4.2 - The SCIENTIFIC REVOLUTION

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1. 释义

If you were a European before the 1500s, you wouldn’ t believe some wonky 古怪的；离奇的 things about the world.You would believe that the Earth was the center of the universe, and that a full quarter 整整四分之一 of the human body was made of mucus 粘液；黏液.But now that we’ re beginning Unit Four, we’ re gonna see how 主 all of that 谓 began to change (v.) in something called the Scientific Revolution 科学革命.我们将看到这一切是如何在所谓的科学革命中开始改变的。
If you want notes (n.) to follow along with 跟随；伴随 this video, then get your clicky finger out and check the link in the description.If you’ re ready to get them brain cows milked Copernican (a.)哥白尼的 Revolution style （幽默表达，以哥白尼革命的方式获取知识）, then let’ s get to it.

Now prior to 在……之前 the Scientific Revolution, 主 much of the accepted 公认的，为公众所接受的 knowledge 公认的知识

about the natural world 谓 came from ancient Greece, and more specifically Aristotle 亚里士多德.
He taught that the Earth was *at the center of* the universe, which was further surrounded (v.)围绕；包围 by *concentric 同轴的；同中心的 crystal 结晶，晶体；水晶 spheres* 同心水晶球 into which were embedded (v.)嵌入 other planets and stars. The Catholic Church 天主教会 gave this cosmology 宇宙论 a thumbs up 竖起大拇指（习语，表示认可；赞同）because it **squared** (v.)使成正方形；使成四方形 nicely **with** （使）与…一致，与……相符 *the creation* account (n.描述，报道) 创世记载 in Genesis 1 《创世纪》第一章.So for about two thousand years, this is how Europeans understood (v.) the world.

Example 1. 案例
square

1.**~ sth (off)** : to make sth have straight edges and corners 使成正方形；使成四方形
•It was like trying to square (v.) a circle.That is, it was impossible.这就好比要把圆的变成方的。也就是说，是不可能的。
•The boat is rounded at the front but squared off at the back.这条船船头是圆的，船尾则是方的。

2.**square (v.) sth with sth |'square with sth**: to make two ideas, facts or situations agree or combine well with each other; to agree or be consistent with another idea, fact or situation （使）与…一致，与…相符
•The interests of farmers need **to be squared (v.) with** those of consumers.农场主的利益需要同消费者的利益相一致。
•How can you **square (v.) this with your conscience** ?做这样的事你怎么能问心无愧呢？
•Your theory does not **square (v.) with the facts**.你的理论与事实不符。

So where did the Scientific Revolution come from? Well, there are many roots 根源, but I’ m only going to give you three of the most significant 重要的.

First was the establishment of universities 大学的建立 during the medieval times 中世纪. Thanks to Islamic scholars 伊斯兰学者 who had preserved (v.)保存 and amended (v.)修订，修正 Aristotelian texts 亚里士多德的著作, Greek scholarship (学问；学术；学术研究) 希腊学术 became the foundation of medieval university curriculum 中世纪大学课程的基础.
By the 14th and 15th centuries, however, European universities had established new departments of mathematics 数学 and astronomy 天文学. And so /as these disciplines 学科 **took their place** alongside 与……并列;在……旁边 natural philosophy (自然哲学) 在自然哲学旁边,取得它们的位置—which was the study of the natural world—the stage was set (v.) for 为……而安排（习语，为……做好准备）new ways of thinking about the world.

因此，当这些学科与自然哲学——研究自然世界的学科——并驾齐驱时，就为思考世界的新方式奠定了基础。

The second root was the Renaissance 文艺复兴. Recall (v.)回想 **all the way back to** Unit One 回想一下，一直回到第一单元 /when we talked about the wealthy folks 富人 who patronized 赞助；资助 the arts. Well, they also patronized (v.) many studies into the natural world, and **that makes sense** / 考虑到 **given** the Renaissance emphasis (n.) on realism (现实主义) 考虑到文艺复兴时期对现实主义的强调，这是有道理的.

The third root was, not surprisingly, the printing press 印刷术. New discoveries about the natural world **were being made**

across the globe 全球各地. The printing press **made it possible** to circulate (v.)（液体或气体）环流，循环;传播 those new findings 新发现 with great speed 快速地 to a wide readership 广大读者群. With more people sitting around **scratching their brains**（习语，绞尽脑汁；苦思冥想），there is going to be more opportunity for new ideas.

So now let’ s talk about the Scientific Revolution in terms of 就……而言 astronomy 天文学.

主 The first name you need **to associate with** 与……联系起来 this 系 is Nicholas Copernicus 尼古拉·哥白尼.
Remember that **according to** Aristotle and other Greek thinkers like Ptolemy 托勒密, the Earth was fixed (a.)固定的 and immovable 不可移动的 in the center of the universe.
Look, you can hardly blame (v.) them（习语，很难责怪他们）.
That made a lot of sense 这很有道理 out of what a person sees (v.) with their eyeballs when they look at the sky. It looks like the Earth is still (a.)静止的 and the Moon and the Sun rotate (v.) around 围绕旋转. This is known as *the geocentric 以地球为中心的；由地心开始测量的 model* 地心说模型 of the universe.

So then Copernicus 哥白尼 **came along** 走过来,到达;出現 and said, "You know, maybe we shouldn’ t **come to conclusions** 得出结论 only **based on** what our eyes see, and instead **rely on** 依靠 mathematics /and see where that leads us."
So Copernicus 哥白尼（波兰天文学家） **got down and dirty** 埋头苦干(俯身、蹲下),弄脏自己 in his notebooks（习语，深入钻研）doing complex math 复杂的数学运算 which I couldn’ t

even begin to describe to you, for alas （感叹词，表示遗憾、悲伤等）I am but a humble history teacher 卑微的历史老师.

> Example 2. 案例
> Copernicus **got down and dirty** in his notebooks doing complex math...
>
> "got down" = 俯身、蹲下
> "dirty" = 弄脏
> 字面是“趴在地上弄脏自己”，但这里是比喻。 类似中文的“扎进草稿纸堆里”或“废寝忘食地演算”

But regardless 无论如何, through his mathematical work, Copernicus challenged (v.) the geocentric 以地球为中心的 view 地心说观点 of the universe. Instead, he **put forth** 提出，提议 the heliocentric (a.)以太阳为中心的 model 日心说模型 which said that /the sun was at the center, and 主 the Earth **along with** the other heavenly 天国的；天空的；神圣的 bodies 天体 on display in the sky 谓 revolved (v.)旋转 around the Sun 围绕太阳公转.
Additionally, he was able to demonstrate 证明 that /主 the reason 后定 **it appears that** the sun is rising and setting 日出日落 系 is because the Earth itself spins (v.)（使）快速旋转 upon (=on) an axis 绕轴自转.

And then **building upon** 在……基础上进一步发展,基于 Copernicus’ s work, Johannes Kepler 约翰内斯·开普勒 created another massive breakthrough 重大突破. Again **using (v.) mathematics**, Kepler accepted the heliocentric model of the universe, but *through detailed (a.) computations* 详细的计算 established 确立 (v.) three laws of planetary motion 行星运动三大定律.

First, he discovered that 主 planets orbited (v.)绕轨道运行，环绕 the Sun 谓 not in perfect circles 正圆 but rather in ellipses 椭圆.
Second, he demonstrated 证明，证实 that /planets **move (v.) faster** when they are closer to the Sun /**and slower** when they’ re farther away 离太阳越近运动越快，越远越慢.
And third, he figured out 弄清楚 that 主 the time *a planet takes to orbit (v.) the Sun* 谓 **is exactly related to** its distance from the Sun 行星绕太阳公转的时间与它和太阳的距离密切相关.

And then 主 the third name you need to know under this heading 在这个主题下 系 is Galileo 伽利略.
Now both Copernicus and Kepler **came to their conclusions** mainly by **mapping (v.) them out** with their thinky-thinky parts （幽默表达，通过思考） 通过纯理论推导得出结论，but Galileo **took these conclusions** even further by **taking** the conclusions **out of the brain** /and instead using (v.) his eyeballs （幽默表达，通过观察）.

哥白尼和开普勒主要是靠‘脑瓜子转转’在纸上推演出结论的，而伽利略更进一步——他把这些结论从脑子里拽出来，直接用眼睛去验证。他造了个叫‘望远镜’的新玩意儿（虽然发明权不是他的），让人类能看清遥远太空的细节……

Example 3. 案例

Mapping them out with their thinky-thinky parts

- "mapping them out" 指通过数学模型（如哥白尼的日心说、开普勒的行星轨道定律）在纸上推演宇宙规律。
- "thinky-thinky parts" 是作者自创的幽默说法，指代大脑的思考能力（类似中文的“脑瓜子转转”或“用聪明的小脑袋”）。 用重复的 "thinky-thinky" 模仿儿语，调侃科学家“埋头苦算”的形象。

哥白尼和开普勒的突破性理论（如日心说、椭圆轨道）主要基于数学计算，而非直接观测。作者用这种口语化表达强调："他们是用脑子'算'出真理的，而不是用眼睛'看'出来的。"

Taking the conclusions out of the brain

直译： "把结论从大脑里拿出来"
实际含义： "将理论付诸实践验证" 或 "用实验(望远镜)证明猜想"（对比前文的纯理论推导）。

He built a new contraption 装置 called a telescope 望远镜 — and you know he didn't invent (v.) it, but he did build his own — and this allowed the human eye to see (v.) far greater distances into space 观测到更远的太空.
And with the telescope, Galileo was able to observe (v.)注意到，观察到 in detail 详细观察 the moons of different planets 不同行星的卫星 and was able to prove that those other planets weren't celestial 天空的，天上的 bodies of light 发光的天体 as **had previously been believed**, but rather they **were made out of** 由……制成 the same stuff as Earth 与地球由相同物质构成.
And this experimental method 实验方法 was crucial 至关重要的 in overturning (v.)推翻 the accepted truths 公认的真理 about the universe.

Example 4. 案例
celestial

→ celest←拉丁语caelum（天） 同源词：Selina（赛琳娜（女子名）←天国似的，美好的）；celeste（天蓝色的） 词组习语：celestial body（天体）；celestial being（神灵）；celestial movement（天体运动）

Now it’ s important to emphasize 强调 again that /as each of these men did their work, they were overturning previous assumptions 推翻以前的假设 about how the cosmos 宇宙 worked.
And because the old Aristotelian view 亚里士多德的观点 **lined up with** 与……一致 the Bible — and you know, by the way, "Aristotelian" 亚里士多德的 is just the adjective form 形容词形式 of Aristotle — the Catholic Church was **not happy about** these developments 发展.

So *in addition to* 除了 challenging (v.) established philosophical authority 挑战已有的哲学权威, these scientists were challenging (v.) scriptural 圣经的；手稿的；依据圣经的 authority 圣经权威.

Since much of this was going on /during the Catholic Reformation 天主教改革, when the church **was doing its best** 尽力而为 to clean up its profile (外形；轮廓) 改善形象 in the eyes of Europeans, such challenges were untenable 难以捍卫的；站不住脚的；不堪一击的.
And so 主 Copernicus, Kepler, and Galileo 谓 **ended up** on the church’ s index of prohibited 被禁止的 books 禁书目录, and even Galileo was tried (v.) for heresy (异端；异端邪说；异教) 因异端邪说受审.

> Example 5. 案例
> tenable
>
> → -ten-握,持有 + -able形容词词尾,被动意义

However, by about 1640, the heliocentric model of the universe was pretty widely accepted (v.) by the scientific community 科学界, as well as 和，以及，还有 the contributions of Kepler and Galileo 开普勒和伽利略的贡献.
But 主 what remained unexplained 未被解释的 系 is *by what force* all these heavenly bodies of the universe held together (维系在一起) 是什么力量,使宇宙中的天体凝聚在一起的?.

For that, let me introduce you to my boy Isaac Newton 艾萨克·牛顿. Near the end of the 17th century, Newton was able **to combine** (v.)结合 the physics of Galileo 伽利略的物理学 **with** the mathematical computations 数学计算 of Kepler and Copernicus /to produce (v.) the law of universal gravitation (万有引力，重力) 万有引力定律.
It was a force (n.) called gravity 重力 **that** kept all the planets **revolving** 旋转 in relation to 关于；与……相关 one another 使所有行星相互环绕旋转.
And gravity was **directly proportional** (a.)成比例的；相称的; 成正比, he said, **to** *the size and weight* of the planetary objects *in question* (讨论中的) . 他说，重力与所讨论的行星物体的大小和重量成正比。

It was Newton’ s theory of gravity 牛顿的引力理论 that defined (v.)定义 the field of astronomy 天文学,天文学领域 until Albert Einstein **came along** 出现. But you know, we’ ll talk about that /in another video.

So this Scientific Revolution didn’ t just apply to 适用于 the realm of 领域 space and stars and planets. It was also applied to the study of the human body 人体研究. *The same thing*

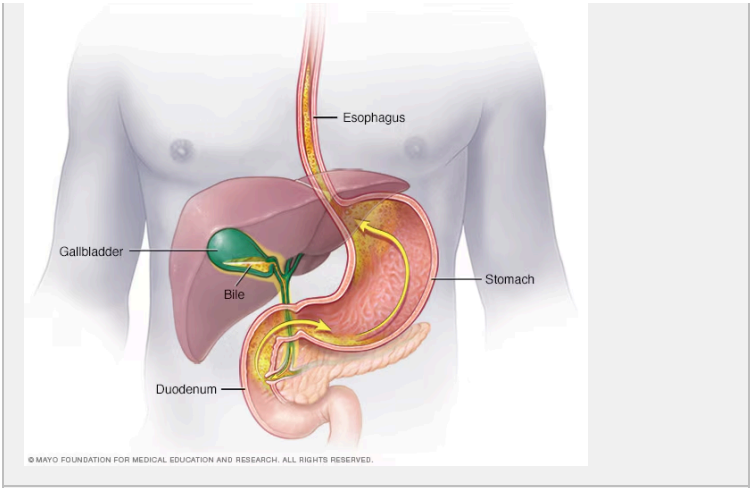
was happening here 后定 *that happened with astronomy* (天文学) 这里发生的事情, 和天文学那边发生的事情是一样的.

Old Greek understandings (n.)理解，领悟 of the body 古希腊对人体的认识 were being overturned (v.) 推翻 in favor of 支持；赞同 *newer, more accurate understanding* (n.)新的、更准确的认识.
Basically, it was the ancient Greek Galen 盖伦 whose theories about the human body 谓 dominated (v.) this field 主导这个领域.
Galen **argued 争论；争辩 for** 赞成；支持 what he called *the humoral 体液的；由体液引起的 theory* of the body 体液学说, which said that /the body **was composed of** 由……组成 four kinds of substances or humors 体液. Those four substances were blood 血液, yellow bile (胆汁；愤怒) 黄胆汁, black bile 黑胆汁, and phlegm 痰,黏液. Now I don’ t know enough about Galen /to tell you why he thought that a quarter of the human body was composed of mucus 粘液；黏液, but you know, he did.

Example 6. 案例

bile

→ 在希波克拉底的“体液学说”中，人体由血液、粘液、黄胆汁、黑胆汁这四种体液构成，其中黄、黑胆汁都能使人易怒，所以表示“胆汁”的单词bile在口语中还可以表示“愤怒”。
助记窍门：bile→谐音bear（熊）→活熊取胆汁，熊很愤怒→胆汁、愤怒 衍生词：bilious（胆汁的，坏脾气的）
来自拉丁词bilis，同bladder, 胆囊。



Regardless 无论如何, according to Galen, when these four humors 体液 were in balance 平衡, the body was healthy, but when they **got out of** balance 失衡, that was the cause for sickness and disease 疾病的原因.

But then along came some folks 人们 in this period /to overturn (v.) Galen’ s ideas through experimentation and observation 实验和观察.
First was the Swiss physician Paracelsus 帕拉塞尔苏斯, who rejected (v.)摒弃;驳回；不同意 *the humoral theory* of disease 疾病的体液学说 and claimed that it was chemical imbalances 化学失衡 that caused disease.
And if that was true, then chemical remedies (解决方法，纠正方法) 化学药物 could solve those imbalances 解决这些失衡问题.

Like if someone was sick under Galen’ s care, then 主 the go-to (a.)（指对象）寻求协助的，征询意见的 method 常用方法 of curing (v.) them 系 was bloodletting 放血. "You’ re sick,

which means your humors are out of balance, so let’ s get rid of 摆脱,除去 some of your blood." Paracelsus said, "No, how about we let the patients keep their blood /and give them chemical medicines /to address (v.) their problems."

Example 7. 案例

go-to

(a.)used to refer to the person or place that sb goes to for help, advice or information （指对象）寻求协助的，征询意见的

•He’ s the president’ s *go-to (a.) guy* on Asian politics. 他是总统的亚洲政治智囊。

And then came Andreas Vesalius 安德烈亚斯·维萨里, who contributed to the study of anatomy 解剖学研究 by dissecting 解剖 dead bodies by the hundreds 成百上千的尸体.
He published his findings 研究成果 in a book /and completely debunked 揭穿；驳斥，拆穿（谎言、神话、误解等） Galen’ s understanding of the body /and revolutionized 彻底改革 the understanding of the human body.

And finally, you need to know William Harvey 威廉·哈维. He further overturned (v.) Galen’ s ideas, this time about circulation 血液循环.
Galen taught (v.)教授 that there were two different systems of blood 后定 contained in the body 体内有两套不同的血液系统, and they did not interact (v.)相互交流，互动 with one another 互不流通.
But Harvey, through experimentation 实验, discovered that the circulatory system 循环系统 was one integrated (a.)各部分密切协调的，综合的 whole 一个完整的整体. Blood **is pumped**

out of the heart 心脏泵血 through 穿过，从一端到另一端 the body /and **returns to the heart** to do the whole thing over again 流回心脏循环往复.

Example 8. 案例

dissect

→ dis-, 分开。-sect, 剪，切，词源同section, segment.即解开，引申词义解剖。

debunk

→ de-, 不，非，使相反。bunk, 瞎话；胡话。

And finally, the Scientific Revolution included a revolution in the way people reasoned 推理方式.

First, let me introduce you to Francis Bacon 弗朗西斯·培根. His major contribution to the thinky-thinky world 思想领域 was an emphasis on **empiricism 经验主义**, 主 **which** when being defined 定义为 系 is *the pursuit of knowledge* through **inductive (v.)归纳的，归纳法的 reasoning** (推理，推论) 归纳推理—主 **which** when being defined 谓 means (v.) understanding the world first by observing (v.) the smallest parts of it 观察最小的部分 /and then generalizing (v.) 归纳 those findings to the largest part 最大的部分.

Example 9. 案例

empirical

→ em-, 进入，使。-pir, 尝试，冒险，词源同 pirate 海盗, expert.字面意思即尝试过的，有经验的。

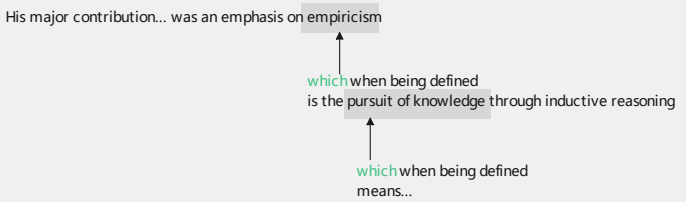
empiricism, 主 which when being defined 系 is the pursuit of knowledge through *inductive reasoning — 主 which* when

being defined 谓 means...

这里的两个 "which when being defined" 确实看起来有些重复，但并非错误，而是作者刻意使用的一种 嵌套式解释结构，目的是逐步拆解复杂概念。这种写法在学术或教学语境中偶尔会出现，用于分层阐明术语。

第一层结构：解释「empiricism（经验主义）」
原句： "His major contribution... was an emphasis on *empiricism* 经验主义；经验论, **which** when being defined **is** the pursuit of knowledge through inductive reasoning..."
作用： 先用 "which when being defined" **引入对「empiricism」的定义**，即「通过归纳推理（inductive reasoning）追求知识」。

第二层结构：**进一步解释「inductive reasoning（归纳推理）」**
原句： "*inductive reasoning* 归纳推理 — **which** when being defined **means** (v.) understanding the world first by observing the smallest parts..."
作用： 由于「归纳推理」本身也是一个专业术语，作者再次用 "which when being defined" 嵌套解释其含义，即「从观察局部到推导整体的过程」。



Francis Bacon

培根,是一位英国哲学家和政治家, 被称为"经验主义"之父。 **他主张仅基于"归纳推理"和对自然事件的仔细观察, 就可以获得科学知识。**

Then there was René Descartes 勒内·笛卡尔, who developed a system of deductive (a.)演绎的，推论的 reasoning 演绎推理体系. This **came about** 产生 because of the revolution in astronomy (天文学) 天文学革命.
主 The geocentric 以地球为中心的 conception 观念 of the universe 谓 seemed good /because it aligned with 与……一致 what a person could see, but then mathematics **came along** 出现,取得进展 and undermined (v.) 削弱 the senses 感官认知. So Descartes figured (v.)认为，认定（某事将发生或属实） it was necessary to doubt (v.) everything that could reasonably be doubted (合理怀疑一切) 怀疑一切"可以合理怀疑的东西"是必要的, and once you **ran into** 撞到,偶遇 something that was undoubtable 无可置疑的, then you could **build** (v.) your reasoning 推理，推论 **upon** that first principle 第一原理. And then from those big ideas 大的概念, you could **work your way 逐步向下移动或完成一系列任务，直到达到最终目标或位置 down to** the smaller ideas 小的概念.

Either way 不管怎样；无论哪种方式, both of these men were the first major players 重要人物 in challenging (v.) the dominance of ancient Greek philosophy 挑战古希腊哲学的主导地位.

Example 10. 案例

René Descartes

勒内·笛卡尔, 是法国哲学家、 科学家和数学家 ，被认为是"现代哲学和科学"兴起的开创性人物。数学是他研究方法中至关重要的部

分.

勒内·笛卡尔常被尊称为“现代哲学之父”。一方面是因为**他与当时盛行的传统经院哲学-亚里士多德哲学的决裂**，另一方面是**他对新兴机械论科学的发扬和发展。**他与经院哲学的根本区别体现在两个方面。首先，**笛卡尔认为经院哲学的方法容易引起"怀疑"，因为他们依赖"感觉"作为所有知识的来源。**其次，他希望用更现代的机械论模型, 取代他们最终的科学解释因果模型。

笛卡尔试图通过他的怀疑方法来解决前一个问题。**他的基本策略是，任何信念，只要有哪怕是最轻微的怀疑，就认定为错误。这种“夸张怀疑”为笛卡尔认为的不带偏见的真理探索扫清了道路。**清除他先前持有的信念，**使他处于认识论的零点。从这里开始，笛卡尔开始寻找一些毫无疑问的东西。他最终发现“I exist 我存在”是不可怀疑的，因此是绝对确定的。正是从这一点出发，笛卡尔继续论证上帝的存在.** 即, 清晰明了的事物的确定性，提供了笛卡尔试图寻找的认识论基础。

However, despite these massive innovations 重大创新 in how humans understood (v.) their world and the world beyond them, older beliefs 旧观念 continued to persist (v.) 持续存在. Some of these pathfinders 开拓者，先驱者 of the new science still **held (v.) on to** 坚持,抓住 beliefs (n.) in alchemy 炼金术; （改变事物的）神秘力量，魔力, which was the attempt **to turn** (v.) base metals 贱金属 **into** gold and silver 金银, and astrology 占星术, which taught (v.) that 主 the position of planets and stars 谓 affected (v.) the outcome 结果，效果 of human life 行星和恒星的位置影响人类生活的结果.
For example, while Johannes Kepler was busy **blowing (v.) our minds** （习语，让我们大为惊讶）with the scientific laws of planetary (a.)行星的；（与）地球（有关）的 motion 行星运动科学定律, he was also a court mathematician (数学家) 宫廷数学家 whose duties included (v.) **printing out** horoscopes (占星预言) 打印占星图 for the day.

例如，当约翰内斯·开普勒忙于用行星运动的科学定律，震撼我们的头脑时，他也是一名宫廷数学家，他的职责包括打印当天的星座运势。

So you know, it wasn’ t all changed. There were some significant continuities 延续性 as well.

Example 11. 案例

alchemy

→ alchemy = al（定冠词）+chemy（炼金术）→炼金术.
同源词：alchemist（炼金术士），chemistry（化学），chemical（化学的），chemist（化学家）

astrology

→ -astr-星 + -o- + -logy...学科

horoscope

a description of what is going to happen to sb in the future, based on the position of the stars and the planets when the person was born 占星预言

All right, click here if you want to keep reviewing (v.) Unit 4 of the AP European History curriculum 课程. Additionally, click right here if you want to grab the video note 笔记，记录；注释，批注 guides (指南) 视频笔记指南 which **correspond to** 与……对应 all my videos /and will most assuredly 肯定地 help you get an A in your class /and a five on your exam in May. *I’ ll catch you on the flip-flop* 人字拖鞋；夹脚趾拖鞋（口语表达，回头见）. Time’ s out.

Example 12. 案例

"catch you on the flip-flop" 是一个非正式（甚至有点幽默）的表达，意思是 “回头见” 或 “下次见” 。

字面意思： **"Flip-flop" 原指 "人字拖"（拖鞋），或者 "来回翻转的动作"（比如开关的切换）。 在口语中，它也可以表示 “来回、反复”（比如 "flip-flop opinions" 指反复无常的观点）。**

俚语用法： 在这里，"on the flip-flop" 是一种俏皮的说法，类似于：
"Catch you on the rebound."（反弹时见 → 稍后见）
"See you on the flip （使）快速翻转，迅速翻动 side."（原指黑胶唱片的B面 → 引申为“下次见”）
这种表达带有轻松、随意的语气，常见于美式口语（尤其是视频博主或年轻人之间的调侃）。

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2. 中文释义

如果你生活在16世纪之前的欧洲，你会相信一些关于世界的奇怪说法。你会认为地球是宇宙的中心，并且人体的四分之一是由黏液组成的。但现在我们开始学习第四单元，我们将看到所有这些观念，是如何在一场被称为"科学革命"的运动中开始改变的。如果你想要与这个视频配套的笔记，那就伸出你的手指点击描述中的链接。如果你准备好像哥白尼革命那样充实自己的知识，那我们开始吧。

在科学革命之前，关于自然世界的许多被接受的知识，都来自古希腊，更具体地说，来自亚里士多德。他认为地球是宇宙的中心，地球周围环绕着同心水晶球，其他行星和恒星镶嵌其中。天主教会对这种宇宙观表示认可，因为它与《创世纪》第一章中的创世记载相符。所以在大约两千年的时间里，欧洲人就是这样理解世界的。

那么"科学革命"是怎么产生的呢？嗯，它有很多根源，但我只给你讲三个最重要的。首先是中世纪大学的建立。多亏了那些保存和修正亚里士多德著作的伊斯兰学者，希腊学术成为了中世纪大学课程的基础。然而，到了14和15世纪，欧洲的大学建立了新的数学和天

文学系。所以，随着这些学科与自然哲学（即对自然世界的研究）并驾齐驱，为思考世界的新方式奠定了基础。

第二个根源是**文艺复兴。**回想一下第一单元，我们谈到了**那些赞助艺术的富人。嗯，他们也赞助了许多对自然世界的研究，**考虑到文艺复兴对"现实主义"的强调，这是有道理的。
第三个根源，并不奇怪，是印刷机。**世界各地都有关于自然世界的新发现。印刷机使得这些新发现能够迅速传播给广大读者。**随着更多的人绞尽脑汁思考，产生新思想的机会也就更多了。

现在让我们从天文学的角度谈谈"科学革命"。你需要记住的第一个人是尼古拉·哥白尼（Nicholas Copernicus）。记住，根据亚里士多德和其他像托勒密这样的希腊思想家的观点，地球是固定不动地位于宇宙的中心。看，你不能责怪他们。从人们用眼睛观察天空的角度来看，这种观点很有道理。看起来地球是静止的，月亮和太阳围绕着它旋转。这就是所谓的"宇宙地心说模型"。

然后哥白尼出现了，他说：“你知道吗，也许我们不应该仅仅根据眼睛所看到的就下结论，而应该依靠数学，看看数学能把我们引向何方。”所以哥白尼在他的笔记本上努力钻研复杂的数学，这些数学我甚至无法向你描述，因为我只是一个谦逊的历史老师。但不管怎样，通过他的数学研究，哥白尼挑战了"宇宙地心说"观点。相反，他提出了"日心说模型"，认为太阳是宇宙的中心，地球和天空中其他天体都围绕太阳旋转。此外，他还证明了太阳看起来升起和落下的原因, 是地球本身在绕轴自转。

然后，约翰内斯·开普勒（Johannes Kepler）在哥白尼的工作基础上, 取得了另一个重大突破。**开普勒同样运用数学，接受了"宇宙日心说模型"，但通过详细的计算，他确立了行星运动的三大定律。**首先，他发现**行星绕太阳的轨道不是完美的圆形，而是椭圆形。**其次，他证明了**行星离太阳越近,运动得越快; 离太阳越远,运动得越**

慢。第三，他弄清楚了**行星绕太阳公转的时间，与它和太阳的距离精确相关。**

在这个主题下你需要知道的第三个人是伽利略（Galileo）。哥白尼和开普勒得出结论，主要是通过思考推理，但伽利略更进一步，不再仅仅依靠思考，而是运用他的眼睛进行观察。他制造了一个新装置，叫做望远镜（他并不是望远镜的发明者，但他制造了自己的望远镜），这使得人类的眼睛能够看到太空中更远的地方。有了望远镜，伽利略能够详细地观察不同行星的卫星，并且能够证明，其他行星并不像以前认为的那样是发光的天体，而是和地球由相同的物质构成。这种实验方法，对于推翻关于宇宙的公认真理，至关重要。

现在要再次强调的是，当这些人进行他们的研究时，他们在推翻以前关于宇宙如何运行的假设。而且，由于古老的亚里士多德观点与《圣经》相符（顺便说一下，“Aristotelian”是亚里士多德的形容词形式），天主教会对这些发展并不满意。所以，**除了挑战已有的哲学权威之外，这些科学家还在挑战《圣经》的权威。**由于这一切大多发生在天主教改革时期，当时教会正尽力改善它在欧洲人眼中的形象，对这样的挑战，教会是难以捍卫自己原观点的。所以哥白尼、开普勒和伽利略的著作最终被列入了教会的禁书目录，甚至伽利略还因异端邪说而受审。

然而，到了大约1640年，宇宙日心说模型在科学界被广泛接受，开普勒和伽利略的贡献也是如此。**但仍有一个问题没有得到解释，那就是是什么力量，让宇宙中的所有天体维系在一起。**为此，让我给你介绍艾萨克·牛顿（Isaac Newton）。**在17世纪末，牛顿**能够将伽利略的物理学与开普勒和哥白尼的数学计算结合起来，提出了万有引力定律。**他说，有一种叫做引力的力量使所有行星相互环绕。并且"引力"与"所涉及的行星物体的大小和重量"成正比。**在阿尔伯

特·爱因斯坦（Albert Einstein）出现之前，牛顿的引力理论定义了天文学领域。但我们会在另一个视频中谈到这一点。

所以这场"科学革命"不仅仅适用于太空、恒星和行星领域。它也应用于对人体的研究。在这里发生的事情和天文学领域类似。古希腊人对人体的旧有理解被推翻，取而代之的是更新、更准确的理解。**基本上，是古希腊的盖伦**（Galen）关于人体的理论, 在这个领域占据主导地位。盖伦提出了他所谓的**"人体体液理论"，他认为人体由四种物质或体液组成。这四种物质是血液、黄胆汁、黑胆汁和黏液。**我对盖伦的理论了解得不够多，无法告诉你他为什么认为人体的四分之一是由黏液组成的，但他就是这么认为的。

不管怎样，**根据盖伦的理论，当这四种体液平衡时，身体是健康的，但当它们失衡时，疾病就产生了。**但在这个时期，一些人通过实验和观察推翻了盖伦的观点。第一个是瑞士医生帕拉塞尔苏斯（Paracelsus），他拒绝接受疾病的体液理论，声称疾病是由"化学失衡"引起的。如果这是真的，那么化学药物可以解决这些失衡问题。比如，**如果一个人在盖伦的理论下生病，当时的治疗方法是放血。“你生病了，这意味着你的体液失衡了，所以我们放掉一些你的血吧。”**帕拉塞尔苏斯说：“不，我们为什么不让病人保留他们的血液，而是给他们化学药物来解决问题呢。”

然后是安德烈亚斯·维萨里（Andreas Vesalius），他通过解剖数百具尸体为解剖学研究做出了贡献。他在一本书中发表了他的发现，彻底推翻了盖伦对人体的理解，革新了对人体的认识。最后，你需要了解威廉·哈维（William Harvey）。他进一步推翻了盖伦的观点，这次是关于血液循环的观点。盖伦认为人体内有两种不同的血液系统，它们彼此不相互作用。但哈维通过实验发现，循环系统是一个完整的整体。血液从心脏被泵出，流经身体，然后再回到心脏，循环往复。

最后，科学革命还包括人们推理方式的革命。首先，让我给你介绍**弗朗西斯•培根（Francis Bacon）。他对思想世界的主要贡献是强调"经验主义"，经验主义被定义为通过"归纳推理"来追求知识——归纳推理的定义是: 先通过观察事物的最小部分来理解世界，然后将这些发现推广到更大的范围。**然后是**勒内•笛卡尔（René Descartes），他发展出了"演绎推理"系统。**这是由于天文学的革命而产生的。宇宙地心说概念看起来不错，因为它与人们所能看到的相符，但后来数学的发展削弱了感官的作用。所以**笛卡尔认为有必要怀疑一切合理的事物，一旦你遇到了不可怀疑的事物，你就可以基于这个第一原则进行推理。然后从这些大的理念出发，你可以推导出较小的理念。**不管怎样，这两个人是挑战古希腊哲学主导地位的主要先驱者。

然而，尽管人类对自己的世界以及世界之外的理解，有了这些重大创新，旧有的信仰仍然存在。一些新科学的开拓者，仍然相信"炼金术"（试图将贱金属变成黄金和白银）和"占星术"（认为行星和恒星的位置会影响人类生活的结果）。例如，当约翰内斯·开普勒忙于用行星运动的科学定律让我们惊叹时，他也是一位宫廷数学家，他的职责包括印制当天的星象图。所以，并不是所有的一切都改变了，也有一些显著的延续性。

好的，如果你想继续复习美国大学预修课程欧洲历史的第四单元，点击这里。此外，如果你想获取与我所有视频对应的视频笔记指南，点击这里，这些笔记肯定会帮助你在课堂上得A，并在五月份的考试中得5分。我们下次再见。时间到。

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3. pure

If you were a European before the 1500s, you wouldn’t believe some wonky things about the world. You would believe that the Earth was the center of the universe, and that a full quarter of the human body was made of mucus. But now that we’re beginning Unit Four, we’re gonna see how all of that began to change in something called the Scientific Revolution. If you want notes to follow along with this video, then get your clicky finger out and check the link in the description. If you’re ready to get them brain cows milked Copernican Revolution style, then let’s get to it.

Now prior to the Scientific Revolution, much of the accepted knowledge about the natural world came from ancient Greece, and more specifically Aristotle. He taught that the Earth was at the center of the universe, which was further surrounded by concentric crystal spheres into which were embedded other planets and stars. The Catholic Church gave this cosmology a thumbs up because it squared nicely with the creation account in Genesis 1. So for about two thousand years, this is how Europeans understood the world.

So where did the Scientific Revolution come from? Well, there are many roots, but I’m only going to give you three of the most significant. First was the establishment of universities during the medieval times. Thanks to Islamic scholars who had preserved and amended Aristotelian texts, Greek scholarship became the foundation of medieval university curriculum. By the 14th and 15th centuries, however, European universities had established new departments of mathematics and astronomy. And so as these

disciplines took their place alongside natural philosophy—which was the study of the natural world—the stage was set for new ways of thinking about the world.

The second root was the Renaissance. Recall all the way back to Unit One when we talked about the wealthy folks who patronized the arts. Well, they also patronized many studies into the natural world, and that makes sense given the Renaissance emphasis on realism. The third root was, not surprisingly, the printing press. New discoveries about the natural world were being made across the globe. The printing press made it possible to circulate those new findings with great speed to a wide readership. With more people sitting around scratching their brains, there is going to be more opportunity for new ideas.

So now let's talk about the Scientific Revolution in terms of astronomy. The first name you need to associate with this is Nicholas Copernicus. Remember that according to Aristotle and other Greek thinkers like Ptolemy, the Earth was fixed and immovable in the center of the universe. Look, you can hardly blame them. That made a lot of sense out of what a person sees with their eyeballs when they look at the sky. It looks like the Earth is still and the Moon and the Sun rotate around. This is known as the geocentric model of the universe.

So then Copernicus came along and said, "You know, maybe we shouldn't come to conclusions only based on what our eyes see, and instead rely on mathematics and see where

that leads us." So Copernicus got down and dirty in his notebooks doing complex math which I couldn't even begin to describe to you, for alas I am but a humble history teacher. But regardless, through his mathematical work, Copernicus challenged the geocentric view of the universe. Instead, he put forth the heliocentric model which said that the sun was at the center, and the Earth along with the other heavenly bodies on display in the sky revolved around the Sun. Additionally, he was able to demonstrate that the reason it appears that the sun is rising and setting is because the Earth itself spins upon an axis.

And then building upon Copernicus's work, Johannes Kepler created another massive breakthrough. Again using mathematics, Kepler accepted the heliocentric model of the universe, but through detailed computations established three laws of planetary motion. First, he discovered that planets orbited the Sun not in perfect circles but rather in ellipses. Second, he demonstrated that planets move faster when they are closer to the Sun and slower when they're farther away. And third, he figured out that the time a planet takes to orbit the Sun is exactly related to its distance from the Sun.

And then the third name you need to know under this heading is Galileo. Now both Copernicus and Kepler came to their conclusions mainly by mapping them out with their thinky-thinky parts, but Galileo took these conclusions even further by taking the conclusions out of the brain and instead using his eyeballs. He built a new contraption called

a telescope — and you know he didn't invent it, but he did build his own — and this allowed the human eye to see far greater distances into space. And with the telescope, Galileo was able to observe in detail the moons of different planets and was able to prove that those other planets weren't celestial bodies of light as had previously been believed, but rather they were made out of the same stuff as Earth. And this experimental method was crucial in overturning the accepted truths about the universe.

Now it's important to emphasize again that as each of these men did their work, they were overturning previous assumptions about how the cosmos worked. And because the old Aristotelian view lined up with the Bible — and you know, by the way, "Aristotelian" is just the adjective form of Aristotle — the Catholic Church was not happy about these developments. So in addition to challenging established philosophical authority, these scientists were challenging scriptural authority. Since much of this was going on during the Catholic Reformation, when the church was doing its best to clean up its profile in the eyes of Europeans, such challenges were untenable. And so Copernicus, Kepler, and Galileo ended up on the church's index of prohibited books, and even Galileo was tried for heresy.

However, by about 1640, the heliocentric model of the universe was pretty widely accepted by the scientific community, as well as the contributions of Kepler and Galileo. But what remained unexplained is by what force all these heavenly bodies of the universe held together. For that,

let me introduce you to my boy Isaac Newton. Near the end of the 17th century, Newton was able to combine the physics of Galileo with the mathematical computations of Kepler and Copernicus to produce the law of universal gravitation. It was a force called gravity that kept all the planets revolving in relation to one another. And gravity was directly proportional, he said, to the size and weight of the planetary objects in question. It was Newton's theory of gravity that defined the field of astronomy until Albert Einstein came along. But you know, we'll talk about that in another video.

So this Scientific Revolution didn't just apply to the realm of space and stars and planets. It was also applied to the study of the human body. The same thing was happening here that happened with astronomy. Old Greek understandings of the body were being overturned in favor of newer, more accurate understanding. Basically, it was the ancient Greek Galen whose theories about the human body dominated this field. Galen argued for what he called the humoral theory of the body, which said that the body was composed of four kinds of substances or humors. Those four substances were blood, yellow bile, black bile, and phlegm. Now I don't know enough about Galen to tell you why he thought that a quarter of the human body was composed of mucus, but you know, he did.

Regardless, according to Galen, when these four humors were in balance, the body was healthy, but when they got out of balance, that was the cause for sickness and disease.

But then along came some folks in this period to overturn Galen’s ideas through experimentation and observation. First was the Swiss physician Paracelsus, who rejected the humoral theory of disease and claimed that it was chemical imbalances that caused disease. And if that was true, then chemical remedies could solve those imbalances. Like if someone was sick under Galen’s care, then the go-to method of curing them was bloodletting. "You’re sick, which means your humors are out of balance, so let’s get rid of some of your blood." Paracelsus said, "No, how about we let the patients keep their blood and give them chemical medicines to address their problems."

And then came Andreas Vesalius, who contributed to the study of anatomy by dissecting dead bodies by the hundreds. He published his findings in a book and completely debunked Galen’s understanding of the body and revolutionized the understanding of the human body. And finally, you need to know William Harvey. He further overturned Galen’s ideas, this time about circulation. Galen taught that there were two different systems of blood contained in the body, and they did not interact with one another. But Harvey, through experimentation, discovered that the circulatory system was one integrated whole. Blood is pumped out of the heart through the body and returns to the heart to do the whole thing over again.

And finally, the Scientific Revolution included a revolution in the way people reasoned. First, let me introduce you to Francis Bacon. His major contribution to the thinky-thinky

world was an emphasis on empiricism, which when being defined is the pursuit of knowledge through inductive reasoning — which when being defined means understanding the world first by observing the smallest parts of it and then generalizing those findings to the largest part. Then there was René Descartes, who developed a system of deductive reasoning. This came about because of the revolution in astronomy. The geocentric conception of the universe seemed good because it aligned with what a person could see, but then mathematics came along and undermined the senses. So Descartes figured it was necessary to doubt everything that could reasonably be doubted, and once you ran into something that was undoubtable, then you could build your reasoning upon that first principle. And then from those big ideas, you could work your way down to the smaller ideas. Either way, both of these men were the first major players in challenging the dominance of ancient Greek philosophy.

However, despite these massive innovations in how humans understood their world and the world beyond them, older beliefs continued to persist. Some of these pathfinders of the new science still held on to beliefs in alchemy, which was the attempt to turn base metals into gold and silver, and astrology, which taught that the position of planets and stars affected the outcome of human life. For example, while Johannes Kepler was busy blowing our minds with the scientific laws of planetary motion, he was also a court mathematician whose duties included printing out

horoscopes for the day. So you know, it wasn’t all changed. There were some significant continuities as well.

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