St Hilda's College
UNIVERSITY OF OXFORD

Reading List for Physics

Congratulations on your offer of a place at Oxford. I hope that you will enjoy your time at St Hilda's, and I look forward to welcoming you in October.

Before coming up to Oxford it will be very helpful to revise (or learn) some mathematics. Work through "Suggested Vacation Work in Mathematics and Mechanics" (enclosed) to identify areas you have not covered. Please make the effort to fill any gaps.

We shall be studying Newtonian mechanics which many of you will have covered at A level. -If not, it is worth reading Introduction to Classical Mechanics by French and Ebison (particularly chapters 5, 7, 9, not chapter 10).

When you arrive, please check your email to find out the arrangements for our first meeting.

You will also receive additional materials from the Physics Department. These are normally sent out in August.

Yours sincerely,

Professor Claire Gwenlan

Fellow and Tutor in Physics

Vacation Work: Maths & Mechanics

The Oxford Physics course contains a lot of maths and it is important to ensure that you are as far as possible up to speed before arriving in Oxford. This is particularly important if you have not studied Further Maths or equivalent. This document gives some advice on preparation before arrival, and a set of problems which you should attempt over the summer.

Maths Textbooks

The recommended maths text for the course is *Mathematical Methods for Physics and Engineering* by K. F. Riley, M. P. Hobson and S. J. Bence (3rd edition, Cambridge University Press). This is a very large book, but will cover all the maths you need for the compulsory parts of the physics course. You are advised, if possible, to obtain a copy before coming up to Oxford.

You may initially find this text very tough. A useful transition text is *Further Mathematics for the Physical Sciences* by Tinker and Lambourne, which is divided into a number of modules with self assessment tests so that you can work out which chapters you need to read.

Introductory Problems

We will assume that you are familiar with Chapter 1 of Riley, Hobson and Bence on arrival. This chapter covers the solution of polynomials, trigonometric identities, coordinate geometry, partial fractions, the binomial expansion, and methods of proof. The problems listed below are adapted from the end of this chapter. You may find these problems quite tricky at first, but with thought they should be possible. If you find them easy then look at some other problems in Chapter 1.

Calculus

Although the Oxford Physics course in principle covers calculus from scratch, in practice elementary techniques are covered *very* quickly, and you should ensure that you are familiar with these before arrival. This includes differentiation and integration of polynomials, trigonometric functions, and exponential and logarithmic functions; differentiation of products and quotients and use of the chain rule; implicit differentiation; integration by parts and by substitution.

Mechanics

The first "physics" subject you will study at Oxford is mechanics. Unlike school courses the Oxford course quickly begins to make use of a significant amount of maths, and many students find it hard to *combine* maths with physics. This involves taking a problem posed in ordinary language, setting it up in precise mathematical terms, using mathematical techniques to find a solution, and then translating this back into ordinary terms. This process may not be very familiar to you now but is going to be very important throughout your course.

The mechanics problems provided can mostly be solved using techniques familiar from A-level, but it is important to begin by adopting a proper approach straight away: the way in which you solve these problems and set out your answers is more important than the answers themselves! In particular you should avoid at all costs simply plugging numbers into standard formulae using a calculator: you should solve each problem *in the general case* before dealing with the numbers given.

A. Introductory Problems

1. Consider the 3rd order polynomial

$$g(x) = 4x^3 + 3x^2 - 6x - 1$$

   (a) Show that $g(x)$ must have at least one real root.

   (b) Make a table of $g(x)$ for integer values of x between -2 and 2, and hence find one root by inspection.

   (c) Factorise the equation as a product of the first root and a quadratic, and hence find values of all three roots.

2. A polynomial equation can be written in terms of coefficients

$$f(x) = a_n x^n + a_{n-1}x^{n-1} + \cdots + a_1 x + a_0 = 0$$

   or in terms of roots

$$f(x) = a_n(x - \alpha_1)(x - \alpha_2)\cdots(x - \alpha_n) = 0.$$

   (a) By expanding these expressions show that

$$\sum_{k=1}^{n} \alpha_k = -\frac{a_{n-1}}{a_n} \quad \text{and} \quad \prod_{k=1}^{n} \alpha_k = (-1)^n \frac{a_0}{a_n}$$

   where Π indicates a product of terms just as Σ indicates a sum.

   (b) Show that these formulae give the right results for $g(x)$ in the previous question.

3. Use double angle formulae to prove that $s = \sin(\pi/8)$ is one of the four roots of

$$8s^4 - 8s^2 + 1 = 0$$

   and use your knowledge of the sin function to show that

$$\sin(\pi/8) = \sqrt{\frac{2 - \sqrt{2}}{4}}.$$

   Find an expression for $\cos(\pi/8)$ and show that $\tan(\pi/8) = \sqrt{2} - 1$. (Hint: first find the "obvious" form for $\tan(\pi/8)$ and then simplify this using surds.)

4. Show that the equation

$$f(x, y) = x^2 + y^2 + 6x + 8y = 0$$

represents a circle, and find its centre and radius.

5. Show that the equation

$$f(x, y) = 2x^2 + 2y^2 + 5xy - 4x + y - 6 = 0$$

represents a pair of straight lines, and find their point of intersection. (Hint: write

$$f(x, y) = -6(ax + by + 1)(cx + dy + 1) = 0$$

and solve for the four coefficients, being careful with the ambiguity between a and c and between b and d.)

6. Express the following as partial fractions:

$$\text{(a)} \quad \frac{2x+1}{x^2+3x-10} \qquad \text{(b)} \quad \frac{4}{x^2-3x} \qquad \text{(c)} \quad \frac{x^2+x-1}{x^2+x-2}$$

(In the last case you will have to start by identifying multiples of the denominator in the numerator and subtracting these from the fraction.)

7. Use a binomial expansion to evaluate (a) $(1 + x)^5$, (b) $1/(1 + x)$, and (c) $1/\sqrt{1 + x}$ up to second order. Use the last result to find a value of $1/\sqrt{4.2}$ to three decimal places.

8. Prove by induction that

   (a) $\sum_{r=1}^{n} r = \frac{1}{2}n(n + 1)$

   (b) $\sum_{r=1}^{n} r^3 = \frac{1}{4}n^2(n + 1)^2$

9. The sum of a geometric progression can be written as

$$S_n = 1 + r + r^2 + \cdots + r^n$$

Evaluate rS_n and use this to show that $S_n = (1 - r^{n+1})/(1 - r)$.

B. Calculus

Differentiation

1. Differentiate each of the following functions:

   (a) $f(x) = x^2 \sin(x) + \log_e(x)$

   (b) $f(x) = 1/\sin(x)$

   (c) $f(x) = 2^x$

2. Find the first two derivatives of the following functions:

   (a) $F(x) = 3\sin x + 4\cos x$

   (b) $y = \log_e x \quad x > 0$

3. Let $x = a(\theta - \sin\theta)$ and $y = a(1 - \cos\theta)$, where a is a constant; find $\frac{dy}{dx}$ in terms of θ. Then find d^2y/dx^2 in terms of θ.
   (Hint: let $f(\theta)$ stand for your expression for $\frac{dy}{dx}$ in terms of θ; then $\frac{d^2y}{dx^2} = \frac{d}{dx}(\frac{dy}{dx}) = \frac{d}{dx}f(\theta) = \frac{df}{d\theta}\frac{d\theta}{dx}$.)

Stationary points and graph sketching

4. Under certain circumstances, when sound travels from one medium to another, the fraction of the incident energy that is transmitted across the interface is given by

   $$E(r) = 4r/(1+r)^2$$

   where r is the ratio of the acoustic resistances of the two media. Find any stationary points of $E(r)$, and classify them as local maxima, minima, or points of inflection. For what value of r is $d^2E/dr^2 = 0$? Sketch the graph of $E(r)$ for $r > 0$, marking the special values of r you have found.

Hyperbolic functions

5. The hyperbolic functions are defined in terms of the exponential function e^x by

   $$\sinh(x) = \frac{e^x - e^{-x}}{2} \qquad \cosh(x) = \frac{e^x + e^{-x}}{2} \qquad \tanh(x) = \frac{\sinh(x)}{\cosh(x)}$$

   Sketch each of these functions against x. Do not use a calculator!

6. Find the first derivatives of $\sinh(x)$ and $\tanh(x)$ with respect to x, expressing your answers in terms of $\cosh(x)$.

Integration

7. Evaluate the following indefinite integrals:

   (a) $\int (1 + 2x + 3x^2)\, dx$

   (b) $\int [\sin(2x) - \cos(3x)]\, dx$

   (c) $\int (e^t + \frac{1}{t^2})\, dt$

   (d) $\int dw$

8. Evaluate the following definite integrals:

   (a) $\int_{-1/4}^{1/4} \cos(2\pi x)\, dx$

   (b) $\int_0^3 (2t - 1)^2\, dt$

   (c) $\int_1^2 \frac{(1+e^t)^2}{e^t}\, dt$

   (d) $\int_4^9 \sqrt{x}(x - \frac{1}{x})\, dx$

   (e) $\int_{-1}^1 x^3\, dx$; explain your answer with a sketch.

9. Find the indefinite integral $\int x^2 e^{-x}\, dx$.

10. Find the indefinite integral $\int \sin x (1 + \cos x)^4\, dx$.

11. Find the area of the region bounded by the graph of the function $y = x^2 + 2$ and the line $y = 5 - 2x$.

C. Mechanics

Motion in one dimension

1. A car accelerates uniformly from rest to 80 km per hour in 10 s. How far has the car travelled?

2. A stone falls from rest with an acceleration of $9.8\,\mathrm{ms}^{-2}$. How fast is it moving after it has fallen through 2 m?

3. A car is travelling at an initial velocity of $6\,\mathrm{ms}^{-1}$. It then accelerates at $3\,\mathrm{ms}^{-2}$ over a distance of 20 m. What is its final velocity?

Work and energy

4. The brakes on a car of mass 1000 kg travelling at a speed of $15\,\mathrm{ms}^{-1}$ are suddenly applied so that the car skids to a stop in a distance of 30 m. Use energy considerations to determine the magnitude of the total frictional force acting on the tyres, assuming it to be constant throughout the braking process. What is the car's speed after the first 15 m of this skid?

5. The gravitational potential energy for a mass m at a distance $R+h$ from the centre of the earth (where R is the radius of the earth) is $-GMm/(R+h)$ where G is Newton's gravitational constant and M is the mass of the earth. If $h \ll R$ show that this is approximately equal to a constant (independent of h) plus mgh, where $g = GM/R^2$. [Hint: write $R+h = R(1+h/R)$ and expand $(1+h/R)^{-1}$ by the binomial theorem.]

6. Show that the minimum speed with which a body can be projected from the surface of the earth to enable it to just escape from the earth's gravity (and reach "infinity" with zero speed) is given by $v_{escape} = \sqrt{2GM/R}$, where G, M and R are defined as in the previous question. If a body is projected vertically with speed $\frac{1}{2}v_{escape}$, how high will it get? (Give the answer in terms of R and neglect air resistance throughout this question.)

Simple harmonic motion

7. The position of a particle as a function of time is given by $x(t) = A\sin(\omega t + \phi)$, where A, ω and ϕ are constants. Obtain similar formulae for (a) the velocity, (b) the acceleration of the particle. If $\phi = \pi/6$, find in terms of A the value of x at $t = \pi/6\omega$. What is the value of x (in terms of A) when the acceleration is greatest in magnitude?

8. A particle of mass m moves in one dimension under the action of a force given by $-kx$ where x is the displacement of the body at time t, and k is a positive constant. Using $F = ma$ write down a differential equation for x, and verify that its solution is $x = A\cos(\omega t + \phi)$, where $\omega^2 = k/m$. If the body starts from rest at the point $x = A$ at time $t = 0$, find an expression for x at later times.

Vacation Work: Maths & Mechanics Answers

A. Introductory Problems

1. (a) $g(x \to -\infty) \to -\infty$ and $g(x \to \infty) \to \infty$ so must cross zero.

   (b) Table below; one root is $x = 1$.

x	-2	-1	0	1	2
g	-9	4	-1	0	31

   (c) Factors to $f = (x-1)(4x^2 + 7x + 1)$ so roots are $x = 1$ and $x = (-7 \pm \sqrt{33})/8$.

2. (a) Standard method.

   (b) Sum of roots is $-3/4$ and product is $1/4$ as expected.

3. Use $\cos(2\theta) = \cos^2\theta - \sin^2\theta = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$ to get $\cos(4\theta) = 2\cos^2(2\theta) - 1 = 2(1 - 2\sin^2\theta)^2 - 1 = 8\sin^4\theta - 8\sin^2\theta + 1$. Then take $\theta = \pi/8$ to get $\cos(\pi/2) = 0 = 8s^4 - 8s^2 + 1$. Solve quadratic in s^2 to get $s = \pm\sqrt{(2 \pm \sqrt{2})/4}$. Choose between the $\pm$ signs as $\sin(\pi/8)$ lies between $\sin(0) = 0$ and $\sin(\pi/6) = \frac{1}{2}$ to get $\sin(\pi/8) = \sqrt{(2-\sqrt{2})/4}$. Then $\cos(\pi/8) = \sqrt{1 - \sin^2(\pi/8)} = \sqrt{(2+\sqrt{2})/4}$. Finally $\tan = \sin / \cos$ so

   $$\tan(\pi/8) = \frac{\sqrt{(2-\sqrt{2})/4}}{\sqrt{(2+\sqrt{2})/4}} = \sqrt{\frac{2-\sqrt{2}}{2+\sqrt{2}}} = \sqrt{\frac{(2-\sqrt{2})^2}{(2+\sqrt{2})(2-\sqrt{2})}}$$

   which simplifies to $(2-\sqrt{2})/\sqrt{2} = \sqrt{2} - 1$ as desired.

4. Complete the square to get $f = (x+3)^2 + (y+4)^2 = 3^2 + 4^2 = 5^2$, so a circle, centre at $x = -3$, $y = -4$, radius 5.

5. Multiply out the form given to get

   $$f = -6ac\,x^2 - 6ad\,xy - 6a\,x - 6bc\,xy - 6bd\,y^2 - 6b\,y - 6c\,x - 6d\,y - 6$$

   and equating coefficients gives

   $$\begin{array}{ccc} -6ac = 2 & -6bd = 2 & -6(ad+bc) = 5 \\ -6(a+c) = -4 & -6(b+d) = 1 & \end{array}$$

Solve $ac = -1/3$ and $a + c = 2/3$ by substituting second equation into first equation to get either $(a = 1,\ c = -1/3)$ or *vice versa.* Use the forms given and substitute into $ad + bc = -5/6$ to get $d - b/3 = -5/6$, which combines with $b + d = -1/6$ to give $(b = 1/2,\ d = -2/3)$. So

$$f = -6(x + y/2 + 1)(-x/3 - 2y/3 + 1) = (2x + y + 2)(x + 2y - 3)$$

which multiplies out to the correct result. This is the product of two straight lines, $y = -2x - 2$ and $y = (3 - x)/2$ which intersect at $x = -7/3$, $y = 8/3$.

6. Usual method for partial fractions:

   (a)
$$\frac{2x+1}{x^2+3x-10} = \frac{2x+1}{(x+5)(x-2)} = \frac{9/7}{x+5} + \frac{5/7}{x-2}$$

   (b)
$$\frac{4}{x^2-3x} = \frac{4}{x(x-3)} = \frac{-4/3}{x} + \frac{4/3}{x-3}$$

   (c)
$$\frac{x^2+x-1}{x^2+x-2} = 1 + \frac{1}{(x+2)(x-1)} = 1 + \frac{-1/3}{x+2} + \frac{1/3}{x-1}$$

7. (a) $(1 + x)^5 = 1 + 5x + 10x^2 + \cdots$

   (b) $(1 + x)^{-1} = 1 - x + x^2 + \cdots$

   (c) $(1 + x)^{-1/2} = 1 - \frac{1}{2}x + \frac{3}{8}x^2 + \cdots$

   (d)
$$\frac{1}{\sqrt{4.2}} = \frac{1}{2}\left(1 + \frac{1}{20}\right)^{-1/2} \approx \frac{1}{2}\left(1 - \frac{1}{40} + \frac{3}{3200}\right) = \frac{3123}{6400} \approx 0.488$$

8. (a) $S_n = \sum_{r=1}^{n} r = \frac{1}{2}n(n + 1)$ so
$$S_n + (n + 1) = (n + 1)(\tfrac{1}{2}n + 1) = \tfrac{1}{2}(n + 1)(n + 2) = S_{n+1}$$
   and $S_1 = 1$ as desired.

   (b) $S_n = \sum_{r=1}^{n} r^3 = \frac{1}{4}n^2(n + 1)^2$ so
$$\begin{aligned} S_n + (n+1)^3 &= \tfrac{1}{4}n^2(n+1)^2 + (n+1)(n+1)^2 \\ &= \tfrac{1}{4}(n+1)^2(n^2 + 4n + 4) \\ &= \tfrac{1}{4}(n+1)^2(n+2)^2 = S_{n+1} \end{aligned}$$
   and $S_1 = 1$ as desired.

9.

$$
\begin{aligned}
S_n &= 1 + r + r^2 + \cdots + r^n \\
rS_n &= r + r^2 + \cdots + r^n + r^{n+1} = S_n + r^{n+1} - 1 \\
S_n(1-r) &= 1 - r^{n+1} \\
S_n &= (1 - r^{n+1})/(1-r)
\end{aligned}
$$

B. Calculus

1. (a) $f'(x) = x^2\cos(x) + 2x\sin(x) + 1/x$
   (b) $f'(x) = -1(\sin(x))^{-2}\cos(x) = -\cos(x)/\sin^2(x) = -\cot(x)\csc(x)$
   (c) $\ln(f) = x\ln(2)$ so $(1/f)f' = \ln 2$ or $f'(x) = 2^x \ln 2$
2. (a) $F'(x) = 3\cos x - 4\sin x$ and $F''(x) = -3\sin x - 4\cos x$
   (b) $dy/dx = 1/x$ and $d^2y/dx^2 = -1/x^2$
3.

$$
\frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{a(-\sin\theta)}{a(1-\cos\theta)} = \frac{\sin\theta}{\cos\theta - 1} = f
$$

$$
\begin{aligned}
\frac{d^2y}{dx^2} = \frac{df/d\theta}{dx/d\theta} &= \frac{\frac{cos\theta}{1-\cos\theta} - \frac{\sin^2\theta}{(1-\cos\theta)^2}}{a(1-\cos\theta)} \\
&= \frac{(\cos\theta - \cos^2\theta - \sin^2\theta)/(1-\cos\theta)^2}{a(1-\cos\theta)} \\
&= \frac{\cos\theta - 1}{a(1-\cos\theta)^3} \\
&= \frac{-1}{a(\cos\theta - 1)^2}
\end{aligned}
$$

4. Differentiate $E(r) = 4r/(1+r)^2$ by quotient rule to get

$$
E'(r) = \frac{4(1-r)}{(1+r)^3}
$$

and

$$
E''(r) = \frac{8(r-2)}{(1+r)^4}
$$

Turning points occur at $E' = -$ so $r = 1$; this has $E'' < 0$ so a maximum. Solving $E'' = 0$ gives $r = 2$. Sketch shows rise from $(0,0)$ to maximum at (1,1), and then falls back to zero as $r \to \infty$. Curvature changes from negative to positive at $r = 2$.

5. Standard sketches

6. Start from $d \sinh x/dx = \cosh x$ and $d \cosh x/dx = \sinh x$ which follow from the exponential forms. Then use quotient rule to get

$$\frac{d \tanh x}{dx} = \frac{\cosh^2 x - \sinh^2 x}{\cosh^2 x} = \frac{1}{\cosh^2 x}$$

using
$\cosh^2 x - \sinh^2 x = (\cosh x + \sinh x)(\cosh x - \sinh x) = e^x e^{-x} = 1.$

7. Indefinite integrals:

   (a) $x + x^2 + x^3 + C$
   (b) $-\cos(2x)/2 - \sin(3x)/3 + C$
   (c) $e^t - 1/t + C$
   (d) $w + C$

8. Definite integrals:

   (a) $[\sin(2\pi x)/2\pi]_{-1/4}^{1/4} = 1/\pi$
   (b) $[\frac{4}{3}t^3 - 2t^2 + t]_0^3 = 21$
   (c) $e^2 - e + 2 + 1/e - 1/e^2 = 2(1 + \sinh 2 - \sinh 1)$
   (d) $[\frac{2}{5}x^{5/2} - 2x^{1/2}]_4^9 = \frac{412}{5}$
   (e) zero by symmetry

9. By parts twice; $I = -(x^2 + 2x + 2)e^{-x} + C$.

10. By inspection; $I = -\frac{1}{5}(1 + \cos x)^5 + C$.

11. Line crosses curve at $x = -3$ and $x = 1$. Integral under line is $[5x - x^2]_{-3}^{1} = 28$ and under curve is $[x^3/3 + 2x]_{-3}^{1} = 17\frac{1}{3}$ so area is $10\frac{2}{3} = \frac{32}{3}$.

C. Mechanics

1. $s = \frac{1}{2}vt \approx 111\,\mathrm{m}$.

2. $v = \sqrt{2as} \approx 6.26\,\mathrm{m\,s^{-1}}$.

3. $v = \sqrt{u^2 + 2as} \approx 12.5\,\mathrm{m\,s^{-1}}$.

4. $E = \frac{1}{2}mu^2 = fs$ so $f = mu^2/2s = 3750\,\mathrm{N}$. After braking for a distance b have $v = \sqrt{u^2 + 2ab}$ with $a = -f/m$ so

$$v = \sqrt{u^2 - \frac{2fb}{m}} = \sqrt{u^2 - \frac{2mu^2b}{2ms}} - u\sqrt{1 - \frac{b}{s}} = \frac{15}{\sqrt{2}} \approx 10.6\,\mathrm{m\,s^{-1}}$$

5.
$$U = \frac{-GMm}{R+h} = \frac{-GMm}{R}\left(1 + \frac{h}{R}\right)^{-1} \approx \frac{-GMm}{R}\left(1 - \frac{h}{R}\right)$$

6. Use $E = P + K$ to get

$$\frac{-GMm}{R} + \tfrac{1}{2}mv_{esc}^2 = \frac{-GMm}{R+\infty} = 0$$

to get $v_{esc} = \sqrt{2GM/R}$. The for $v = \frac{1}{2}v_{esc}$ get

$$\begin{aligned}\frac{-GMm}{R+h} &= \frac{-GMm}{R} + \tfrac{1}{8}mv_{esc}^2 \\ &= \frac{-GMm}{R} + \frac{GMm}{4R} \\ &= \frac{-3GMm}{4R}\end{aligned}$$

which rearranges to $h = R/3$.

7. $v(t) = x'(t) = \omega A\cos(\omega t + \phi)$ and $a(t) = x''(t) = -\omega^2 A\sin(\omega t + \phi)$. Given $\phi = \pi/6$, then at $t = 6\pi/\omega$ we have $\omega t + \phi = \pi/3$ so $x = A\sin(\pi/3) = A\sqrt{3}/2$. As $a = -\omega^2 x$ maximum magnitude of a coincides with maximum magnitude of x, that is $x = \pm A$.

8. Combining $F = -kx$, $F = ma$ and $a = x''$ gives

$$\frac{d^2x}{dt^2} = -\frac{k}{m}x$$

and for the given trial solution $x = A\cos(\omega t + \phi)$ we have $d^2x/dt^2 = -\omega^2 x$, so this is a solution if $\omega^2 = k/m$. Differentiating gives $v = -A\omega\sin(\omega t + \phi)$; given $v(0) = -A\omega\sin\phi = 0$ we know that $\phi = 0$ or $\phi = \pi$, and $x(0) = A$ fixes $\phi = 0$. So solution at all times is $x = A\cos(\omega t)$.

Introduction to Computing in the Oxford Physics Course

Being able to write a computer program is an important skill for all physicists. In physics, computing is mainly required for the following types of task:

1. Analysis of experimental data
2. Solving numerical problems such as differential equations
3. Controlling scientific instruments and acquiring data from them

We aim to teach you all these skills during your time in Oxford. In the first year we focus on the first two aspects. The third aspect is generally learnt by doing experiments in the teaching labs, where you will experience some data acquisition software during first year practicals. You will spend more time writing your own code for data acquisition and control in the second and third year lab experiments.

Physicists use many different computing packages, and our philosophy is to expose you to a range of different programming environments during your time in Oxford, so that, like professional physicists, you learn to choose which you prefer for different tasks. In the first year we teach you two programming languages, Python (for analysing data) and Matlab. Your first lab classes will be introductory exercises in both languages.

Many modern computing languages are interchangeable in the sense they can all be used to carry out the tasks above, although there are a few differences between languages, which you will learn about in the computing lectures. In the first year, we encourage you to use Python for data analysis, whereas Matlab is used to train you mainly in solving numerical problems but both can be used for either application.

Here we provide some introductory resources that use free and friendly web-based tools to get you used to the basics of computing. Python is open source which means it is free to download and use, whereas Matlab needs a license and cannot be downloaded in its full form before you arrive in Oxford. Both programming languages are essentially independent of operating system i.e. it will not make a difference if you try something on a Mac at home and use a Windows machine in Oxford, or vice versa.

We strongly recommend that you do EITHER

- *BOTH the online introductions to Matlab and Python.*
- *OR one of the online Python courses*

Physics and Philosophy student? You will need to do an exercise in Python when you start lab work in Oxford in the second year, so best to focus on this.

Matlab

An online introduction to Matlab, Matlab Onramp, is available here:

https://matlabacademy.mathworks.com/

The course is web-based (you must register with the provider) and uses an interface similar to Matlab. It covers the basics of programming in Matlab and develops many of the skills you will need for the first year computing course. The course providers suggest that the course will take about two hours. You can work through the sections in any order.

If you do want to try out the full version of Matlab before you come to Oxford, a free 30-day trial can be downloaded from: https://uk.mathworks.com/programs/trials/trial_request.html

Python

You should aim to do one of the free courses listed below but it will not matter which one you complete and may depend on how long you have to spend:

- A short free course in Python 3 is available at: https://www.learnpython.org/. This online course will take a couple of hours and you should study the sections labelled 'Learn the Basics' and 'Data Science Tutorials'. You do not need to do the Advanced tutorials.
- The free parts of the basic course on Python at: https://www.datacamp.com/courses/intro-to-python-for-data-science is useful for those with no computing experience. The course is web based and you will need to register with DataCamp to obtain access. You do not need to sign up to any parts of the courses on this website which cost money, the free parts of the course will be enough. The free part of the Intermediate Python for Data Science: https://www.datacamp.com/courses/intermediate-python-for-data-science which covers Matplotlib (used for plotting graphs) would also be useful. The rest of the course requires payment and is not needed at this time.
- A longer course on Python 2 is available at https://www.codecademy.com . You need to register but you should not pay for the Pro parts of the course, the free parts are enough. This is a much longer course and will take 10+ hours to complete.

Notes

- We regret that we are not able to provide IT support before you attend the introductory lectures at the start of Michaelmas Term, however there are many web resources available beyond the ones we have listed here.
- We do not recommend any specific operating systems or types of computer. We have Windows, Mac and Linux systems available for undergraduate use, and our students buy many different types of personal computer.