1. **Title of the module**

PH323 Thermodynamics and Matter

1. **School or partner institution which will be responsible for management of the module**

School of Physical Sciences

1. **The level of the module (e.g. Level 4, Level 5, Level 6 or Level 7)**

4

1. **The number of credits and the ECTS value which the module represents**

15 credits (7.5 ECTS)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Term 2

1. **Prerequisite and co-requisite modules**

Pre-requisites:

UK Advanced Level Physics Examinations with a normal minimum attainment of a

Grade C on the main Physics A - Level. Any generally accepted equivalent of this

content and attainment is regarded as an acceptable prerequisite.

Co-requisite PH300 Mathematics, PH304 Astrophysics, Space Science and Cosmology, PH321 Mechanics, PH322 Electricity and Light, PS370 Skills for Physicists.

1. **The programmes of study to which the module contributes**

Physics (BSc, BSc with Foundation Year, BSc with Year in Industry, MPhys, MPhys with Year Abroad)

Physics with Astrophysics (BSc, MPhys, MPhys with Year Abroad)

Astronomy, Space Science and Astrophysics (BSc, MPhys, MPhys with Year Abroad)

This is not available as a wild module.

1. **The intended subject specific learning outcomes.
On successfully completing the module students will be able to:**

8.1 Knowledge and understanding of laws and principles of thermodynamics and matter, and their application to diverse areas of physics. (A1)

8.2 An ability to identify relevant principles and laws of thermodynamics and matter when dealing with problems,and to make approximations necessary to obtain solutions. (B1)

* 1. An ability to solve problems involving thermodynamics and matter using appropriate mathematical tools. (B2)
	2. An ability to use mathematical techniques and analysis to model behaviour involving thermodynamics and matter. (B4)
	3. An ability to present and interpret information relating to thermodynamics and matter graphically. (C2)
	4. An ability to make use of appropriate texts, research-based materials or other learning resources about thermodynamics and matter as part of managing their own learning. (C6)
1. **The intended generic learning outcomes.
On successfully completing the module students will be able to:**
	1. Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems; an ability to formulate problems in precise terms and to identify key issues, and the confidence to try different approaches in order to make progress on challenging problems. Numeracy is subsumed within this area. (D1)
	2. Analytical skills – associated with the need to pay attention to detail and to develop an ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly. (D4)
2. **A synopsis of the curriculum**

Static Equilibrium, Elasticity and fluids; Elasticity: stress, strain, Hooke’s law, Young’s modulus, shear modulus, forces between atoms or molecules, intermolecular potential energy curve, equilibrium separation, Morse and 6-12 potentials, microscopic interpretation of elasticity, relation between Young’s modulus and parameters of the interatomic potential energy curve, the nature of interatomic forces, the ionic bond, calculation of the energy to separate the ions in an ionic crystal, viscosity of fluids, Poiseuille’s law, Stokes’ law.

Thermodynamics; Thermal equilibrium, temperature scales, thermal expansion of solids, relation between thermal expansion and the interatomic potential energy curve, the transfer of thermal energy: conduction, convection, radiation, the ideal-gas law, Boltzmann’s constant, Avogadro’s number, the universal gas constant. The kinetic theory of gases, pressure of a gas, molecular interpretation of temperature, molecular speeds, mean free path, specific heat, molar specific heat. The equipartition theorem, degrees of freedom. Heat capacities of monatomic and diatomic gases and of solids. Internal energy of a thermodynamic system, the first law of thermodynamics, work and the PV diagram of a gas, work done in an isothermal expansion of an ideal gas. Molar heat capacities of gases at constant pressure and at constant volume and the relation between them. Adiabatic processes for an ideal gas. Heat engines and the Kelvin statement of the second law of thermodynamics, efficiency of a heat engine. Refrigerators and the Clausius statement of the second law of thermodynamics. Equivalence of the Kelvin and Clausius statements. The Carnot cycle, the Kelvin temperature scale.

Atoms; The nuclear atom, Rutherford scattering and the nucleus, Bohr model of the atom, energy level calculation and atom spectra, spectral series for H atom. Limitation of Bohr theory. Emission from Molecules. Photoelectric Effect. Blackbody Radiation. Heisenberg’s Uncertainty Principle.

1. **Reading List (Indicative list, current at time of publication. Reading lists will be published annually)**

*Physics for Scientists and Engineers* (6th Ed.); Tipler, P.A. & Mosca, G. (2008)

1. **Learning and Teaching methods**
* Contact hours: Lectures (24 hours); workshop sessions (6 hours)
* The number of independent learning hours, including assignments 120 hrs
* Total number of study hours 150 hrs

Achievement of module learning outcomes:

* Lectures (8.1-8.5)
* Workshop sessions (8.1-8.6, 9.1, 9.2)
* Assignments (8.1-8.6, 9.1, 9.2)
* Self-study (8.1-8.6, 9.1, 9.2)
1. **Assessment methods.**

• Coursework 20%; comprising at least one ICT (in-course test) and at least one piece of independent work involving problem solving.

• Final (written, unseen, length 2 hours) exam 80%.

The above assessments test students’ knowledge and understanding of laws and principles (8.1, 8.2, 9.2) and application of techniques to model behaviour and solve problems (8.3, 8.4, 8.5, 9.1, 9.2). In preparing for the assessments, students will need to manage their own revision using reference materials. (8.6, 9.2)

1. **Map of Module Learning Outcomes (sections 8 & 9) to Learning and Teaching Methods (section12) and methods of Assessment (section 13)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** |  | 8.1 | 8.2 | 8.3 | 8.4 | 8.5 | 8.6 | 9.1 | 9.2 |  |  |  |  |
| **Learning/ teaching method** | **Hours allocated** |  |  |  |  |  |  |  |  |  |  |  |  |
| Lectures | 24 | **x** | **x** | **x** | **x** | **x** |  |  |  |  |  |  |  |
| Workshops | 6 | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |  |
| Self-study | 120 | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Coursework |  | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |  |
| Examination |  | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |  |

1. **The School recognises and has embedded the expectations of current disability equality legislation, and supports students with a declared disability or special educational need in its teaching. Within this module we will make reasonable adjustments wherever necessary, including additional or substitute materials, teaching modes or assessment methods for students who have declared and discussed their learning support needs. Arrangements for students with declared disabilities will be made on an individual basis, in consultation with the University’s disability/dyslexia student support service, and specialist support will be provided where needed.**
2. **Campus(es) or Centre(s) where module will be delivered:**

Canterbury

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**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

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| --- | --- | --- | --- | --- |
| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
| 26/05/16 | Major | September 2016 | 6, 10, 13 | No |
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