国际青少年科学奥林匹克竞赛中国区组委会
青少年国际竞赛与交流中心

# INTERNATIONAL JUNIOR SCIENCE OLYMPIAD CHINA FINALS
# 国际青少年科学奥林匹克中国区终选

## SYLLABUS

## 大纲

For Final Contest in July 2018
2018 年 7 月 初赛

This syllabus is approved for use in China
本大纲已批准在中国使用

# 1. Contents 内容

# 2. IJSO Introduction 国际青少年科学奥林匹克竞赛介绍

## 2.1 International Junior Science Olympiad 国际青少年科学奥林匹克竞赛

The International Junior Science Olympiad (IJSO) is an annual individual and team competition in the Natural Sciences for students who are under sixteen years old on 31st December of the competition year. IJSO has been established in recognition of the significance of the Natural Sciences in the general education of young people and in all aspects of their lives. It is a purely educational event.

国际青少年科学奥林匹克竞赛(IJSO)是一项每年举办的个人和团体的自然科学比赛。参赛学生的年龄为 16 岁以下（竞赛年 12 月 31 日之前）。IJSO 的竞赛精神是崇尚自然科学教育对青年人以及他们生活各个方面的重要性。这是一项纯粹的教育活动。

## 2.2 Aims 宗旨

➢ To promote and reward the pursuit of excellence in scientific endeavor.
促进和褒奖为追求卓越而努力的科学精神。

➢ To challenge, stimulate and encourage gifted students to further develop their talents in Natural Sciences.
挑战、激发和鼓励有天赋的学生在自然科学领域进一步发展他们的才能。

➢ To create friendship and relationships among students around the world from an early age.
为世界各地的学生从少年时期开始建立国际友谊和关系。

## 2.3 Objectives 目标

➢ To stimulate the active interest of students in the Natural Sciences.
激发学生对自然科学的积极兴趣。

➢ To promote their careers as scientists.
推动学生们把科学家考虑为自己以后的事业。

➢ To enhance and develop international contacts in the Natural Sciences.
加强和发展自然科学的国际交往和对话。

➢ To promote future scientific collaboration.
促进未来的科学合作。

➢ To encourage the formation of friendships within the scientific community.
鼓励在科学界建立更多友谊。

➢ To offer the opportunity to compare the syllabi and educational trends in science education within the participating countries.
提供在参赛国之间比较教学大纲和科学教育的趋势的机会。

# 3.Syllabus content at a glance 大纲内容总览

| Learners study the following topics:<br>学习者研究如下主题： |
|---|
| **1. Particles, waves and matter 粒子，波和物质** |
| **1.1 What things are made of** 物质的构成 |
| **1.2 Periodic table - concept, organization and structure** 元素周期表-概念，组织和结构 |
| **1.3 States of matter and its properties** 物质的状态和性质 |
| **1.4 Waves** 波 |
| **1.5 Light** 光 |
| **2. Energy 能量** |
| **2.1 Nature of energy and energy conservation** 能量与能量守恒 |
| **2.2 Various forms of energy** 能量的形式 |
| **2.3 Transfer of energy** 能量转换 |
| **2.4 Sources of energy** 能源 |
| **2.5 Power** 功率 |
| **3. Interactions 相互作用** |
| **3.1 Kinematics and Forces** 力与运动 |
| **3.2 Electric, magnetic and gravitational fields** 电场，磁场，重力场 |
| **3.3 Type of chemical bonding - nature, structure and strength** 化学键的种类，结构和强弱 |
| **3.4 Chemical Reactions** 化学反应 |
| **3.5 Diffusion, osmosis and surface tension** 扩散，渗透和表面张力 |
| **3.6 Principle of thin layer and paper chromatography** 纸层析和薄层分离法的原理 |
| **3.7 Effects of radiation on organisms** |
| **3.8 Forms of communication** 通讯方式 |
| **4. Structure, properties and functions 结构，性质和功能** |
| **4.1 Cells** 细胞 |
| **4.2 Parts of the body** 人体组成 |
| **4.3 Homogeneous and heterogeneous catalysts** 均相与异相催化剂 |
| **4.4 Acids and bases** 酸和碱 |
| **5. Systems 系统** |
| **5.1 Continuity principles in closed systems cycles** 封闭系统中的连续原理，循环平衡 |
| **5.2 Equilibriums** 平衡 |
| **5.3 Scales of nature** 自然尺度 |
| **5.4 Basic concepts about cycles in nature** 自然界中循环的基本概念 |
| **5.5 Ecology** 生态 |
| **5.6 Pollution effects of different modes of power generation** 不同发电模式的污染效应 |
| **5.7 Organisms as systems** 生物系统 |
| **5.8 Plant physiology** 生物生理 |
| **5.9 Electric Circuits** 电路 |
| **5.10 Thermodynamical systems** 热力学系统 |
| **5.11 Astrophysical** 天体物理 |
| **6. Development and Evolution 发展和演化** |
| **6.1 Strategies of environmental adaptation** 环境适应策略 |
| **6.2 Theory of evolution** 进化理论 |
| **6.3 Cell cycle and cell division** 细胞周期和细胞分裂 |
| **6.4 Reproduction in humans, animals and plants** 人类、动物和植物的繁殖 |
| **6.5 Genes, chromosomes and genetics** 基因、染色体和遗传 |
| **6.6 Diseases** 疾病 |

# 4.Assessment at a glance 评价总览

| Learners take:<br>学习者参加： | Learners take:<br>学习者参加： |
|---|---|
| **Theoretical task　　　　　150 minutes**<br>**简答题　　　　　　　　　　150 分钟**<br>A written paper consisting of short-answer and structured questions.<br>笔答试卷包括简答题和分步计算题。<br><br>This paper will test assessment objectives AO * 1 and AO2. Questions will be based on the syllabus content.<br>本测试试卷包括评级目标 1 与评价目标 2。所有问题的知识范围在大纲内容中。 | **Multiple-choice and open-ended question task**<br>**150 minutes**<br>**选择题和开放问答题　　　　150 分钟**<br>This paper includes two sections. Section A consists of **45** items of the multiple-choice questions. Section B consists of **9** items of the open-ended questions.<br>本测试试卷分两部分。A 部分 45 道选择题。B 部分 9 道开放问答题。<br><br>This paper will test assessment objectives AO1 and AO2. Questions will be based on the syllabus.<br>本测试试卷包括评级目标 1 与评价目标 2。所有问题的知识范围在大纲内容中。 |

\* AO refer to assessment objective AO 指的是评价目标

# 5.Syllabus aims, objectives and assessment objectives 大纲宗旨、目标与评价目标

## 5.1 Syllabus aims and objective 大纲宗旨与目标

The syllabus aims and objectives listed below are the same for all learners and are not listed in order of priority. Some of these may be delivered by the use of suitable local, international or historical examples and applications, or through collaborative experimental work.
以下所有大纲目标对于所有学习者都是等同的，顺序没有主次之分。通过使用合适的本地，国际或历史实例和应用程序，或通过合作实验工作来实现其中一些目标。

**The aims are : 宗旨是 :**
1. To encourage gifted students to further develop their talents in Natural Sciences.
   鼓励有科学天赋的学生在科学方面学有所长。
2. To cultivate students' scientific thinking method from an early age to lay foundation for lifelong learning and lifelong development of students.
   从小培养学生的科学思维方法，为学生的终生学习、终生发展奠定基础。
3. To set up a bridge between knowledge and application and build a bridge between disciplines.
   搭建知识与应用之间的桥梁，搭建学科与学科之间的桥梁。

**The objectives are : 目标是 :**
1. To stimulate the active interest of students in the Natural Sciences.
   激发学生对自然科学的浓厚兴趣。
2. To advance with the modern times, pay attention to social hot issues and learn more about the necessary scientific knowledge for life.
   把握时代脉搏，关注社会热点问题，更多地学习生活必备的科学知识。
3. To promote students' career-oriented scientific future.

促进学生未来科学相关的职业导向。
4. To build friendship and connections among young scientists.
   帮助青少年科学家之间建立友谊与联系。

## 5.2 Assessment objectives 评价目标

### AO1: Knowledge with understanding 理解知识

Learner should be able to 学习者应该能够：

1. Demonstrate scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics
   以生物、化学和物理等具体学科为载体，展现对科学知识和概念的理解。

2. Recall and understand scientific facts, terminology, principles, concepts, practical techniques and apparatus, as well as applications and implications of science
   回忆并理解科学事实，术语，原理，概念，实验操作和仪器，以及科学的意义及应用

### AO2: Handling information and problem solving 信息处理与问题解决

Learners should be able to 学习者应该能够：

1. Explain phenomena and interpret data, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical), by applying their scientific knowledge
   应用科学知识，以文字或其他书面表达形式（符号，图形和数字）来解释现象和解读数据

2. Carry out calculations and make predictions
   完成计算，做出推测

3. Extract, analyze, evaluate, translate and present information and data to identify patterns, report trends and draw inferences
   采集、分析、评估、解读和呈现信息和数据，以识别规律，报告趋势并得出推论

4. Evaluate claims through critical analysis of the methodology, evidence and conclusions, both qualitatively and quantitatively
   通过对方法论、证据及结论进行定量及定性的批判性分析，对论断进行评价。

5. Apply scientific knowledge to new and unfamiliar situations
   在新的和陌生的情境中应用科学知识

# 6. Syllabus content 大纲内容

## 6.1. PARTICLES, WAVES AND MATTER 粒子，波与物质

Matter is structured from the smallest particle to the size of the universe.

The microscopic structure of matter is responsible for the features we observe macroscopically.

The students should be aware of this structure and be familiar with the following concepts

物质包括最小的粒子到广袤的宇宙。物质的微观结构形成了我们所看到的种种特征。学生应该认识到这种体系并熟悉以下概念：

| | Learning outcomes<br>学习目标<br>Learners should be able to demonstrate and apply their knowledge and understanding of:<br>学习者能够展现和运用以下的知识与理解 |
|---|---|
| **1.1 WHAT THINGS ARE MADE OF**<br>**物质的构成** | 1.　structure of particles and atom<br>　　微粒和原子的结构<br>　a.　modern atomic model<br>　　　现代原子模型<br>　b.　history of the atomic model<br>　　　原子模型发展的历史<br>　c.　neutrons, protons, electrons- relative charges and masses<br>　　　质子，中子和电子的相对电荷量和质量<br>　d.　scale of atoms and small molecules<br>　　　原子和小分子的尺寸<br>　e.　nature of bonding<br>　　　化学键的基本原理<br><br>2.　elements, isotopes and compounds<br>　　元素，同位素和化合物<br>　a.　calculate number of protons, neutrons, electrons, atomic number and atomic mass based on the atomic symbol<br>　　　利用原子符号的信息计算质子，中子，电子，原子序数和原子质量<br>　b.　define isotope and calculate average relative atomic weight based on isotope weight and abundance<br>　　　同位素的定义并根据同位素质量和丰度计算元素的平均相对原子量<br><br>3.　composition of molecules, chemical substances<br>　　分子的组成和化学物质<br>　a.　relative formula mass and relative molecular mass<br>　　　相对化学式质量和相对分子量<br>　b.　empirical formula and molecular formula<br>　　　经验式和分子式<br>　c.　name compounds from given formulae<br>　　　根据化学式命名<br>　d.　mixtures, colloids and suspensions<br>　　　混合物，胶体和悬浊液<br>　e.　mixture and pure substance<br>　　　混合物和纯净物<br>　f.　definition, application and separation of solution, colloids and suspension<br>　　　溶液，胶体和悬浊液的定义，应用和分离 |
| **1.2 PERIODIC TABLE - CONCEPT, ORGANIZATION AND STRUCTURE**<br>**元素周期表-概念，组织和结构** | 1.　history of the periodic table<br>　　元素周期表的历史<br><br>2.　metals and non-metals<br>　　金属和非金属<br><br>3.　groups and periods<br>　　族与周期 |

| | |
|---|---|
| | 4. position of an element in the periodic table and its relation to the atomic number, electron arrangement, outer shell electrons and chemical property<br>元素在周期表中的位置与其原子序数，电子排布，最外层电子和化学性质的关系 |
| | 5. group 1, 7 and 0 elements- common properties and trends<br>第 1，7 和 0 族元素的性质及变化趋势 |
| | 6. transitional metals- property and application<br>常见过渡金属的性质和应用 |

**1.3 STATES OF MATTER AND ITS PROPERTIES**
物质的状态和性质

1.  solids, liquids, gases and plasmas - characteristics and differences
    固体，液体，气体和等离子体的特定和区别
    a.  particle model and the three states of matter
        粒子模型和固液气三相
    b.  phase change
        相变
    c.  plasma
        等离子体
    d.  molar volume of gases
        气体摩尔体积

2.  lattice as a special form of solid matter
    固体的晶体结构
    a.  ionic lattice
        离子晶体
    b.  metallic lattice
        金属晶体
    c.  giant covalent/macromolecular lattice
        共价/大分子晶体
    d.  simple molecular lattice
        小分子晶体

3.  properties of matter
    物质的性质
    a.  relates material structure to its property
        物质结构与性质的关系
    b.  property and application of common materials
        常见材料的性质和应用
    c.  density
        密度
    d.  volume
        体积
    e.  electrical conductivity, insulators and conductors
        导电性，绝缘体和导体
    **f.  elastic behavior**
        **弹性**
    **g.  thermal expansion**
        **热膨胀**
    **h.  (specific) heat capacity**
        **（比）热容**
    i.  defining properties of metals, non-metals, alloys
        金属，非金属和合金的主要性质

4.  phase transitions and their influence on the properties of matter
    相变及其对物质性质的影响
    a.  change of volume and density
        体积和密度的变化
    b.  water and its different phases
        水和它的相变
    **c.  latent heat**
        **潜热**
    **d.  phase diagrams**
        **相图**

| | |
|---|---|
| **1.4 WAVES**<br>波 | 1. amplitude, wavelength, period, phase difference, frequency and speed of a wave<br>振幅，波长，周期，相位差，频率，波速<br><br>2. the relationship between frequency, wavelength and speed of a wave<br>波的频率，波长，波速以及他们之间的关系<br><br>3. progressive waves/difference between transversal and longitudinal waves<br>行波/横波与纵波的区别<br><br>4. superposition of waves<br>波的叠加<br><br>5. **sound as longitudinal pressure wave, perception of sound**<br>**声音的传播-纵波和压力波**<br><br>6. **classical Doppler effect**<br>**经典多普勒效应** |
| **1.5 LIGHT**<br>光 | 1. **wave and particle interpretation of light**<br>**光的波粒二象性**<br><br>2. propagation and speed of light in vacuum and media, refractive index<br>波在真空与介质中的传播，折射率<br><br>3. reflection and refraction of light at mirrors and lenses<br>平面镜反射与透镜折射<br>(angle of incident and reflected beams, snell's law, total internal reflection)<br>(入射、反射光线，斯涅耳定律，全反射)<br><br>4. **formation of images with mirrors and lenses**<br>**通过镜面和透镜成像**<br>**(focal length, thin lens formula, magnification, magnifying glasses, microscopes, telescopes, glasses)**<br>**（焦距，透镜成像公式，放大，放大镜，显微镜，显微镜，眼镜）**<br><br>5. connection between wavelength and color, electromagnetic spectrum and the light absorption<br>波长与颜色的关系，光谱与光的吸收<br><br>6. the interactions of light intensity in limiting the rate of photosynthesis<br>光的强度限制光合作用速率的作用 |

# 6.2. ENERGY 能量

Energy is essential in our everyday life as energy conversion is the reason for many dynamical phenomena in our world.
Energy is therefore one of the main concepts in science.
The students are expected to know about the following topics.

能量在我们的日常生活中是必不可少的，因为能量转换是生活中许多动力现象的原因。因此，能量是科学的主要概念之一。期望学生了解以下主题。

| | Learning outcomes<br>学习目标<br>Learners should be able to demonstrate and apply their knowledge and understanding of:<br>学习者能够展现和运用以下的知识与理解 |
|---|---|
| **2.1 NATURE OF ENERGY AND ENERGY CONSERVATION**<br>能量与能量受恒 | 1. work and conservation of energy<br>功、能量守恒<br>a. work done by a force; the unit joule<br>一个力所做的功; 单位焦耳<br>b. the principle of conservation of energy<br>能量守恒定律<br>c. energy in different forms; transfer and conservation |

|  |  |
|---|---|
|  | 能量的不同形式; 转化和守恒 |
|  | d. transfer of energy is equal to work done.<br>功是能量转换的量度 |
| **2.2 VARIOUS FORMS OF ENERGY**<br>能量的形式 | 1. kinetic and potential energies<br>动能和势能 |
|  | a. kinetic energy of an object<br>物体的动能 |
|  | b. gravitational potential energy of an object in a uniform gravitational field;<br>均匀引力场中物体的重力势能 |
|  | c. elastic potential energy<br>弹性势能 |
|  | 2. Internal Energy<br>内能 |
|  | a. internal energy as the sum of the random distribution of kinetic and potential energies associated with the molecules of a system<br>内能等于系统内部所有分子无规则运动的动能和势能之和 |
|  | b. absolute zero (0 K) as the lowest limit for temperature; the temperature at which a substance has minimum internal energy<br>绝对零度（0 K）是温度的最低值; 物质具有最小内能的温度 |
|  | c. increase in the internal energy of a body as its temperature rises<br>随着温度升高，物体内能量增大 |
|  | d. changes in the internal energy of a substance during change of phase; constant temperature during change of phase.<br>物态变化过程中物体内能的变化; 物态变化时物体的温度恒定。 |
| **2.3 TRANSFER OF ENERGY**<br>能量转换 | 1. The exchange between gravitational potential energy and kinetic energy<br>重力势能与动能之间的转化 |
|  | 2. Mechanisms of heat transfer, transfer of energy via waves<br>热传递的机制，通过波传递能量 |
|  | 3. Bonding energy and temperature or the loss of energy to the environment by radiation<br>键能与温度 - 通过辐射向环境散失的能量 |
|  | a. relates temperature of phase change, e.g. boiling point, to energy transfer and the relative strength of chemical bonds and intermolecular forces<br>建立相变温度与能量转化及化学键和分子间相互作用力的关系 |
|  | b. endothermic and exothermic reactions<br>吸热和放热反应 |
|  | c. reaction profile<br>反应能量示意图 |
|  | d. energy changes in a chemical reaction and bonding energy<br>化学反应能量变化与键能 |
|  | 4. $\text{efficiency} = \frac{useful\ energy\ output}{energy\ input} \times 100\%$ 效率 = 有用功/总能量 x 100%<br>$\text{efficiency} = \frac{useful\ power\ output}{power\ input} \times 100\%$ 效率 = 有用功率/总功率 x 100% |
|  | 5. The role of photosynthesis in the cycling of matter and flow of energy into and out of organism<br>光合作用在生物体内物质和能量流动过程中的作用 |
|  | 6. How food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism<br>生物体内，食物通过一系列化学反应，分解形成了新的分子，助于生长并且/或者释放能量 |
| **2.4 SOURCES OF ENERGY**<br>能源 | 1. sources of energy for animals, plants, societies and engines<br>动物，植物，社会和发动机的能量来源 |
|  | 2. fossil and renewable energy sources<br>化石燃料和可再生能源 |
|  | a. crude oil- composition, application, importance and limited availability<br>原油的组成，应用，重要性和有限的储量 |
|  | b. fractional distillation and cracking of crude oil<br>原油的分馏和裂解 |

| | |
|---|---|
| | **i.**     **name of fractions and their applications**<br>分馏产物的名称及其应用 |
| | **ii.**     **explain the process in terms of molecular size and intermolecular forces**<br>从分子尺寸和分子作用力的角度解释分馏和裂解过程 |
| | c.     cracking of crude oil<br>原油的裂解 |
| | 3.   interdependent relationships in ecosystem<br>生态系统中的相互关系 |
| | 4.   the effects on resource availability and populations of organisms in an ecosystem<br>生态系统中的资源可用性与生物种群 |
| | 5.   patterns of interactions among organisms across multiple ecosystems<br>多种生态系统之间的生物相互作用 |
| | 6.   the cycling of matter and flow of energy among living and nonliving parts of an ecosystem<br>生态系统中生物与非生物之间的物质循环与能量流动 |
| | 7.   photosynthesis in plants and algae as an endothermic reaction that uses light energy to react carbon dioxide and water to produce glucose and oxygen<br>植物和藻类的光合作用是吸热反应，利用光能将二氧化碳和水转化为葡萄糖和氧气 |
| | 8.   the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol<br>酶是重要的生物催化剂，能够催化碳水化合物、蛋白质、脂质的合成，也将它们分解为糖类、氨基酸和脂肪酸和甘油 |
| **2.5 POWER**<br>功率 | 1.   power<br>功率 |
| | 2.   power; the unit watt<br>功率；单位：瓦特 |
| | 3.   efficiency of a mechanical system;<br>机械系统的效率 |
| | **4.**   **muscular power**<br>肌肉力量 |
| | **5.**   **power output of engines or stars**<br>发动机和恒星的功率 |
| | **6.**   **power dissipation in resistors**<br>电阻的耗散功率 |

# 6.3. INTERACTIONS 相互作用

Conversion of energy and our perception of the world around us are only possible due to interactions.
The students should know about and be able to work with the following concepts:

因为相互作用，能量转换及我们对周围世界的感知才成为可能。学生应该了解并能够使用以下概念：

| | Learning outcomes<br>学习目标<br>Learners should be able to demonstrate and apply their knowledge and understanding of:<br>学习者能够展现和运用以下的知识与理解 |
|---|---|
| **3.1 KINEMATICS AND FORCES**<br>运动与力 | Kinematics 运动学<br>1.   kinematics in one dimension 一维运动<br>    a.   displacement, instantaneous speed, average speed, velocity and acceleration<br>      位移，瞬时/平均速率，速度和加速度<br>    b.   graphical representations of displacement, speed, velocity and acceleration<br>      位移，速率，速度和加速度的图示<br>    c.   displacement–time graphs; calculate velocity from the gradient of a displacement-time graph |

位移-时间图像，位移-时间图像的斜率表示速度

d. velocity–time graphs; calculate acceleration from the gradient of a velocity-time graph; calculate the area under a velocity-time curve to work out the distance.
速度-时间图像，通过速度-时间图像的斜率计算加速度；通过速度-时间图像线下面积，计算位移

e. the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance
匀加速直线运动公式，包括自由落体运动

**2. Circular motion**
**圆周运动**

a. **angular frequency**
**角频率**

b. **centripetal force**
**向心力**

c. **Kepler's laws, movement of the earth around the sun**
**开普勒定律，地球围绕太阳的运动**

Dynamics
动力学

**1. force and types of forces**
**力和力的种类**

a. **understands the vector nature of force, and find and use components and resultants**
**力是矢量，分量和求和**

b. **uses the principle that, when a particle is in equilibrium, the vector sum of the forces acting is zero, or equivalently, that the sum of the components in any direction is zero**
**质点处于平衡状态时合外力为零，即各个方向上的分力的合力为零**

c. **use a vector triangle to represent coplanar forces in equilibrium**
**使用矢量三角形表示共面力的平衡**

d. **types of forces: gravitational force, electrostatic force, magnetic force, static and dynamic frictional forces, buoyancy, van-der-waals force**
**力的种类：重力，静电力，磁力，静摩擦与动摩擦力，浮力，范德华力**

**2. mass and weight, centre of mass**
**质量和重力，质心**

3. **newton's law (1st 2nd 3rd), inertial systems**
**牛顿定律（第一、第二、第三定律），惯性系统**

4. momentum and impulse, the equation for impulse
动量和冲量，动量定理

**5. levers and torque**
**杠杆 和力矩**

a. **define and apply the moment of a force**
b. **知道、应用力矩的定义**
c. **principle of moments**
d. **力矩平衡方程**

**6. elastic forces, Hooke's law and harmonic motions**
**弹力，胡克定律和简谐运动**

**7. pressure**
**压强**

a. **atmospheric pressure**
b. **大气压强**
c. **static pressure in liquids**
d. **静止流体的压强**

| | |
|---|---|
| **3.2 ELECTRIC, MAGNETIC AND GRAVITATIONAL FIELDS**<br>**电场，磁场和重力场** | 1. gravitational field<br>重力场<br><br>a. gravitational fields are due to objects having mass<br>质量激发重力场<br><br>b. describe a gravitational electric field as a region in which a particle mass charge experiences a force |

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重力场是一个区域/空间，在这个空间中质量会受到力的作用

2. electric field
电场

   a. electric fields are due to charges
   电荷激发电场

   b. Use electric field lines to map electric fields
   电场线

   c. describe an electric field as a region in which an electric charge experiences a force
   电场是一个区域/空间，在这个空间中质点会受到力的作用

   d. Describe simple field patterns, including the field around a point charge, the field around a charged conducting sphere and the field between two parallel plates
   用电场线描述简单的电场，譬如，点电荷，带电球形导体，平行极板

3. magnetic field
磁场

   a. magnetic fields are due to moving charges or permanent magnets
   运动的电荷和永磁体激发磁场

   b. use magnetic field lines to map magnetic fields
   磁感应线

   c. magnetic field patterns for a long straight current carrying conductor, a flat coil and a long solenoid
   长直流电流，线圈和螺线管周围的磁场

| | |
|---|---|
| **3.3 TYPE OF CHEMICAL BONDING - NATURE, STRUCTURE AND STRENGTH**<br>化学键的种类，结构和强弱 | 1. covalent and ionic bonds<br>共价键和离子键<br><br>a. ionic bond- electron transfer<br>离子键- 电子转移<br><br>b. covalent bond- sharing of electrons<br>共价键- 电子共享<br><br>c. Lewis structure<br>刘易斯结构式<br><br>**2. hydrogen bonding and van-der-Waals interaction**<br>**氢键和范德华相互作用** |
| **3.4 CHEMICAL REACTIONS**<br>化学反应 | 1. Chemical equations - balancing and stoichiometry<br>化学方程式- 配平和化学计量法<br><br>a. chemical formula and nomenclature<br>化学式和命名<br><br>b. law of conservation of mass<br>质量守恒定律<br><br>c. balance chemical equation<br>配平化学方程式<br><br>d. **construct balanced ionic equations**<br>**书写并配平离子反应方程式**<br><br>e. **Avogadro's constant and the mole**<br>**阿伏加德罗常数和摩尔**<br><br>f. **mole, mass and molar mass of a substance**<br>**摩尔，质量和物质的摩尔质量**<br><br>g. **mole of solute, concentration and volume of solution**<br>**溶质的摩尔数，摩尔浓度和溶液的体积**<br><br>h. **mole and volume of gas at room temperature and pressure**<br>**摩尔数与常温常压下的气体体积**<br><br>i. **calculates theoretical yield and percentage yield**<br>**计算理论产量和百分产率**<br><br>j. **atom economy- definition and calculation and analysis**<br>**原子经济性的定义和计算和分析**<br><br>**2. basic and most common reactions for determination of unknown substances**<br>**未知物质鉴定的基本反应**<br><br>a. **gases – oxygen, hydrogen, carbon dioxide and chlorine**<br>**气体 – 氧气，氢气，二氧化碳和氯气**<br><br>b. **aqueous cations and anions – calcium, copper, iron (II), iron(III) and zink using NaOH; carbonates and sulfates using aqueous barium chloride followed by hydrochloric acid; chloride, bromide and iodide using silver nitrate** |

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|---|---|
|  | 水溶液中的阴阳离子 – 用氢氧化钠鉴定钙离子，铜离子，铁离子，亚铁离子和锌离子；用氯化钡与稀盐酸鉴定碳酸根和硫酸根；用硝酸银鉴定氯离子，溴离子和碘离子<br><br>c. **flame test**<br>**焰色反应**<br><br>3. Types of chemical reactions<br>化学反应的分类<br>    a. acid/base neutralizations<br>        酸碱中和反应<br>    b. redox reactions<br>        氧化还原反应<br>    c. thermal decompositions<br>        热分解反应<br><br>4. rate of reactions, factors affecting reaction rate like catalyst, temperature and concentration<br>反应速率和影响因素，例如催化剂，温度和浓度<br>    a. methods for determining rate of reaction<br>        测定反应速率的方法<br>    b. effects of changes in temperature, concentration, pressure, surface area and catalyst on rate of reaction<br>        温度，浓度，压强，表面积和催化剂对反应速率的影响<br>    c. collision theory<br>        碰撞理论<br><br>5. **dynamic equilibrium and le Chatelier's principle**<br>**动态平衡和勒夏特列原理**<br>    a. **reversible reaction**<br>        **可逆反应**<br>    b. **dynamic equilibrium**<br>        **动态平衡**<br>    c. **effects of changes in concentration, temperature and pressure on equilibrium position – Le Chatelier's principle**<br>        **浓度，温度和压强变化对平衡位置的影响，勒夏特列原理**<br>    d. **Haber process and contact process – the trade-off between rate of production and position of equilibrium**<br>        **哈伯法和接触法制硫酸的过程 – 生产速率和平衡位置的综合考虑**<br><br>6. common ion effect<br>同离子效应 |
| **3.5 DIFFUSION, OSMOSIS AND SURFACE TENSION**<br>扩散，渗透和表面张力 | 1. diffusion- definition, examples and proof of the particle theory of matter<br>扩散的定义，实例及它对物质粒子模型的论证<br><br>2. how substances are transported into and out of cells<br>细胞的物质运输<br><br>3. gain and loss of mass in osmosis<br>渗透作用导致的质量变化<br><br>4. surface tension<br>表面张力 |
| **3.6 PRINCIPLE OF THIN LAYER AND PAPER CHROMATOGRAPHY**<br>纸层析和薄层色谱分离法的原理 |  |
| **3.7 EFFECTS OF RADIATION ON ORGANISMS**<br>辐射对生物体的影响 | **ionising radiation and some chemicals increase the rate of mutation**<br>电离辐射和化学成分增加突变的几率 |
| **3.8 FORMS OF COMMUNICATION**<br>通讯的形式 | 1. function of hormones and pheromones in living organisms<br>生物体激素和信息素的功能<br>2. Where hormones are produced and how they are transported from endocrine glands to their target organs 激素的产生和运输 |

| | 3. communications between cells, allowing recognition of 'self' and 'foreign' cells by the immune system.<br>细胞的信号传递，免疫系统识别"自己"与"异己" |

## 6.4. STRUCTURE, PROPERTIES AND FUNCTIONS 结构，性质和功能

The different constituents of a system usually have specific properties which allow them to fulfil their function in the intended way.
The students should know the structure of the following components and understand in which way they fulfil their functions.

系统的不同组成部分通常具有特定的性质，能够使它们能够以预期的方式实现其功能。

学生应该了解以下组成部分的结构，并了解它们是怎么发挥作用的。

| | Learning outcomes<br>学习目标<br>Learners should be able to demonstrate and apply their knowledge and understanding of:<br>学习者能够展现和运用以下的知识与理解 |
|---|---|
| **4.1 CELLS**<br>细胞 | 1. basic structure of cells and its constituents<br>细胞的基本结构和组成<br><br>2. differences between animal, plant cells and bacteria<br>区别动物细胞、植物细胞和细菌<br><br>3. living things are made of cells<br>生物由细胞构成<br><br>4. the function of a cell<br>细胞的功能<br><br>5. specialized cells are adapted to their function<br>特化细胞适于其功能<br><br>6. the changes of microscope technology increased our understanding of the role of sub-cellular structures<br>显微技术的发展增强人们对亚细胞结构的理解<br><br>7. basic concepts of the biochemistry of molecules-carbohydrates, proteins, lipids and nucleic acids<br>碳水化合物、蛋白质、脂类和核酸的生物化学的基本概念 |
| **4.2 PARTS OF THE BODY**<br>人体的组成 | 1. anatomy and function of main organs and tissues in animals and humans<br>动物和人体的主要器官、组织及其功能<br><br>2. properties of muscles<br>肌肉的特征<br><br>3. alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries<br>肺泡气体交换的原理：气体通过扩散作用进入肺部毛细管<br><br>4. the structure of the blood vessels is related to their function<br>血管与其功能相适应 |
| **4.3 HOMOGENEOUS AND HETEROGENEOUS CATALYSTS**<br>均相和异相催化剂 | |
| **4.4 ACIDS AND BASES**<br>酸和碱 | 1. properties of acids and bases<br>酸和碱的性质<br>    a. acid- form hydrogen ion |

酸- 形成氢离子

b. base- form hydroxide ion
碱- 形成氢氧根离子

2. pH values and neutralisation pH 值和中和反应

a. definition and measurement of pH
pH 的定义和测定

3. indicators
指示剂

4. **titration 滴定**
   a. **titration technique and titration curve**
      **滴定的实验方法和滴定曲线**
   b. **calculation**
      **计算**

5. formation and effect of acidic rain
酸雨的形成和效果

6. electrolysis
电解
   a. migration of ions
      离子的移动
   b. faraday constant
      法拉第常数
   c. electrochemical cells
      电化学电池

## 6.5. SYSTEMS 系统

Things in life are organized in open or closed systems.

It is therefore important to not only look at the components of a system and its interdependencies but also at the system as a whole.

The students should be able to employ the concepts of

生活中的事物是在开放或封闭的系统中被组织起来的。因此，重要的不仅是研究系统的组成部分及其相互依存性，而且也要关注作为系统的整体性。

学生应该能够应用以下概念：

| | Learning outcomes<br>学习目标<br>Learners should be able to demonstrate and apply their knowledge and understanding of:<br>学习者能够展现和运用以下的知识与理解 |
|---|---|
| **5.1 CONTINUITY PRINCIPLES IN CLOSED SYSTEMSCYCLES**<br>封闭系统中的连续原理，循环平衡 | **principle of fluid mechanics**<br>流体力学原理 |
| **5.2 EQUILIBRIUMS**<br>平衡 | 1. equilibrium of forces:<br>力的平衡<br>   a. understand that when there is no resultant force and no resultant torque, a system is in equilibrium<br>   理解：当合外力与合外力矩同时等于零时，物体保持平衡状态。<br><br>2. **chemical/ionic equilibrium**<br>**化学和离子平衡**<br><br>3. **thermodynamical equilibrium**<br>**热力学平衡**<br><br>4. **ecosystem dynamic, functioning, and resilience**<br>**生态系统的动态平衡，运作机制和恢复力** |

| 5.3 SCALES OF NATURE<br>自然尺度 | **1.** | **biological systems**<br>**生物系统**<br>**(how the body is a system of interacting subsystems composed of groups of cells)**<br>生物体是一个由细胞组成的组织或器官相互配合而形成的系统 |
| --- | --- | --- |
| | **2.** | **astrophysics**<br>**天体物理** |
| 5.4 BASIC CONCEPTS ABOUT CYCLES IN NATURE<br>自然界中循环的基本概念 | 1. | Carbon cycle<br>碳循环 |
| | 2. | water cycle<br>水循环 |
| | 3. | Nitrogen cycle<br>氮循环 |
| | 4. | Oxygen cycle<br>氧循环 |
| | 5. | Ozone cycle<br>臭氧循环 |
| | 6. | renewable and non- renewable natural resources<br>可再生与不可再生的自然资源 |
| | 7. | earth's climate<br>地球的气候<br>   a.   greenhouse effect and greenhouse gases<br>      温室效应和温室气体<br>   b.   global warming- causes and solution<br>      全球变暖的原因和解决方案 |
| | 8. | the need to transport substances into and out of a range of organisms<br>很多生物具有吸收物质和排泄物质的需求 |
| | 9. | different materials cycle through the abiotic and biotic components of an ecosystem<br>生态系统中不同物质循环过程通过生物和非生物完成 |
| | 10. | Carbon cycle and the role of microorganism<br>碳循环和微生物的作用 |
| | 11. | Nitrates are made available for plant uptake, and the role of bacteria in the nitrogen cycle<br>植物对硝酸盐的吸收，细菌在氮循环中的作用 |
| | 12. | use of fertilizers, crop rotation<br>化肥的使用、轮作 |
| 5.5 ECOLOGY<br>生态 | **1.** | **levels of organization in the biosphere**<br>**生物圈的不同层次** |
| | **2.** | **factors affecting ecosystems (abiotic and biotic)**<br>**影响生态系统的因素（生物与非生物因素）** |
| | 3. | interactions between organisms (e.g. competition, predation, mutualism)<br>生物之间的关系（例如：竞争、捕食、共生） |
| | 4. | the survival of some organisms is dependent on other species, including parasitism and mutualism<br> 一些生物依赖于其他物种生存，包含寄生关系和共生关系 |
| | 5. | producers, consumers and decomposers<br>生产者、消费者和分解者 |
| | 6. | food chains, food webs<br>食物链和食物网 |
| | 7. | the importance of interdependence in a community |

| | | |
|---|---|---|
| | | 群落内部相互依存关系的重要性 |
| | 8. | factors affecting growth of populations, typical growth-curves for populations<br>影响种群增长的因素和典型的种群增长曲线 |
| | 9. | basic principles of conservation of biodiversity<br>生物多样性保护的基本原则 |
| **5.6 POLLUTION EFFECTS OF DIFFERENT MODES OF POWER GENERATION** 不同发电模式的污染效应 | **1.**<br><br>**2.**<br><br>**3.** | **generators**<br>发电机<br>**electrochemistry**<br>电化学<br>**photovoltaic effect**<br>光伏效应 |
| **5.7 ORGANISMS AS SYSTEMS**<br>生物系统 | 1.<br><br>**2.** | Transformation of matter and energy in organisms<br>生物体内的物质和能量的转化<br>**Basic knowledge of digestive, circulatory, respiratory, excretory, nervous. Immune and endocrine systems**<br>消化、循环、呼吸、排泄、神经、免疫和内分泌系统 |
| **5.8 PLANT PHYSIOLOGY**<br>植物生理 | 1. | absorption by roots, diffusion, osmosis<br>根的吸收、扩散和渗透作用 |
| | **2.** | **respiration and exchange of gases**<br>呼吸和气体交换 |
| | **3.** | **tropism of plants**<br>植物的向性 |
| | 4. | photosynthesis<br>光合作用 |
| | 5. | the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms<br>光合作用在物质循环和能量流动过程中的作用 |
| | 6. | photosynthetic organisms as the main producers of food<br>光合作用生物是主要的食物生产者 |
| | 7. | limiting factors on the rate of photosynthesis<br>光合作用反应速率的限制因素 |
| | 8. | water and mineral ions are transported through the plant by transpiration, including the structure and function of the stomata<br>植物的蒸腾作用（水和矿物质元素的运输），气孔结构和功能 |
| | 9. | how sucrose is transported around the plant by translocation<br>蔗糖的转运 |
| **5.9 ELECTRIC CIRCUITS**<br>电路 | 1.<br><br>a.<br><br><br>b.<br><br>c.<br><br>d. | DC electric circuits<br>直流电路<br>components of circuits(resistors and wires, bulbs, voltage sources, ammeters, voltmeters)<br>电路元件：电阻，导线，电灯，电源，电流表，电压表<br>Ohm's law, charge, current, voltage<br>欧姆定律，电荷，电流，电压<br>series and parallel circuits<br>串并联电路<br>**Kirchhoff's laws**<br>**基尔霍夫定律** |
| | **2.** | **difference between AC and DC currents/voltages**<br>交流和直流电流/电压的差别 |
| | **3.** | **qualitative knowledge of electromagnetic induction and Lenz's law** |

| | | 电磁感应和楞次定律 |
|---|---|---|
| | 4. | **basic principles of generators and motors**<br>发电机和电动机的基本原理 |
| **5.10 THERMODYNAMICAL SYSTEMS 热力学系统** | 1. | **(absolute) temperature**<br>(绝对)温度 |
| | 2. | **deal gas law (isothermal, isochoric and isobaric processes)**<br>理想气体状态方程：等温，等容和等压过程 |
| | 3. | **Hess's law**<br>赫斯定律 |
| | 4. | **combustion cycles**<br>燃烧循环 |
| **5.11 ASTROPHYSICAL 天体物理 SYSTEMS** | 1. | **main characteristics of stars, planets, moons, comets, asteroids**<br>恒星，行星，卫星，彗星，小行星的主要特征 |
| | 2. | **solar systems**<br>太阳系 |
| | 3. | **galaxies**<br>星系 |

# 6.6. DEVELOPMENT AND EVOLUTION 发展和演化

Living organisms are not static and undergo constant change and adaption.
The students are expected to show proficiency in the following areas:

有机体不是静止的，它们时刻都在变化，适应着环境。

希望学生能够熟练掌握以下几个主题：

| | | Learning outcomes<br>学习目标<br>Learners should be able to demonstrate and apply their knowledge and understanding of:<br>学习者能够展现和运用以下的知识与理解 |
|---|---|---|
| **6.1 STRATEGIES OF ENVIRONMENTAL ADAPTATION 环境适应策略** | 1. | characteristics of adaptation, structural, physiological and behavioral adaptation<br>适应的特征，结构、生理和行为的适应 |
| | 2. | the structures of the xylem and phloem are adapted to their function in the plant<br>植物的木质部和韧皮部的结构与其功能相适应 |
| | 3. | the structure of the root hair cells is adapted to absorb water and mineral ions<br>根毛细胞的结构与水的吸收和矿物质的吸收相适应 |
| | 4. | transpiration, the structure and function of the stomata<br>蒸腾作用，气孔结构与功能 |
| | 5. | how alveoli are adapted for gas exchange<br>肺泡结构与气体交换相适应 |
| **6.2 THEORY OF EVOLUTION 进化理论** | 1. | theory of evolution (natural selection, neo-Darwinian revolution, evidence of evolution)<br>演化理论（自然选择理论，新达尔文主义，进化的证据） |
| | 2. | natural selection may lead to increases and decreases of specific traits in populations over time<br>自然选择可能强化或者弱化种群的某种特征 |
| | 3. | how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment<br>在特定环境中，种群中的变异增加一些个体的生存和繁殖的概率 |
| | 4. | how the emergence of resistant organisms supports Darwin's theory of evolution |

耐药微生物的出现如何支持达尔文的演化理论

5. how humans influence the inheritance of desired traits in organisms
   人类如何影响生物某些特征的遗传

6. evidence of common ancestry and diversity
   不同物种共同祖先的证据和生物多样性

7. the evidence for evolution, based on fossils
   基于化石的进化证据

8. how genetic analysis has led to the suggestion of the three domains rather than the five kingdoms classification method
   相比五界系统，基因分析的结果更支持三界系统的原因

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| **6.3 CELL CYCLE AND CELL DIVISION**<br>**细胞周期和细胞分裂** | Cell cycle and cell division<br>细胞周期和细胞分裂<br>a. basic principles of meiosis<br>   有丝分裂，<br>b. mitosis<br>   减数分裂<br>c. haploidy and diploidy<br>   单倍体和多倍体 |
| **6.4 REPRODUCTION IN HUMANS, ANIMALS AND PLANTS**<br>**人类、动物和植物的繁殖** | 1. principles of creation of new life<br>   新生命诞生的原则<br><br>2. plant reproduction<br>   植物的繁殖<br><br>**3. basic principles of plant reproduction (asexual and sexual)**<br>**   植物的有性生殖和无性生殖**<br><br>4. human reproduction<br>   人类的繁殖<br><br>5. human reproductive organs and sex cells<br>   人类的生殖器官和性细胞<br><br>6. changes that take place in boy's and girl's bodies during puberty<br>   青春期男孩和女孩的身体变化 |
| **6.5 GENES, CHROMOSOMES AND GENETICS**<br>**基因、染色体和遗传** | 1. inheritance of genetic characteristics<br>   基因特征的遗传<br><br>2. inheritance of traits<br>   性状的遗传<br><br>3. variation of traits<br>   性状的变异<br><br>4. Mendel's laws, mutation<br>   孟德尔定律，突变<br><br>5. why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism<br>   染色体的基因突变可能影响蛋白质的功能，对生物体的影响可能是有害的、有益的也可能是中性的<br><br>6. asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.<br>   无性生殖的后代遗传信息相同，有性生殖的后代存在遗传变异<br><br>7. the genome, gene and DNA<br>   基因组、基因与 DNA 的关系 |

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| | 8.  the causes of variation that influence phenotype<br>影响表型的变异的形成原因<br><br>9.  there is usually extensive genetic variation within a population of a species and that these arise through mutations<br>种群中的大量遗传变异来自突变的积累 |
| **6.6 DISEASES**<br>疾病 | 1.  cause and transmission of diseases (microorganisms causing common diseases, viruses, genetic defects)<br>疾病的传播和起因（微生物致病、病毒、基因缺陷等）<br><br>2.  communicable and non-communicable diseases<br>传染性疾病和非传染性疾病<br><br>3.  common infection and precautions<br>常见的感染和预防<br><br>4.  physical barriers and chemical defenses of the human body provide protection from pathogens<br>人体抵抗病原体的物理和化学防线<br><br>5.  principles of vaccination<br>疫苗接种的原则<br><br>6.  antibiotics<br>抗生素 |

# 7. General science skills 通用的科学技能

As a general prerequisite, the students should be familiar with and be able to
作为先决条件，学生应该熟悉并能够做到：

7.1.  Employ and explain scientific methods
运用和解释科学的方法

7.2.  Use scientific terminology
使用科学术语

7.3.  Put forward hypotheses
提出假设

7.4.  Devise and accurately describe methods/experiments to test hypotheses
设计并准确地描述方法/实验来检验假设

7.5.  Assess the validity of different sources of information and be aware that data might be inaccurate or even wrong
评估不同信息来源的有效性，并注意数据可能不准确甚至错误

# 8. Mathematics requirement 数学要求

The emphasis of the tests should be on natural sciences. Nevertheless, mathematics is an indispensable tool to the natural sciences. The students should therefore know about and be able to make use of
测试的重点应该放在自然科学上。 尽管如此，数学是自然科学不可或缺的工具。 因此学生应该知道并能够使用：

8.1.   Fractions (Use ratios, fractions and percentages)
         分数（会使用比率，分数和百分比）

8.2.   Logarithms and exponential functions
         对数和指数函数

8.3.   Powers and roots
         幂和根

8.4.   Polynomials (e.g. solving quadratic equations)
         多项式（例如求解二次方程）

8.5.   Trigonometric functions (Use calculators to handle $\sin x$, $\cos x$ and $\tan x$ when $x$ is expressed in degrees or radians)
         三角函数（会使用计算器来处理 $\sin x$，$\cos x$ 和 $\tan x$，$x$ 以度或弧度表示）

8.5.1.   Simple geometry (geometry of triangles and circles, areas and volumes of basic planar forms and solids)
           简单几何（三角形和圆形的几何学，会计算几种基本的二维平面图形的面积，三维立体图形的表面积和体积）

8.5.2.   Basic vector algebra (decomposition and addition of vectors)
           基本矢量运算（矢量的加减法）

8.5.3.   Simple statistics (mean values, standard deviations, basic notion of probabilities)
            基本的统计知识（平均值，标准差，概率的基本概念）

# 9. Appendix 附录

## 9.1. Periodic Table of the Elements 化学元素周期表

## 9.2 Constants　常量

acceleration of free fall:  $g = 9.81\ m/s^2$
重力加速度
speed of light in a vacuum:  $c = 3.00 \times 10^8\ m/s$
真空中光速
Avogadro constant:  $N_A = 6.02 \times 10^{23}\ mol^{-1}$
阿伏伽德罗常数
molar gas constant:  $R =\ 8.3145\ J/(mol \cdot K)$
理想气体气体常数

## 9.3 Mathematical equations 数学公式

circumference of circle:  $C = 2\pi r$
圆的周长
area of circle:  $A = \pi r^2$
圆的面积
volume of cylinder:  $V = \pi r^2 h$
圆柱体体积
volume of sphere:  $V = \frac{4}{3}\pi r^3$
球体体积
Pythagoras' theorem:  $a^2 = b^2 + c^2$
毕达哥拉斯定理

## 9.4 Formulae and relationships 公式和关系

Topic 1: PARTICLES, WAVES AND MATTER 粒子，波与物质

| density 密度 | 密度 | $\rho = \dfrac{m}{V}$ |
|---|---|---|
| waves | 波速 | $v = f\lambda$ |
| 波 | 频率 | $f = \dfrac{1}{T}$ |
| refraction | 折射率 | $n = \dfrac{c}{v}$ |
| 折射 | 全反射角 | $sinC = \dfrac{1}{n}$ |

Topic 2: ENERGY 能量

| Work, energy and power | 做功 | $W = Fxcos\theta$ |
|---|---|---|
| 功、能和功率 | 机械效率 | $efficiency = \dfrac{useful\ energy\ output}{total\ energy\ input} \times 100\%$ |
| | 功率 | $P = \dfrac{W}{t}$ <br> $P = Fv$ |
| | 重力势能 | $g.p.e = mgh$ |
| | 动能 | $k.e = \dfrac{1}{2}mv^2$ |

| 热能 | $Q = cm\Delta T$ |
|---|---|

## Topic 3: INTERACTIONS 相互作用

| Vectors<br>**矢量** | 力的分解 | $F_x = Fcos\theta$<br>$F_y = Fsin\theta$ |
|---|---|---|
| uniformly<br>accelerated<br>motion<br>匀加速直线<br>运动 | 平均速度 | $\bar{v} = \dfrac{d}{t}$ |
| | 加速度 | $a = \dfrac{v_f - v_i}{t}$ |
| force<br>力 | 牛顿第二<br>定律 | $F = ma$ |
| | 重力 | $W = mg$ |
| | 胡克定律 | $F = kx$ |
| Turning<br>effects<br>转动 | 力矩 | torque = Fd |
| Pressure<br>压强 | 压强 | $P = \dfrac{F}{A}$<br>$P = h\rho g$ |

## Topic 5: SYSTEMS 系统

| Ohm's law<br>欧姆定律 | 电压 | $V = IR$ |
|---|---|---|
| charge<br>电荷 | 电荷 | $\Delta Q = I\Delta t$ |
| work done<br>电功 | 电功 | $W = VIt$ |
| | 电热 | $Q = I^2Rt$ |
| Power<br>电功率 | 电功率 | $P = VI, P = I^2R$ and $P = \dfrac{V^2}{R}$ |