Prva gimnazija Varaždin
International Baccalaureate Diploma Programme

Sshool Year 2014/2015

CURRICULUM

CONTENT:

IB mission statement

The International Baccalaureate aims to develop inquiring, knowledgable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect.
These programme encourage students across the world to become active, compassionate and lifelong learners who understand that other people, with their differences, can also be right.

IB Curricular Model

Subjects offered by the School

GROUP	SUBJECT	LEVEL	TEACHER	GENERATION
1. Studies in Language and Literature	Croatian A Literature	HL/SL	Bojana Barlek Miljenka Štimec	4.IB 3.IB
2. Language Acquisition	English B	HL/S	Irena Kocijan Pevec Ivica Cikač	4.IB 3.IB
	German B	HL/SL	Jadranka Šemiga	4.IB/3.IB
3. Individuals and Societies	B&M	HL/SL	Kristina Oršić Manojlović	4.IB/3.IB
	Geography	HL/SL	Kruno Rukelj	4.IB/3.IB
	History	HL/SL	Ivan Lajnvaš Ivan Lončar	4.IB 3.IB
4. Sciences	Biology	HL/SL	Vinka Sambolec Škerbić Martina Vidović	4.IB 3.IB
	Chemistry	HL/SL	Tihana Čus	4.IB/3.IB
	Physics	HL/SL	Dinko Meštrović	4.IB/3.IB
	Comp. Sci.	HL/SL	Bojan Banić	4.IB/3.IB
5. Mathematics	Mathematics	HL	Stanko Husak	3.IB
	Mathematics	SL	Milada Erhatić	4.IB/3.IB
6. The Arts	Visual Arts	HL/SL	Ksenija Kipke	4.IB/3.IB
TOK			Dražen Dragović	4.IB/3.IB
CAS			Sanja Hajdin	4.IB/3.IB

IB DP
School Year 2014/2015
GENERAL PLAN

CONTENT:

- **Students**
- **Teachers; Workshops**
- **IB Comunity**
- **School Comunity**
- **Field Trips, Field Works**
- **TOK Coordination**
- **CAS Coordination**

STUDENTS

- **We have 26 IB students enroled in the Diploma Programme for current School year. 14 in the final year (4.IB), and 12 in the First year (3.IB).**
- **Students will be provided with University Counseling (Coordinator), will cooperate in IB DP promotional events (for new students), will be an important part in all IB activities in our school.**
- **We are planning to organise Alumni organisation of our graduates, and encourage present ones to join the international IB Alumni organisation.**
- **We are planing to deliver a School document, *Student's Handbook*, according to recognised need for such a publication.**
- **Students are strongly advised to cooperate in all school and comunity activities according to IB DP best practise.**
- **Students are strongly advised to follow standards of IB DP based on *Learner's Profile*, and *Academic Honesty* documents.**

TEACHERS

- **There are 19 IB DP Teachers in the School, providing 12 optional, and 3 core programmes (12 subjects, TOK, CAS, EE).**
- **Teachers are strongly advised to act and teach according to IB DP standards and practise documents, subject's guides and others, in order to be *Row models* for their students.**
- **We are (and hopefully be in the future), up to dating profesional development of IB DP teachers.**
- **This year we are planning several Workshops and seminars:**

CHEMISTRY Cat.1 (new teacher to the programme), October 2014
IB Conference Rome (Coordinator), October 2014
CAS Cat.1 (new teacher to the programe, new programe), spring 2015
History SSS (new programe), spring 2015
Biology Cat.2 (new programe), till the end of the school year.
IB Coordinator Cat.3, till the end of the school year.
IB COMUNITY

- **We are planning to achieve more contacts to other IB Schools.**

- **We will encourage more teachers to join other IBO activities such as becomming IB DP Examiners, to apply for Curriculum revues, Examining monitoring and others.**
- **Generaly we would like to develop in more internationaly minded school, with more contacts, international projects, through practise and skills benefitting both teachers and students, comunity aswell.**
- **We will encourage students to participate in special IB or internationaly organised programes and projects, summer schools, workshops etc.**

SCHOOL COMUNITY

- **We did, and we will in the future, join and cooperate in all School projects and activities.**
- **We believe that the differences between national and IB programme may enrich all participants in such events, benefiting school and teaching practise of all teachers.**

FIELD TRIPS/FIELD WORKS

- **Teachers and students will provide Field Works according to subject syllabuses.**
- **Project 4 (Science group), will be provided during first Weekend in June.**
- **We are planning to provide the Field Trip for all IB DP students, based on all subject fields, according to specific organisation of all teachers/students, ones in the School Year (April or August).**

TOK COORDINATION

- **For the first time this school year we are introducing the newly organised TOK Coordination activities.**
- **General idea was to organise monthly discusions on some actual, international topics.**
- **Topics are thought to be complex enough to enable both students and teachers to approach to the problem from more diferent perspectives in order to learn defferences and more than one possibilities in problem solving skills.**
- **The aim of such discusions would be, ammong others, to become aware (of the problem), to learn to respect (differences), to respond (activly participate) to any kind of challenge (academic, social, personal).**
- **We would like to understand how humanities interact with sciences, what impact (if) does it have on society (historical events, politics, religion), and ofcourse, why ?**

CAS COORDINATION

- **We will continue in providing this programe, but planning to introduce more inovative approach in practise.**
- **Some new projects are created to fit in IB CAS demands.**
- **Generaly, we are going to base CAS activities more on our own projects rather than just join other organisation's needs.**

IB DP Coordinator, Ksenija Kipke

TOK Coordination plan - LET'S TALK TOK

Rough explanation of monthly meetings "Let's Talk TOK"
Grade A
Pertinent knowledge issues are explored thoroughly and linked effectively to areas of knowledge and/ or ways of knowing. There is strong evidence of a personal exploration of knowledge issues, including consideration of different perspectives. Arguments are clearly developed and well supported by effective concrete examples; counterclaims and implications are explored
(GRADE DESCRIPTORS For use from September 2014/January 2015)

Grade A descriptor is put above for teachers to see what should we have in focus discussing in the meeting *Let's Talk TOK* as a final goal, no matter what the exact title or topic might be.
For more precise description, please read my reduced version of TOK syllabus and for any questions you may ask me personally or via e-mail. You can ask for the TOK syllabus IB Coordinator or contact me via e-mail *drazendragovic@gmail.com*.

TOPICS FOR THE DISCUSSION AMONG SUBJECTS TEACHERS ,TOK TEACHER AND IB STUDENTS

***Topic 1*. "Context is all" Discuss it considering at least two areas of knowledge.**

***Topic 2*. Can we know nature of reality?**

***Topic 3*. War**

***Topic 4*. In "global village" where media rule, how can we know are we really free to choose?**

***Topic* 5. What is relationship between language and truth?**

***Topic 6*. Paradox of starvation and obesity in dehumanized world.**

***Topic 7*. To what extent can emotions act as a reliable source of evidence? Consider this in the arts and one other area of knowledge.**

*** * ***

Aim:
To improve understanding of TOK as a core IB subject both for the students and the teachers to incorporate knowledge questions into subjects they teach. Some students are struggling with examples in their TOK essays and TOK presentations, so it might be a great opportunity to be inspired by some ideas useful for the purpose.
Topics suggested are not a mentioned to be strictly followed if some teachers have better ideas fulfilling the purpose.
The form may be lecturing with discussion afterwards; a short documentary or video as

support of the topic may be included; the form generally is not important as long as the purpose of clearing up mentioned elements is followed.

I would like to encourage teachers to involve into the meetings and not to bother much about TOK as a subject, but simply to concentrate on the question "How do we know?" inside the area of a subject they teach. I sincerely believe the upcoming meetings can enrich us as co-teachers dealing with demanding, but adventurous way of critical thinking thus being the role model for our students.

Suggested timetable: twice a month, for instance every second Thursday for hour and a half in the evening.

TOK Coordinator, Dražen Dragović

CAS Coordination plan

Creativity Action Service (CAS) Syllabus

***School year:* 2014/2015**
***CAS coordinator:* Sanja Hajdin, professor of philosophy and religion**

Creativity, action, service involves students in experiential learning through a range of artistic, sporting, physical and service activities.

***Creativity* – arts, and other experiences that involve creative thinking.**
***Action* – physical exertion contributing to a healthy lifestyle, complementing academic work elsewhere in the Diploma Programme.**
***Service* – an unpaid and voluntary exchange that has a learning benefit for the student. The rights, dignity and autonomy of all those involved are respected.**

A CAS programme should be both challenging and enjoyable, a personal journey of self‑ discovery. It should involve:

- **real, purposeful activities, with significant outcomes**
- **personal challenge—tasks must extend the student and be achievable in scope**
- **thoughtful consideration, such as planning, reviewing progress, reporting**
- **reflection on outcomes and personal learning.**

CAS activities should continue on a regular basis for as long as possible throughout the programme, and certainly for at least 18 months.

The CAS programme aims to develop students who are:

- **reflective thinkers—they understand their own strengths and limitations, identify goals and devise strategies for personal growth**
- **willing to accept new challenges and new roles**
- **aware of themselves as members of communities with responsibilities towards each other and the environment**
- **active participants in sustained, collaborative projects**
- **balanced—they enjoy and find significance in a range of activities involving intellectual, physical, creative and emotional experiences.**

Learning outcomes

Learning outcomes are differentiated from assessment objectives because they are not rated on a scale. The completion decision for the school in relation to each student is, simply, "Have these outcomes been achieved?"

As a result of their CAS experience as a whole, including their reflections, there should be evidence that students have:

1. **increased their awareness of their own strengths and areas for growth**

They are able to see themselves as individuals with various skills and abilities, some more developed than others, and understand that they can make choices about how they wish to move forward.

2. **undertaken new challenges**

A new challenge may be an unfamiliar activity, or an extension to an existing one.

3. **planned and initiated activities**

Planning and initiation will often be in collaboration with others. It can be shown in activities that are part of larger projects, for example, ongoing school activities in the local community, as well as in small student‐ led activities.

4. **worked collaboratively with others**

Collaboration can be shown in many different activities, such as team sports, playing music in a band, or helping in a kindergarten. At least one project, involving collaboration and the integration of at least two of creativity, action and service, is required.

5. **shown perseverance and commitment in their activities**

At a minimum, this implies attending regularly and accepting a share of the responsibility for dealing with problems that arise in the course of activities.

6. **engaged with issues of global importance**

Students may be involved in international projects but there are many global issues that can be acted upon locally or nationally (for example, environmental concerns, caring for the elderly).

7. **considered the ethical implications of their actions**

Ethical decisions arise in almost any CAS activity (for example, on the sports field, in musical composition, in relationships with others involved in service activities). Evidence of thinking about ethical issues can be shown in various ways, including journal entries and conversations with CAS advisers.

8. **developed new skills**

As with new challenges, new skills may be shown in activities that the student has not previously undertaken, or in increased expertise in an established area.

All eight outcomes must be present for a student to complete the CAS requirement. Some may be demonstrated many times, in a variety of activities, but completion requires only that there is some evidence for every outcome. This focus on learning outcomes emphasizes that it is the quality of a CAS activity (its contribution to the student's development) that is of most importance. The guideline for the minimum amount of CAS activity is approximately the equivalent of half a day per school week (three to four hours per week), or approximately 150 hours in total, with a reasonable balance between creativity, action and service. "Hour counting", however, is not encouraged.

Coordinators must notify the IB office whether or not candidates have completed their CAS programme by completing the appropriate electronic form on IBIS by 1 June/1 December in the diploma year.

CAS Coordinator, Sanja Hajdin

Prva gimnazija Varaždin – International Baccalaureate Diploma Programme

CALENDAR
School year 2014. /2015.
4. IB
Session May 2015.

GENERAL	
School year start	September 8. 2014
School year end	April 24. 2015
First term	Sept. 8. – Dec. 23. 2014. (15 weeks)
Second term	Jan. 12. – Apr. 24. (14 weeks)
Winter holidays	Dec. 24. – Jan. 9.
Spring holidays	March 30. – April 6.
First term finals (Exam Week)	Dec. 8. – 13. 2014
Mock Exam	Mar. 16. – 21. 2015
Final Exams	May 4. – 22. 2015

EVENT/ACTION/ SUBMISSION	INTERNAL DEADLINE	WHO/ RESPONSIBILITY	FORM/ METHOD
SEPTEMBER			
Project 4, 4.IB	Sept. 3.-5.	Group4 Teachers Students	Field Trip
Annual Fee	Sept.	Account./Coord.	Bank transfer
TOK Topics	Sept. 1.	TOK Coord.	OCC
First term start	Sept. 8	All	
Parents meeting	Mid Sept.	Homeroom/Coord.	
IB teachers meeting	Mid Sept.	Coord./Teachers	
EE first draft	End Sept.	Teachers	
OCTOBER			
TOK first draft	Oct. 31.	TOK Coord.	
CAS first check up	Oct. 31.	CAS Coord.	
Final exams registration	Oct.	Coord.	IBIS
Application to foreign Universities start	Oct.	Students/Coord.	
NOVEMBER			
Exam November2014(Retake) -Mathematics HL	Nov.12. p1 Nov.13. p2, p3	Coord./Teachers	
Aplication to foreign	Nov. on	Coord./Students	

Universities continuum			
Parents Meeting	**Mid. Nov.**	**Homeroom/Coord.**	
TOK second draft	**Nov. 30.**	**TOK Coord.**	
EE second draft	**Nov. 30**	**Teachers**	
Croatian A advance notice of works studies	**Nov. 30.**	**Cro.Teacher/Coord.**	**IBIS**
DECEMBER			
Exam Fee	**Dec. 15.**	**Account./Coord.**	**Bank transfer**
Exam Week	**Dec. 8.-13.**	**Coord./Teachers**	
CAS second check up	**Mid. Dec.**	**CAS Coord.**	
JANUARY			
November2014 Exam results	**Jan. 5.**	**Coord.**	**IBIS**
TOK final essay	**Jan. 15.**	**TOK Coord.**	
EE final	**Jan. 15**	**Teachers**	
Croatian A WA	**End. Jan.**	**Cro.Teacher**	
Language B WA	**End. Jan.**	**Lang. Teachers**	
FEBRUARY			
Croatian A Oral recording	**Mid. Feb.**	**Cro. Teacher**	
Language B Oral recording	**End. Feb.**	**Lang. Teachers**	
Parents Meeting	**Mid. Feb.**	**Homeroom/Coord.**	
Promo/parents meetings	**Feb.**	**Coord.**	
MARCH			
TOK submission/upload	**Till Mar. 1.**	**Students**	**IBIS**
	Till Mar. 5.	**TOK Coord.**	**IBIS**
	Till Mar. 10.	**Coordinator**	**IBIS**
EE submission	**Till Mar. 1.**	**Coord.**	**Courier**
WA submission	**Till Mar. 1.**	**Coord.**	**Courier**
VA Exam recording	**Mid. Mar.**	**VA Teacher**	
MOCK EXAM	**Mar. 16.-21.**	**Coord./Teachers**	
APRIL			
IA PG deadline	**Apr. 1.**	**Teachers**	**IBIS**
	Apr. 10.	**Coordinator**	**IBIS**
VA upload all materials	**Apr. 10.**	**VA Teacher**	**IBIS**
IA materials submission	**Apr. 1.**	**TeachersCoord.**	**Courier**
Parents Meeting	**Till Apr. 25.**	**Homeroom/Coord.**	
Field Trip, Field Work	**Apr. last week**	**Teachers/Coordinations**	**optional**
MAY			
FINAL EXAMS	**May 4.-22.**	**Coord./Teachers**	

CAS diaries submission	**May 25.**	**CAS Coord./Coord.**	**IBIS**
JUNE			
Return all materials to school (Textbooks, Notebooks, Calculators), check payments.	**June**	**Students**	
JULY			
May 2015 Exam results	**July 5.**	**Coord.**	**IBIS**
AUGUST			
IB Diplomas	**Aug. 20.**	**Coord.**	**Courier**

SUBJECT	**INTERNAL DEADLINES**		
	First draft/check up	**Sec.draft/check up**	**Final submission**
TOK	**End Oct.**	**End Nov.**	**Jan. 15.**
EE	**End. Sept.**	**End Nov.**	**Jan. 15.**
CAS	**End Oct.**	**Mid. Dec.**	**May 25.**
EA (WA,EE,TOK)			**March 1.**
IA (all subjects)			**April 1.**
PG (all subjects)			**April 1.**

CAS Coordination

School Year	**Continual check ups**	**To be finish at the end of first term**
Final	**Finished CAS Diaries**	**May 25.**

TOK Coordination

School year	**Monthly topics discussion**	**Teachers&Students compulsory participation**
Final	**Min. 3 sessions**	**End April**

FIELD WORKS, FIELD TRIPS activities

School year	**According to subject needs**	
Final	**Optional**	

Prva gimnazija Varaždin – International Baccalaureate Diploma Programe

CALENDAR
School year 2014./2015.
3. IB
Session May 2016.

GENERAL	
School year start	September 8. 2014
School year end	June 16. 2015
First term	Sept. 8. – Dec. 23. 2014 (15 weeks)
Second term	Jan. 12. – June 16. (21weeks)
Winter holidays	Dec. 24. 2014 – Jan. 9. 2015
Spring holidays	March 30. – April 3. 2015
First term finals (Exam Week)	Dec. 8. – 13. 2014
Second term finals (Exam Week)	May 25. – 30. 2015

EVENT/ACTION/ SUBMISSION	INTERNAL DEADLINE	WHO/ RESPONSIBILITY	FORM/ METHOD
SEPTEMBER			
Sshool year start	Sept. 8.	Homeroom teacher	
General instructions	Sept.	Coord./Homeroom. /Teachers	
Parent meeting	Mid. Sept.	Coord./Homeroom	
Textbooks, equipment acquisition	Sept.	Homeroom/Coord.	
OCTOBER			
General instructions on EE		Coord./Homeroom./ Teachers	
NOVEMBER			
CAS diary first check up	End Nov.	CAS Coord.	
Parents meeting	End Nov.	Homeroom/Coord	
General instructions on EE	End Nov.	Coordinator	
DECEMBER			
Exam Week	Dec. 8.-13.	Coord./Teachers	
CAS diary check up	Dec. 20.	CAS Coord.	
First term end - report	Dec. 23	Homeroom	

JANUARY			
Second term start	**Jan. 12**		
FEBRUARY			
Parents Meeting	**End Feb.**	**Homeroom/Coord.**	
CAS Diary check up	**End. Feb.**	**CAS Coord.**	
MARCH			
CAS diary check up		**CAS Coord.**	
EE acquisition process start	**March**	**Teachers/Students**	
Spring holidays start	**Mar. 30.**		
APRIL			
Back to school	**Apr. 7.**		
EE acquisition continuum	**April**	**Coord./Teachers /Students**	
CAS Diary Second draft	**Apr. 23.**	**CAS Coord.**	
Field trip, Field work	**April last week**	**Coord./teachers /students**	
MAY			
Exam Week	**May 25.-30.**	**Coord./Teachers**	
EE subject/topics registration	**Mid. May**	**Coord./Teachers**	
Parents meeting	**Mid. May**	**Homeroom/Coord.**	
JUNE			
IA (all groups) report/outlines	**Jun. 10.**	**Teachers**	
EE outlines/first draft	**Jun. 10.**	**Teachers**	
WA Croatian A first draft	**Jun. 10**	**Cro. Teacher**	
CAS diaries report	**Jun. 10.**	**CAS Coordinator**	
Project 4	**Jun. 4. – 6.**	**Coord./Teachers**	
Second term end	**Jun. 16.**		

CAS Coordination

School year	**Continual monthly consultations&check ups**	**First draft – End Nov. Second draft – Apr. 23. Final – Jun. 6.**
Final	**2/3 of the total (two years period) finished**	**Jun. 6**

TOK Coordination

School year	**Monthly Topics discussion**	**Teachers&Students compulsory participation**

Final	**Min. 5 sessions**	**Jun. 10.**

FIELD WORKS, FIELD TRIPS activities

School year	**-According to subject needs** **-Project 4 (Science group 4)** **-Field Trip (All)**	**Coordinators, Teachers, Students** **Compulsory participation**
Final	**Compulsory**	**End of School year (August 31. 2015)**

IB DP
MAY 2015
FINAL EXAMINATION SCHEDULE

DATE	MORNING	TIME	AFTERNOON	TIME
Monday 4 May	English B Paper1	1h30m		
Tuesday 5 May			English B Paper2	1h30m
Wednesday 6 May	Biology HL Paper1 Paper2 Biology SL Paper1 Paper2	 1h 2h15m 45m 1h15m		
Thursday 7 May			Biology HL Paper3 Biology SL Paper3	 1h15m 1h
Friday 8 May	Physics HL Paper1 Paper2	 1h 2h15m	Croatian A HL Paper1 Croatian A SL Paper1	 2h 1h30m
Monday 11 May	Croatian A HL Paper2 Croatian A SL Paper2	 2h 1h30m	Physics HL Paper3	 1h15m
Tuesday 12 May	Mathematics SL Paper1	 1h30m		
Wednesday 13 May			Mathematics SL Paper2	 1h30m
Thursday 14 May	History HL/SL Paper1	 1h	Chemistry HL Paper1 Paper2 Chemistry SL Paper1 Paper2	 1h 2h15m 45m 1h15m
Friday 15 May	Chemistry HL Paper3 Chemistry SL Paper3	 1h15m 1h	History HL/SL Paper2	 1h30m
Monday 18 May	History HL Paper3	 2h30m	German B HL Paper1	1h30m

			German B SL Paper1	 1h30m
Tuesday 19 May			Comp.Sci. HL Paper1 Comp.Sci SL Paper1 Geography HL/SL Paper1	 2h10m 1h30m 1h30m
Wednesday 20 May	Comp.Sci. HL Paper2 Paper3 Comp.Sci. SL Paper2 Geography HL Paper2 Paper3 Geography SL Paper2	 1h20m 1h 1h 2h 1h 1h20m	B&M HL Paper1 B&M SL Paper1	 2h15m 1h15m
Thursday 21 May	B&M HL Paper2 B&M SL Paper2	 2h15m 1h45m		
Friday 22 May			German B HL Paper2 German B SL Paper2	 1h30m 1h30m

IB DP
NOVEMBER 2014
EXAMINATION SCHEDULE (RETAKE)

DATE	MORNING	TIME	AFTERNOON	TIME
Wednesday 12 Nov.			Mathematics HL Paper1	 2h
Thursday 13 Nov.	Mathematics HL Paper2	 2h	Mathematics HL Paper3	 1h

FIRST TERM FINALS (Exam Week)

- **December 8 – 13 2014**

MOCK EXAM

- **March 16 – 21 2015**

SECOND TERM FINALS (Exam Week 3IB)

- **May 25 – 30 2015**

SYLLABUSES

HRVATSKI JEZIK – CROATIAN A LITERATURE – HL I SL (Miljenka Štimec i Bojana Barlek)

Ciljevi programa: upoznati učenike s djelima različitih književnih razdoblje, stilova i vrsta; razviti sposobnost detaljne analize i interpretacije tekst, razviti učeničke sposobnosti usmenog i pismenog izražavanja, prepoznavanje važnosti konteksta u kojem je djelo napisano, promicati uvažavanje različitih perspektiva, potaknuti učenike na uočavanje estetskih vrijednosti književnog teksta, promicati cjeloživotno zanimanje za jezik i književnost. Važno je također uočavanje i razumijevanje književnih postupaka te razvijenje neovisnih sudova i argumenata o književnom djelu.

Part 1 *Works in translation* - djela iz svjetske književnosti (3 HL, 2 SL)
- **različiti autori, važnost kultorološkog konteksta**
- **književni esej od 1200 do 1500 riječi i osvrt na diskusiju**

Part 2 *Detailed Study* – detaljna analiza i interpretacija – (3 HL, 2 SL)
- **različite književne vrste: roman, novela, drama, poezija – obavezno za HL**
- **hrvatski autori**
- **usmeni komentar ulomka teksta ili pjesme (usmena diskusija HL)**

Part 3 *Literary Genres* – književna vrsta (poezija, novela, roman ili drama – (4 HL, 3 SL)
- **uočavanje žanrovskih konvencija, osobitosti pojedine književne vrste**
- **hrvatski autori**
- ***paper 2* – vanjsko ocjenjivanje, komparativni esej na zadano pitanje**

Part 4 *Options* – slobodni odabir djela (3 HL i SL)
- **usmena prezentacija**

Djela se odabiru iz popisa svjetskih i hrvatskih autora i djela koje objavljuje IBO.

Ocjenjivanje

***External Assessment* 70% - 4 sata** ***Paper 1* (2 sata) – *Literary commentary* – interpretacija nepoznatog teksta (2 odlomka; poezija ili proza) – 20%** ***Paper 2* (2 sata) – komparativni esej na temelju djela iz odjeljka 3 – 25%** ***Written assignment* – esej na temelju jednog djela iz odjeljka 1 25%** - ***reflective statement* – osvrt – 300 do 400 riječi** - **književni esej – 1200 – 1500 riječi** ***Internal Assessment* – 30%** **Učenici moraju obaviti usmeni dio ispita koji ocjenjuje professor, a moderiraju ga vanjski ocjenjivači.** **a) usmeni komentar i diskusija HL (20 min); usmeni komentar SL (10 min) – temelji se odjeljku 2** **b) usmenka prezentacija – temelji se na odjeljku 4 (10 – 15 minutes) – 15%**

Popis djela za May 2016 bit će utvrđen u listopadu 2014.

Popis djela za May 2015

	HL	SL
Part 1	1. **M. J. Ljermontov: *Junak našega doba*** 2. **Henrik Ibsen: *Nora*** 3. **Umberto Eco: *Ime ruže***	1. **M. J. Ljermontov: *Junak našega doba*** 2. **Henrik Ibsen: *Nora***
Part 2	1. **ROMAN – Milutin Cihlar Nehajev: *Bijeg*** 2. **DRAMA – Ivo Brešan: *Predstava Hamleta u selu Mrduša Donja***	1. **ROMAN – Milutin Cihlar Nehajev: *Bijeg*** 2. **DRAMA – Ivo Brešan: *Predstava Hamleta u selu Mrduša Donja***

	3. POEZIJA – Tin Ujević – izbor iz lirike	
Part 3	1. Ksaver Šandor Gjalski: *Pod starim krovovima* (izbor) 2. Miroslav Krleža: M. Krleža: *Hrvatski bog Mars* (izbor) 3. Ranko Marinković: *Ruke* (izbor) 4. Antun Šoljan – novele (izbor)	1. Ksaver Šandor Gjalski: *Pod starim krovovima* (izbor) 2. Miroslav Krleža: M. Krleža: *Hrvatski bog Mars* (izbor) 3. Ranko Marinković: *Ruke* (izbor)
Part 4	1. Patrick Süskind: *Parfem* 2. Gustave Flaubert: *Gospođa Bovary* 3. Stamać: Antologija hrvatskoga pjesništva	1. Patrick Süskind: *Parfem* 2. Gustave Flaubert: *Gospođa Bovary* 3. Stamać: Antologija hrvatskoga pjesništva

ENGLISH B (Ivica Cikač i Irena Kocijan Pevec)
3IB & 4IB – SYLLABUS

Chapter 1 SOCIAL RELATIONSHIPS (core)	Linguistic dominance Language extinction	• Reading comprehension • Interactive oral activity – research; debate • Personal response • Interactive oral activity – discussion; presentation; role-play • Personal response • SL Written Assignment	Grammar – tenses review
CULTURAL DIVERSITY (option)	Language & cultural identity Self-identity	• Writing skills: review • TOK – The Sapir Whorf Hypothesis • Reading comprehension • Film review writing • HL Writing Assignment	
CUSTOMS & TRADITIONS (option)	Uniforms	• Reading comprehension • Debate writing • TOK: Uniforms & identity • Individual oral (HL/SL)	
Chapter 2 COMMUNICATION & MEDIA (core)	Advertising Radio & Television Advertising effects	• Reading comprehension • Internet research & presentation • Writing skills: Set of instructions or guidelines • The personal response • TOK: political correctness • Reading comprehension • Internet research & presentation • Writing skills: Speech • The personal response • Interactive oral	Grammar: Parts of speech; rhetorical devices

		activity • Reading comprehension • Movie debate • Writing skills – register • The personal response • Interactive oral activity – role-play • SL written assignment	
HEALTH (option)	**Mental health** **Eating disorders**	• Writing skills – register and discourse coherence • The individual oral (HL/SL) • Individual oral activity: photo discussion • Reading comprehension • TOK: health & perception of an individual • Research: obesity, manorexia, bulimia • Writing skills: Article	
CULTURAL DIVERSITY (option)	**Subcultures**	• Reading comprehension • Research – Anglophone subcultures • Writing skills: discourse analysis • Writing activity: Article • TOK: language and (sub)cultures • Writing skills: Diary entry • The individual oral (HL/SL) • HL Written Assignment	
Chapter 3 GLOBAL ISSUES (core)	**Geo-engineering** **Global warming**	• Reading comprehension • Research – US ecology	

	& Science Energy conservation	• Interactive oral activity – presentation • Writing skills: Brochure • Reading comprehension • Writing skills: News report • Personal response • Research – presentation • Writing skills: rationale writing • Personal response • Interactive oral activity: pamphlet • The SL Written Assignment • TOK: Climate change & empirical approach	
SCIENCE & TECHNOLOGY (option)	**Computers Mobile phones** **Weapons**	• Writing activity: Speech • Reading comprehension • The Individual Oral (Hl/SL)- photo • The HL Written Assignment • TOK: suggestive language	
LEISURE (option)	**International Youth Festivals** **Book festivals**	• Reading comprehension • Writing skills: Brochure-pamphlet-flyer • Research project • The Individual oral (HL/SL) • Writing activity: brochure (article) • TOK: cultures and bias	
Chapter 4 LITERATURE	**Literature in English B**	• Reading comprehension • Literary features • Literary discussions	**Vocabulary and literary features**

		• HL Written Assignment • TOK: translations • The Individual Oral (HL/SL)	
Exam practice: Paper I (SL)			
Exam practice: Individual oral			
Exam practice: Interactive oral			
Chapter 5 CULTURAL DIVERSITY (option)	**Population diversity – Traditional cultures in Singapore**	• **Reading** • **Writing: Feature article** • **Speaking: Individual oral (SL)**	
	Interlinguistic influence Singlish: Broken English or Badge of Identity	• **Reading** • **Speaking: individual oral – analyzing a photograph** • **Culture: Pidgins, creoles-research**	
	Multilinugal identity (excerpt) by Minfong Ho	• **Reading (scanning)** • **Writing: feature article – profile (interview)** • **Fluency vs. accuracy – discussion**	
SOCIAL RELATIONSHIPS (core)	**Cultural identity: Third Culture Kids by**	• **Reading –** • **Writing: set of instructions or guidelines** • **The personal response** • **Speaking: interactive oral – debate (Barack Obama)** • **Colors by Whitney Thomas (a poem)**	**Grammar: result, contrast, reason, purpose**
	Help Children Maintain their Culture	• **Reading** • **Proverbs** • **Writing: the personal response (a letter to the editor of the newspaper)** • **Advice column – set of instructions (advice**	

		column for parents) • Speaking: interactive oral – a role play (a family moving abroad)	
	Language and cultural identity: I don't understand the words by Feroz Salam (blogger)	• Reading (a blog) • Speaking: interactive oral – a panel discussion (Third Culture Kids) • The personal response • Writing: set of instructions – organizing a discussion group • Culture: It' not Easy Being Green (a poem)	**Conditional clauses**
	Education & minorities: Memories of a Chinese-American childhood	• Reading comprehension • Speaking: interactive oral – a plan to help new students integrate • Writing: a blog entry • The personal response • TOK • Immigration - research	**Modals: advice obligation**
GLOBAL ISSUES (core)	**Prejudice: Scrap the Teen Stereotypes**	• Reading comprehension • Speaking: interactive oral - interview • Writing: interview vs. magazine article • The personal response • Culture: news reports & magazines – teenagers in Anglophone countries	
	The Courage to Change by Shazia Mirza (a stand-up comic)	• Reading comprehension • Speaking: Interactive oral – role play • Writing: interview (discriminated person) • The personal response (stereotypes – Asian women)	

		• Culture: heroes & heroines (research)	
	Racism: Ignoring the Bananas	• Reading comprehension • Speaking: interactive oral presentation based on the research (anti-discriminatory bodies) + general discussion • Writing: a newspaper report • TOK: Benjamin Zephaniah • The personal response (racism)	
	Prejudice, discrimination, & racism: Wild Meat & the Bully burgers (excerpt from the novel)	• Reading comprehension • Interactive oral: hot seating • HL WRITTEN ASSIGNEMENT – diary entry • The personal response • Extension: anti-bullying • Reflection point	
	An episode of War - story	• Reading comprehension • Culture: gender stereotypes • Speaking: interactive oral – PTSD (research + presentation) • HL WRITTEN ASSIGNEMENT	
Chapter 7 HEALTH (option)	Traditional medicine	• Reading • Writing: blog entry	
	Alternative medicine	• Reading • Writing: opinion essay	
	In favor of complementary medicine	• Reading • Writing: balanced essay • TOK: MEDICAL CONTROVERSIES	
GLOBAL ISSUES	Substance abuse	• Reading	

(core)		**comprehension** • **Writing – proposal** • **Speaking: interactive oral – research, presentation (school problems)**	
	Drug abuse	• **Reading comprehension** • **Culture: laws & regulations on drugs (the controlled Substances Act)** • **Requiem for a Dream – a film** • **Writing: a personal response**	
SOCIAL RELATIONSHIPS (core)	**Education: Mitigate Crime, poverty and Drug Use through Education**	• **Reading comprehension** • **Culture: educational programs** • **TOK (Maslow's pyramid of needs)** • **Writing: the personal response (Education – empathy, social responsibility)**	
	Effects of alcoholism on social relationships Alcoholic Memoirs by Jack London	• **Reading comprehension** • **Culture: alcoholism** • **Speaking: interactive oral a song, a sketch – on social issues** • **HL WRITTEN ASSIGNEMENT** • **TOK (language learning and self-esteem)**	
Chapter 8 LITERATURE	**Short stories through cooperative learning**	• **4 short stories** • **TOK – understanding literature (characters) through TOK)** • **1 story – dissection – detailed analysis**	
EXAM PRACTICE 2 (HL)			
Chapter 9 LEISURE	**Travel and recreation**	• **Reading**	

(option)		• Beyond the text: travel blogs • Writing: a letter of application	
	Recreational dangers	• Reading: • Writing: News report • Speaking: interactive oral (photos)	
	Responsible travelling	• Reading • Writing: Interview • TOK: CAS & ethical education, ethical responsibilities	
GLOBAL ISSUES (core)	The impact of man on nature – The environmental impacts of kayaking	• Reading • Writing: Personal response • Speaking: interactive oral – presentation (Earth Day)	
	What can you do to help the environment?	• Reading • Speaking: interactive oral – sketch • Writing: SL written assignment • TOK: controversies – objectivity (right vs. wrong) • CAS: green school	
		•	
COMMUNICATION & MEDIA (core)	The media and environmental issues	• Film: An Inconvenient Truth • Reading: Walle • Writing: informal correspondence • The personal response • Speaking: Interactive oral	
	Social networking	• Reading • Film: The Social Network • Writing: email, • Personal response • Interactive oral • HL Written assignment – poems	

		• TOK: creativity in media	
Chapter 10 Science and technology (option)	Renewable energy – bio-fuels	• Reading • Speaking: individual oral	
	Ethics and science	• Reading • Speaking: individual oral • Beyond the text: bio-fuels • Writing: essay	
	Stem cell research	• Reading • Speaking: individual oral • TOK	
	Scientific research	• Reading: case studies • Writing: speech	
COMMUNICATION AND MEDIA (core)	The Internet Telephone	• Reading • Speaking: interactive oral • Writing: speech • TOK: mobile phones – more information/knowledg e	
	Advertising: Micro-banking	• Reading • Speaking: interactive oral • Writing: various text types • Personal response • Beyond the text: Advertising techniques	
	Global communication Mobile Innovations for social causes	• Reading • Speaking: interactive oral – presentations • TOK: 24 October – United NATIONS DAY	
Chapter 11 THE WRITTEN ASSIGNEMENT (ST, HL)	Guideline		

Exam practice 3			
EXTENDED ESSAY: English B			

GERMAN B COURSE HL/SL, Jadranka Šemiga

TEACHER: Jadranka Šemiga
SYLLABUS OUTLINE:
GLanguage B is a language acquisition course developed at two levels—standard level (SL) and higher level (HL)—for students with some background in the target language. While acquiring a language, students will explore the culture(s) connected to it. The focus of these courses is language acquisition and intercultural understanding.
The language B syllabus approaches the learning of language through meaning. Through the study of the core and the options at SL and HL, plus two literary works at HL, students build the necessary skills to reach the assessment objectives of the language B course through the expansion of their receptive, productive and interactive skills.ER
g
The core—with topics common to both levels—is divided into three areas.

<u>CORE:</u>

- **Communication and media**
- **Global issues**
- **Social relationships**

In addition, at both SL and HL, from the following five
<u>OPTIONS:</u>

- **Cultural diversity**
- **Customs and traditions**
- **Health**
- **Leisure**
- **Science and technology**

we will study 2 options: <u>Health</u> and <u>Leisure.</u>

Also, at HL, students read two works of literature.llabus outlineSyllabus outline

SYLLABUS CONTENT

TOPICS
The course comprises five topics: three from the core and two chosen from the five options. At least two aspects will be covered in each of the five topics that make up the course.
Additionally, at HL students must read two works of literature. We will read „Crazy“ (Benjamin Lebert) and „Der Vorleser“ (Bernhard Schlink).
A course will be structured as follows:

TOPIC	ASPECTS COVERED	+

Communication and media	**Television, advertising…**	**Internet, Books…**
Global issues	**Food and water, poverty, Racism, prejudice, discrimination…**	**Global warming,climate change,natural disasters, The environment**
Social relationships	**Social structures, Relationships (friendship, family)**	**Facebook, celebrations, educational system**
Health	**Plastic surgery (concepts of beauty and health)**	**Diet and nutrition, drug abuse**
Leisure	**Hobbies, sports, travelling**	**Volunteer …**

***The following list gives some <u>text types</u> with which students are encouraged to be familiar.**

- **Article, column**
- **Blog**
- **Brochure, leaflet, flyer, pamphlet, advertisement**
- **Essay**
- **Interview in any form**
- **News report**
- **Report**
- **Review**
- **Set of instructions, guidelines**
- **Written correspondence**

<u>ASSESSMENT OUTLINE - SL</u>

<u>Assessment component +Weighting</u>

<u>External assessment 70%</u>

Paper 1 (1 hour 30 minutes): Receptive skills
Text-handling exercises on four written texts, based on the core.
25%
Paper 2 (1 hour 30 minutes): Written productive skills
One writing exercise of 250–400 words from a choice of five, based on the options.
25%
Written assignment: Receptive and written productive skills
Inter-textual reading followed by a written task of 300–400 words plus a 150–200 word rationale, based on the core.
20%

<u>Internal assessment</u>

Internally assessed by the teacher and externally moderated by the IB.
30%
Individual oral (8–10 minutes)
Based on the options: 15 minutes' preparation time and a 10 minute (maximum) presentation and discussion with the teacher.
20%
Interactive oral activity
Based on the core: Three classroom activities assessed by the teacher.

10%

<u>ASSESSMENT OUTLINE – HL</u>

<u>Assessment component + Weighting</u>

<u>External assessment 70%</u>
Paper 1 (1 hour 30 minutes): Receptive skills
Text-handling exercises on five written texts, based on the core.
25%
Paper 2 (1 hour 30 minutes): Written productive skills
Two compulsory writing exercises.
Section A: One task of 250–400 words, based on the options, to be selected from a choice of five.
Section B: Response of 150–250 words to a stimulus text, based on the core.
25%
Written assignment: Receptive and written productive skills
Creative writing of 500–600 words plus a 150–250 word rationale, based on one or both of the literary texts read.
20%
<u>Internal assessment</u>
Internally assessed by the teacher and externally moderated by the IB.
30%
Individual oral (8–10 minutes)
Based on the options: 15 minutes' preparation time and a 10 minute (maximum) presentation and discussion with the teacher.
20%
Interactive oral activity
Based on the core: Three classroom activities assessed by the teacher.
10%

BUSINESS & MANAGEMENT, Kristina Oršić Manojlović

Syllabus component	Teaching hours SL	HL
Unit 1: Business organization and environment	**40**	**50**
1.1 Introduction to business management		
1.2 Types of organizations		
1.3 Organizational objectives		
1.4 Stakeholders		
1.5 External environment		
1.6 Growth and evolution		
1.7 Organizational planning tools (HL only)		
Unit 2: Human resource management	**15**	**30**
2.1 Functions and evolution of human resource management		
2.2 Organizational structure		
2.3 Leadership and management		
2.4 Motivation		
2.5 Organizational (corporate) culture (HL only)		
2.6 Industrial/employee relations (HL only)		
Unit 3: Finance and accounts	**35**	**50**
3.1 Sources of finance		
3.2 Costs and revenues		
3.3 Break-even analysis		
3.4 Final accounts (some HL only)		
3.5 Profitability and liquidity ratio analysis		
3.6 Efficiency ratio analysis (HL only)		
3.7 Cash flow		
3.8 Investment appraisal (some HL only)		
3.9 Budgets (HL only)		
Unit 4: Marketing	**35**	**50**
4.1 The role of marketing		
4.2 Marketing planning (including introduction to the four Ps)		
4.3 Sales forecasting (HL only)		
4.4 Market research		
4.5 The four Ps (product, price, promotion, place)		
4.6 The extended marketing mix of seven Ps (HL only)		
4.7 International marketing (HL only)		
4.8 E-commerce		
Unit 5: Operations management	**10**	**30**
5.1 The role of operations management		
5.2 Production methods		
5.3 Lean production and quality management (HL only)		
5.4 Location		
5.5 Production planning (HL only)		
5.6 Research and development (HL only)		

5.7 Crisis management and contingency planning (HL only)

Internal assessment	**15**	**30**
Total teaching hours	**150**	**240**

GEOGRAPHY, Krunoslav Rukelj

Syllabus outline

Geography syllabus component	Teaching hours SL/HL
Geographic skills—integrated throughout the course **Part 1: Core theme—patterns and change (SL/HL)** There are four compulsory topics in this core theme. 1. Populations in transition 2. Disparities in wealth and development 3. Patterns in environmental quality and sustainability 4. Patterns in resource consumption	70/70
Part 2: Optional themes (SL/HL) There are seven optional themes; each requires 30 teaching hours. Two optional themes are required at SL. Three optional themes are required at HL. A. Freshwater—issues and conflicts B. Oceans and their coastal margins C. Extreme environments D. Hazards and disasters—risk assessment and response E. Leisure, sport and tourism F. The geography of food and health G. Urban environments	60/90
Part 3: HL extension—global interactions (HL only) There are seven compulsory topics in the HL extension. 1. Measuring global interactions 2. Changing space—the shrinking world 3. Economic interactions and flows 4. Environmental change 5. Sociocultural exchanges 6. Political outcomes 7. Global interactions at the local level	60
Fieldwork (SL/HL) Fieldwork, leading to one written report based on a fieldwork question, information, collection and analysis with evaluation.	20/20
Total teaching hours	150/240

Teacher: Krunoslav Rukelj, prof.

HISTORY, Ivan Lajnvaš

Prva Gimnazija Varaždin
IB DIPLOMA SYLLABUS
2014./2015

Subject: HISTORY
Teacher: Ivan Lajnvaš, prof.

AIMS of the history course:
- the acquisition and understanding of historical knowledge in breadth and in depth, and from different cultures
- a developing appreciation and understanding of history as a discipline, including the nature and diversity of its sources, methods and interpretations
- international awareness and understanding of people living in a variety of places at different times
- a better understanding of the present through and understanding of the past
- an ability to use and communicate historical knowledge and understanding
- a lasting interest in history

SYLLABUS:

I. 20TH CENTURY WORLD HISTORY TOPICS

- <u>TOPIC 1: CAUSES, PRACTICES AND EFFECTS OF WAR</u>

War was a major feature of the 20th century. In this topic the different types of war should be identified, and the causes, practices and effects of these conflicts should be studied.

Major themes:

• Different types and nature of 20th century warfare
- civil, guerilla, limited war, total war
• Origins and causes of war
- long-term, short-term, and immediate causes
- economic, ideological, political, religious causes
• Nature of 20th century wars
- technological developments, tactics and strategies, air, land, sea
- Home front: economic and social impact (including changes in the role and status of women)
- resistance and revolutionary movements
• Effects and results
- Peace settlements and wars ending without treaties
- Attempts at collective security post-Second World War

- Political repercussions and territorial changes
- post-war economic problems

Material for detailed study:

- **Second World War (1939-45)**
- **Africa: Algerian War (1954-62)**
- **Americas: Falklands/Malvinas war (1982)**
- **Europe: Spanish Civil War (1936-9)**

- <u>TOPIC 2: THE COLD WAR</u>

This topic addresses East–West relations from 1945. It aims to promote an international perspective and understanding of the origins, course and effects of the Cold War - a conflict that dominated global affairs from the end of the Second World War to the early 1990s. It includes superpower rivalry and events in all areas affected by Cold War politics such as spheres of interest, wars (proxy), alliances and interference in developing countries.

Major themes:

Origins of the Cold War
- ideological differences
- mutual suspicion and fear
- from wartime allies to post-war enemies

Nature of the Cold War
- Ideological opposition
- Superpowers and spheres of influence
- Alliances and diplomacy in the Cold War

Development and impact of the Cold War
- Global spread of the Cold War from its European origins
- Cold War policies of containment, brinkmanship, peaceful coexistence, détente
- Role of the United Nations and the Non-Aligned Movement
- Role and significance of leaders
- Arms race, proliferation and limitation
- Social, cultural and economic impact

End of the Cold War
- Break-up of Soviet Union: internal problems and external pressures
- Breakdown of Soviet control over Central and Eastern Europe

Material for detailed study:

- Wartime conferences: Yalta and Potsdam
- US policies and developments in Europe: Truman Doctrine, Marshall Plan, NATO
- Soviet policies, Sovietization of Eastern and Central Europe, COMECON, Warsaw Pact

- Sino–Soviet relations
- US–Chinese relations
- Germany (especially Berlin (1945‑ 61)), Afghanistan (1979‑ 88), Korea, Cuba, Vietnam, Middle East
- Castro, Gorbachev, Kennedy, Mao, Reagan, Stalin, Truman

II. PRESCRIBED SUBJECT: Communism in crisis 1976‑ 89

This prescribed subject addresses the major challenges—social, political and economic—facing the regimes in the leading socialist (Communist) states from 1976 to 1989 and the nature of the response of these regimes. In some cases challenges, whether internal or external in origin, produced responses that inaugurated a reform process contributing significantly to the end of the USSR and the satellite states in Central and Eastern Europe. In other cases repressive measures managed to contain the challenge and the regime maintained power in the period.

• the struggle for power following the death of Mao Zedong (Mao Tse-tung), Hua Guofeng (Hua Kuo‑ feng), the re-emergence of Deng Xiaoping (Teng Hsiao-p'ing) and the defeat of the Gang of Four
• China under Deng Xiaoping: economic policies and the Four Modernizations
• China under Deng Xiaoping: political changes, and their limits, culminating in Tiananmen Square (1989)
• domestic and foreign problems of the Brezhnev era: economic and political stagnation; Afghanistan
• Gorbachev and his aims/policies (glasnost and perestroika) and consequences for the Soviet state
• consequences of Gorbachev's policies for Eastern European reform movements: Poland—the role of Solidarity; Czechoslovakia—the Velvet Revolution; fall of the Berlin Wall.

III. HISTORICAL INVESTIGATION

A written account of between 1,500‑ 2,000 words for SL and HL, which must consist of: a cover page with student name, number, research question and accurate word count, a plan of the historical investigation, a summary of evidence, an evaluation of sources, an analysis, a conclusion, a list of sources.

HISTORY, Ivan Lončar

IBDP
Prva gimnazija Varaždin
Teacher: Ivan Lončar
Subject: History SL
Route 2
Syllabus components
<u>Two topics from the 20th century world history</u>
Topic 2: Democratic states – challenges and responses

Detailed study would cover following examples from two regions

- **Europe and Middle East: Weimar Germany 1919-1933; France 1958-1969; Great**

Britain and Northern Ireland 1967-1990

- **Americas: United States 1953-1973, Eisenhower, Kennedy, Johnson, Nixon;**

Argentina 1983-1995, Alfonsin and Menem; Canada 1968-1984, Trudeau
Topic 5: The Cold War

Detailed study would cover following examples

- **Wartime conferences: Yalta and Potsdam**
- **US polices and developments in Europe: Truman Doctrine, Marshall Plan, NATO**
- **Soviet policies, Sovietization of Eeastern and Central Europe, COMECON, Warsaw Pact**
- **Sino-Soviet relations**
- **US-Chinese relations**
- **Germany 1945-1961,Korea, Cuba, Vietnam, Middle East, Afghanistan 1979-1988**
- **Stalin, Truman, Mao, Castro, Kennedy, Reagan, Gorbachev**

<u>Prescribed subject 3: Communism in crisis 1976-1989</u>
Areas on which the source-based questions will focus are:

- **the struggle for power following the death of Mao Zedong, the re-emergence of Deng Xiaoping and defeat oft he Gang of Four**
- **China under Deng Xiaoping: economic policies and the Four Modernizations**
- **China under Deng Xiaoping: political changes, Tiananmen Square 1989**
- **economic and political stagnation under Brezhnev; Afghanistan**
- **Gorbachev; glasnost and perestroika**
- **reform movement in Poland; role of Solidarity; Czechoslovakia 1989, Berlin Wall 1989**

<u>Historical investigation</u>
Students will be required to produce a witten account of between 1500 - 2000 words using a good range of historical sources.

BIOLOGY, Martina Vidović

Syllabus component Teaching hours

SL HL

Core 95
1. Cell biology 15
2. Molecular biology 21
3. Genetics 15
4. Ecology 12
5. Evolution and biodiversity 12
6. Human physiology 20

Additional higher level (AHL) 60
7. Nucleic acids 9
8. Metabolism, cell respiration and photosynthesis 14
9. Plant biology 13
10. Genetics and evolution 8
11. Animal physiology 16

Option 15 25
1. Neurobiology and behaviour 15 25
2. Biotechnology and bioinformatics 15 25
3. Ecology and conservation 15 25
4. Human physiology 15 25

Practical scheme of work 40 60
Practical activities 20 40
Individual investigation (internal assessment–IA) 10 10
Group 4 project 10 10

Total teaching hours 150 240

BIOLOGY, Vinka Sambolec Škerbić

4.IB BIOLOGY, 2014./2015.

Teacher: Vinka Sambolec Škerbić

Syllabus overview	HL	SL
Core		
Topic 6: Human health and physiology	20	20
Additional higher level - AHL		
Topic 9: Plant science	11	-
Topic 11: Human health and physiology	17	-
Options		
Option E: Neurobiology and behaviour	22	15
Option F: Microbes and biotechnology	22	15
Practical scheme of work		
Practical activities	20	10
Individual investigation for internal assessment (IA)	10	10
Other activities		
Repetition, topic exams, first term final exam, mock exam	23	14
Total teaching hours	145	84

CHEMISTRY, Tihana Čus

Syllabus component

Core
1. Stoichiometric relationships
2. Atomic structure
3. Periodicity
4. Chemical bonding and structure
5. Energetics/thermochemistry
6. Chemical kinetics
7. Equilibrium
8. Acids and bases
9. Redox processes
10. Organic chemistry
11. Measurement and data processing
Additional higher level (AHL)
12. Atomic structure
13. The periodic table—the transition metals
14. Chemical bonding and structure
15. Energetics/thermochemistry
16. Chemical kinetics
17. Equilibrium
18. Acids and bases
19. Redox processes
20. Organic chemistry
21. Measurement and analysis
Option
A. Materials
B. Biochemistry
C. Energy
D. Medicinal chemistry

Practical scheme of work
Practical activities
Individual investigation (internal assessment–IA)
Group 4 project

Total teaching hours

CHEMISTRY, Tihana Čus

Syllabus component

Core
1. **Measurement and data processing**
2. **Quantitative chemistry**
3. **Atomic structure**
4. **Periodicity**
5. **Bonding**
6. **Energetics**
7. **Kinetics**
8. **Equilibrium**
9. **Acids and bases**
10. **Oxidation and reduction**
11. **Organic chemistry**

Additional higher level (AHL)

12. **Atomic structure**
13. **Periodicity**
14. **Bonding**
15. **Energetics**
16. **Kinetics**
17. **Equilibrium**
18. **Acids and bases**
19. **Oxidation and reduction**
20. **Organic chemistry**

Option

A. Modern analytical chemistry
B. Human biochemistry
C. Chemistry in industry and technology
D. Medicines and drugs
E. Environmental chemistry
F. Food chemistry
G. Further organic chemistry

Practical scheme of work
Investigations
Group 4 project

Total teaching hours

Syllabus overview

The syllabus for the Diploma Programme physics course is divided into three parts: the core, the AHL material and the options. The *Physics data booklet* is an integral part of the syllabus and should be used in conjunction with the syllabus. Students should use the data booklet during the course, and they should be issued with clean copies for papers 1, 2 and 3 in the examination.

		Teaching hours
Core		**80**
Topic 1:	Physics and physical measurement	5
Topic 2:	Mechanics	17
Topic 3:	Thermal physics	7
Topic 4:	Oscillations and waves	10
Topic 5:	Electric currents	7
Topic 6:	Fields and forces	7
Topic 7:	Atomic and nuclear physics	9
Topic 8:	Energy, power and climate change	18
AHL		**55**
Topic 9:	Motion in fields	8
Topic 10:	Thermal physics	6
Topic 11:	Wave phenomena	12
Topic 12:	Electromagnetic induction	6
Topic 13:	Quantum physics and nuclear physics	15
Topic 14:	Digital technology	8
Options		**15/22**
Options SL		
Option A:	Sight and wave phenomena	15
Option B:	Quantum physics and nuclear physics	15
Option C:	Digital technology	15
Option D:	Relativity and particle physics	15

		Teaching hours
Options SL and HL		
Option E:	Astrophysics	15/22
Option F:	Communications	15/22
Option G:	Electromagnetic waves	15/22
Options HL		
Option H:	Relativity	22
Option I:	Medical physics	22
Option J:	Particle physics	22

Students at SL are required to study any **two** options from A–G.
The duration of each option is 15 hours.

Students at HL are required to study any **two** options from E–J.
The duration of each option is 22 hours.

Syllabus content

Recommended teaching hours

Core	**95 hours**
Topic 1: Measurements and uncertainties	**5**
1.1 – Measurements in physics	
1.2 – Uncertainties and errors	
1.3 – Vectors and scalars	
Topic 2: Mechanics	**22**
2.1 – Motion	
2.2 – Forces	
2.3 – Work, energy and power	
2.4 – Momentum and impulse	
Topic 3: Thermal physics	**11**
3.1 – Thermal concepts	
3.2 – Modelling a gas	
Topic 4: Waves	**15**
4.1 – Oscillations	
4.2 – Travelling waves	
4.3 – Wave characteristics	
4.4 – Wave behaviour	
4.5 – Standing waves	
Topic 5: Electricity and magnetism	**15**
5.1 – Electric fields	
5.2 – Heating effect of electric currents	
5.3 – Electric cells	
5.4 – Magnetic effects of electric currents	

Additional higher level (AHL) — 60 hours

Options

15 hours (SL)/25 hours (HL)

A: Relativity

Core topics

A.1 – The beginnings of relativity

A.2 – Lorentz transformations

A.3 – Spacetime diagrams

Additional higher level topics

A.4 – Relativistic mechanics (HL only)

A.5 – General relativity (HL only)

B: Engineering physics

Core topics

B.1 – Rigid bodies and rotational dynamics

B.2 – Thermodynamics

Additional higher level topics

B.3 – Fluids and fluid dynamics (HL only)

B.4 – Forced vibrations and resonance (HL only)

Option C: Imaging

Core topics

C.1 – Introduction to imaging

C.2 – Imaging instrumentation

C.3 – Fibre optics

Additional higher level topics

C.4 – Medical imaging (HL only)

Option D: Astrophysics

Core topics

D.1 – Stellar quantities

D.2 – Stellar characteristics and stellar evolution

D.3 – Cosmology

Additional higher level topics

D.4 – Stellar processes (HL only)

D.5 – Further cosmology (HL only)

COMPUTER SCIENCE, Bojan Banić

Bojan Banic - Teaching Order

SL & HL

Year 1

Term	Theory topics	OOP option topics	Practical tasks and tests	Comments
1	The common core SL/HL - Architecture (simple); primary and secondary memory; machine instruction cycle; operating system; applications; data representation; simple logic gates and operations. Additional HL - Microprocessor controlled systems; sensors, transducers, feedback, distributed systems.	The common core SL/HL - Sequence, selection, repetition; planning solutions; pre and post conditions1; concurrent processing (threads); abstraction and decomposition; flow chart and pseudocode representations of algorithms. Programming languages; operators, variables, constants, selection and repetition constructs; collections; methods.	Week 8: Creating the flow chart and preudocode for simple problem. Week 12: Create the simple program using selection and repetition instructions. Week 15: User documentation and developer documentation for simple problem	This term will concentrate on the key elements of computer hardware and software and into learning to programming in Java.
2	The common core SL/HL - Organizational planning and system installation; user documentation; backup; software deployment (maintenance); system design and analysis; social and ethical issues; usability and accessibility. Additional HL -	The common core SL/HL - Based in a subset of the Java language. Understand Objects and simple Object diagrams; Object oriented design; main features of OOP; libraries and modules; Java and OOP terminology and syntax; code construction; internationalization and ethical and moral obligations of	Week 20: Design prototype using GUI and implement solution to simple problem. Collecting data and programming a simple project. Definition of project choice, data collection and analysis. Define the	This term will spend some time getting familiar with OOP programming concepts and GUIs. Preparing for project definition and other steps in the project.

	Microprocessor controlled systems; sensors, transducers, feedback, distributed systems.	**programmers.** **The common core SL/HL - arrays and standard algorithms (sort, search), algorithm efficiency.** **Additional HL - Recursion; 2D arrays, stacks, queues and binary trees; linked lists.** **Additional HL - Programming recursion.**	**proposed solution.**	

Syllabus content

Topic 1—Core: Algebra

30 hours

The aim of this topic is to introduce students to some basic algebraic concepts and applications.

	Content	Further guidance	Links
1.1	Arithmetic sequences and series; sum of finite arithmetic series; geometric sequences and series; sum of finite and infinite geometric series. Sigma notation. Applications.	Sequences can be generated and displayed in several ways, including recursive functions. Link infinite geometric series with limits of convergence in 6.1. Examples include compound interest and population growth.	**Int:** The chess legend (Sissa ibn Dahir). **Int:** Aryabhatta is sometimes considered the “father of algebra”. Compare with al-Khawarizmi. **Int:** The use of several alphabets in mathematical notation (eg first term and common difference of an arithmetic sequence). **TOK:** Mathematics and the knower. To what extent should mathematical knowledge be consistent with our intuition? **TOK:** Mathematics and the world. Some mathematical constants (π , e, φ , Fibonacci numbers) appear consistently in nature. What does this tell us about mathematical knowledge? **TOK:** Mathematics and the knower. How is mathematical intuition used as a basis for formal proof? (Gauss’ method for adding up integers from 1 to 100.) *(continued)*

	Content	Further guidance	Links
			(see notes above) **Aim 8:** Short-term loans at high interest rates. How can knowledge of mathematics result in individuals being exploited or protected from extortion? **Appl:** Physics 7.2, 13.2 (radioactive decay and nuclear physics).
1.2	Exponents and logarithms. Laws of exponents; laws of logarithms. Change of base.	Exponents and logarithms are further developed in 2.4.	**Appl:** Chemistry 18.1, 18.2 (calculation of pH and buffer solutions). **TOK:** The nature of mathematics and science. Were logarithms an invention or discovery? (This topic is an opportunity for teachers and students to reflect on “the nature of mathematics”.)
1.3	Counting principles, including permutations and combinations.	The ability to find $\binom{n}{r}$ and $^{n}P_{r}$ using both the formula and technology is expected. Link to 5.4.	**TOK:** The nature of mathematics. The unforeseen links between Pascal’s triangle, counting methods and the coefficients of polynomials. Is there an underlying truth that can be found linking these?
	The binomial theorem: expansion of $(a+b)^n$, $n \in$. **Not required:** Permutations where some objects are identical. Circular arrangements. Proof of binomial theorem.	Link to 5.6, binomial distribution.	**Int:** The properties of Pascal’s triangle were known in a number of different cultures long before Pascal (eg the Chinese mathematician Yang Hui). **Aim 8:** How many different tickets are possible in a lottery? What does this tell us about the ethics of selling lottery tickets to those who do not understand the implications of these large numbers?

	Content	Further guidance	Links
1.4	Proof by mathematical induction.	Links to a wide variety of topics, for example, complex numbers, differentiation, sums of series and divisibility.	**TOK:** Nature of mathematics and science. What are the different meanings of induction in mathematics and science? **TOK:** Knowledge claims in mathematics. Do proofs provide us with completely certain knowledge? **TOK:** Knowledge communities. Who judges the validity of a proof?
1.5	Complex numbers: the number $\mathrm{i} = \sqrt{-1}$; the terms real part, imaginary part, conjugate, modulus and argument. Cartesian form $z = a + \mathrm{i}b$. Sums, products and quotients of complex numbers.	When solving problems, students may need to use technology.	**Appl:** Concepts in electrical engineering. Impedance as a combination of resistance and reactance; also apparent power as a combination of real and reactive powers. These combinations take the form $z = a + \mathrm{i}b$. **TOK:** Mathematics and the knower. Do the words imaginary and complex make the concepts more difficult than if they had different names? **TOK:** The nature of mathematics. Has “i” been invented or was it discovered? **TOK:** Mathematics and the world. Why does “i” appear in so many fundamental laws of physics?

	Content	Further guidance	Links
1.6	Modulus–argument (polar) form $z = r(\cos\theta + \mathrm{i}\sin\theta) = r\,\mathrm{cis}\,\theta = r\,\mathrm{e}^{\mathrm{i}\theta}$. The complex plane.	$r\,\mathrm{e}^{\mathrm{i}\theta}$ is also known as Euler's form. The ability to convert between forms is expected. The complex plane is also known as the Argand diagram.	**Appl:** Concepts in electrical engineering. Phase angle/shift, power factor and apparent power as a complex quantity in polar form. **TOK:** The nature of mathematics. Was the complex plane already there before it was used to represent complex numbers geometrically? **TOK:** Mathematics and the knower. Why might it be said that $\mathrm{e}^{\mathrm{i}\pi} + 1 = 0$ is beautiful?
1.7	Powers of complex numbers: de Moivre's theorem. n^{th} roots of a complex number.	Proof by mathematical induction for $n \in {}^{+}$.	**TOK:** Reason and mathematics. What is mathematical reasoning and what role does proof play in this form of reasoning? Are there examples of proof that are not mathematical?
1.8	Conjugate roots of polynomial equations with real coefficients.	Link to 2.5 and 2.7.	
1.9	Solutions of systems of linear equations (a maximum of three equations in three unknowns), including cases where there is a unique solution, an infinity of solutions or no solution.	These systems should be solved using both algebraic and technological methods, eg row reduction. Systems that have solution(s) may be referred to as consistent. When a system has an infinity of solutions, a general solution may be required. Link to vectors in 4.7.	**TOK:** Mathematics, sense, perception and reason. If we can find solutions in higher dimensions, can we reason that these spaces exist beyond our sense perception?

Topic 2—Core: Functions and equations

22 hours

The aims of this topic are to explore the notion of function as a unifying theme in mathematics, and to apply functional methods to a variety of mathematical situations. It is expected that extensive use will be made of technology in both the development and the application of this topic.

	Content	Further guidance	Links
2.1	Concept of function $f : x \mapsto f(x)$: domain, range; image (value).		**Int:** The notation for functions was developed by a number of different mathematicians in the 17th and 18th centuries. How did the notation we use today become internationally accepted?
	Odd and even functions.		
	Composite functions $f \circ g$.	$(f \circ g)(x) = f(g(x))$. Link with 6.2.	**TOK:** The nature of mathematics. Is mathematics simply the manipulation of symbols under a set of formal rules?
	Identity function.		
	One-to-one and many-to-one functions.	Link with 3.4.	
	Inverse function f^{-1}, including domain restriction. Self-inverse functions.	Link with 6.2.	

	Content	Further guidance	Links
2.2	The graph of a function; its equation $y = f(x)$. Investigation of key features of graphs, such as maximum and minimum values, intercepts, horizontal and vertical asymptotes and symmetry, and consideration of domain and range. The graphs of the functions $y = \lvert f(x) \rvert$ and $y = f(\lvert x \rvert)$. The graph of $y = \frac{1}{f(x)}$ given the graph of $y = f(x)$.	Use of technology to graph a variety of functions.	**TOK:** Mathematics and knowledge claims. Does studying the graph of a function contain the same level of mathematical rigour as studying the function algebraically (analytically)? **Appl:** Sketching and interpreting graphs; Geography SL/HL (geographic skills); Chemistry 11.3.1. **Int:** Bourbaki group analytical approach versus Mandlebrot visual approach.
2.3	Transformations of graphs: translations; stretches; reflections in the axes. The graph of the inverse function as a reflection in $y = x$.	Link to 3.4. Students are expected to be aware of the effect of transformations on both the algebraic expression and the graph of a function.	**Appl:** Economics SL/HL 1.1 (shift in demand and supply curves).
2.4	The rational function $x \quad \frac{ax+b}{cx+d}$, and its graph. The function $x \quad a^x$, $a > 0$, and its graph. The function $x \quad \log_a x$, $x > 0$, and its graph.	The reciprocal function is a particular case. Graphs should include both asymptotes and any intercepts with axes. Exponential and logarithmic functions as inverses of each other. Link to 6.2 and the significance of e. Application of concepts in 2.1, 2.2 and 2.3.	**Appl:** Geography SL/HL (geographic skills); Physics SL/HL 7.2 (radioactive decay); Chemistry SL/HL 16.3 (activation energy); Economics SL/HL 3.2 (exchange rates).

	Content	Further guidance	Links
2.5	Polynomial functions and their graphs. The factor and remainder theorems. The fundamental theorem of algebra.	The graphical significance of repeated factors. The relationship between the degree of a polynomial function and the possible numbers of x-intercepts.	
2.6	Solving quadratic equations using the quadratic formula. Use of the discriminant $\Delta = b^2 - 4ac$ to determine the nature of the roots.	May be referred to as roots of equations or zeros of functions.	**Appl:** Chemistry 17.2 (equilibrium law). **Appl:** Physics 2.1 (kinematics). **Appl:** Physics 4.2 (energy changes in simple harmonic motion).
	Solving polynomial equations both graphically and algebraically.	Link the solution of polynomial equations to conjugate roots in 1.8.	**Appl:** Physics (HL only) 9.1 (projectile motion).
	Sum and product of the roots of polynomial equations.	For the polynomial equation $\sum_{r=0}^{n} a_r x^r = 0$, the sum is $\frac{-a_{n-1}}{a_n}$, the product is $\frac{(-1)^n a_0}{a_n}$.	**Aim 8:** The phrase "exponential growth" is used popularly to describe a number of phenomena. Is this a misleading use of a mathematical term?
	Solution of $a^x = b$ using logarithms. Use of technology to solve a variety of equations, including those where there is no appropriate analytic approach.		

	Content	Further guidance	Links
2.7	Solutions of $g(x) \geq f(x)$. Graphical or algebraic methods, for simple polynomials up to degree 3. Use of technology for these and other functions.		

Topic 3—Core: Circular functions and trigonometry

22 hours

The aims of this topic are to explore the circular functions, to introduce some important trigonometric identities and to solve triangles using trigonometry.

On examination papers, radian measure should be assumed unless otherwise indicated, for example, by $x \mapsto \sin x$.

	Content	Further guidance	Links
3.1	The circle: radian measure of angles. Length of an arc; area of a sector.	Radian measure may be expressed as multiples of π, or decimals. Link with 6.2.	**Int:** The origin of degrees in the mathematics of Mesopotamia and why we use minutes and seconds for time.
3.2	Definition of $\cos\theta$, $\sin\theta$ and $\tan\theta$ in terms of the unit circle. Exact values of sin, cos and tan of $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}$ and their multiples. Definition of the reciprocal trigonometric ratios $\sec\theta$, $\csc\theta$ and $\cot\theta$. Pythagorean identities: $\cos^2\theta + \sin^2\theta = 1$; $1 + \tan^2\theta = \sec^2\theta$; $1 + \cot^2\theta = \csc^2\theta$.		**TOK:** Mathematics and the knower. Why do we use radians? (The arbitrary nature of degree measure versus radians as real numbers and the implications of using these two measures on the shape of sinusoidal graphs.) **TOK:** Mathematics and knowledge claims. If trigonometry is based on right triangles, how can we sensibly consider trigonometric ratios of angles greater than a right angle? **Int:** The origin of the word "sine". **Appl:** Physics SL/HL 2.2 (forces and dynamics).
3.3	Compound angle identities. Double angle identities. **Not required:** Proof of compound angle identities.	Derivation of double angle identities from compound angle identities. Finding possible values of trigonometric ratios without finding θ, for example, finding $\sin 2\theta$ given $\sin\theta$.	**Appl:** Triangulation used in the Global Positioning System (GPS). **Int:** Why did Pythagoras link the study of music and mathematics? **Appl:** Concepts in electrical engineering. Generation of sinusoidal voltage. *(continued)*

	Content	Further guidance	Links
3.4	Composite functions of the form $f(x) = a \sin(b(x + c)) + d$. Applications.		*(see notes above)* **TOK:** Mathematics and the world. Music can be expressed using mathematics. Does this mean that music is mathematical, that mathematics is musical or that both are reflections of a common "truth"? **Appl:** Physics SL/HL 4.1 (kinematics of simple harmonic motion).
3.5	The inverse functions $x \quad \arcsin x$, $x \quad \arccos x$, $x \quad \arctan x$; their domains and ranges; their graphs.		
3.6	Algebraic and graphical methods of solving trigonometric equations in a finite interval, including the use of trigonometric identities and factorization. **Not required:** The general solution of trigonometric equations.		**TOK:** Mathematics and knowledge claims. How can there be an infinite number of discrete solutions to an equation?
3.7	The cosine rule The sine rule including the ambiguous case. Area of a triangle as $\frac{1}{2}ab \sin C$. Applications.	 Examples include navigation, problems in two and three dimensions, including angles of elevation and depression.	**TOK:** Nature of mathematics. If the angles of a triangle can add up to less than 180°, 180° or more than 180°, what does this tell us about the "fact" of the angle sum of a triangle and about the nature of mathematical knowledge? **Appl:** Physics SL/HL 1.3 (vectors and scalars); Physics SL/HL 2.2 (forces and dynamics). **Int:** The use of triangulation to find the curvature of the Earth in order to settle a dispute between England and France over Newton's gravity.

Topic 4—Core: Vectors

24 hours

The aim of this topic is to introduce the use of vectors in two and three dimensions, and to facilitate solving problems involving points, lines and planes.

	Content	Further guidance	Links
4.1	Concept of a vector.		**Aim 8:** Vectors are used to solve many problems in position location. This can be used to save a lost sailor or destroy a building with a laser-guided bomb.
	Representation of vectors using directed line segments.		
	Unit vectors; base vectors $\boldsymbol{i}, \boldsymbol{j}, \boldsymbol{k}$.		
	Components of a vector:		**Appl:** Physics SL/HL 1.3 (vectors and scalars); Physics SL/HL 2.2 (forces and dynamics).
	$\boldsymbol{v} = \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix} = v_1\boldsymbol{i} + v_2\boldsymbol{j} + v_3\boldsymbol{k}$.		**TOK:** Mathematics and knowledge claims. You can perform some proofs using different mathematical concepts. What does this tell us about mathematical knowledge?
	Algebraic and geometric approaches to the following: • the sum and difference of two vectors; • the zero vector $\boldsymbol{0}$, the vector $-\boldsymbol{v}$; • multiplication by a scalar, $k\boldsymbol{v}$; • magnitude of a vector, $\lvert\boldsymbol{v}\rvert$ • position vectors $\overrightarrow{OA} = \boldsymbol{a}$.	Proofs of geometrical properties using vectors.	
	$\overrightarrow{AB} = \boldsymbol{b} - \boldsymbol{a}$	Distance between points A and B is the magnitude of $\overrightarrow{AB}$.	

	Content	Further guidance	Links
4.2	The definition of the scalar product of two vectors. Properties of the scalar product: $\boldsymbol{v} \cdot \boldsymbol{w} = \boldsymbol{w} \cdot \boldsymbol{v}$; $\boldsymbol{u} \cdot (\boldsymbol{v} + \boldsymbol{w}) = \boldsymbol{u} \cdot \boldsymbol{v} + \boldsymbol{u} \cdot \boldsymbol{w}$; $(k\boldsymbol{v}) \cdot \boldsymbol{w} = k(\boldsymbol{v} \cdot \boldsymbol{w})$; $\boldsymbol{v} \cdot \boldsymbol{v} = \lvert\boldsymbol{v}\rvert^2$. The angle between two vectors. Perpendicular vectors; parallel vectors.	$\boldsymbol{v} \cdot \boldsymbol{w} = \lvert\boldsymbol{v}\rvert\lvert\boldsymbol{w}\rvert \cos\theta$, where θ is the angle between $\boldsymbol{v}$ and $\boldsymbol{w}$. Link to 3.6. For non-zero vectors, $\boldsymbol{v} \cdot \boldsymbol{w} = 0$ is equivalent to the vectors being perpendicular. For parallel vectors, $\lvert\boldsymbol{v} \cdot \boldsymbol{w}\rvert = \lvert\boldsymbol{v}\rvert\lvert\boldsymbol{w}\rvert$.	**Appl:** Physics SL/HL 2.2 (forces and dynamics). **TOK:** The nature of mathematics. Why this definition of scalar product?
4.3	Vector equation of a line in two and three dimensions: $\boldsymbol{r} = \boldsymbol{a} + \lambda\boldsymbol{b}$. Simple applications to kinematics. The angle between two lines.	Knowledge of the following forms for equations of lines. Parametric form: $x = x_0 + \lambda l$, $y = y_0 + \lambda m$, $z = z_0 + \lambda n$. Cartesian form: $\frac{x - x_0}{l} = \frac{y - y_0}{m} = \frac{z - z_0}{n}$.	**Appl:** Modelling linear motion in three dimensions. **Appl:** Navigational devices, eg GPS. **TOK:** The nature of mathematics. Why might it be argued that vector representation of lines is superior to Cartesian?
4.4	Coincident, parallel, intersecting and skew lines; distinguishing between these cases. Points of intersection.		

	Content	Further guidance	Links
4.5	The definition of the vector product of two vectors. Properties of the vector product: $\boldsymbol{v} \times \boldsymbol{w} = -\boldsymbol{w} \times \boldsymbol{v}$; $\boldsymbol{u} \times (\boldsymbol{v} + \boldsymbol{w}) = \boldsymbol{u} \times \boldsymbol{v} + \boldsymbol{u} \times \boldsymbol{w}$; $(k\boldsymbol{v}) \times \boldsymbol{w} = k(\boldsymbol{v} \times \boldsymbol{w})$; $\boldsymbol{v} \times \boldsymbol{v} = \boldsymbol{0}$. Geometric interpretation of $\lvert \boldsymbol{v} \times \boldsymbol{w} \rvert$.	$\boldsymbol{v} \times \boldsymbol{w} = \lvert\boldsymbol{v}\rvert\lvert\boldsymbol{w}\rvert \sin\theta\, \boldsymbol{n}$, where θ is the angle between $\boldsymbol{v}$ and $\boldsymbol{w}$ and $\boldsymbol{n}$ is the unit normal vector whose direction is given by the right-hand screw rule. Areas of triangles and parallelograms.	**Appl:** Physics SL/HL 6.3 (magnetic force and field).
4.6	Vector equation of a plane $\boldsymbol{r} = \boldsymbol{a} + \lambda \boldsymbol{b} + \mu \boldsymbol{c}$. Use of normal vector to obtain the form $\boldsymbol{r} \cdot \boldsymbol{n} = \boldsymbol{a} \cdot \boldsymbol{n}$. Cartesian equation of a plane $ax + by + cz = d$.		
4.7	Intersections of: a line with a plane; two planes; three planes. Angle between: a line and a plane; two planes.	Link to 1.9. Geometrical interpretation of solutions.	**TOK:** Mathematics and the knower. Why are symbolic representations of three-dimensional objects easier to deal with than visual representations? What does this tell us about our knowledge of mathematics in other dimensions?

Topic 5—Core: Statistics and probability 36 hours

The aim of this topic is to introduce basic concepts. It may be considered as three parts: manipulation and presentation of statistical data (5.1), the laws of probability (5.2–5.4), and random variables and their probability distributions (5.5–5.7). It is expected that most of the calculations required will be done on a GDC. The emphasis is on understanding and interpreting the results obtained. Statistical tables will no longer be allowed in examinations.

	Content	Further guidance	Links
5.1	Concepts of population, sample, random sample and frequency distribution of discrete and continuous data. Grouped data: mid-interval values, interval width, upper and lower interval boundaries. Mean, variance, standard deviation. **Not required:** Estimation of mean and variance of a population from a sample.	For examination purposes, in papers 1 and 2 data will be treated as the population. In examinations the following formulae should be used: $\mu = \frac{\sum_{i=1}^{k} f_i x_i}{n}$, $\sigma^2 = \frac{\sum_{i=1}^{k} f_i (x_i - \mu)^2}{n} = \frac{\sum_{i=1}^{k} f_i x_i^2}{n} - \mu^2$.	**TOK:** The nature of mathematics. Why have mathematics and statistics sometimes been treated as separate subjects? **TOK:** The nature of knowing. Is there a difference between information and data? **Aim 8:** Does the use of statistics lead to an overemphasis on attributes that can easily be measured over those that cannot? **Appl:** Psychology SL/HL (descriptive statistics); Geography SL/HL (geographic skills); Biology SL/HL 1.1.2 (statistical analysis). **Appl:** Methods of collecting data in real life (census versus sampling). **Appl:** Misleading statistics in media reports.

	Content	Further guidance	Links
5.2	Concepts of trial, outcome, equally likely outcomes, sample space (U) and event. The probability of an event A as $\mathrm{P}(A) = \frac{n(A)}{n(U)}$. The complementary events A and A' (not A). Use of Venn diagrams, tree diagrams, counting principles and tables of outcomes to solve problems.		**Aim 8:** Why has it been argued that theories based on the calculable probabilities found in casinos are pernicious when applied to everyday life (eg economics)? **Int:** The development of the mathematical theory of probability in 17^{th} century France.
5.3	Combined events; the formula for $\mathrm{P}(A \cup B)$. Mutually exclusive events.		
5.4	Conditional probability; the definition $\mathrm{P}(A \mid B) = \frac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$. Independent events; the definition $\mathrm{P}(A \mid B) = \mathrm{P}(A) = \mathrm{P}(A \mid B')$. Use of Bayes' theorem for a maximum of three events.	Use of $\mathrm{P}(A \cap B) = \mathrm{P}(A)\mathrm{P}(B)$ to show independence.	**Appl:** Use of probability methods in medical studies to assess risk factors for certain diseases. **TOK:** Mathematics and knowledge claims. Is independence as defined in probabilistic terms the same as that found in normal experience?

	Content	Further guidance	Links
5.5	Concept of discrete and continuous random variables and their probability distributions. Definition and use of probability density functions.		**TOK:** Mathematics and the knower. To what extent can we trust samples of data?
	Expected value (mean), mode, median, variance and standard deviation.	For a continuous random variable, a value at which the probability density function has a maximum value is called a mode.	
	Applications.	Examples include games of chance.	**Appl:** Expected gain to insurance companies.
5.6	Binomial distribution, its mean and variance. Poisson distribution, its mean and variance. **Not required:** Formal proof of means and variances.	Link to binomial theorem in 1.3. Conditions under which random variables have these distributions.	**TOK:** Mathematics and the real world. Is the binomial distribution ever a useful model for an actual real-world situation?
5.7	Normal distribution.	Probabilities and values of the variable must be found using technology. The standardized value (z) gives the number of standard deviations from the mean.	**Appl:** Chemistry SL/HL 6.2 (collision theory); Psychology HL (descriptive statistics); Biology SL/HL 1.1.3 (statistical analysis). **Aim 8:** Why might the misuse of the normal distribution lead to dangerous inferences and conclusions?
	Properties of the normal distribution. Standardization of normal variables.	Link to 2.3.	**TOK:** Mathematics and knowledge claims. To what extent can we trust mathematical models such as the normal distribution? **Int:** De Moivre's derivation of the normal distribution and Quetelet's use of it to describe *l'homme moyen*.

Topic 6—Core: Calculus

48 hours

The aim of this topic is to introduce students to the basic concepts and techniques of differential and integral calculus and their application.

	Content	Further guidance	Links
6.1	Informal ideas of limit, continuity and convergence. Definition of derivative from first principles $f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$. The derivative interpreted as a gradient function and as a rate of change. Finding equations of tangents and normals. Identifying increasing and decreasing functions. The second derivative. Higher derivatives.	Include result $\lim_{\theta \to 0} \frac{\sin\theta}{\theta} = 1$. Link to 1.1. Use of this definition for polynomials only. Link to binomial theorem in 1.3. Both forms of notation, $\frac{dy}{dx}$ and $f'(x)$, for the first derivative. Use of both algebra and technology. Both forms of notation, $\frac{d^2y}{dx^2}$ and $f''(x)$, for the second derivative. Familiarity with the notation $\frac{d^ny}{dx^n}$ and $f^{(n)}(x)$. Link with induction in 1.4.	**TOK:** The nature of mathematics. Does the fact that Leibniz and Newton came across the calculus at similar times support the argument that mathematics exists prior to its discovery? **Int:** How the Greeks' distrust of zero meant that Archimedes' work did not lead to calculus. **Int:** Investigate attempts by Indian mathematicians (500–1000 CE) to explain division by zero. **TOK:** Mathematics and the knower. What does the dispute between Newton and Leibniz tell us about human emotion and mathematical discovery? **Appl:** Economics HL 1.5 (theory of the firm); Chemistry SL/HL 11.3.4 (graphical techniques); Physics SL/HL 2.1 (kinematics).

	Content	Further guidance	Links
6.2	Derivatives of x^n, $\sin x$, $\cos x$, $\tan x$, e^x and $\ln x$. Differentiation of sums and multiples of functions. The product and quotient rules. The chain rule for composite functions. Related rates of change. Implicit differentiation. Derivatives of $\sec x$, $\csc x$, $\cot x$, a^x, $\log_a x$, $\arcsin x$, $\arccos x$ and $\arctan x$.		**Appl:** Physics HL 2.4 (uniform circular motion); Physics 12.1 (induced electromotive force (emf)). **TOK:** Mathematics and knowledge claims. Euler was able to make important advances in mathematical analysis before calculus had been put on a solid theoretical foundation by Cauchy and others. However, some work was not possible until after Cauchy's work. What does this tell us about the importance of proof and the nature of mathematics? **TOK:** Mathematics and the real world. The seemingly abstract concept of calculus allows us to create mathematical models that permit human feats, such as getting a man on the Moon. What does this tell us about the links between mathematical models and physical reality?
6.3	Local maximum and minimum values. Optimization problems. Points of inflexion with zero and non-zero gradients. Graphical behaviour of functions, including the relationship between the graphs of f, f' and f''. **Not required:** Points of inflexion, where $f''(x)$ is not defined, for example, $y = x^{1/3}$ at $(0,0)$.	Testing for the maximum or minimum using the change of sign of the first derivative and using the sign of the second derivative. Use of the terms "concave up" for $f''(x) > 0$, "concave down" for $f''(x) < 0$. At a point of inflexion, $f''(x) = 0$ and changes sign (concavity change).	

	Content	Further guidance	Links
6.4	Indefinite integration as anti-differentiation. Indefinite integral of x^n, $\sin x$, $\cos x$ and e^x. Other indefinite integrals using the results from 6.2. The composites of any of these with a linear function.	Indefinite integral interpreted as a family of curves. $\int \frac{1}{x} \mathrm{d}x = \ln \lvert x \rvert + c$. Examples include $\int (2x-1)^5 \mathrm{d}x$, $\int \frac{1}{3x+4} \mathrm{d}x$ and $\int \frac{1}{x^2+2x+5} \mathrm{d}x$.	
6.5	Anti-differentiation with a boundary condition to determine the constant of integration. Definite integrals. Area of the region enclosed by a curve and the x-axis or y-axis in a given interval; areas of regions enclosed by curves. Volumes of revolution about the x-axis or y-axis.	The value of some definite integrals can only be found using technology.	**Appl:** Industrial design.

	Content	Further guidance	Links
6.6	Kinematic problems involving displacement *s*, velocity *v* and acceleration *a*. Total distance travelled.	$v = \frac{\mathrm{d}s}{\mathrm{d}t},\ a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2} = v\frac{\mathrm{d}v}{\mathrm{d}s}$. Total distance travelled $= \int_{t_1}^{t_2} \lvert v \rvert \,\mathrm{d}t$.	**Appl:** Physics HL 2.1 (kinematics). **Int:** Does the inclusion of kinematics as core mathematics reflect a particular cultural heritage? Who decides what is mathematics?
6.7	Integration by substitution Integration by parts.	On examination papers, non-standard substitutions will be provided. Link to 6.2. Examples: $\int x \sin x \,\mathrm{d}x$ and $\int \ln x \,\mathrm{d}x$. Repeated integration by parts. Examples: $\int x^2 \mathrm{e}^x \,\mathrm{d}x$ and $\int \mathrm{e}^x \sin x \,\mathrm{d}x$.	

Topic 7—Option: Statistics and probability

48 hours

The aims of this option are to allow students the opportunity to approach statistics in a practical way; to demonstrate a good level of statistical understanding; and to understand which situations apply and to interpret the given results. It is expected that GDCs will be used throughout this option, and that the minimum requirement of a GDC will be to find probability distribution function (pdf), cumulative distribution function (cdf), inverse cumulative distribution function, *p*-values and test statistics, including calculations for the following distributions: binomial, Poisson, normal and *t*. Students are expected to set up the problem mathematically and then read the answers from the GDC, indicating this within their written answers. Calculator-specific or brand-specific language should not be used within these explanations.

	Content	Further guidance	Links
7.1	Cumulative distribution functions for both discrete and continuous distributions. Geometric distribution. Negative binomial distribution. Probability generating functions for discrete random variables. Using probability generating functions to find mean, variance and the distribution of the sum of n independent random variables.	$G(t) = \mathrm{E}(t^X) = \sum_x P(X = x)t^x$.	**Int:** Also known as Pascal's distribution. **Aim 8:** Statistical compression of data files.
7.2	Linear transformation of a single random variable. Mean of linear combinations of n random variables. Variance of linear combinations of n independent random variables. Expectation of the product of independent random variables.	$\mathrm{E}(aX + b) = a\mathrm{E}(X) + b$, $\mathrm{Var}(aX + b) = a^2\,\mathrm{Var}(X)$. $\mathrm{E}(XY) = \mathrm{E}(X)\mathrm{E}(Y)$.	

	Content	Further guidance	Links
7.3	Unbiased estimators and estimates. Comparison of unbiased estimators based on variances. $\bar{X}$ as an unbiased estimator for μ. S^2 as an unbiased estimator for σ^2.	T is an unbiased estimator for the parameter θ if $\mathrm{E}(T) = \theta$. T_1 is a more efficient estimator than T_2 if $\mathrm{Var}(T_1) < \mathrm{Var}(T_2)$. $\bar{X} = \sum_{i=1}^{n} \frac{X_i}{n}$. $S^2 = \sum_{i=1}^{n} \frac{(X_i - \bar{X})^2}{n-1}$.	**TOK**: Mathematics and the world. In the absence of knowing the value of a parameter, will an unbiased estimator always be better than a biased one?
7.4	A linear combination of independent normal random variables is normally distributed. In particular, $X \sim \mathrm{N}(\mu, \sigma^2) \Rightarrow \bar{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$. The central limit theorem.		**Aim 8/TOK:** Mathematics and the world. “Without the central limit theorem, there could be no statistics of any value within the human sciences.” **TOK:** Nature of mathematics. The central limit theorem can be proved mathematically (formalism), but its truth can be confirmed by its applications (empiricism).

	Content	Further guidance	Links
7.5	Confidence intervals for the mean of a normal population.	Use of the normal distribution when σ is known and use of the t-distribution when σ is unknown, regardless of sample size. The case of matched pairs is to be treated as an example of a single sample technique.	**TOK:** Mathematics and the world. Claiming brand A is "better" on average than brand B can mean very little if there is a large overlap between the confidence intervals of the two means. **Appl:** Geography.
7.6	Null and alternative hypotheses, H_0 and H_1 . Significance level. Critical regions, critical values, p-values, one-tailed and two-tailed tests. Type I and II errors, including calculations of their probabilities. Testing hypotheses for the mean of a normal population.	Use of the normal distribution when σ is known and use of the t-distribution when σ is unknown, regardless of sample size. The case of matched pairs is to be treated as an example of a single sample technique.	**TOK:** Mathematics and the world. In practical terms, is saying that a result is significant the same as saying that it is true? **TOK:** Mathematics and the world. Does the ability to test only certain parameters in a population affect the way knowledge claims in the human sciences are valued? **Appl:** When is it more important not to make a Type I error and when is it more important not to make a Type II error?

	Content	Further guidance	Links
7.7	Introduction to bivariate distributions.	Informal discussion of commonly occurring situations, eg marks in pure mathematics and statistics exams taken by a class of students, salary and age of teachers in a certain school. The need for a measure of association between the variables and the possibility of predicting the value of one of the variables given the value of the other variable.	**Appl:** Geographic skills. **Aim 8:** The correlation between smoking and lung cancer was "discovered" using mathematics. Science had to justify the cause.
	Covariance and (population) product moment correlation coefficient ρ.	$\mathrm{Cov}(X,Y) = \mathrm{E}[(X-\mu_x)(Y-\mu_y)]$ $= \mathrm{E}(XY) - \mu_x\mu_y$, where $\mu_x = \mathrm{E}(X)$, $\mu_y = \mathrm{E}(Y)$. $\rho = \dfrac{\mathrm{Cov}(X,Y)}{\sqrt{\mathrm{Var}(X)\mathrm{Var}(Y)}}$.	**Appl:** Using technology to fit a range of curves to a set of data.
	Proof that $\rho = 0$ in the case of independence and ± 1 in the case of a linear relationship between X and Y.	The use of ρ as a measure of association between X and Y, with values near 0 indicating a weak association and values near +1 or near –1 indicating a strong association.	**TOK:** Mathematics and the world. Given that a set of data may be approximately fitted by a range of curves, where would we seek for knowledge of which equation is the "true" model?
	Definition of the (sample) product moment correlation coefficient R in terms of n paired observations on X and Y. Its application to the estimation of ρ.	$R = \dfrac{\sum_{i=1}^{n}(X_i-\overline{X})(Y_i-\overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\overline{X})^2\sum_{i=1}^{n}(Y_i-\overline{Y})^2}}$ $= \dfrac{\sum_{i=1}^{n}X_iY_i - n\overline{X}\,\overline{Y}}{\sqrt{\left(\sum_{i=1}^{n}X_i^2 - n\overline{X}^2\right)\left(\sum Y_i^2 - n\overline{Y}^2\right)}}$.	**Aim 8:** The physicist Frank Oppenheimer wrote: "Prediction is dependent only on the assumption that observed patterns will be repeated." This is the danger of extrapolation. There are many examples of its failure in the past, eg share prices, the spread of disease, climate change. *(continued)*

	Content	Further guidance	Links
	Informal interpretation of r, the observed value of R. Scatter diagrams.	Values of r near 0 indicate a weak association between X and Y, and values near ±1 indicate a strong association.	*(see notes above)*
	The following topics are based on the assumption of bivariate normality.	It is expected that the GDC will be used wherever possible in the following work.	
	Use of the t-statistic to test the null hypothesis $\rho = 0$.	$R\sqrt{\frac{n-2}{1-R^2}}$ has the student's t-distribution with $(n-2)$ degrees of freedom.	
	Knowledge of the facts that the regression of X on Y $\left(\mathrm{E}(X) \mid Y = y\right)$ and Y on X $\left(\mathrm{E}(Y) \mid X = x\right)$ are linear. Least-squares estimates of these regression lines (proof not required). The use of these regression lines to predict the value of one of the variables given the value of the other.	$x - \bar{x} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2}(y - \bar{y})$ $= \frac{\sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y}}{\sum_{i=1}^{n} y_i^2 - n\bar{y}^2}(y - \bar{y})$, $y - \bar{y} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}(x - \bar{x})$ $= \frac{\sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y}}{\sum_{i=1}^{n} x_i^2 - n\bar{x}^2}(x - \bar{x})$.	

Topic 8—Option: Sets, relations and groups 48 hours

The aims of this option are to provide the opportunity to study some important mathematical concepts, and introduce the principles of proof through abstract algebra.

	Content	Further guidance	Links
8.1	Finite and infinite sets. Subsets. Operations on sets: union; intersection; complement; set difference; symmetric difference.		**TOK:** Cantor theory of transfinite numbers, Russell's paradox, Godel's incompleteness theorems.
	De Morgan's laws: distributive, associative and commutative laws (for union and intersection).	Illustration of these laws using Venn diagrams. Students may be asked to prove that two sets are the same by establishing that $A \subseteq B$ and $B \subseteq A$.	**Appl:** Logic, Boolean algebra, computer circuits.
8.2	Ordered pairs: the Cartesian product of two sets.		
	Relations: equivalence relations; equivalence classes.	An equivalence relation on a set forms a partition of the set.	**Appl**, **Int:** Scottish clans.
8.3	Functions: injections; surjections; bijections.	The term codomain.	
	Composition of functions and inverse functions.	Knowledge that the function composition is not a commutative operation and that if f is a bijection from set A to set B then f^{-1} exists and is a bijection from set B to set A.	

	Content	Further guidance	Links
8.4	Binary operations. Operation tables (Cayley tables).	A binary operation $*$ on a non-empty set S is a rule for combining any two elements $a, b \in S$ to give a unique element c. That is, in this definition, a binary operation on a set is not necessarily closed.	
8.5	Binary operations: associative, distributive and commutative properties.	The arithmetic operations on and . Examples of distributivity could include the fact that, on , multiplication is distributive over addition but addition is not distributive over multiplication.	**TOK:** Which are more fundamental, the general models or the familiar examples?
8.6	The identity element e. The inverse a^{-1} of an element a. Proof that left-cancellation and right-cancellation by an element a hold, provided that a has an inverse. Proofs of the uniqueness of the identity and inverse elements.	Both the right-identity $a * e = a$ and left-identity $e * a = a$ must hold if e is an identity element. Both $a * a^{-1} = e$ and $a^{-1} * a = e$ must hold.	

	Content	Further guidance	Links
8.7	The definition of a group $\{G, *\}$. The operation table of a group is a Latin square, but the converse is false. Abelian groups.	For the set G under a given operation $*$: • G is closed under $*$; • $*$ is associative; • G contains an identity element; • each element in G has an inverse in G. $a * b = b * a$, for all $a, b \in G$.	**Appl:** Existence of formula for roots of polynomials. **Appl:** Galois theory for the impossibility of such formulae for polynomials of degree 5 or higher.
8.8	Examples of groups: • , , and under addition; • integers under addition modulo n; • non-zero integers under multiplication, modulo p, where p is prime; symmetries of plane figures, including equilateral triangles and rectangles; invertible functions under composition of functions.	The composition $T_2 \; T_1$ denotes T_1 followed by T_2.	**Appl:** Rubik’s cube, time measures, crystal structure, symmetries of molecules, strut and cable constructions, Physics H2.2 (special relativity), the 8–fold way, supersymmetry.
8.9	The order of a group. The order of a group element. Cyclic groups. Generators. Proof that all cyclic groups are Abelian.		**Appl:** Music circle of fifths, prime numbers.

	Content	Further guidance	Links
8.10	Permutations under composition of permutations. Cycle notation for permutations. Result that every permutation can be written as a composition of disjoint cycles. The order of a combination of cycles.	On examination papers: the form $p = \begin{pmatrix} 1 & 2 & 3 \\ 3 & 1 & 2 \end{pmatrix}$ or in cycle notation (132) will be used to represent the permutation $1 \to 3$, $2 \to 1$, $3 \to 2$.	**Appl:** Cryptography, campanology.
8.11	Subgroups, proper subgroups.	A proper subgroup is neither the group itself nor the subgroup containing only the identity element.	
	Use and proof of subgroup tests.	Suppose that $\{G, *\}$ is a group and H is a non-empty subset of G. Then $\{H, *\}$ is a subgroup of $\{G, *\}$ if $a * b^{-1} \in H$ whenever $a, b \in H$. Suppose that $\{G, *\}$ is a finite group and H is a non-empty subset of G. Then $\{H, *\}$ is a subgroup of $\{G, *\}$ if H is closed under $*$.	
	Definition and examples of left and right cosets of a subgroup of a group.		
	Lagrange's theorem. Use and proof of the result that the order of a finite group is divisible by the order of any element. (Corollary to Lagrange's theorem.)		**Appl:** Prime factorization, symmetry breaking.

	Content	Further guidance	Links
8.12	Definition of a group homomorphism.	Infinite groups as well as finite groups. Let $\{G,*\}$ and $\{H, \}$ be groups, then the function $f: G \to H$ is a homomorphism if $f(a*b) = f(a) f(b)$ for all $a, b \in G$.	
	Definition of the kernel of a homomorphism. Proof that the kernel and range of a homomorphism are subgroups.	If $f: G \to H$ is a group homomorphism, then $\text{Ker}(f)$ is the set of $a \in G$ such that $f(a) = e_H$.	
	Proof of homomorphism properties for identities and inverses.	Identity: let e_G and e_H be the identity elements of $(G,*)$ and $(H,)$, respectively, then $f(e_G) = e_H$. Inverse: $f(a^{-1}) = (f(a))^{-1}$ for all $a \in G$.	
	Isomorphism of groups.	Infinite groups as well as finite groups. The homomorphism $f: G \to H$ is an isomorphism if f is bijective.	
	The order of an element is unchanged by an isomorphism.		

Topic 9—Option: Calculus

48 hours

The aims of this option are to introduce limit theorems and convergence of series, and to use calculus results to solve differential equations.

	Content	Further guidance	Links
9.1	Infinite sequences of real numbers and their convergence or divergence.	Informal treatment of limit of sum, difference, product, quotient; squeeze theorem. Divergent is taken to mean not convergent.	**TOK:** Zeno's paradox, impact of infinite sequences and limits on our understanding of the physical world.
9.2	Convergence of infinite series. Tests for convergence: comparison test; limit comparison test; ratio test; integral test.	The sum of a series is the limit of the sequence of its partial sums. Students should be aware that if $\lim_{x\to\infty} x_n = 0$ then the series is not necessarily convergent, but if $\lim_{x\to\infty} x_n \neq 0$, the series diverges.	**TOK:** Euler's idea that $1 - 1 + 1 - 1 + \dots = \frac{1}{2}$. Was it a mistake or just an alternative view?
	The p-series, $\sum \frac{1}{n^p}$.	$\sum \frac{1}{n^p}$ is convergent for $p > 1$ and divergent otherwise. When $p = 1$, this is the harmonic series.	
	Series that converge absolutely. Series that converge conditionally.	Conditions for convergence.	
	Alternating series. Power series: radius of convergence and interval of convergence. Determination of the radius of convergence by the ratio test.	The absolute value of the truncation error is less than the next term in the series.	

	Content	Further guidance	Links
9.3	Continuity and differentiability of a function at a point. Continuous functions and differentiable functions.	Test for continuity: $\lim_{x \to a^-} f(x) = f(a) = \lim_{x \to a^+} f(x)$. Test for differentiability: f is continuous at a and $\lim_{h \to 0^-} \frac{f(a+h) - f(a)}{h}$ and $\lim_{h \to 0^+} \frac{f(a+h) - f(a)}{h}$ exist and are equal. Students should be aware that a function may be continuous but not differentiable at a point, eg $f(x) = \lvert x \rvert$ and simple piecewise functions.	
9.4	The integral as a limit of a sum; lower and upper Riemann sums. Fundamental theorem of calculus. Improper integrals of the type $\int_a^\infty f(x)\,dx$.	 $\frac{d}{dx} \int_a^x f(y)\,dy = f(x)$.	**Int:** How close was Archimedes to integral calculus? **Int:** Contribution of Arab, Chinese and Indian mathematicians to the development of calculus. **Aim 8:** Leibniz versus Newton versus the “giants” on whose shoulders they stood—who deserves credit for mathematical progress? **TOK:** Consider $f(x) = \frac{1}{x}$, $1 \le x \le \infty$. An infinite area sweeps out a finite volume. Can this be reconciled with our intuition? What does this tell us about mathematical knowledge?

	Content	Further guidance	Links
9.5	First-order differential equations. Geometric interpretation using slope fields, including identification of isoclines. Numerical solution of $\frac{dy}{dx} = f(x, y)$ using Euler's method. Variables separable. Homogeneous differential equation $\frac{dy}{dx} = f\left(\frac{y}{x}\right)$ using the substitution $y = vx$. Solution of $y' + P(x)y = Q(x)$, using the integrating factor.	$y_{n+1} = y_n + hf(x_n, y_n)$, $x_{n+1} = x_n + h$, where h is a constant.	**Appl:** Real-life differential equations, eg Newton's law of cooling, population growth, carbon dating.
9.6	Rolle's theorem. Mean value theorem. Taylor polynomials; the Lagrange form of the error term. Maclaurin series for e^x, $\sin x$, $\cos x$, $\ln(1+x)$, $(1+x)^p$, $p \in$. Use of substitution, products, integration and differentiation to obtain other series. Taylor series developed from differential equations.	Applications to the approximation of functions; formula for the error term, in terms of the value of the $(n+1)^{\text{th}}$ derivative at an intermediate point. Students should be aware of the intervals of convergence.	**Int, TOK:** Influence of Bourbaki on understanding and teaching of mathematics. **Int:** Compare with work of the Kerala school.

	Content	Further guidance	Links
9.7	The evaluation of limits of the form $\lim\limits_{x \to a} \frac{f(x)}{g(x)}$ and $\lim\limits_{x \to \infty} \frac{f(x)}{g(x)}$. Using l'Hôpital's rule or the Taylor series.	The indeterminate forms $\frac{0}{0}$ and $\frac{\infty}{\infty}$. Repeated use of l'Hôpital's rule.	

Topic 10—Option: Discrete mathematics

48 hours

The aim of this option is to provide the opportunity for students to engage in logical reasoning, algorithmic thinking and applications.

	Content	Further guidance	Links
10.1	Strong induction. Pigeon-hole principle.	For example, proofs of the fundamental theorem of arithmetic and the fact that a tree with n vertices has $n-1$ edges.	**TOK:** Mathematics and knowledge claims. The difference between proof and conjecture, eg Goldbach's conjecture. Can a mathematical statement be true before it is proven? **TOK:** Proof by contradiction.
10.2	$a \mid b \Rightarrow b = na$ for some $n \in$.		
	The theorem $a \mid b$ and $a \mid c \Rightarrow a \mid (bx \pm cy)$ where $x, y \in$.	The division algorithm $a = bq + r$, $0 \le r < b$.	
	Division and Euclidean algorithms. The greatest common divisor, gcd(a, b), and the least common multiple, lcm(a, b), of integers a and b. Prime numbers; relatively prime numbers and the fundamental theorem of arithmetic.	The Euclidean algorithm for determining the greatest common divisor of two integers.	**Int:** Euclidean algorithm contained in Euclid's *Elements*, written in Alexandria about 300 BCE. **Aim 8:** Use of prime numbers in cryptography. The possible impact of the discovery of powerful factorization techniques on internet and bank security.
10.3	Linear Diophantine equations $ax + by = c$.	General solutions required and solutions subject to constraints. For example, all solutions must be positive.	**Int:** Described in Diophantus' *Arithmetica* written in Alexandria in the 3rd century CE. When studying *Arithmetica*, a French mathematician, Pierre de Fermat (1601–1665) wrote in the margin that he had discovered a simple proof regarding higher-order Diophantine equations—Fermat's last theorem.

	Content	Further guidance	Links
10.4	Modular arithmetic. The solution of linear congruences. Solution of simultaneous linear congruences (Chinese remainder theorem).		**Int:** Discussed by Chinese mathematician Sun Tzu in the 3rd century CE.
10.5	Representation of integers in different bases.	On examination papers, questions that go beyond base 16 will not be set.	**Int:** Babylonians developed a base 60 number system and the Mayans a base 20 number system.
10.6	Fermat's little theorem.	$a^p = a \pmod{p}$, where p is prime.	**TOK:** Nature of mathematics. An interest may be pursued for centuries before becoming "useful".

	Content	Further guidance	Links
10.7	Graphs, vertices, edges, faces. Adjacent vertices, adjacent edges. Degree of a vertex, degree sequence. Handshaking lemma.	Two vertices are adjacent if they are joined by an edge. Two edges are adjacent if they have a common vertex.	**Aim 8:** Symbolic maps, eg Metro and Underground maps, structural formulae in chemistry, electrical circuits. **TOK:** Mathematics and knowledge claims. Proof of the four-colour theorem. If a theorem is proved by computer, how can we claim to know that it is true?
	Simple graphs; connected graphs; complete graphs; bipartite graphs; planar graphs; trees; weighted graphs, including tabular representation. Subgraphs; complements of graphs.	It should be stressed that a graph should not be assumed to be simple unless specifically stated. The term adjacency table may be used.	**Aim 8:** Importance of planar graphs in constructing circuit boards.
	Euler's relation: $v - e + f = 2$; theorems for planar graphs including $e \leq 3v - 6$, $e \leq 2v - 4$, leading to the results that κ_5 and $\kappa_{3,3}$ are not planar.	If the graph is simple and planar and $v \geq 3$, then $e \leq 3v - 6$. If the graph is simple, planar, has no cycles of length 3 and $v \geq 3$, then $e \leq 2v - 4$.	**TOK:** Mathematics and knowledge claims. Applications of the Euler characteristic $(v - e + f)$ to higher dimensions. Its use in understanding properties of shapes that cannot be visualized.
10.8	Walks, trails, paths, circuits, cycles.		
	Eulerian trails and circuits.	A connected graph contains an Eulerian circuit if and only if every vertex of the graph is of even degree.	**Int:** The "Bridges of Königsberg" problem.
	Hamiltonian paths and cycles.	Simple treatment only.	
10.9	Graph algorithms: Kruskal's; Dijkstra's.		

	Content	Further guidance	Links
10.10	Chinese postman problem. **Not required:** Graphs with more than four vertices of odd degree.	To determine the shortest route around a weighted graph going along each edge at least once.	**Int:** Problem posed by the Chinese mathematician Kwan Mei-Ko in 1962.
	Travelling salesman problem. Nearest-neighbour algorithm for determining an upper bound. Deleted vertex algorithm for determining a lower bound.	To determine the Hamiltonian cycle of least weight in a weighted complete graph.	**TOK:** Mathematics and knowledge claims. How long would it take a computer to test all Hamiltonian cycles in a complete, weighted graph with just 30 vertices?
10.11	Recurrence relations. Initial conditions, recursive definition of a sequence.		**TOK:** Mathematics and the world. The connections of sequences such as the Fibonacci
	Solution of first- and second-degree linear homogeneous recurrence relations with constant coefficients. The first-degree linear recurrence relation $u_n = au_{n-1} + b$.	Includes the cases where auxiliary equation has equal roots or complex roots.	sequence with art and biology.
	Modelling with recurrence relations.	Solving problems such as compound interest, debt repayment and counting problems.	

Topic 1—Algebra 9 hours

The aim of this topic is to introduce students to some basic algebraic concepts and applications.

	Content	Further guidance	Links
1.1	Arithmetic sequences and series; sum of finite arithmetic series; geometric sequences and series; sum of finite and infinite geometric series. Sigma notation.	Technology may be used to generate and display sequences in several ways. Link to 2.6, exponential functions.	**Int:** The chess legend (Sissa ibn Dahir). **Int:** Aryabhatta is sometimes considered the “father of algebra”. Compare with al-Khawarizmi. **TOK:** How did Gauss add up integers from 1 to 100? Discuss the idea of mathematical intuition as the basis for formal proof. **TOK:** Debate over the validity of the notion of “infinity”: finitists such as L. Kronecker consider that “a mathematical object does not exist unless it can be constructed from natural numbers in a finite number of steps”. **TOK:** What is Zeno’s dichotomy paradox? How far can mathematical facts be from intuition?
	Applications.	Examples include compound interest and population growth.	

	Content	Further guidance	Links
1.2	Elementary treatment of exponents and logarithms. Laws of exponents; laws of logarithms. Change of base.	*Examples*: $16^{\frac{3}{4}} = 8$; $\frac{3}{4} = \log_{16} 8$; $\log 32 = 5\log 2$; $(2^3)^{-4} = 2^{-12}$. *Examples*: $\log_4 7 = \frac{\ln 7}{\ln 4}$, $\log_{25} 125 = \frac{\log_5 125}{\log_5 25}\left(=\frac{3}{2}\right)$. Link to 2.6, logarithmic functions.	**Appl:** Chemistry 18.1 (Calculation of pH). **TOK:** Are logarithms an invention or discovery? (This topic is an opportunity for teachers to generate reflection on “the nature of mathematics”.)
1.3	The binomial theorem: expansion of $(a+b)^n$, $n \in \mathbb{N}$. Calculation of binomial coefficients using Pascal’s triangle and $\binom{n}{r}$. **Not required:** formal treatment of permutations and formula for ${}^nP_r$.	Counting principles may be used in the development of the theorem. $\binom{n}{r}$ should be found using **both** the formula and technology. *Example*: finding $\binom{6}{r}$ from inputting $y = 6^nC_rX$ and then reading coefficients from the table. Link to 5.8, binomial distribution.	**Aim 8:** Pascal’s triangle. Attributing the origin of a mathematical discovery to the wrong mathematician. **Int:** The so-called “Pascal’s triangle” was known in China much earlier than Pascal.

Topic 2—Functions and equations 24 hours

The aims of this topic are to explore the notion of a function as a unifying theme in mathematics, and to apply functional methods to a variety of mathematical situations. It is expected that extensive use will be made of technology in both the development and the application of this topic, rather than elaborate analytical techniques. On examination papers, questions may be set requiring the graphing of functions that do not explicitly appear on the syllabus, and students may need to choose the appropriate viewing window. For those functions explicitly mentioned, questions may also be set on composition of these functions with the linear function $y = ax + b$.

	Content	Further guidance	Links
2.1	Concept of function $f : x \mapsto f(x)$. Domain, range; image (value).	*Example*: for $x \mapsto \sqrt{2-x}$, domain is $x \leq 2$, range is $y \geq 0$. A graph is helpful in visualizing the range.	**Int:** The development of functions, Rene Descartes (France), Gottfried Wilhelm Leibniz (Germany) and Leonhard Euler (Switzerland).
	Composite functions.	$(f \circ g)(x) = f(g(x))$.	**TOK:** Is zero the same as “nothing”? **TOK:** Is mathematics a formal language?
	Identity function. Inverse function f^{-1}.	$(f \circ f^{-1})(x) = (f^{-1} \circ f)(x) = x$.	
	Not required: domain restriction.	On examination papers, students will only be asked to find the inverse of a *one-to-one* function.	
2.2	The graph of a function; its equation $y = f(x)$.		**Appl:** Chemistry 11.3.1 (sketching and interpreting graphs); geographic skills.
	Function graphing skills. Investigation of key features of graphs, such as maximum and minimum values, intercepts, horizontal and vertical asymptotes, symmetry, and consideration of domain and range.	**Note** the difference in the command terms “draw” and “sketch”.	**TOK:** How accurate is a visual representation of a mathematical concept? (Limits of graphs in delivering information about functions and phenomena in general, relevance of modes of representation.)
	Use of technology to graph a variety of functions, including ones not specifically mentioned.	An analytic approach is also expected for simple functions, including all those listed under topic 2.	
	The graph of $y = f^{-1}(x)$ as the reflection in the line $y = x$ of the graph of $y = f(x)$.	Link to 6.3, local maximum and minimum points.	

	Content	Further guidance	Links
2.3	Transformations of graphs. Translations: $y = f(x) + b$; $y = f(x - a)$. Reflections (in both axes): $y = -f(x)$; $y = f(-x)$. Vertical stretch with scale factor *p*: $y = pf(x)$. Stretch in the *x*-direction with scale factor $\frac{1}{q}$: $y = f\left(qx\right)$. Composite transformations.	Technology should be used to investigate these transformations. Translation by the vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ denotes horizontal shift of 3 units to the right, and vertical shift of 2 down. *Example*: $y = x^2$ used to obtain $y = 3x^2 + 2$ by a stretch of scale factor 3 in the *y*-direction followed by a translation of $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$.	**Appl:** Economics 1.1 (shifting of supply and demand curves).
2.4	The quadratic function $x \mapsto ax^2 + bx + c$: its graph, *y*-intercept $(0, c)$. Axis of symmetry. The form $x \mapsto a(x - p)(x - q)$, *x*-intercepts $(p, 0)$ and $(q, 0)$. The form $x \mapsto a(x - h)^2 + k$, vertex (h, k).	Candidates are expected to be able to change from one form to another. Links to 2.3, transformations; 2.7, quadratic equations.	**Appl:** Chemistry 17.2 (equilibrium law). **Appl:** Physics 2.1 (kinematics). **Appl:** Physics 4.2 (simple harmonic motion). **Appl:** Physics 9.1 (HL only) (projectile motion).

	Content	Further guidance	Links
2.5	The reciprocal function $x \mapsto \frac{1}{x}$, $x \neq 0$: its graph and self-inverse nature. The rational function $x \mapsto \frac{ax+b}{cx+d}$ and its graph. Vertical and horizontal asymptotes.	*Examples*: $h(x) = \frac{4}{3x-2}$, $x \neq \frac{2}{3}$; $y = \frac{x+7}{2x-5}$, $x \neq \frac{5}{2}$. Diagrams should include all asymptotes and intercepts.	
2.6	Exponential functions and their graphs: $x \mapsto a^x$, $a > 0$, $x \mapsto \mathrm{e}^x$. Logarithmic functions and their graphs: $x \mapsto \log_a x$, $x > 0$, $x \mapsto \ln x$, $x > 0$. Relationships between these functions: $a^x = \mathrm{e}^{x \ln a}$; $\log_a a^x = x$; $a^{\log_a x} = x$, $x > 0$.	Links to 1.1, geometric sequences; 1.2, laws of exponents and logarithms; 2.1, inverse functions; 2.2, graphs of inverses; and 6.1, limits.	**Int:** The Babylonian method of multiplication: $ab = \frac{(a+b)^2 - a^2 - b^2}{2}$. Sulba Sutras in ancient India and the Bakhshali Manuscript contained an algebraic formula for solving quadratic equations.

	Content	Further guidance	Links
2.7	Solving equations, both graphically and analytically. Use of technology to solve a variety of equations, including those where there is no appropriate analytic approach. Solving $ax^2 + bx + c = 0$, $a \neq 0$. The quadratic formula. The discriminant $\Delta = b^2 - 4ac$ and the nature of the roots, that is, two distinct real roots, two equal real roots, no real roots. Solving exponential equations.	Solutions may be referred to as roots of equations or zeros of functions. Links to 2.2, function graphing skills; and 2.3–2.6, equations involving specific functions. *Examples*: $\mathrm{e}^x = \sin x$, $x^4 + 5x - 6 = 0$. *Example*: Find k given that the equation $3kx^2 + 2x + k = 0$ has two equal real roots. *Examples*: $2^{x-1} = 10$, $\left(\frac{1}{3}\right)^x = 9^{x+1}$. Link to 1.2, exponents and logarithms.	
2.8	Applications of graphing skills and solving equations that relate to real-life situations.	Link to 1.1, geometric series.	**Appl:** Compound interest, growth and decay; projectile motion; braking distance; electrical circuits. **Appl:** Physics 7.2.7–7.2.9, 13.2.5, 13.2.6, 13.2.8 (radioactive decay and half-life)

Topic 3—Circular functions and trigonometry 16 hours

The aims of this topic are to explore the circular functions and to solve problems using trigonometry. On examination papers, radian measure should be assumed unless otherwise indicated.

	Content	Further guidance	Links
3.1	The circle: radian measure of angles; length of an arc; area of a sector.	Radian measure may be expressed as exact multiples of π, or decimals.	**Int:** Seki Takakazu calculating π to ten decimal places. **Int:** Hipparchus, Menelaus and Ptolemy. **Int:** Why are there 360 degrees in a complete turn? Links to Babylonian mathematics. **TOK:** Which is a better measure of angle: radian or degree? What are the "best" criteria by which to decide? **TOK:** Euclid's axioms as the building blocks of Euclidean geometry. Link to non-Euclidean geometry.
3.2	Definition of $\cos\theta$ and $\sin\theta$ in terms of the unit circle. Definition of $\tan\theta$ as $\frac{\sin\theta}{\cos\theta}$. Exact values of trigonometric ratios of $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}$ and their multiples.	The equation of a straight line through the origin is $y = x\tan\theta$. *Examples*: $\sin\frac{\pi}{3} = \frac{\sqrt{3}}{2}$, $\cos\frac{3\pi}{4} = -\frac{1}{\sqrt{2}}$, $\tan 210° = \frac{\sqrt{3}}{3}$.	**Aim 8:** Who really invented "Pythagoras' theorem"? **Int:** The first work to refer explicitly to the sine as a function of an angle is the Aryabhatiya of Aryabhata (ca. 510). **TOK:** Trigonometry was developed by successive civilizations and cultures. How is mathematical knowledge considered from a sociocultural perspective?

	Content	Further guidance	Links
3.3	The Pythagorean identity $\cos^2\theta + \sin^2\theta = 1$. Double angle identities for sine and cosine.	Simple geometrical diagrams and/or technology may be used to illustrate the double angle formulae (and other trigonometric identities).	
	Relationship between trigonometric ratios.	*Examples*: Given $\sin\theta$, finding possible values of $\tan\theta$ without finding θ. Given $\cos x = \frac{3}{4}$, and x is acute, find $\sin 2x$ without finding x.	
3.4	The circular functions $\sin x$, $\cos x$ and $\tan x$: their domains and ranges; amplitude, their periodic nature; and their graphs.		**Appl:** Physics 4.2 (simple harmonic motion).
	Composite functions of the form $f(x) = a\sin\left(b(x+c)\right) + d$.	*Examples*: $f(x) = \tan\left(x - \frac{\pi}{4}\right)$, $f(x) = 2\cos\left(3(x-4)\right) + 1$.	
	Transformations.	*Example*: $y = \sin x$ used to obtain $y = 3\sin 2x$ by a stretch of scale factor 3 in the y-direction and a stretch of scale factor $\frac{1}{2}$ in the x-direction. Link to 2.3, transformation of graphs.	
	Applications.	Examples include height of tide, motion of a Ferris wheel.	

	Content	Further guidance	Links
3.5	Solving trigonometric equations in a finite interval, both graphically and analytically.	*Examples*: $2\sin x = 1$, $0 \le x \le 2\pi$, $2\sin 2x = 3\cos x$, $0^{\circ} \le x \le 180^{\circ}$, $2\tan\left(3(x-4)\right) = 1$, $-\pi \le x \le 3\pi$.	
	Equations leading to quadratic equations in $\sin x$, $\cos x$ or $\tan x$. **Not required:** the general solution of trigonometric equations.	*Examples*: $2\sin^2 x + 5\cos x + 1 = 0$ for $0 \le x < 4\pi$, $2\sin x = \cos 2x$, $-\pi \le x \le \pi$.	
3.6	Solution of triangles.	Pythagoras' theorem is a special case of the cosine rule.	**Aim 8:** Attributing the origin of a mathematical discovery to the wrong mathematician. **Int:** Cosine rule: Al-Kashi and Pythagoras.
	The cosine rule. The sine rule, including the ambiguous case.	Link with 4.2, scalar product, noting that: $\boldsymbol{c} = \boldsymbol{a} - \boldsymbol{b} \Rightarrow \lvert \boldsymbol{c} \rvert^2 = \lvert \boldsymbol{a} \rvert^2 + \lvert \boldsymbol{b} \rvert^2 - 2\boldsymbol{a} \cdot \boldsymbol{b}$.	
	Area of a triangle, $\frac{1}{2}ab\sin C$.		
	Applications.	Examples include navigation, problems in two and three dimensions, including angles of elevation and depression.	**TOK:** Non-Euclidean geometry: angle sum on a globe greater than 180°.

Topic 4—Vectors 16 hours

The aim of this topic is to provide an elementary introduction to vectors, including both algebraic and geometric approaches. The use of dynamic geometry software is extremely helpful to visualize situations in three dimensions.

	Content	Further guidance	Links
4.1	Vectors as displacements in the plane and in three dimensions.	Link to three-dimensional geometry, x, y and z-axes.	**Appl:** Physics 1.3.2 (vector sums and differences) Physics 2.2.2, 2.2.3 (vector resultants). **TOK:** How do we relate a theory to the author? Who developed vector analysis: JW Gibbs or O Heaviside?
	Components of a vector; column representation; $\boldsymbol{v}=\begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix}=v_1\boldsymbol{i}+v_2\boldsymbol{j}+v_3\boldsymbol{k}$.	Components are with respect to the unit vectors $\boldsymbol{i}$, $\boldsymbol{j}$ and $\boldsymbol{k}$ (standard basis).	
	Algebraic and geometric approaches to the following:	Applications to simple geometric figures are essential.	
	• the sum and difference of two vectors; the zero vector, the vector $-\boldsymbol{v}$;	The difference of $\boldsymbol{v}$ and $\boldsymbol{w}$ is $\boldsymbol{v}-\boldsymbol{w}=\boldsymbol{v}+(-\boldsymbol{w})$. Vector sums and differences can be represented by the diagonals of a parallelogram.	
	• multiplication by a scalar, $k\boldsymbol{v}$; parallel vectors;	Multiplication by a scalar can be illustrated by enlargement.	
	• magnitude of a vector, $\lvert\boldsymbol{v}\rvert$;		
	• unit vectors; base vectors; $\boldsymbol{i}$, $\boldsymbol{j}$ and $\boldsymbol{k}$;		
	• position vectors $\overrightarrow{\text{OA}}=\boldsymbol{a}$;		
	• $\overrightarrow{\text{AB}}=\overrightarrow{\text{OB}}-\overrightarrow{\text{OA}}=\boldsymbol{b}-\boldsymbol{a}$.	Distance between points A and B is the magnitude of $\overrightarrow{\text{AB}}$.	

	Content	Further guidance	Links
4.2	The scalar product of two vectors. Perpendicular vectors; parallel vectors. The angle between two vectors.	The scalar product is also known as the "dot product". Link to 3.6, cosine rule. For non-zero vectors, $\boldsymbol{v} \cdot \boldsymbol{w} = 0$ is equivalent to the vectors being perpendicular. For parallel vectors, $\boldsymbol{w} = k\boldsymbol{v}$, $\lvert \boldsymbol{v} \cdot \boldsymbol{w} \rvert = \lvert \boldsymbol{v} \rvert \lvert \boldsymbol{w} \rvert$.	
4.3	Vector equation of a line in two and three dimensions: $\boldsymbol{r} = \boldsymbol{a} + t\boldsymbol{b}$. The angle between two lines.	Relevance of $\boldsymbol{a}$ (position) and $\boldsymbol{b}$ (direction). Interpretation of t as time and $\boldsymbol{b}$ as velocity, with $\lvert \boldsymbol{b} \rvert$ representing speed.	**Aim 8:** Vector theory is used for tracking displacement of objects, including for peaceful and harmful purposes. **TOK:** Are algebra and geometry two separate domains of knowledge? (Vector algebra is a good opportunity to discuss how geometrical properties are described and generalized by algebraic methods.)
4.4	Distinguishing between coincident and parallel lines. Finding the point of intersection of two lines. Determining whether two lines intersect.		

Topic 5—Statistics and probability 35 hours

The aim of this topic is to introduce basic concepts. It is expected that most of the calculations required will be done using technology, but explanations of calculations by hand may enhance understanding. The emphasis is on understanding and interpreting the results obtained, in context. Statistical tables will no longer be allowed in examinations. While many of the calculations required in examinations are estimates, it is likely that the command terms “write down”, “find” and “calculate” will be used.

	Content	Further guidance	Links
5.1	Concepts of population, sample, random sample, discrete and continuous data. Presentation of data: frequency distributions (tables); frequency histograms with equal class intervals; box-and-whisker plots; outliers. Grouped data: use of mid-interval values for calculations; interval width; upper and lower interval boundaries; modal class. **Not required:** frequency density histograms.	Continuous and discrete data. Outlier is defined as more than $1.5 \times \text{IQR}$ from the nearest quartile. Technology may be used to produce histograms and box-and-whisker plots.	**Appl:** Psychology: descriptive statistics, random sample (various places in the guide). **Aim 8:** Misleading statistics. **Int:** The St Petersburg paradox, Chebychev, Pavlovsky.

	Content	Further guidance	Links
5.2	Statistical measures and their interpretations. Central tendency: mean, median, mode. Quartiles, percentiles. Dispersion: range, interquartile range, variance, standard deviation. Effect of constant changes to the original data. Applications.	On examination papers, data will be treated as the population. Calculation of mean using formula and technology. Students should use mid-interval values to estimate the mean of grouped data. Calculation of standard deviation/variance using only technology. Link to 2.3, transformations. *Examples*: If 5 is subtracted from all the data items, then the mean is decreased by 5, but the standard deviation is unchanged. If all the data items are doubled, the median is doubled, but the variance is increased by a factor of 4.	**Appl:** Psychology: descriptive statistics (various places in the guide). **Appl:** Statistical calculations to show patterns and changes; geographic skills; statistical graphs. **Appl:** Biology 1.1.2 (calculating mean and standard deviation); Biology 1.1.4 (comparing means and spreads between two or more samples). **Int:** Discussion of the different formulae for variance. **TOK:** Do different measures of central tendency express different properties of the data? Are these measures invented or discovered? Could mathematics make alternative, equally true, formulae? What does this tell us about mathematical truths? **TOK:** How easy is it to lie with statistics?
5.3	Cumulative frequency; cumulative frequency graphs; use to find median, quartiles, percentiles.	Values of the median and quartiles produced by technology may be different from those obtained from a cumulative frequency graph.	

	Content	Further guidance	Links
5.4	Linear correlation of bivariate data. Pearson's product–moment correlation coefficient r. Scatter diagrams; lines of best fit. Equation of the regression line of y on x. Use of the equation for prediction purposes. Mathematical and contextual interpretation. **Not required:** the coefficient of determination R^2.	Independent variable x, dependent variable y. Technology should be used to calculate r. However, hand calculations of r may enhance understanding. Positive, zero, negative; strong, weak, no correlation. The line of best fit passes through the mean point. Technology should be used find the equation. Interpolation, extrapolation.	**Appl:** Chemistry 11.3.3 (curves of best fit). **Appl:** Geography (geographic skills). Measures of correlation; geographic skills. **Appl:** Biology 1.1.6 (correlation does not imply causation). **TOK:** Can we predict the value of x from y, using this equation? **TOK:** Can all data be modelled by a (known) mathematical function? Consider the reliability and validity of mathematical models in describing real-life phenomena.
5.5	Concepts of trial, outcome, equally likely outcomes, sample space (U) and event. The probability of an event A is $\mathrm{P}(A)=\frac{n(A)}{n(U)}$. The complementary events A and A' (not A). Use of Venn diagrams, tree diagrams and tables of outcomes.	The sample space can be represented diagrammatically in many ways. Experiments using coins, dice, cards and so on, can enhance understanding of the distinction between (experimental) relative frequency and (theoretical) probability. Simulations may be used to enhance this topic. Links to 5.1, frequency; 5.3, cumulative frequency.	**TOK:** To what extent does mathematics offer models of real life? Is there always a function to model data behaviour?

	Content	Further guidance	Links
5.6	Combined events, $\mathrm{P}(A \cup B)$. Mutually exclusive events: $\mathrm{P}(A \cap B) = 0$. Conditional probability; the definition $\mathrm{P}(A \mid B) = \dfrac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$. Independent events; the definition $\mathrm{P}(A \mid B) = \mathrm{P}(A) = \mathrm{P}(A \mid B')$. Probabilities with and without replacement.	The non-exclusivity of “or”. Problems are often best solved with the aid of a Venn diagram or tree diagram, without explicit use of formulae.	**Aim 8:** The gambling issue: use of probability in casinos. Could or should mathematics help increase incomes in gambling? **TOK:** Is mathematics useful to measure risks? **TOK:** Can gambling be considered as an application of mathematics? (This is a good opportunity to generate a debate on the nature, role and ethics of mathematics regarding its applications.)
5.7	Concept of discrete random variables and their probability distributions. Expected value (mean), $\mathrm{E}(X)$ for discrete data. Applications.	Simple examples only, such as: $\mathrm{P}(X = x) = \frac{1}{18}(4 + x)$ for $x \in \{1, 2, 3\}$; $\mathrm{P}(X = x) = \frac{5}{18}, \frac{6}{18}, \frac{7}{18}$. $\mathrm{E}(X) = 0$ indicates a fair game where X represents the gain of one of the players. Examples include games of chance.	

	Content	Further guidance	Links
5.8	Binomial distribution. Mean and variance of the binomial distribution. **Not required:** formal proof of mean and variance.	Link to 1.3, binomial theorem. Conditions under which random variables have this distribution. Technology is usually the best way of calculating binomial probabilities.	
5.9	Normal distributions and curves. Standardization of normal variables (z-values, z-scores). Properties of the normal distribution.	Probabilities and values of the variable must be found using technology. Link to 2.3, transformations. The standardized value (z) gives the number of standard deviations from the mean.	**Appl:** Biology 1.1.3 (links to normal distribution). **Appl:** Psychology: descriptive statistics (various places in the guide).

Topic 6—Calculus 40 hours

The aim of this topic is to introduce students to the basic concepts and techniques of differential and integral calculus and their applications.

	Content	Further guidance	Links
6.1	Informal ideas of limit and convergence. Limit notation. Definition of derivative from first principles as $f'(x)=\lim_{h\to 0}\left(\frac{f(x+h)-f(x)}{h}\right)$. Derivative interpreted as gradient function and as rate of change. Tangents and normals, and their equations. **Not required:** analytic methods of calculating limits.	*Example*: 0.3, 0.33, 0.333, ... converges to $\frac{1}{3}$. Technology should be used to explore ideas of limits, numerically and graphically. *Example*: $\lim_{x\to\infty}\left(\frac{2x+3}{x-1}\right)$ Links to 1.1, infinite geometric series; 2.5–2.7, rational and exponential functions, and asymptotes. Use of this definition for derivatives of simple polynomial functions only. Technology could be used to illustrate other derivatives. Link to 1.3, binomial theorem. Use of both forms of notation, $\frac{\mathrm{d}y}{\mathrm{d}x}$ and $f'(x)$, for the first derivative. Identifying intervals on which functions are increasing or decreasing. Use of both analytic approaches and technology. Technology can be used to explore graphs and their derivatives.	**Appl:** Economics 1.5 (marginal cost, marginal revenue, marginal profit). **Appl:** Chemistry 11.3.4 (interpreting the gradient of a curve). **Aim 8:** The debate over whether Newton or Leibnitz discovered certain calculus concepts. **TOK:** What value does the knowledge of limits have? Is infinitesimal behaviour applicable to real life? **TOK:** Opportunities for discussing hypothesis formation and testing, and then the formal proof can be tackled by comparing certain cases, through an investigative approach.

	Content	Further guidance	Links
6.2	Derivative of x^n $(n \in \mathbb{Q})$, $\sin x$, $\cos x$, $\tan x$, e^x and $\ln x$.		
	Differentiation of a sum and a real multiple of these functions.		
	The chain rule for composite functions.	Link to 2.1, composition of functions.	
	The product and quotient rules.	Technology may be used to investigate the chain rule.	
	The second derivative.	Use of both forms of notation, $\frac{d^2y}{dx^2}$ and $f''(x)$.	
	Extension to higher derivatives.	$\frac{d^ny}{dx^n}$ and $f^{(n)}(x)$.	

	Content	Further guidance	Links
6.3	Local maximum and minimum points. Testing for maximum or minimum.	Using change of sign of the first derivative and using sign of the second derivative. Use of the terms "concave-up" for $f''(x) > 0$, and "concave-down" for $f''(x) < 0$.	**Appl:** profit, area, volume.
	Points of inflexion with zero and non-zero gradients.	At a point of inflexion, $f''(x) = 0$ and changes sign (concavity change). $f''(x) = 0$ is not a sufficient condition for a point of inflexion: for example, $y = x^4$ at $(0,0)$.	
	Graphical behaviour of functions, including the relationship between the graphs of f, f' and f''. Optimization.	Both "global" (for large $\|x\|$) and "local" behaviour. Technology can display the graph of a derivative without explicitly finding an expression for the derivative. Use of the first or second derivative test to justify maximum and/or minimum values.	
	Applications. **Not required:** points of inflexion where $f''(x)$ is not defined: for example, $y = x^{1/3}$ at $(0,0)$.	Examples include profit, area, volume. Link to 2.2, graphing functions.	

	Content	Further guidance	Links
6.4	Indefinite integration as anti-differentiation. Indefinite integral of x^n $(n \in \mathbb{Q})$, $\sin x$, $\cos x$, $\frac{1}{x}$ and e^x. The composites of any of these with the linear function $ax+b$. Integration by inspection, or substitution of the form $\int f(g(x))g'(x)\mathrm{d}x$.	$\int \frac{1}{x}\mathrm{d}x = \ln x + C$, $x > 0$. *Example*: $f'(x) = \cos(2x+3) \quad \Rightarrow \quad f(x) = \frac{1}{2}\sin(2x+3) + C$. *Examples*: $\int 2x\left(x^2+1\right)^4 \mathrm{d}x$, $\int x\sin x^2 \,\mathrm{d}x$, $\int \frac{\sin x}{\cos x}\mathrm{d}x$.	
6.5	Anti-differentiation with a boundary condition to determine the constant term. Definite integrals, both analytically and using technology. Areas under curves (between the curve and the x-axis). Areas between curves. Volumes of revolution about the x-axis.	*Example*: if $\frac{\mathrm{d}y}{\mathrm{d}x} = 3x^2 + x$ and $y = 10$ when $x = 0$, then $y = x^3 + \frac{1}{2}x^2 + 10$. $\int_a^b g'(x)\mathrm{d}x = g(b) - g(a)$. The value of some definite integrals can only be found using technology. Students are expected to first write a correct expression before calculating the area. Technology may be used to enhance understanding of area and volume.	**Int:** Successful calculation of the volume of the pyramidal frustum by ancient Egyptians (Egyptian Moscow papyrus). Use of infinitesimals by Greek geometers. Accurate calculation of the volume of a cylinder by Chinese mathematician Liu Hui **Int:** Ibn Al Haytham: first mathematician to calculate the integral of a function, in order to find the volume of a paraboloid.
6.6	Kinematic problems involving displacement s, velocity v and acceleration a. Total distance travelled.	$v = \frac{\mathrm{d}s}{\mathrm{d}t}$; $a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2}$. Total distance travelled $= \int_{t_1}^{t_2} \lvert v \rvert \,\mathrm{d}t$.	**Appl:** Physics 2.1 (kinematics).

VISUAL ARTS, Ksenija Kipke

VISUAL ARTS
2014/2015

Syllabus outline

Core areas
The visual arts core syllabus at SL and HL consists of three equal interrelated areas as shown in figure 2.

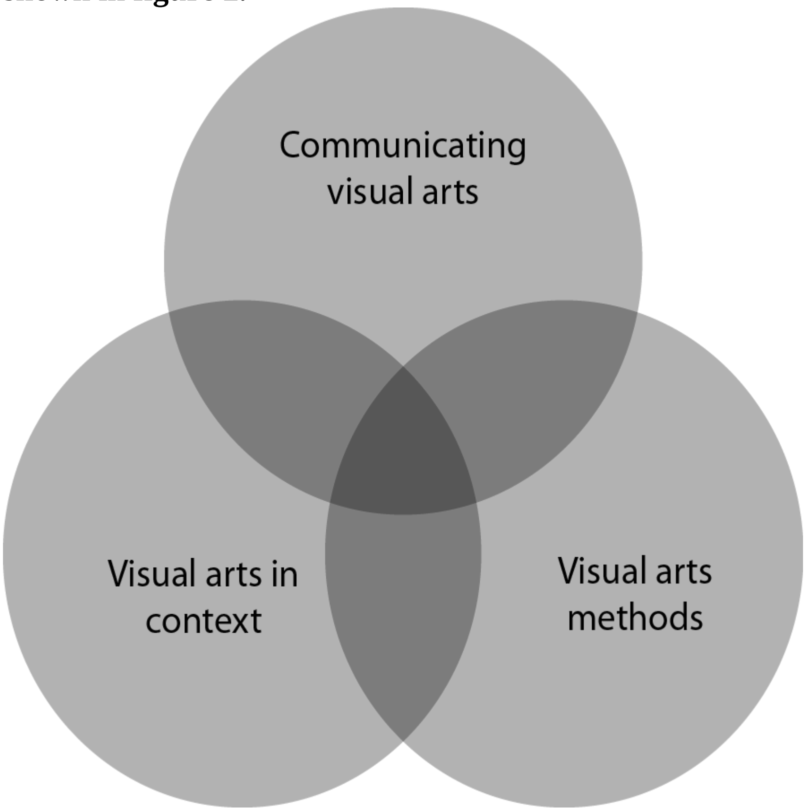

Figure 2
These core areas, which have been designed to fully interlink with the assessment tasks, must be central to the planning of the taught course that is designed and delivered by the teacher. Students are required to understand the relationship between these areas and how each area informs and impacts their work in visual arts.

Visual arts in context
The visual arts in context part of the syllabus provides a lens through which students are encouraged to explore perspectives, theories and cultures that inform and influence visual arts practice. Students should be able to research, understand and appreciate a variety of contexts and traditions and be able to identify links between them.
Through the visual arts in context area, students will:

- **be informed about the wider world of visual arts and they will begin to understand and appreciate the cultural contexts within which they produce their own works**

- **observe the conventions and techniques of the artworks they investigate, thinking critically and experimenting with techniques, and identifying possible uses within their own art-making practice**
- **investigate work from a variety of cultural contexts and develop increasingly sophisticated, informed responses to work they have seen and experienced.**

Visual arts methods
The visual arts methods part of the syllabus addresses ways of making artwork through the exploration and acquisition of skills, techniques and processes, and through engagement with a variety of media and methods.
Through the visual arts methods area, students will:

- **understand and appreciate that a diverse range of media, processes, techniques and skills are required in the making of visual arts, and how and why these have evolved**
- **engage with the work of others in order to understand the complexities associated with different art-making methods and use this inquiry to inspire their own experimentation and art-making practice**
- **understand how a body of work can communicate meaning and purpose for different audiences.**
-

Communicating visual arts
The communicating visual arts part of the syllabus involves students investigating, understanding and applying the processes involved in selecting work for exhibition and public display. It engages students in making decisions about the selection of their own work.
Through the communicating visual arts area, students will:

- **understand the many ways in which visual arts can communicate and appreciate that presentation constructs meaning and may influence the way in which individual works are valued and understood**
- **produce a body of artwork through a process of reflection and evaluation and select artworks for exhibition, articulating the reasoning behind their choices and identifying the ways in which selected works are connected**
- **explore the role of the curator; acknowledging that the concept of an exhibition is wide ranging and encompasses many variables, but most importantly, the potential impact on audiences and viewers.**

Mapping the course
Students are required to investigate the core syllabus areas through exploration of the following practices:

- **theoretical practice**
- **art-making practice**
- **curatorial practice.**

The table below shows how these activities link with the core syllabus areas at both SL and HL.

	Visual arts in context	**Visual arts methods**	**Communicating visual arts**
Theoretical practice	**Students examine and compare the work of**	**Students look at different techniques for making**	**Students explore ways of communicating through**

	artists from different cultural contexts. Students consider the contexts influencing their own work and the work of others.	art. Students investigate and compare how and why different techniques have evolved and the processes involved.	visual and written means. Students make artistic choices about how to most effectively communicate knowledge and understanding.
Art-making practice	Students make art through a process of investigation, thinking critically and experimenting with techniques. Students apply identified techniques to their own developing work.	Students experiment with diverse media and explore techniques for making art. Students develop concepts through processes that are informed by skills, techniques and media.	Students produce a body of artwork through a process of reflection and evaluation, showing a synthesis of skill, media and concept.
Curatorial practice	Students develop an informed response to work and exhibitions they have seen and experienced. Students begin to formulate personal intentions for creating and displaying their own artworks.	Students evaluate how their ongoing work communicates meaning and purpose. Students consider the nature of "exhibition" and think about the process of selection and the potential impact of their work on different audiences.	Students select and present resolved works for exhibition. Students explain the ways in which the works are connected. Students discuss how artistic judgments impact the overall presentation.

To fully prepare students for the demands of the assessment tasks teachers should ensure that their planning addresses each of the syllabus activities outlined above, the content and focus of which is not prescribed. The connections between the syllabus areas and the assessment tasks can be seen in the table in the section "Linking the visual arts core syllabus areas to the assessment tasks".

The visual arts journal

Throughout the course students at both SL and HL are required to maintain a visual arts journal. This is their own record of the two years of study and should be used to document:

- the development of art-making skills and techniques
- experiments with media and technologies
- personal reflections
- their responses to first-hand observations
- creative ideas for exploration and development
- their evaluations of art practices and art-making experiences
- their responses to diverse stimuli and to artists and their works
- detailed evaluations and critical analysis
- records of valued feedback received
- challenges they have faced and their achievements.

Students should be encouraged to find the most appropriate ways of recording their development and have free choice in deciding what form the visual arts journal should take. The aim of the visual arts journal is to support and nurture the acquisition of skills and ideas, to record developments, and to critique challenges and successes. It is expected that much of the written work submitted for the assessment tasks at the end of the course will have evolved and been drawn from the contents of the visual arts journal. Although sections of the journal will be selected, adapted and presented for assessment, the journal itself is not directly assessed or moderated. It is, however, regarded as a fundamental activity of the course.

Art-making forms

Throughout the course students are expected to experience working with a variety of different art-making and conceptual forms. SL students should, as a minimum, experience working with at least two art-making forms, each selected from separate columns of the table below. HL students should, as a minimum, experience working with at least three art-making forms, selected from a minimum of two columns of the table below. The examples given are for guidance only and are not intended to represent a definitive list.

Two-dimensional forms	**Three-dimensional forms**	**Lens-based, electronic and screen-based forms**
• **Drawing: such as charcoal, pencil, ink** • **Painting: such as acrylic, oil, watercolour** • **Printmaking: such as relief, intaglio, planographic, chine collé** • **Graphics: such as illustration and design**	• **Sculpture: such as ceramics, found objects, wood, assemblage** • **Designed objects: such as fashion, architectural, vessels** • **Site specific/ephemeral: such as land art, installation, mural** • **Textiles: such as fibre, weaving, printed fabric**	• **Time-based and sequential art: such as animation, graphic novel, storyboard** • **Lens media: such as still, moving, montage** • **Digital/screen based: such as vector graphics, software generated**

Interaction and engagement with local artists or collections as well as visits to museums, galleries, exhibitions and other kinds of presentations provide valuable first-hand opportunities for investigation and should be used to inform student work wherever possible. Personal responses to these experiences should be documented in the visual arts journal.

Research

When carrying out research, students should be encouraged to consult a suitable range of primary and secondary sources. As well as the more obvious sources (books, websites, videos, DVDs, articles) research may also include art-making experiences and encounters such as workshops, lectures, correspondence with experts and visits to exhibitions. All sources consulted during the course must be cited following the protocol

of the referencing style chosen by the school and be presented in a bibliography or as footnotes.

Topics

Topics are chosen primarily from modern and contemporary art, from different cultures and contextes. They can be paraleled with certan historical styles and cultures if it is student's choice, and matter of their investigations. Topics are chosen according to student's interests and their previous work of their own.

Chosen curricular topics should meet the needs of achieving aims given through the chapters of this syllabus: Visual Arts in context, Visual arts methods, Communicating visual arts, Mapping the course, The visual arts journal, Art-making forms, Research.

THEORY OF KNOWLEDGE, Dražen Dragović

IB Theory of Knowledge Syllabus adjusted to TOK Guide 2015

Knowledge is the raw material of the TOK course. It is important that students and teachers have a clear idea of what might be meant by the term "knowledge", however, this is not such a simple matter.
It is not a course of abstract analysis of concepts. TOK is designed to apply a set of conceptual tools to concrete situations encountered in the student's Diploma Programme subjects and in the wider world outside school. The course should therefore not be devoted to a technical philosophical investigation into the nature of knowledge.

Knowledge can be viewed as the production of one or more human beings. It can be the work of a single individual arrived at as a result of a number of factors including the ways of knowing. Such individual knowledge is called personal knowledge. But knowledge can also be the work of a group of people working together either in concert or, more likely, separated by time or geography. Areas of knowledge such as the arts and ethics are of this form. These are examples of shared knowledge. There are socially established methods for producing knowledge of this sort, norms for what counts as a fact or a good explanation, concepts and language appropriate to each area and standards of rationality.
These aspects of areas of knowledge can be organized into a knowledge framework.

Shared and personal knowledge

In many languages, the verb "to know" has two first person forms: "I know" and "we know". "I know" refers to the possession of knowledge by an individual—personal knowledge. "We know" refers to knowledge that belongs to a group—shared knowledge.

Shared knowledge is highly structured, is systematic in its nature and the product of more than one individual. Much of it is bound together into more or less distinct areas of knowledge such as the familiar groups of subjects studied in the Diploma Programme. While individuals contribute to it, shared knowledge does not depend only upon the contributions of a particular individual—there are possibilities for others to check and amend individual contributions and add to the body of knowledge that already exists.

Example:
The knowledge required to build a computer, for instance, is shared. It is unlikely that there is an individual who has the knowledge of building such a device from scratch (rather than simply assembling it from pre-constructed components). Yet we know how to make computers. A computer is the result of a complex worldwide cooperative effort.

The questions related to the area of shared knowledge might be:
Is it really possible to have knowledge of a culture in which we have not been raised?
Are those outside a particular religious tradition really capable of understanding its key ideas?
Does there exist a neutral position from which to make judgments about competing claims from different groups with different traditions and different interests?

Thinking about shared knowledge allows us to think about the nature of the group that does the sharing. It allows international-mindedness into our exploration of knowledge questions.

Personal knowledge

Personal knowledge, on the other hand, depends crucially on the experiences of a particular individual. It is gained through experience, practice and personal involvement and is intimately bound up with the particular local circumstances of the individual such as biography, interests, values, and so on. It contributes to, and is in turn influenced by, an individual's personal perspective.

Personal knowledge is made up of:

- **skills and procedural knowledge that I have acquired through practice and habituation**
- **what I have come to know through experience in my life beyond academia**
- **what I have learned through my formal education (mainly shared knowledge that has withstood the scrutiny of the methods of validation of the various areas of knowledge)**
- **the results of my personal academic research (which may have become shared knowledge because I published it or made it available in some other way to others).**

Knowledge claims

In TOK there are two types of knowledge claims.

- **Claims that are made within *particular areas of knowledge* or by individual knowers about the world. It is the job of TOK to examine the basis for these first-order claims.**

- **Claims that are made *about knowledge*. These are the second-order claims made in TOK that are justified using the tools of TOK which usually involve an examination of the nature of knowledge.**

Here are some examples:

- **"There are an infinite number of prime numbers." This is a first-order knowledge claim because it resides firmly inside the area of knowledge mathematics. It is established using the method of mathematical proof.**
- **"Mathematical knowledge is certain." This is a second-order knowledge claim because it is about mathematical knowledge. We establish this by examining the methods of mathematics themselves using the tools of TOK.**

Both types of knowledge claims might be found in TOK. The first type will feature in examples offered in the essay and presentation illustrating the manner in which areas of knowledge go about the business of producing knowledge. The second type will constitute the core of any piece of TOK analysis.

Knowledge questions

TOK is primarily concerned with knowledge questions. This phrase is used often in describing what is seen in a good TOK presentation or a good TOK essay. An essay or presentation that does not identify and treat a knowledge question has missed the point.To put it briefly, the whole point of the presentation and essay tasks is to deal with knowledge questions.

Knowledge questions are questions about knowledge, and contain the following features.

• Knowledge questions are questions about knowledge. Instead of focusing on specific content, they focus on how knowledge is constructed and evaluated. In this sense, knowledge questions are a little different from many of the questions dealt with in the subject classrooms. In this way, they are considered second-order questions in TOK.

• Knowledge questions are open in the sense that there are a number of plausible answers to them.

The questions are contestable. Dealing with open questions is a feature of TOK. Many students encountering TOK for the first time are struck by this apparent difference from many of the other classes in their school experience.

Many find the lack of a single "right" answer slightly disorienting.

Example:

In physics, one deals with questions about the material world. In TOK, we ask questions about knowledge in physics. How can the physicist be sure of his or her conclusions given that they are based on hypothesis and experiment? The student in TOK is not talking in physical terms because he or she is not talking about the physical world but the discipline of physics. Therefore, it is necessary to use a different, more generalized vocabulary. The physicist uses terms like particle, energy, mass and charge. In TOK, the student uses terms such as hypothesis, experimental data, interpretation, anomaly, induction, certainty, uncertainty, belief and knowledge. So knowledge questions should employ these terms, not the terms of physics.

REAL LIFE SITUATION – vocabulary specific to Area of Knowledge

KNOWLEDGE QUESTION – vocabulary specific to Theory of Knowledge

EXAMPLES OF KNOWLEDGE QUESTIONS

Example 1: Future population growth in Africa

• Not a knowledge question: "How can we predict future population growth in Africa?" This is not a knowledge question because it is a technical question within the discipline of population studies.

**• Good knowledge question: "How can a mathematical model give us knowledge even if it does not yield accurate predictions?" This is now sufficiently general and explores the purpose and nature of
mathematical modelling.**

Example 2: The placebo effect and its impact on the medical profession

• Not a knowledge question: "How does the placebo effect work?" An answer to this might involve a technical explanation in psychology. This therefore sits above the line in figure 4.

• A good knowledge question: “How could we establish that X is an ‘active ingredient’ in causing Y?”
This question is actually a rather general one about how we can know about causal links. It is a classic knowledge question.

Knowledge questions and assessment

Knowledge questions are at the heart of the assessment of TOK. The presentation and the essay both deal with knowledge questions.

The TOK presentation **starts above the line with a real-life situation described in “real-life” terms. At a certain point in the presentation the student is required to identify the underlying knowledge question (below the line). This is then explored using the language of TOK and a conclusion is reached which is translated back into real-life terms.**

The TOK essay **follows a path that is in some sense a mirror image of this. The prescribed titles for the essay are expressed in rather general TOK language; they sit below the line. The student is required to identify knowledge questions connected to the prescribed title. The student must then give them some concrete form by finding examples. These examples are explored using the tools of TOK (which might require some excursions back below the line). Finally, a general conclusion to the essay will be located in TOK language below the line.**

WAYS OF KNOWING

The TOK course identifies eight specific ways of knowing (WOKs). They are:
• language
• sense perception
• emotion
• reason
• imagination
• faith
• intuition
• memory.

Students must explore a range of WOKs. It is suggested that studying four of these eight in depth would be appropriate. The WOKs selected for detailed study should be carefully selected to ensure a coherent and balanced approach.
There are two central purposes to the WOKs in TOK. On the one hand they are the tools that answer the question “how do we know?” and on the other hand they help us answer the question “how do I know?”

AREAS OF KNOWLEDGE

How do we know things? We know things because we use a range of methods of inquiry that incorporate ways of knowing to help construct knowledge in different areas of knowledge (AOKs).

The theory of knowledge course distinguishes between eight AOKs:
- **mathematics**
- **natural sciences**
- **human sciences**
- **history**
- **the arts**
- **ethics**
- **religious knowledge systems**
- **indigenous knowledge systems.**

Students must explore a range of AOKs. It is suggested that six of these eight would be appropriate. While this guide identifies eight broad AOKs, students should be encouraged to think about individual academic disciplines, that is, to think about the nature of knowledge in their own specific IB subjects, such as chemistry, geography and dance.

Knowledge framework

One effective way to examine the AOKs is through a knowledge framework. A knowledge framework is a way of unpacking the AOKs and provides a vocabulary for comparing AOKs.

For each AOK the following can be examined:
- **scope, motivation and applications**
- **specific terminology and concepts**
- **methods used to produce knowledge**
- **key historical developments**
- **interaction with personal knowledge.**

Within this knowledge framework, key features of each area are identified, as are specific terminology and concepts which shape that area of knowledge. The key historical developments that have influenced and shaped each area are identified, as well as the ways that each makes use of particular methodology. Finally, there is opportunity for reflection on the interaction between shared and personal knowledge in each area. Knowledge frameworks are a very effective device to compare and contrast areas of knowledge.

Students will use *TOK Course Companion* – Dombrowski, Rotenberg, Beck, Oxford, First Published 2013

Documentaries; TED discussions, different internet and other resources given on OCC as Teacher Support Material or materials given to the TOK teacher by Bill Roberts on the last Oxford TOK seminar in June, 2013.

PROJECTS

B&M

IB DP PROGRAM
PRVA GIMNAZIJA VARAŽDIN
KRISTINA ORŠIĆ MANOJLOVIĆ
BUSINESS MANAGEMENT

PLAN RADA ZA ŠKOLSKU GODINU 2014/15

eTwinning PROJECT „SOCIALPRENEUR“ with partner schools from Poland and Portugal
Duration: Sept 2014 – May 2015
Students from 3IB and 4IB to be included (B&M students only)
All activities to be held during B&M classes, except these two:
November 2014 – visit to local social entrepreneur – Humana Nova, Čakovec
5th December 2014 – International Volunteer Day – exhibit with posters from our visit in the school hallway

17 – 23 November 2014 – **Global Entrepreneurship Week (GEW)** – to invite guest lecturers to the school on one day during that week

February 2015 – **Ideja godine** (with students interested to apply. 3IB only)

<u>Interesting topcis that could be discussed within TOK and some other subjects</u>:

- Ethics in food production: From consumer concerns to professional ethics (BM, TOK, Biology, Chemistry)
- Advertising to children: Is it ethical? (BM, TOK)
- Culture in Business communication (BM, Languages, TOK)
- The real face of corporate social responsibility vs social entrepreneurship (TOK, BM)

BIOLOGY

Prva gimnazija Varaždin
Obrazac za planiranje rada – projekti
Voditelj aktivnosti: Martina Vidović, Anamarija Melnjak

Aktivnosti, program i/ili projekt	**Ciljevi aktivnosti, programa i/ili projekta**	**Namjena aktivnosti (očekivani rezultati i usvojene kompetencije)**	**Nositelji aktivnosti (odgovorna osoba)**	**Način realizacije**	**Vremenik**
On-line projekt *International Student Carbon Footprint Challenge (ISCFC)* • U projektu će sudjelovati učenici 3.IB razreda pod vodstvom profesorice Martine Vidović i 4.L razreda pod vodstvom profesorice Anamarije Melnjak	• analizirati svoje životne navike i navike svoje obitelji (prijevoz, ishrana, stanovanje i kupovina) i izračunati svoj ugljični otisak uz pomoć on-line upitnika	• učenici će diskutirati o dobivenim rezultatima i komentirati vlastiti ugljični otisak preko komunikacijske platforme za razgovore „Muut“, obrazložiti će svoje rezultate i navesti navike koje pridonose povećanju emisije ugljikova dioksida, usporediti ugljične otiske učenika iz različitih zemalja i iznijeti prijedloge kako promijeniti životne navike koje doprinose njegovom povećanju • učenici će povezivati nastavne sadržaje biologije i kemije • senzibiliziranje učenika za probleme onečišćenja okoliša i poticanje odgovornosti pojedinca za izgled i stanje okoliša	Martina Vidović, Anamarija Melnjak	• prikupljanje podataka o životnim navikama i analiza uz pomoć on-line upitnika • diskusija o dobivenim rezultatima preko komunikacijske platforme „Muut“	9.-10. mj. ; 2. mj. 2014.

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