THE UNIVERSITY OF SYDNEY

School of Physics

PHYS 1002 Physics 1 (Fundamentals) – Semester 1, 2011

Module 2 – Mechanics

This module is one of 3 comprising PHYS 1002 Physics 1 (Fundamentals). This document describes details of this module and should be read in conjunction with the more general unit of study outline for PHYS 1002 Physics 1 (Fundamentals).

GENERAL GOALS OF THIS MODULE

This module will reinforce the goals from the Language of Physics module. You will understand the concept of force and learn to apply Newton's Laws of Motion to simple mechanical systems. You will understand the concepts of centre of mass, torque and static equilibrium. You will also learn the concept of momentum, energy, energy transformation in mechanical systems and mechanical work. You will develop an ability to apply the principles of conservation of energy and momentum in mechanical systems, and an ability to solve quantitative problems for simple mechanical systems involving all the concepts stated.

TIMETABLE

All **lectures** are held in the Physics Building. There will be two streams of the Mechanics module, each with 13 lectures. You will be scheduled into one lecture stream, with three one-hour lectures per week.

Stream	Lecture Theatre	Lecture times	Lecturer	Room No.
1	LT1	Mon, Wed, Fri – all at 10am beginning Mon 28 Mar, ending Wed 4 May	Dr Helen Johnston	563
2	LT1	Mon, Wed, Thu – all at 2pm beginning Mon 28 Mar, ending Wed 4 May	A/Prof Kevin Varvell	344

You should also attend a single one-hour **workshop tutorial** per week in Room 331 Madsen Building and a one three-hour **laboratory** session per week in the Carslaw Building on Level 4 (rooms 401, 402, 407 and 408).

Note: there will be no lecture on Thursday, 21 April. There are also no classes from Friday 22 April and over Easter (Friday 22 April to Friday 29 April). There is no lab on some weeks (consult the back cover of your Lab Manual for details).

You should also plan to spend about 6 hours per week on **independent study** to read through and understand the textbook, work through assigned examples and complete assignments, and to study for progressive tests and the final examination.

TEXTBOOK

This module is defined in terms of the text: Knight, Jones & Field, *College Physics*, 2nd ed. published by Pearson, Addison Wesley, 2010.

MASTERING PHYSICS – TUTORIAL and ASSIGNMENT QUESTIONS

MasteringPhysics may be accessed at http://www.masteringphysics.com. At this stage of the semester you should be familiar with using your chosen username and password to login to *MasteringPhysics* (you should be taken automatically to course ID **SUPHYS1002Y2011**).

Questions in *MasteringPhysics* are presented in groups (called 'assignments' by the system) with a title such as *Mechanics - Assignment 2 and Tutorial Questions*. There is one 'assignment' for this Module.

Mechanics – Assignment 2 and Tutorial Questions

To be completed by 7pm Friday 6 May

The Assignment is divided into two components.

- **Tutorial Questions**. These mostly feature the full *MasteringPhysics* Socratic dialogue - when you get stuck in answering a problem it offers a simpler problem and provides feedback tailored to your answers. These have been selected by your lecturers to help your understanding and problem solving ability. They are not assessed but we strongly recommend you look at some of these questions, which will remain available after the assignment deadline until the end of the semester.
- **Assignment Questions** are compulsory questions and represent the *minimum* use you should make of the system. 8 questions are offered, each worth 5 marks even though some are a little longer than others. Each assignment is worth about 2% towards your total assessment (see the unit of study outline for full details of how marks count towards your final assessment). The questions are a mix: tutorial-style questions teaching you concepts and problem solving techniques; and end-of-chapter problems from the textbook. The tutorial-style questions have full hints and feedback, while the end-of-chapter questions do not.

  The marking scheme gives a small reward when answers are achieved without using the hints, but no penalty if you do use them. See the *MasteringPhysics* FAQ at http://sydney.edu.au/science/physics/pdfs/current/jphys/MP_faq.pdf for more details.

Assignment questions must be completed by 7pm (local time) on the date noted in the table above. Available assignment marks ramp down to zero in the five hours after the assignment deadline. It is therefore essential that you seek permission if you need to submit the assignment late. Assignment questions remain accessible to you for review (but no more marks!) until the end of the semester.

Read and/or print each problem, then work on it *before* trying to enter your answer. We don't want you to sit down and type in the answers without working on and thinking about them first. Try the problem without a hint first, then, if you get stuck, try the hint. For assignment questions, we give you eight chances to get the correct answer (although there is a small penalty for wrong answers). The objective is to get the right answer using as much help as it takes.

Your answers need to be formatted correctly so be smart and use the help the system provides:

- Values of constants can be found using the 'constants' button near the top of the page.
- See the Help linked from "?" at the right end of relevant boxes for more help with formatting.
- Move your mouse over symbols in the question to see how to type then in the correctly.

We encourage students to cooperate in understanding all the questions since the objective is to understand concepts and develop your problem solving ability. However **all Assignment Questions using *MasteringPhysics* must be completed individually**. Simply copying the work of another person without acknowledgment is plagiarism and contrary to University policies on **Academic Honesty in Coursework** (see http://sydney.edu.au/ab/policies/Academic_Honesty_Cwk.pdf).

MasteringPhysics marks the assignments automatically and you immediately know your result. Worked solutions to all Assignment Questions will be posted on the web, although you should have the answer once you complete each *MasteringPhysics* question. Note that some assignment questions use randomised values - i.e. different students see the question with different values.

Question/Problems?

Help in using *MasteringPhysics* can be obtained from:

- Extensive on-line help
- An FAQ list at http://sydney.edu.au/science/physics/pdfs/current/jphys/MP_faq.pdf
- A discussion group on eLearning for this unit is monitored by Physics staff.

If for any reason you cannot complete the assignment on-line, you may request a paper copy of the assignment and permission to submit a paper copy of the solution. You must submit an *Application for Consideration of Special Circumstances by Physics* (see the Unit Outline or http://sydney.edu.au/science/physics//current/consideration.shtml). Paper-based assignments will not be accepted unless permission is obtained beforehand, since the objective is for you to use the tutoring ability of *MasteringPhysics* to improve your ability to solve problems and your understanding of concepts.

INTERACTIVE LECTURE DEMONSTRATIONS

There will be 3 Interactive Lecture Demonstrations in this module. These will involve individual and group work during a lecture. As you leave the lecture, you will submit individual sheets. The Interactive Lecture Demonstrations will be held in lectures on the 31st March/1st April, 6th April and 2nd of May. There is a small mark for participation in ILDs. This is a total of 3% for all modules.

REMINDERS

eLearning

Unit web pages are provided under eLearning, which can be accessed from links on the Junior Physics web pages (http://sydney.edu.au/science/physics/current/jpc.shtml) or your MyUni pages (http://sydney.edu.au/myuni). A brief introduction to help you with web access is available on the Junior Physics web page at http://sydney.edu.au/science/physics/pdfs/current/jphys/webct_handout.pdf.

Email

The University provides you with email access based on your username. We may use this email address to provide you with important information regarding this unit of study. **We expect you to periodically read the your email account or to forward mail from it to an email account you do read (eg. a hotmail account).**

Where to go for help

If you need help, you can

- as a first step, always check your unit eLearning pages for information, documents and links
- go to the Physics Student Services Office, Room 202 in the Physics building, or phone 9351 3037
- ask your lecturer or tutor
- ask other students using the Discussion forum provided in the *Communication* link on the unit eLearning page.
- ask a Duty Tutor - a staff member who is available Tuesday – Friday, 1-2 pm, in Physics LT4 to help you with problems with physics course material available from *Week 3* of semester.
- consult one of the many services provided by the University, such as the Maths Learning Centre. These can be found by choosing *Junior Physics Resources and Links* from the unit eLearning page or your *MyUni* pages (http://sydney.edu.au/myuni).

Consideration of factors affecting your study

If your academic performance in a Science Faculty unit of study is adversely affected by **illness or some other serious event**, such as an accident, you should notify the **Faculty of Science Student Information Office** (level 2 of the Carslaw building) within 7 days after the period for which consideration is sought, by completing an *Application for Special Consideration* with accompanying documentation. This is especially important if you miss an examination.

If you have another reason for the Science Faculty to take account of your circumstances - religious commitments, legal commitments (e.g. Jury duty), elite sporting or cultural commitments (representing the University, state or country), or Australian Defence Force commitments (e.g. Army Reserve) - you should notify the **Faculty of Science Student Information Office** (level 2 of the Carslaw building) at least 7 days BEFORE the period for which consideration is sought, by completing an *Application for Special Arrangements* with accompanying documentation.

These two forms of Consideration should cover most allowable circumstances. However, if you have **another reason** for requiring the School of Physics to take account of your circumstances, you should notify the **School of Physics Student Services Office** immediately.

You should **not** submit an application of any type if

- there is no assessment associated with a missed class, or
- you have a reasonable opportunity to make up any work you missed.

If for example, you miss an assignment, an application for appropriate Consideration is required to allow late submission, but we do expect the assignment to be submitted. Sometimes catching up may be impossible, in which case we will consider a pro-rata adjustment of your marks on the basis of an application for Consideration.

Special Consideration or Special Arrangements
To submit an application for *Special Consideration* or *Special Arrangements* you should:

1. Obtain the appropriate Application pack from the Student Information Office of the Faculty of Science, the Faculty website at http://sydney.edu.au/cstudent/ug/forms.shtml, or the Physics Student Services Office.
2. Complete the forms and obtain whatever original documentary evidence is appropriate. Note especially that the Professional Practitioner's Certificate is essential for Special Consideration on grounds of serious illness - Medical Certificates will NOT be accepted.
3. Take the original copy of all forms and documents, plus sufficient copies for each unit of study affected and yourself, to the Faculty of Science Student Information Office (NOT any other Faculty Office if you are seeking Consideration in a unit taught by Physics). They will sign/stamp both the original application form and the copies. In the case of Physics units, one copy of the documentation must then be submitted to the Physics Student Services Office. Keep one copy yourself. A formal decision on your application will be sent to your **university email** address within 14 days.

Further details on University policy regarding Considerations can be found in policy documents entitled *Assessment and Examination* at the University Policy web site (http://sydney.edu.au/policy/).

Students unsure what type of Consideration is appropriate, or unhappy with a Consideration decision, should consult the Physics Student Services Office.

It is important to realise that the policies on *Special Consideration* and *Special Arrangements* apply throughout the University. Policies on other forms of Consideration are specific to Physics and may be different in Departments responsible for your other units of study.

MODULE DEFINITION – MECHANICS

PREAMBLE

This module is an introduction to the area of Physics known as "Mechanics". Mechanics is the study of how and why objects move (or not) under the influence of forces and collisions with other objects. This module introduces the concepts of **force**, **momentum** and **energy** and the mathematically based methods needed to solve mechanical problems. Therefore this module is more mathematical than the previous module (Language of Physics) and builds on the definitions you learned there. An understanding of force, momentum and energy is also required for you to study and learn about other branches of Physics, some of which you will encounter in later modules in Fundamentals.

Specific objectives detailed below in the **COURSE CONTENT** section define what concepts and applications you should learn and understand. By "understanding" a concept, we mean that you should be able to;

- explain its meaning in words and give examples,
- interpret it correctly when you read or hear it,
- use it correctly in your own writing,
- apply it correctly in solving both qualitative and quantitative problems.

In the exam you will be asked to write descriptive answers to qualitative questions and to derive numerical and algebraic answers to quantitative problems. Your *explanations* and use of *physical principles* are the most important parts of these answers, and these are used to test your understanding, rather than just “getting the right number”. Memorisation of formulas and algebraic manipulation without understanding the physics is not the point and will receive very little reward.

ASSUMED KNOWLEDGE

Literacy, numeracy and general knowledge at HSC standard
Basic algebra, trigonometry (sine, cosine, tangent, triangles), basic differentiation and integration,
Concepts and definitions from the Language of Physics module especially the following:

- Measurement, order of magnitude, significant figures, SI system of units, change of units
- Vectors, vector addition and subtraction, vector components
- Motion along a straight line and in two and three dimensions

HINTS FOR STUDY

It is strongly recommended that you understand the sample problems from your lectures, and from the text. Ensure you understand the Workshop Tutorial problems and demonstrations.

A list of formulae is provided in the exam. It is desirable to become familiar with this list, however it will not be available till the end of semester. It is suggested that you become familiar with the list for last year, which is towards the back of your *Laboratory Manual*. The list for this year may be slightly different. The laboratory, tutorial and lecture materials are coupled so use them together.

COURSE CONTENT

Listed below are the sections in Knight, Jones & Field relevant to the topics covered in this module.

FORCE AND NEWTON'S LAWS (5 lectures)

This section commences the study of *dynamics*, *i.e.* the causes of the changes in the state of motion. Central to this study are Newton's Laws of Motion which introduce the distinct concepts of *force* and *mass*. In understanding the concept of force, it is necessary to identify all the forces acting **on** the selected system and then be able to correctly apply Netwon's Laws both qualitatively and quantitatively.

Text Sections: Chapter 4, 5.1 – 5.4
Make sure you review Chapter 3 on Vectors.

Suggested Conceptual questions (C), Multiple choice questions (M), Problems (P) and Student Workbook questions (W):

Chapter 4 22M, 67P, 7W, 26W.
Chapter 5 22M, 24M, 1W, 19W, 25W, 29W 4P, 13P, 38P and 61P.

***Specific Objectives* after studying this chapter you should be able to:**

- Understand and be able to use the following concepts: Force, net force, mass, particle (or point mass);
- Describe the following different forces, gravitational force, weight, contact force, normal force, frictional force, string force (Tension) and use them where appropriate.
- Understand and apply Newton's three Laws of Motion.
- Be able to draw free body diagrams and solve problems using Newton's Laws.

MORE ON FORCE: CIRCULAR MOTION AND FRICTION (2 lectures)

Special attention is given to the forces of friction. These appear at the surface of objects in contact, whether solid or fluid. Uniform circular motion is also examined.

Text Sections: 3.8, 5.5, 6.1 – 6.4

Suggested Conceptual questions (C), Multiple choice questions (M), Problems (P) and Student Workbook questions (W):

Chapter 3 15C and 44W.
Chapter 5 13P, 25P 28P and 21W.
Chapter 6 3C, 23M, 25M, 16P, 19P, 24P, 11W and 14W.

***Specific Objectives* after studying this section you should be able to:**

- Describe the different types of frictional forces - static frictional force, kinetic frictional force, coefficient of (static or kinetic) friction.
- Apply the different types of frictional forces in appropriate situations.
- Discuss the concept of centripetal acceleration and identify the forces that supply this acceleration.

CENTRE OF MASS, TORQUE AND EQUILIBRIUM (1 lecture)

The idea of *Centre of mass* is introduced and Newton's Second Law of Motion is refined accordingly. When applying Newton's Laws to complex objects or collections of particles acting together, one should consider the motion of the centre of mass, rather than any other arbitrary point within the object or collection. The centre of mass is the mean position of the object's mass. (*Centre of gravity* is closely related).

Archimedes' law of the Lever is used to introduce the idea of *Torque*, a "twisting force" that occurs when a force applied to an object is not directly in line with the *axis of rotation*.

Conditions for equilibrium are applied to bodies at rest. These conditions are that the net force is zero and the net torque is zero.

Text Sections: 7.2 – 7.3, 8.1 – 8.2

Suggested Conceptual questions (C), Multiple choice questions (M), Problems (P) and Student Workbook questions (W):

Chapter 7 2C, 7C, 16M, 10P, 12P and 17P.
Chapter 8 4C, 18M, 1P, 7P, 15P and 13W.

***Specific Objectives* after studying this chapter you should be able to:**

- Understand and be able to use the concept of centre of mass and be able to estimate or calculate the position of this (in 1 and 2 dimensions) for simple objects or collections of particles.
- Understand and be able to use the following concepts: angular velocity, angular displacement, tangential velocity, arc length or tangential displacement.
- Understand the following concepts: Torque, rotation axis, point of application of a force and line of action of a force.
- Apply these concepts to find the torque of a force about an axis of rotation.
- Calculate necessary values of forces for equilibrium conditions, using the fact that, for equilibrium, the sum of forces and the sum of torques are both zero.

MOMENTUM AND COLLISIONS (2 lectures)

The concept of *momentum* is introduced. Linear momentum is always conserved and this law is presented as a consequence of the absence of net external force on the system. The application of a force in time is revisited, to explore its action and effects: Impulse and change in linear momentum. The common phenomenon of collisions is examined under conditions in which kinetic energy is conserved and not conserved.

Text Sections: 9.1 – 9.6

Suggested Conceptual questions (C), Multiple choice questions (M), Problems (P) and Student Workbook questions (W):

Chapter 9 4C, 9C, 20M, 25M, 1P, 8P, 14P, 29P, 39P, 44P, 67P, 7W and 8W.

***Specific Objectives* after studying this chapter you should be able to**

- Understand the concepts of linear momentum, total linear momentum, conservation of linear momentum, internal force, external force.
- Understand the law of conservation of linear momentum for a system of particles.
- Apply Newton's second law of motion to a system of particles using the concept of linear momentum for a system of particles.
- Understand the concepts of impulse, average force.
- Apply the impulse-linear momentum theorem.
- Understand the difference between an elastic and inelastic collision, and apply the relevant conservation laws in each case.

ENERGY AND WORK (3 lectures)

The concept of *Energy* is introduced. The total energy of the universe is constant or *"conserved"* but it can be converted from one form to another, for example *Kinetic* and *Gravitational Potential* energy. Kinetic energy and potential energy taken all together are called *Mechanical Energy*. Mechanical energy is not conserved on its own if there are any *dissipative* or *non-conservative* forces like friction or drag. Forces for which mechanical energy *is* conserved are called *conservative* forces. *Work* is done when an applied force causes a transfer of energy from one object to another. The rate at which work is done is called *Power*.

Text Sections: Chapter 10

Suggested Conceptual questions (C), Multiple choice questions (M), Problems (P) and Student Workbook questions (W):

Chapter 10 1C, 15C, 23M, 24M, 27M, 1P, 3P, 11P, 26P, 30P, 41P, 50P, 53P, 8W, and 26W.

***Specific Objectives* after studying this chapter you should be able to**

- Describe the concepts of, kinetic energy, potential energy, work and power.
- Calculate the work done by the gravitational force
- Calculate the work done by a variable force
- Explain the difference between conservative and non-conservative (or dissipative) forces.
- Understand and apply the principle of conservation of mechanical energy for an isolated system.
- Understand the relationship between work done by external forces, including frictional forces, and the change in energy of the system.
- Use the above concepts and principles for calculations in appropriate situations.

