers; Mortars.

Classification as Mountain; Field; Siege; Heavy.

Classification as R. B. L.; R. M. L.; converted.

Composition of Siege Train.

The question of B. L. versus M. L.

OBLIGATORY COURSE.

2ND CLASS.—Total Marks, 1,500.

MILITARY CARRIAGES—

Mountain, field, siege and garrison carriages.

Principles of construction.

The various strains on a field gun carriage; considerations by which they may be minimized.

Construction of wheels: (1) old pattern; (2) new pattern or "Madras" wheel, and its advantages.

Description of "Dish," "Hollow," "Lead," "Set," showing the necessity for each.

Comparison of wooden and iron carriages.

Wooden field gun carriage and limber.

Mark II, carriage for 9 pr. R. M. L.

Special characteristics of larger natures.

The overbank attachment.

Howitzer beds.

Modes of checking recoil.

Garrison wooden carriages : (1) standing ; (2) sliding.

Wooden platforms.

Wrought iron single and double plate sliding carriages.

Wrought iron standing carriage.

Cast iron do (old pattern.)

Wrought iron platforms ; Elswick compressor ; hydraulic buffer.

The Moncrieff system.

GUNNERY.—General principles and result ; further investigations being reserved for the Voluntary Course.

Objects of rifling, angle of spiral, twist of rifling, relative advantages of "uniform" and "increasing" twist.

Velocity of rotation, how measured ; the considerations on which the amount of rotation to be given depends.

Derivation or drift ; how counteracted in the sighting.

Systems of rifling in common use, their advantages and defects. Various forms of grooves ; disadvantages of grooves, studs, and ribs.

Care and preservation of ordnance and stores.

VOLUNTARY COURSE.

2ND CLASS—Total Marks, 1,000.

SECTION A.—Construction and action of the service time and percussion fuzes.

The principal metals used in the construction of ordnance and stores. Their most important physical properties with reference to their employment. Special attention to the distinctive characteristics of wrought iron, steel, and the various descriptions of cast iron. Puddling and other metallurgic processes carried on in the Royal Arsenal or elsewhere, with special reference to military purposes.

History and construction of ordnance, including cast iron, bronze and Woolwich guns. Detailed account of all the processes of modern manufacture as carried on in the Royal Arsenal.

Proofs and tests for wrought iron ; steel tubes, before boring, with special reference to tempering in oil ; the finished tube after tempering ; and, finally, the finished gun.

Manufacture of carriages and physical properties of the more important woods employed ; without paying much attention to detail.

Manufacture of ammunition and stores connected with artillery. Marks, 400.

Section B. (*Staden's Principles of Gunnery.*)

Chapter I.—Definition of terms used in gunnery.

Chapter II.—Relation between and problems upon the "angle of spiral" and "twist of rifling." Velocity of rotation determined from that of translation. "Energy" due both to translation and to rotation, omitting the note to pages 15, 16. Velocity of recoil without noticing the weight of the cartridge and without the considerations in pages 18, 19, which should however be read over, the causes of inaccuracy being noticed. Energy of recoil omitting the cartridge as before. Omit Major Kemmis' table.

Chapter III.—Pressure in the bore of a gun.

Chapter IV.—Work done by a charge of powder, omitting the table of work and its applications. "Factor of Effect." Velocity in the bore and muzzle. Velocity omitting details in pages 31, 32.

Chapter V.—Resistance of the air. History up to Bashforth's experiments and conclusions. Calculations leading to $v = \frac{V}{1 + cV_s}$ and to the Tables of remaining Velocity. Practical use of these tables. Consider also the Table of *K* page 48. Omit Table page 54.

Chapter VI.—Calculation of Trajectories ; vertical height and angle of descent. Omit pages 69 to 84.

Chapter VII.—Drift of elongated projectiles. See also manual of Canadian Artillery.

Chapter VIII.—Probability of fire.

Chapter IX.—Penetration of projectiles. General principles without detail.

Appendix.—General acquaintance with the principles of Le Boulenger's Chronograph ; Bashforth's Clock and Gravity Chronograph ; Watkins' Electric Chronograph ; Noble's Crusher Gauge and Chronoscope.....Marks, 500.

Section C.—(Tracts on Mechanics. Part III.)

Application of mathematics to artillery machines, including tackles and purchases ; hydraulic and other jacks ; elevating screws ; triangle gyn, shears, derricks, sling waggon, Gibraltar gyn, strains on a traversing platform, &c.....Marks, 100.

APPENDIX F 4.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF COURSE OF INSTRUCTION IN MILITARY ADMINISTRATION AND LAW.

Total Marks.....2,500.

Third Class.

Total number of Marks (Obligatory) 1,500

Military Administration.	{ Examinations..... 850 }	900	} 1,500
	{ Notes..... 50 }		
Military Law.....	{ Examinations..... 550 }	600	}
	{ Recitations & Notes. 50 }		

MILITARY ADMINISTRATION.

General principles of the organization of armies and the special laws relating to soldiers.

Maintenance of discipline, and chain of responsibility.

British military units from companies, troops and batteries up to army corps.

War establishments of the British army.

A short account of the British method of keeping up an army, recruiting, length of service, &c. Comparison between voluntary and compulsory enlistment, relative advantages and disadvantages of each system. Rules of enlistment. Comparison between long and short service.

Reserves for the British army, army reserve, militia reserve, auxiliary forces. Military force of Great Britain.

Organization of the regular army, infantry, cavalry, artillery, engineers. Non-combatant branches. Commissariat and transport, ordnance store, pay, army medical and veterinary departments.

Pay and allowances, and a brief description of the accounts to be kept by the captain of a company.

Supply and transport in time of peace: rations, quarters, equipment, clothing, necessities.

Sketch of different military systems: the German Empire, France, Austria, Russia, Italy, United States, Canada, Switzerland.

Appointment and promotion of officers in different armies.

Organization and distribution of the staff of the British army. Staff belonging to different units. The Prussian general staff.

Office Work and method of conducting official correspondence.

Conditions and principles of supply in time of war.

Supply of ammunition in the field; expenditure in battle.

Equipment of infantry and cavalry.

Rations.—Amount of nutriment required, carbonaceous and nitrogenous properties of different kinds of diet, daily rations per man and horse, how carried and amount required by an army in the field.

Method of obtaining supplies of food and forage: by contract, by purchase, by requisitions, &c.

Billeting of troops, forage and ration depôts, railway depôts; the Prussian system of supply.

Military Transport.—Employment of inland water transport, such as navigable rivers, lakes, canals, and their comparison with railways. Use of railways in war, construction of military railways. Relative merits of transport by draught and by pack animals, also by human carriers. Requisites of a good military carriage, relative merits of two-wheeled and four-wheeled vehicles.

Traction engines.

Organization of military transport. "Regimental transport" of a battalion, regiment of cavalry and battery of artillery.

"Departmental transport" of an army corps. The Army Service Corps. Calculation of length of road occupied by military transport. Advantages of working "general transport" on the stage system.

Railways.—Their value and use for the conveyance of troops and stores; their influence on supply. Organization required for the working of railways. Administrative and executive staff. Number of trains that can be despatched in one day. Entraining and detraining troops; rate of travelling. Requirements of a railway station.

Arrangements for protecting and maintaining the *line of communications* of an army in the field.

Duties of the Inspector-General, road commandants, station commandants, &c. Force required for the defence of the line of communications.

Encampments.—Military and sanitary requirements. Principles for encampments. Spaces required by different units. Formations for encampments. Estimates of water supply required and watering arrangements. Bivouacs. Cantonments, area over which troops can be spread; calculation as to number of troops that can be cantoned in a town or district; arrangements for cantoning troops.

Marches.—Number of roads to be used by an army; rates of march; length of marches. Arrangements for a march. Order of march in proximity to and at a distance from the enemy. Length of column of route for British divisions and army corps. Calculations of space required. Considerations limiting the size of columns that can march on one road. Marching in "echelon." Framing orders for a march.

Embarkations and Disembarkations.—Transport and freight ships. Vessels, how chartered and by whom. Boards of Survey. Vessels most suitable for troops, capacity required; fittings and interior arrangements of transports. Calculations as to the number of men and horses a ship will accommodate. Operation of embarking troops and horses. Disembarkation in presence of an enemy, orders for. Selection of landing places.

MILITARY LAW.

Comparison between Military Law and Civil Law.

Martial Law contrasted with Military Law, when it may be proclaimed and by what authority.

Martial Law as applicable to officers and soldiers, to provinces during war, and to a whole community in time of rebellion. Lessons to be derived from the past, and opinions of eminent lawyers on the subject.

Brief historical summary of the Military Code in England.

Articles of War issued under the prerogative of the Crown.

Circumstances which led to the introduction of the first Mutiny Act.

Statutory Courts and Prerogative Courts.

Military Law as it concerns the Militia of Canada.

Short description of the Army Discipline Act.

Persons subject to Military Law.

Maintenance of good order and military discipline, chain of responsibility.

Course of procedure on commission of offence. Military custody.

Power of Commanding Officer, with remarks on the punishments he can award.

Provost Marshal.

Courts Martial.—Descriptions, warrants, convening, composition, jurisdiction, order for assembling.

Scale of punishments, when special punishments may be awarded and how combined.

Special application of the Act to Warrant Officers, N.-C. Officers and to persons not belonging to Her Majesty's forces.

Preliminaries to trial, framing an investigation of charges, warning the prisoner for trial.

Responsibilities, duties and privileges of persons attending courts.

Martial.—Witnesses, the Judge Advocate, prosecutor, prisoner, interpreter, the president and members.

Courts Martial.—Description of proceedings, regulations as to challenges, arraignment of prisoner, rules for addresses, examination of witnesses, the finding, sentence, &c. Confirmation, persons having authority to confirm. Duties and powers of confirming authority. Persons having power to alter the sentence after confirmation. Quashing proceedings. Disposal of proceedings.

Crimes.—Their classification and punishments for each. Crimes punishable only by Civil Law, with exceptions. Definitions of some legal terms with explanations.

Courts of Inquiry.—Royal Commissions, courts held under the Statute, ordinary courts. How assembled, duties of members, order of proceedings, powers, &c.

Evidence.—The general rules of evidence, *Res gestae*, presumptions of the law, presumptions drawn from the evidence, documentary and secondary evidence when admissible, &c., proof of handwriting, evidence as to character, confessions by prisoners, depositions, witnesses, number required, their competency, examination of witnesses. Form of proceedings of a general court martial, how recorded, &c. Form of proceedings of Courts of Inquiry and Boards.

Text books used:—

Military Administration, by Major Douglas Jones, R.A.

Regulations and Orders for the Militia of Canada.

Notes on Military Law, by Major Douglas Jones, R.A.

Books recommended and sources from which information may be obtained:—

The Armies of Europe and Asia, by General Upton.

Sir Garnet Wolseley's Soldiers' Pocket Book.

Queen's Regulations and Orders for the Army.

Army Discipline and Regulation Act.

Regulations and Instructions for Encampments.

Army Circulars and General Orders.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF COURSE OF INSTRUCTION IN TACTICS AND STRATEGY.

Total Marks.....3,500.

Second Class.

Total number of Marks (Obligatory).....1,500
Examinations.....1,400 }
Notes.....100 } 1,500

Meaning of "tactics" as distinguished from "strategy."

A short account of the changes that have taken place in tactics at various periods including tactics of the present day, as modified by the experience of recent wars and the introduction of modern weapons.

Tactical units of the different arms.

General functions and characteristics of the different arms.

Time and space occupied in marches and formations.

The principles of attack and defence.

The measures by which armies obtain security and information, whether at the halt or at the march:—

Outposts—Duties, posting, &c., by day and night, infantry and cavalry outposts, distance from main body, infantry and cavalry combined, employment of artillery.

Advanced guards—Infantry and cavalry, separately and combined, or of all arms.

Rear guards—Infantry and cavalry separately and combined, or of all arms.

Reconnaissance of the enemy—The various methods of effecting it, infantry and cavalry patrols, reconnoitering parties.

Screening and reconnoitering duties of cavalry in advance of an army.

Tactical employment of infantry in action, both in attack and defence.

Tactical employment of cavalry in action; cavalry attack; dismounted service of cavalry.

Tactical employment of artillery in action; the positions and objective of artillery in attack and defence.

Tactical employment of the three arms in combination:—in attack; in defence; in pursuit; in retreat.

Duties and responsibilities of the commander of a mixed force.

Marches.

Requirements of a good defensive position.

The occupation of ground.

Attack and defence of positions deliberately taken up.

Attack and defence of rivers, defiles, villages, woods, convoys.

The principles of tactics illustrated by the study of battles at different periods.

First Class.

Total number of marks (obligatory), examinations, 1,800; notes, 200; total, 2,000.

Offensive and defensive strategy; objects to be attained by strategic operations.

Difference between offensive and defensive war; advantages and disadvantages of each.

Base of operations; extent, description, effects of configuration and position; angular bases.

Selection of the objective, and theatre of operations.

Influence of good communications, such as good roads, navigable rivers, and railways, on military operations; also telegraphs.

Line of operations; disadvantages of several lines; independent lines; advantages of operating by several roads.

Combined armies operating from divergent bases, and armies operating on interior lines.

An army throwing itself across its adversary's communications.

Effects of an army operating on a front parallel to its line of communications.

Advantages of compelling an enemy to form front to a flank.

Employment of retarding forces.

Fortresses strategically considered.

Influence of obstacles, such as mountain ranges and rivers, on offensive and defensive operations, when their general direction is either parallel or perpendicular to the line of operations.

The science of strategy illustrated by the study of campaigns at different epochs.

Essays on military subjects.

Revision of course in military administration and law.

Total number of marks for examinations (obligatory), Military Administration, 600; Military Law, 400; total, 1,000.

Text-Books used:—

Clery's Minor Tactics.

Hamley's Operations of War.

Infantry Field Exercise.

Notes on Tactics, etc., by Major Douglas Jones, R. A.

Books recommended, and sources from which information may be obtained:—

Home's *Precis of Tactics*.

Boguslawski's *Campaigns of 1870-71*.

Great Campaigns in Europe, by Major C. Adams.

Journal of the Royal United Service Institution.

R.A. and R.E. Institution Papers.

Cavalry Regulations.

APPENDIX F 5.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF THE COURSE OF INSTRUCTION IN SURVEYING, MILITARY TOPOGRAPHY, RECONNAISSANCE, AND PRACTICAL ASTRONOMY.

Total marks.....6,000.

3rd Class—(Obligatory).

General principles of surveying. Scales generally used. Topographical conventional signs. Difference between deliberately made accurate surveys and rapid sketches for military purposes.

The chains in use, and method of making chain surveys, and keeping the field book. Ground problems relating to chain work. Finding curves.

Making and plotting a small chain survey.

Principles of triangulations. Traversing. Forms of field book used. Uses of the compass and sextant and their respective advantages. Defects of the compass, how obviated. Traversing with the chain and compass.

Making and plotting a triangulation with the sextant, and fitting in the details by the compass and pacing.

Different methods of representing slopes and hills. Use of contours. Scale of strata. The hand level and clinometer and their use.

Drawing a plate of conventional signs.

Copying machine plates.

Putting in contours on a survey.

Two examination surveys with the compass or sextant.

Marks given.....	{ Surveys and drawings.....	700
	{ Examinations.....	700
		1,400

2nd Class.—(Obligatory.)

Uses and adjustments of the theodolite and transit, triangulation and traversing with them. Forms of field book used. Plotting by meridians and by co-ordinates. Finding heights and distances.

Measuring a base and making a theodolite triangulation, calculating all the sides of the triangle, and plotting the survey. Filling up the details by the plane table. Rechainning a survey already made.

Principles of levelling. Corrections for curvation and refraction. The adjustments and uses of the dumpy and Y levels.

Making a theodolite and chain traverse combined with levelling.

Short lectures on railway surveying and laying out curves. Drawing from models in pencil and ink.

Making a sketch without instruments.

Surveying on ice, and in wooded countries.

General principles of Astronomy. Local time, latitude and longitude. The letters formed by signalling time. Taking altitudes with the large sextant and artificial horizon. Corrections to be applied to one altitude. Finding the latitude by a sextant or theodolite. meridian altitude of the sun or a star, especially the pole star. Working on angles. Finding the meridian by equal altitudes of a star.

Marks.....	{ Surveys and plates ..	800
	{ Examinations...	800
		1,600

RECONNAISSANCE.

General principles of reconnaissance. Its use in supplementing maps for military operations. Different kinds of reconnaissance.

Making a reconnaissance of a road.

Making a reconnaissance (in sections) of a defensive position.

Rapid reconnaissance of a piece of country.

Rapid reconnaissance of a road, with a military report on it.

Marks for reconnaissances..... 700

1st Class.—(Obligatory).

Reconnaissances of towns, camping grounds, points, rivers, hilly countries.

Making a careful reconnaissance of a defensive position, with a report on it.

Defending the same with a given force.

A reconnaissance of a camping ground.

One or two rapid reconnaissances of ground.

Combining reconnaissance plans made by different individuals.

Marks for reconnaissances.....800.

1st Class.—(Voluntary).

Adjustments and uses of the larger theodolites; further practice with the theodolite and level; use of the former in measuring bases and making sections; finding heights by the aneroid, barometer, and boiling point; calculating co-ordinates from a traverse.

The accurate measurement of base lines and triangulation on a large scale; compensation bars; various corrections to be made in triangulation for spherical excess, &c.; basis of verification; figures of the earth, how found; measurement of an arc of the meridian; convergence of meridians; laying out townships, &c.; calculation of probable errors.

Practical astronomy continued, its objects; different kinds of time; converting mean time into sidereal and *vice versa*; to find where a star will be on the meridian; finding the meridian by the greatest elongation of a circumpolar star; finding the local time and longitude by an altitude and calculated hour angle of a heavenly body; finding the variations of the compass by an amplitude and by an azimuth.

Interpolation by 1st and 2nd differences.

Description of the portable transit telescope; its uses in correcting the clock by transits; finding the latitude by transits of stars on the prime vertical and longitudes by moon; culminating stars; finding longitudes by lunars.

Marks for voluntary examinations.....1,500

APPENDIX F 6.

ROYAL MILITARY COLLEGE OF CANADA.

SYLLABUS OF THE COURSES OF GEOMETRICAL DRAWING AND DESCRIPTIVE GEOMETRY.

Total Marks—Geometrical Drawing, Obligatory, 600; Voluntary, 500. Descriptive Geometry, Obligatory, 400; Voluntary, 2,500.

The courses in Geometrical Drawing and Descriptive Geometry are divided into two parts, Obligatory and Voluntary.

Text-Books—For the Obligatory part of the courses, and for the Voluntary course in Geometrical Drawing no text-book is used; and its place is supplied by written notes. The text-book in use for the Voluntary course in Descriptive Geometry is "Practical Geometry and Engineering Drawing," by G. S. Clarke, Lieut. R.E.

Outline of Courses—Geometrical Drawing.—Only simple constructions are attempted in the Obligatory part of the course, those for the Voluntary part are more difficult. The course is throughout designed so as to teach ease, accuracy and neatness in drawing with instrument.

Descriptive Geometry.—The Obligatory course consists of such simple problems as are necessary for fortification. The Voluntary course contains that part of the remainder of the subject which is of a higher nature, such as is useful for Civil Engineering.

Method of Instruction.—The instruction is carried out by means of lectures and personal instruction. Fair notes will be compiled by each cadet from the lectures delivered for the Obligatory part of the courses, and for the Voluntary course in Geometrical Drawing. The lectures for the Voluntary course of Descriptive Geometry will be explanatory of the test-book, and occasionally additional matter will be given, of which fair notes will be made. The cadets will further be required to execute numerous plates and exercises.

The course of Geometrical Drawing (Obligatory and Voluntary) will be studied in the 4th class, and the Obligatory course of Descriptive Geometry during the first six months of the 3rd class. The Voluntary course of Descriptive Geometry will be commenced in the 3rd class and will be continued during the 2nd class.

The following is a detailed syllabus of the courses for each class (only fully detailed when no text-book is available for reference).

DETAILED SYLLABUS—IV CLASS—GEOMETRICAL DRAWING—(OBLIGATORY).

Subjects—General rules for the use of instruments, construction and use of ordinary, comparative and diagonal scales and verniers. Explanation of the problems contained in the plates.

Fair Notes—On the whole of the above subjects.

Plates—The following is a list of the plates :

I. Printing plate.

II. To bisect a finite straight line. To draw perpendiculars and parallels to a given straight line.

III. To bisect a given angle. To draw a straight line through a given point to the intersection of two given straight lines, this intersection being unattainable. To plot an angle by means of a table of chords. To plot an angle equal to a given angle. To divide a finite straight line into n equal parts.

IV. Ordinary scales.

V. Comparative scales

VI. Verniers.

VII. To draw a circle of given radius to pass through two points. To draw a circle to pass through three points. To inscribe a circle in a given triangle. To draw the segment of a circle, subtending a given chord, and containing a given angle.

VIII. To draw a tangent to a given circle. To draw a tangent to two given circles. To draw circles tangent to given straight lines, various conditions.

IX. To draw circles tangent to given circles, and straight lines, various conditions.

X. To find a fourth, third, or mean proportional to given finite straight lines. To divide a given finite straight line in extreme and mean ratio.

XI. To draw triangles from various given conditions. To reduce an irregular rectilinear figure to a triangle of equal area.

XII. To inscribe a square regular pentagon or hexagon in a given circle. To draw the same regular polygons given the length of side.

XIII. To inscribe a regular polygon of any number of sides in a given circle. To draw a regular polygon of any number of sides, given the length of side. To circumscribe a regular polygon of any number of sides about a given circle. To draw a figure similar to a given irregular figure, given the proportion between the sides.

XIV. To find $\sqrt{2}$, $\sqrt{3}$, etc., $\sqrt{\frac{1}{2}}$, $\sqrt{\frac{1}{3}}$, etc., of a given finite straight line. To draw rectilinear figures of given area.

XV. To draw an ellipse given the major and minor axis. To draw an ellipse given the conjugate diameters. To draw a tangent to an ellipse. To draw a normal to an ellipse.

Exercises.—Various exercises to teach use of instruments. Laying flat washes of colour.

Subjects for each examination, December.—From beginning up to plate VII. March.—From plate VIII to plate XV. June.—The whole course.

Marks—For work during term.....	260
“ “ “ “ For examinations, December.....	60
“ “ “ “ March.....	60
“ “ “ “ June.....	120

Total.....500

GEOMETRICAL DRAWING (VOLUNTARY).

Subjects. Explanation of the problems contained in the plates.

Fair Notes.—Of the above explanations.

Plates.—The following is a list of the plates:—

XVI. To draw a parabola. To draw a tangent to a parabola. To draw an hyperbola. To draw a tangent to an hyperbola.

XVII. To draw various loci.

XVIII. Copying a drawing.

XIX. “ “

XX. “ “

The drawings for Plates XVIII, XIX and XX will be principally parts of machinery, and will sometimes be colored.

Exercises.—Nil.

Subjects for each examination.—There will only be one examination, in June, and problems based on the obligatory and voluntary courses will be set.

Marks—For work during term.....	260
“ “ “ “ For examination, June.....	240
Total	500

III CLASS.—DESCRIPTIVE GEOMETRY.—(OBLIGATORY.)

Subjects.—Object of descriptive geometry. Necessity for some means of representing points, lines, planes, etc., lying in space on a plane sheet of paper. Explanation of the two methods of doing this, namely the two-plane and indice method. Reasons why indice method is more suitable for fortifications. (N.B.—The problems in the obligatory course will therefore be worked by the indice method.)

Definition of the following terms.—Plane of projection, projector, projecting plane of a straight line, ground line, projection of a point or a straight line, plan, elevation, end view, unit, index of a point, figured plan of a point or a straight line, horizontals of a plane and scale of slope of a plane, line of quickest descent, trace of a straight line, of a plane, contour projection of a plane angle, inclination of a straight line to a plane, dihedral angle contained by two planes, usual meaning of inclination of a straight line, inclination of a plane.

NOTATION.

Theorems of solid geometry required for the prosecution of the subject; stated only.

Proof of the following theorems and deductions therefrom:

I. The plan or elevation of any point must lie in a straight line, at right angles to the ground line.

II. The distance of the elevation of any point from the ground line is equal to the difference of level between the point and the horizontal plane containing the ground line.

III. The length of the projection of any finite straight line on any plane is equal to the length of the finite straight line multiplied by the cosine of the angle of inclination of the straight line to the plane.

Fundamental Problems—1 to 23.

1. To find the elevation of a point on any given ground line from its figured plane.

2. To find the elevation of a given straight line on any ground line. Corollaries: (a) To find the true length of a finite straight line. (b) To find the inclination of a given straight line.

3. To find the figured plan of a straight line given. (a) The angle of inclination. (b) The true length and the difference of level between two points.

4. To find the vertical trace of a plane on a ground line parallel to the scale of slope.

Corollary. To find the angle of inclination of a given plane.

5. To find the scale of slope of a plane of given inclination.

Points fulfilling conditions.

6. To find the conditions that a point may lie in a given straight line.
7. To find the conditions that a point may lie in a given plane.
8. To find the condition that a straight line may pass through a given point.
9. To find the conditions that a straight line may be parallel to a given straight line.
10. To find the conditions that a straight line may lie in a given plane.
11. To find the conditions that a straight line may be parallel to a given plane.
12. To find the conditions that a straight line may be perpendicular to a given straight line.
13. To find the conditions that a straight line may be perpendicular to a given plane.
14. To find the conditions that a straight line may pass through a given point and have a given inclination.

Planes fulfilling conditions.

15. To find the conditions that a plane may pass through a given point.
16. To find the conditions that a plane may pass through two given points or contain a given straight line.
17. To find the conditions that a plane may be parallel to a given plane.
18. To find the conditions that a plane may be parallel to a given straight line.
19. To find the conditions that a plane may be perpendicular to a given straight line.
20. To find the conditions that a plane may be perpendicular to a given plane.
21. To find the conditions that a plane passing through a given point may have a given inclination.

Principle of "constructing" or exhibiting plane figures in their true form :

22. By finding the true lengths of the sides and diagonals.
 23. By "turning down" into the horizontal plane.
- Combination of the above for the solution of the following problems: 24 to 43.
24. To determine a straight line of given inclination, lying in a given plane, also parallel to a given plane.
 25. To draw a straight line through a given point perpendicular to a given plane.
 26. To find a plane passing through three given points. Corollary. To find a plane passing through two intersecting straight lines.
 27. To find a plane of given inclination containing a given straight line, also parallel to a given straight line.
 28. To find a plane containing a given straight line, and perpendicular to a given plane.

Problems on intersections :

29. To ascertain whether two given lines intersect.
30. To find the intersection of two given planes.
31. To find the intersection of a straight line and a plane.

Problems on measurement :

32. To measure the angle contained by two intersecting straight lines.
33. To measure the angle of inclination of a straight line to a plane.
34. To measure the dihedral angle contained by two planes.
35. To measure the distance between two parallel straight lines.
36. To measure the distance between two parallel planes.

Problems relating to ground.

37. To find the plan of a road of given uniform inclination rising up the face of a hill.
38. To find the intersection of a straight line with ground given by its contours.
39. To find the intersection of a plane with ground given by its contours.
40. To determine a plane containing a given straight line and tangent to one hill.
41. To determine a plane containing a given point and tangent to two hills.
42. To determine the most commanding hill with reference to a given point.

43. To find the planes of defilade for a work.

(a) To be defiladed from one hill.

(b) To be defiladed from two hills.

Fair Notes—On the whole of the above subjects.

Plates—The following is a test of the plates :—

I. Problems, various.

II. Problems, various.

III. Contoured work.

IV. Problems relating to ground.

Exercises—Numerous problems to be drawn in pencil, a written explanation of process to be given.

Subjects for examination. December—From beginning to problem 36 inclusive.

March—the whole course. June—The whole course and revision of obligatory course of geometrical drawing.

	Marks.
For work during term.....	200
For examinations—	
December.....	50
March.....	50
June (100 GD+100 GD).....	200
Total.....	500

DESCRIPTIVE GEOMETRY—(VOLUNTARY.)

Subjects—Definitions of terms required by two-plane method. (Clarke, p. 13, 16 and 21.)

Notation. (Clarke, p. 13 and notes.)

Theorems. (Clarke, theorems 1 to 26.)

Fundamental problems—Adaption of the two-plane method to the fundamental problems given in obligatory course. The following additional problems will be adapted to both methods:—

44. To find the conditions that a straight line passing through a given point in a given straight line may make a given angle with this straight line.

45. To find the conditions that a straight line passing through a given point may make a given angle with a given plane.

46. To find the condition that a plane passing through a given point in a given straight line may have a given inclination to this straight line.

47. To find the condition that a plane may pass through a given point and make a given angle with a given plane.

48. To find the horizontal and vertical traces of a cone the position of whose axis is given. (This problem is required for the solution of problems 44 to 48.)

Application of the above problems to the solution of problems on straight lines and planes and the projection of plane figures. (Clarke, chapters II and III.)

Translation of Indices method into two-plane method and *vice versa*. (Notes.)

Fair Notes—Of such matter as is not given in the text-book.

Plates—The following is a list of the plates :

V. Problems relating to straight lines and planes.

VI. Problems relating to plane rectilinear figures.

VII. Problems relating to plane curved figures.

Exercises—Various problems worked out in pencil.

Subjects for each Examination.—There will only be one examination, in June, comprising the whole of the course.

	Marks.
For work during term.....	500
For examination, June.....	500
Total	1,000

DESCRIPTIVE GEOMETRY—2ND CLASS—(VOLUNTARY).

Subjects—Projection of Solids. (Clarke, chapter V.) Description of the most usual solids. Projection of solids in simple positions. Proof that whatever be the data the problem resolves itself into the following: To find the projections of a solid given the plane of one face and the position of an edge lying in that face; solution of this problem and hence: Projection of solids in any position. (Notes.) Projection of right cylinders and cones. (a) When the position of axis is given. (b) When the inclination of plane of base is given. Projection of helices on right cylinders and cones and hence projection of ordinary screws. Contouring a solid. (Note.)

Section of solids by planes. (Clarke, chapter VI.)

Interpenetration of solids. (Clarke, chapter VII.)

Development of surfaces. (Clarke, chapter VII.)

Tangent planes to surfaces such as spheres, cones, cylinders, surfaces of revolution. (Clarke, chapter VIII.)

Projection of curved surfaces tangent to each other. (Note.)

Determination of shadows. (Clarke, chapter IX.)

To determine which faces of a surface bounded by planes are in shadow and which in light. (Note.)

Isometric projection. (Clarke, chapter XI.)

Perspective projection—Definition and use.

Definition of the following terms: Object, vertex.

Plane of projection—To show that the perspective projection of any point can be obtained from its orthographic projections, and hence to obtain the perspective projection of any object in any position from its orthographic projections. Variation of the method in the special case where there are systems of parallel straight lines. Vanishing point. Comparison of this method with the ordinary method. (Notes.)

Fair Notes—Of such matter as is not contained in text-book.

Plates—The following is a list of the plates:

VIII. Interpenetration of solids.

IX. Shadows.

X. Isometric projection.

XI. Perspective projection.

Exercises—Various problems solved either by the Indice or two-plane method.

Subjects for each examination. December—Projection of solids. March—Section of solids by planes. Interpenetration of solids. Development of surfaces. June—The whole course of Descriptive Geometry.

	Marks.
For work during term.....	700
For examination—	
December	150
March.....	150
June.....	500
Total.....	1,500

APPENDIX F 7.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF INSTRUCTION IN FRENCH.

Total marks3,000.

4th Class.

Marks (Obligatory)500 { Examinations..... 200
Notes and Recitations..... 300

3rd Class.

Marks (Obligatory).....600 { Examinations..... 250
Notes and Recitations..... 350

2nd Class.

Marks (Obligatory).....800 { Examinations..... 350
Notes and Recitations..... 450

1st Class.

Marks (Obligatory).....1,100 { Examinations..... 500
Notes and Recitations..... 600

Grammar; reading; dictation; exercises for translation from French into English, and English into French; vocabularies and conversational lessons; comparison of the most usual French and English idioms.

The exercises are graduated in difficulty, according to the ability of cadets.

Special importance is attached to the acquisition at an early stage of the knowledge and correct pronunciation of the sentences, and most ordinarily employed in conversation.

A complete course of literature is also given for those who sufficiently understand the French language.

Text Books used:—

1. Contanseau's French Dictionary.
2. do Grammar.
3. French Classics, Gustave Masson.
4. Horace, Corneille.
5. Cinna do
6. Les Ecrivains Militaires de la France, Karcher.
7. Histoire de Charles XII par Voltaire.
8. Frederick the Great, by Lord Macaulay.
9. Le Page's "French Master for Beginners."
10. do "Petit lecteur des colleges."
11. do "Juvenile treasury of French conversation."

APPENDIX F 8.

ROYAL MILITARY COLLEGE OF CANADA.

SYLLABUS OF INSTRUCTION IN THE GERMAN LANGUAGE.

Total marks..... 3,000

4th Class.

Marks (Voluntary)..... 500 { Examinations..... 375
 Notes and Recitations. 125

3rd Class.

Marks (Voluntary)..... 600 { Examinations 450
 Notes and Recitations. 150

2nd Class.

Marks (Voluntary)..... 800 { Examinations..... 600
 Notes and Recitations. 200

1st Class.

Marks (Voluntary)..... 1,100 { Examinations..... 800
 Notes and Recitations. 300

Grammar; reading; exercises for translating from German into English;
 German conversation; the construction of German sentences; critical examination of
 the works read; lectures on the philological connection of the German language.

Text Books used:—

Otto's Conversational Grammar and Exercises.

Kramer's German Dictionary.

"Das Jahr, 1813," (Clarendon Series).

Schiller's Wilhelm Tell.

Goethe's Egmont.

APPENDIX F 9.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF INSTRUCTION IN CHEMISTRY.

Total marks..... 2,500

2nd Class—(Obligatory).

General Principles—Constitution of matter.
 Matter—Simple and compound.
 Elements and their classification.
 Solid, liquid and gaseous condition of matter.
 Relation of volume of a gas to temperature and pressure.
 Chemical affinity—Chemical combination and mechanical mixture—Solution.
 Laws of combination by weight and volume.
 Equivalent and Atomic numbers—Atomic theory.
 Chemical notation and nomenclature.

Use of Formulæ and Equations.

The Metalloids—Occurrence in nature. Modes of preparation.

Oxygen—Ozone. Anhydrides. Acids. Bases.

Hydrogen—Water. Analysis and Synthesis of Water. Molecular types.

Nitrogen—Atmosphere. Diffusion of gases.

Oxides of Nitrogen—Nitric Acid. Ammonia.

Carbon—Carbon Monoxide and Dioxide.

Silicon—Silicates. Bown. Glass.

Principal Hydrogen Compounds of Carbon.

Manufacture of Coal Gas. Nature of combustion. Structure of flame.

Oxidizing, reducing and illuminating effects of flame. Chemistry of Fuel.

Sulphur—Sulphurous Acid—Manufacture of Sulphuric Acid—Sulphuretted Hydrogen, &c.

Gunpowder—Chemistry of its manufacture and explosion—Preparation of ingredients. Gaseous products. Calculation of force of fired gunpowder.

Gun-cotton. Theory of Explosions. Nitro-glycerine. Fulminates.

Allotment of Marks in Chemistry:

2nd Class.

Notes and Recitations.....	Obligatory.
Examinations.....	100
	400

1st Class—(Voluntary).

Chlorine, Bromine and Iodine—Theory of Bleaching. Hydrochloric Acid.

Fluorine and Hydrofluoric Acid.

Phosphorus—Compounds with Oxygen and Hydrogen. Theory of Acids, Monobasic, dibasic and tribasic.

Metals—General characters—Occurrence in nature.

Alloys—Classification of Metals—Principal metallurgical processes.

General properties of Oxides, Hydrates, Sulphides, Chlorides, Carbonates, Sulphates, Nitrates, Silicates.

Potassium—Nitrate. Potassium Chlorate.

Sodium—Manufacture of Carbonate of Soda.

Barium, Strontium and Calcium Mortars, Cements—Gypsum.

Magnesium, Aluminium, Clay, Porcelain, Glass.

Iron—Cast iron, wrought iron and steel.

Manganese, cobalt, nickel, chromium.

Zinc, Cadmium, Lead, manufacture of White Lead.

Copper, Mercury. Amalgams. Tin, Arsenic, Antimony.

Silver, Gold, Platinum.

Principal compounds of metals, with iron metallic elements.

Metallic Salts—Theory of Salts.

Theory of Spectrum Analysis.

Principles of Organic Chemistry.

Classification of Organic Compounds, based upon the atomicity of carbon.

Text Book:—Bloxam's "Chemistry, Inorganic and Organic."

Practical Chemistry:—Qualitative Analysis. Use of the blow-pipe. Flame reactions. Analysis of gunpowder.

Text Book:—Bloxam's "Laboratory Teaching."

Allotment of Marks in Chemistry:

1st Class.

	Voluntary.
Notes and Recitations.....	200
Laboratory.....	600
Examinations.....	1,200

APPENDIX F 10.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF INSTRUCTION IN EXPERIMENTAL PHYSICS.

Total Marks..... 2,500

2nd Class.—Elementary Course.—Obligatory.

Constitution of matter. Physical condition of matter. Units of measurement. Metric system. Laws of motion. Atomic and molecular forces.

Varieties of energy; conservation of energy.

Undulations, sounds, vibrations of sounding bodies.

Temperature, expansion of solids, liquids and gases, by heat, changes of state and other effects of heat, conduction and connection, specific and latent heat, mechanical equivalent of heat.

Radiant energy, its nature and connection with other forms of energy, reflection and refraction of light, simple optical instruments, dispersion by prism, radiation and absorption of light.

Outlines of electricity and magnetism, development and measurement of electricity, electrical induction, electrical machines.

Magnetism, voltaic batteries, reciprocal action of magnets and currents, voltaic induction, effects of electric current.

Connection of different forms of energy.

Text Books:—Balfour Stewart's "Elementary Physics."

N.B.—The voluntary course embraces a more detailed course in the above subjects.

ALLOTMENT OF MARKS IN PHYSICS.

2nd Class.

	Obligatory.	Voluntary.
Notes and Recitations.....	200
Examinations.....	400	200

1st Class—(Obligatory).

General properties and physical conditions of matter. Theory of the constitution of matter. Gravitation, molecular and atomic forces.

Capillarity, endosmose, diffusion.

Properties of gases, atmosphere, barometers, elastic force of gases and its measurement, apparatus founded on the properties of air.

Sound.—Production, propagation and reflection of sound, measurement of vibrations, vibrations of stretched strings, columns of air, rods, plates and membranes.

Physical theory of music.

Heat.—Expansion of solids, liquids and gases; thermometers; changes of physical condition and attendant phenomena. Conduction, reflection, absorption and radiation of heat. Calorimetry. The steam engine. Theory of heat. Mechanical equivalent of heat.

Light.—Transmission, velocity and intensity of light, reflection and refraction of light, mirrors and lenses, optical instruments, the eyes.

Dispersion, achromatism, interference, polarisation, phosphorescence.

Magnetism.—The magnet and its properties. Terrestrial magnetism. The compass. Declination and inclination. Law of magnetic attractions and repulsions. Magnetisation.

Electricity.—Fundamental notions. Development of electricity. Quantitative laws of electrical action; potential and capacity. Induced electricity. Electrical machines. Condensation of electricity.

Voltaic Pile.—Detection and measurement of voltaic currents; effects of the currents. Electro-dynamics. Mutual action of currents. Magnetisation by currents. The telegraph. Voltaic induction. The electric light. Electrometallurgy. Thermo-electricity. Electric constants. Animal electricity. Outlines of Meteorology and Climatology.

Text Books:—Ganot's "Elementary Physics," (9th edition).

N.B.—The voluntary course embraces a more detailed study of the subjects above enumerated.

ALLOTMENT OF MARKS IN PHYSICS.

1st Class.

Obligatory. Voluntary.

Notes and Recitations.....	200
Examinations.....	800	800

APPENDIX F 11.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF INSTRUCTION IN GEOLOGY AND MINERALOGY.

Total marks.....1,000.

First Class—(Voluntary).

GEOLOGY.

General characteristics of the earth's features. Distribution of the land and water. System of atmospheric and oceanic movements.

Rock material of the globe. Constituent minerals of Rocks, structure and arrangement of Rock-masses.

Rocks, in order of their formation and contemporaneous events in Geological History. Floras. Faunas. Geographical progress. Progress of life.

Effect of Life on the earth's crust, of the Atmosphere, of Water, of Heat, Glaciers, Earthquakes, &c.

Practical Geology. Methods of investigation. Measurements. Use of Clinometer and Polariscopes.

Text Book:—Dana's Manual of Geology (third edition).

MINERALOGY.

First Class—(Voluntary).

General characteristics of Minerals.

Crystallization. Systems of Crystallization in detail. Cleavage. Dimorphism. Measurement of Angles. Crystalline Aggregates.

Physical and Chemical properties of Minerals. Action of acids, blowpipe, &c.

Classification of Minerals. Description of Minerals in detail. Ores. Chemical composition of Minerals.

Methods of determination of Minerals.

Text Books:—Dana's Manual of Mineralogy and Lithology (third edition).

Allotment of marks in Geology and Mineralogy.

First Class.

Voluntary.

Notes and Recitations.....	200
Examinations.....	800

APPENDIX F 12.

ROYAL MILITARY COLLEGE OF CANADA.

SUMMARY OF INSTRUCTIONS—FREEHAND DRAWING AND PAINTING.

Total Marks..... 3,500.

4TH CLASS—OBLIGATORY—300 MARKS.

Drawing from copies and objects.....	{ Examination, 100.
	{ Term work, 200.

3RD CLASS—OBLIGATORY—400 MARKS.

Drawing from copies and objects.....	{ Examination, 150.
	{ Term work, 250.

VOLUNTARY—100 MARKS.

Painting from copies, objects and nature..... Term work, 100.

2ND CLASS—OBLIGATORY—800 MARKS.

Drawing from copies, objects and nature.....	{ Examination, 100.
	{ Term work, 400.

Painting from copies.....	{ Examination, 50.
	{ Term work, 250.

VOLUNTARY—300 MARKS.

Drawing from copies, objects and nature..... Term work, 200.

Painting from copies, objects and nature..... Term work, 100.

1ST CLASS—OBLIGATORY—1,100 MARKS.

Drawing from objects and nature.....	{ Examination, 100.
	{ Term work, 500.

Painting from copies.....	{ Examination, 100.
	{ Term work, 400.

VOLUNTARY—500 MARKS.

Drawing from objects and nature..... Term work, 200.

Painting from objects and nature..... Term work, 300.

SYLLABUS OF FREEHAND DRAWING.—OBLIGATORY AND VOLUNTARY.

Grade 1.

Preliminary courses in linear perspective and architectural details.
 Freehand outline drawing from copies of ornament, objects and models.
 Freehand outline drawing from the "round" models, objects and ornament.
 Shading from flat examples or copies.
 Shading from the "round" or solid forms.
 Time sketching and sketching from memory.
 Drawing the human figure and animal forms from copies in outline.
 Drawing flowers, foliage and landscape details from nature.

Grade 2.

Studies of historic styles of ornament and applied design.
 Drawing in a given time the bones and muscles within the outline of the antique figure.

Drawing the human figure and animal forms from the "round."
 Painting from flat examples and from the cast in monochrome and colour.
 Painting direct from nature in water colour, flowers or still life, landscapes and views of buildings.

This grade to embrace a general knowledge of the principles and practice of Art, i.e., light and shade compositions, science of colour and principles of harmonious colouring.

Grade 3.

Painting the human figure or animals in water colour from copies and from nature.

Time studies from the living model.

Text Books used :—

Burchett's Perspective.

Bonomi's Proportions of the Human Figure.

Redgrave's Catechism on Colour.

Warren's Artistic Anatomy of the Human Figure.

do do of the Horse.

Merrifield's Manual of Light and Shade with reference to Model Drawing.

APPENDIX F 13.

ROYAL MILITARY COLLEGE OF CANADA.

CIVIL ENGINEERING.

SUMMARY OF COURSE OF INSTRUCTION AND ALLOTMENT OF MARKS.

Total Marks..... 5,400.

ENGINEERING AND ARCHITECTURAL.

Section I—Nature, Production and Use of Materials of Construction.

Marks 1,900.

SUB-SECTION A	Materials descriptive and processes	Marks	Examinations.....	400
B	Strength of Materials.....	Marks	{ Examinations.....	300
			{ Notes and Recit'ns...	200
C	Stresses on framed structures.....	Marks	{ Examinations.....	500
			{ Notes and Recit'ns...	500

Section II—Design and Execution of Structures.

Marks 1,900

SUB-SECTION A Field and office work relating to surveys and construction of railways and highways, including locations, drafting culverts, piers, trusses, &c.

Marks	{ Examinations.....	600
	{ Notes and Recit'ns....	400

SUB-SECTION B Construction routine, mason work, foundations, line excavations, and permanent way, common roads.

Marks	Examinations	900
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Section III—*Estimating.*

Marks 200

SUB-SECTION A Estimating, setting out and supervision of works.

Marks Examinations..... 200

Section IV—*Hydraulic Engineering.*

Marks..... 1,900.

SUB-SECTION A Storage, evaporations, flow through orifices and through pipes under pressure.

Marks Examinations..... 500

SUB-SECTION B Practical construction of water works.

Marks ... { Examinations..... 400
Drawings and Notes. 200Section V—*Mechanism and Prime Movers.*

Marks..... 300.

SUB-SECTION A Steam engines and water engines.

Marks Examinations..... 300

NOTE:—If a Cadet takes both the engineering and architectural courses, one-half only of the marks assigned to Section I (being common to engineering and architecture) will be counted to each subject.

CIVIL ENGINEERING COURSE.—TOTAL MARKS, 5,400.

Section I—Marks 1,900.

Nature, production and use of materials of construction (common to engineering and architecture).

(A)—*Materials, Descriptive, and Processes.*

Examination marks 400

Building Stones—Their classification, calcarious, silicious, argillaceous, sedimentary, igneous, metamorphic, sandstones, limestones, granites, slates, trap.
Durability of stone—Hardness of stone, ultimate crushing loads per square foot of brick and stone.

Production of artificial stone and brick.

Limes—Air limes, water limes, cements. Physical characteristics of hydraulic limestones; calcination of limestone; lime-kilns; farm fuel; slaking of lime; manufacture of artificial hydraulic limes and Portland cement and puzzolanas.

Mortar—Sand; manipulation; proportions. Setting and durability of mortars. Theory of the hardening of mortars. Testing lime or cement mortars.

Concrete, Beton—Ingredients; proportions; applications.

Wood—Structure of timber; pine wood.

Leaf woods; appearances of good timber.

Influence of climate and soil.

Age and season for felling.

Seasoning, natural and artificial.

Durability and decay and preservation.
Average ultimate crushing and tensile strength of woods.
Behaviour of timber under water.
Iron—Sources and classes of iron in general.
Impurities.
Cast iron. Source; processes.
Wrought iron. Source; processes.
Preservation of iron.
Crushing and tensile strength.

(B)—*Strength of Materials.*

Marks { Examinations 300
Notes and recitations.... 200

Strain; stress; working level; tests; set.
Factors of safety; modulus of elasticity.
Resistance to shearing; to distortion.
Resistance to compression and direct crushing.
Crushing by cross breaking.
Long pillars—Resistance to collapsing.
Action of a transverse load on a beam.
Shearing stress; bending moment.
Exercises in ditto.
Resistance of beams to cross breaking.
Exercises on moments of resistance.
Cross section of equal strength.
Modulus of rupture of cast iron beams.
Allowance for weight of beam.
Limiting length of beam.
Distribution of shearing stress in beams.
Deflection of beams.
Proportion of the greatest depth of a beam to the span.
Summary of the process of designing a beam.
Suddenly applied load; swiftly moving load.
Expansion and contraction of beams.
Beam fixed at both ends.
Beam fixed at one end.

(C)—*Determination of Stresses on Framed Structures.—(Bridges and Roofs.)*

Marks. { Examinations..... 500
Notes and recitations, 500

This course is begun by considering the internal strength of beams and pillars as referred to in the part B of the syllabus.

Resistance of a beam to crushing or buckling, Gordon's formula.

Practical problems for designing beams to support given loads when acting as pillars.

Formula for the sum of the moments of the fibres of a beam to resist bending.

Formula for the sum of the moments of the fibres of a beam to resist cross-bending.

Formula for the sum of the moments of the fibres of a beam to resist cross-bending with a given factor of safety.

Conditions of equilibrium of any rigid body acted on by a system of forces in space.

Conditions of equilibrium of any rigid body acted on by a system of forces, for a frame.

Rankine's theorem of the equilibrium of all the forces acting on one side of a section.

Expansion of this theorem so as to form a method of sections.

Dead loads, line loads, special loads, apex loads.

Effective reactions at the abutments.

Section to cut three bars.

Infinity to right or left for centre of moments.

Positive and negative rotations.

Kinds of stress—Red, towards the section; blue, from the section.

Stresses on the chords.

Stresses on the verticals.

Stresses on the diagonals.

Braces—Centre braces.

Definition of the Howe truss.

Separation into systems.

Determination in detail of the stresses on every member of the Howe truss.

Designing of a Howe truss.

Testing of a Howe truss.

Position of the rolling load to produce maximum stress on the main braces.

Position of the rolling load to produce maximum stress on the centres.

Position of the rolling load to produce maximum stress on the chords.

Definition, designing, testing and calculation of the Pratt truss in use (the

Whipple).

The Phoenixville truss.

Separation into systems.

Calculation of stresses on all members of the Phoenixville truss.

Towne's lattice truss and its defects.

Definition, designing and calculating and testing of the Warren girder.

The Fink truss.

The Bollman truss.

Practical specification for bridges of wood and iron.

Drafting various type forms of bridge trusses.

The tubular girder.

Other forms of bridge trusses.

Snow and wind pressure on bridges and roofs. Calculations of the Tay bridge.

Stresses on cranes.

CIVIL ENGINEERING COURSE—SECTION II.

Design and erection of structures—Marks, 1,900.

(A)—*Principles of Engineering, Field and Office Work as applied to Surveys and to construction of Railways and Common Roads.*

Marks..... { Examination, 600.
Notes and recitations, 400.

Engineering Explorations—Selections of Route.

Organization of staff.

Methods penetrating country.

Aerial explorations, air lines.

Traversers of roads and rivers.

Trial lines with compass and transit.

Topography, watersheds, summits.

Governing points, ruling gradients and courses.

Approximate estimates off the trial line.

Projected locations—from the trial line.

Profile and alignment, cross sections.

Grade contours, compiled profile.

Approximate quantities.

Actual locations—Tangents, curves, gradients.

Limit of accuracy desirable.

Reduction of quantities of work by successive improvements of a location.

Balancing the excavations and embankments.

Burrowing, wasting.

Engineering office work.

Plans, profiles, cross sections, estimate of quantities off the sections.

General drawings for structures.

Special drawing for each structure to suit local circumstances.

Estimate of gross cost.

Monthly measurements, estimates and returns.

The foregoing course of railway engineering is performed by the cadets in the field, by their running trial and location surveys, exactly the same as if they were in actual service, and the office work is performed in the same manner.

(B)—*Construction and Design in Wood, Stone, Earth, &c.*

Marks.....Examinations, 900.

Carpentry—Framing of wood-work, mortised, scarfed, halved, &c., joints.

Built up beams.

Brick-work—bond-string courses, chimneys mensuration.

Mason-work.

This comprises a full course of instruction on the specifications for the various classes of mason work used on the Government Railway Works of Canada, and is supplemented by excursions to inspect and explain existing railway structures on the Intercolonial or other railways.

Construction of the mason work of bridge piers and abutments, and culverts and cattle guards.

Designing the dimensions at base and top of piers and abutments, and the length of abutments and thickness of retaining walls.

Difference between "wing wall" abutments and "tower" abutments.

Methods of finding length of wing walls.

Methods of finding lengths of inclined or stream culverts on sloping or on level ground by the following methods:—1. Experimentally. 2. By analytical geometry. 3. Graphically.

Principles of economizing mason work in culverts, by reducing their lengths, by use of wing walls and coping, &c., &c.

Principles of economizing masonry in abutments by using cells and wells.

Foundations of structures.

General explanations of the nature of materials met with in forming foundations.

Principles governing the permanence of foundations, settling, scour, frost, springs, piling, platforms, concrete, sand piles, foundations under water.

Copper dams, caissons, pneumatic processes.

Designing and executing earth and rock excavations and embankments, tunnels, slopes, ditches, drainage, fencing snow.

Crib-work, rip-rap, stream diversions.

Railway permanent way, ballast, ties, rails, track laying, gauges, sidings, switches, stations.

Common roads or highways, surveys, gradients, cross section, line excavation, drainage, road bed, suitable materials for metalling, traction.

CIVIL ENGINEERING COURSE—SECTION III.

Estimating, setting out and supervision of Works—Marks for examinations, 200.

(A)—Construction and use of Tables of Excavation and Embankment.

Information necessary before estimate of quantities can be made for earth and rock excavation on a line of railway or canal.

Calculation of cubic contents of line cuttings and embankments by the method of mean heights and tables.

Calculation of do do by the method of prismoidal, formula and tables.

Calculation of do do by the method of mean arms.

Comparison of the advantages and disadvantages of these methods as regards accuracy in theory, and accuracy in practice, and time and labor of the computer.

Construction of tables, MacNeils.

do Canadian Pacific Railway.

Methods used on the Intercolonial Railway, the Canadian Pacific Railway, and the Quebec Government Railways for final estimates for contractors.

Setting out of Excavation and Culverts.

Measurement of line excavations, and borrow pits by level, rod and tape in the field, and degree of accuracy required setting in slope stakes, grade pegs, centre cuts and fills, gulleys, &c., &c.

Setting out position and lengths of level culverts in the field.

Setting out positions and lengths of inclined culverts in the field.

Four methods as shown in the preceding part of this syllabus.

Limit of the safe inclination of a culvert.

Paving to be a few inches below the original level of stream.

Guaging freshet areas, ice marks of floods.

Discharge capacities of various types of culverts.

Precautions with the foundations.

Frost level, springs, scour, wing walls, artificial foundations, &c., &c.

Methods of economising masonry in culverts by reducing length by means of wing walls, coping, &c., &c.

Estimating Quantities of Masonry and Paving.

In abutments, piers, and culverts off the drawings.

Tabular form for culvert quantities.

General Form for Estimates of Quantities from a Railway Profile

Allowance for shrinkage, balancing, excavation and embankment level, waste, borrowing.

Details of items.

do prices.

Various methods of letting contracts.

Schedule of prices for limit of work.

Lump sum.

Comparison and history of these methods.

CIVIL ENGINEERING COURSE—SECTION IV.

Hydraulic EngineeringMarks, 1,100.

(A)—Water Supply; Storage Evaporations, Flow through Orifices and through Pipes under Pressure.

Marks—Examinations, 500.

INTRODUCTION:—Necessity of Public Water Supplies; Physiological Office of Water; Sanitary Office of Water Supply.

Consumption.

Quantity of water required.

Statistics of consumption.

Ancient cities; European cities; American cities.

Increasing consumption.

Relations of supply *per capita* to total population.

Monthly and hourly variations in the draught.

Ratio of monthly consumption.

Reserve for fire purposes.

Rainfall.

The liquid and gaseous successions.

General rainfall statistics.

Climatic effects—sections of maximum rainfall.

American western rain system.

American central rain system.

American eastern coast rain system.

Influence of elevation or precipitation.

River basin rains.

Grouped rainfall statistics.

Monthly fluctuations of rainfall.

Secular do do

Local physical influences.

Uniform effects of natural laws.

Great rainfalls.

Maximum ratios of floods to rainfalls.

Volume of water from given rainfalls.

Guaging rainfalls.

Flow of Stream.

Flood volumes inversely as the areas of basins.

Formulas for flood volumes.

Tables of do

Seasons of floods.

Influence of absorption and evaporation upon flow.

Flow in seasons of minimum rainfall.

Summaries of monthly flow statistics.

Minimum mean and flood flow of streams.

Ratios of monthly flow of streams.

Mean annual flow of streams.

Tables of flow, equivalent to given depths of rain.

Storage and Evaporation.

Artificial storage.

Losses incident to storage.