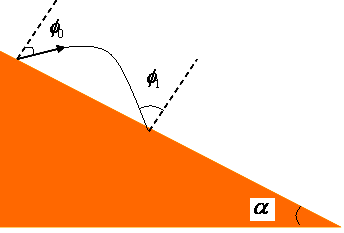
臺灣省中二區102學年度高級中學數理及資訊學科能力競賽

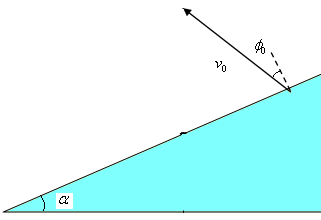
　 物理科理論試題 解答 　 編號：

\*\* 本試題共3頁，試題請連同答案卷一併繳回 \*\*

1. 長斜坡(斜角)，球以初速(發射角)射出，如右圖。(虛線為法線、重力加速度為)。
   1. 球第一次落坡之入射角為*φ*1，求tan*φ*1 = ? (5%)
   2. 球第二次落坡之入射角為*φ*2，求tan*φ*2 = ? (3%)
   3. 球第*n*次落坡之入射角為*φ*3，求tan*φ*3 = ? (2%)

所有碰撞皆為彈性碰撞，答案以、表示

**參考答案：**





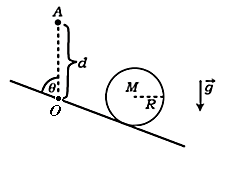








 推廣

1. 如右圖所示，有一半徑為*R* 、質量為*M* 的均勻圓盤，在光滑斜面上作純滾動，圓盤相對其轉動軸的轉動慣量為，且斜面與鉛垂線的夾角為θ。在斜面某處(設為點O)鉛直向上距離*d*的點A處是一吸引力中心，吸引力的方向是沿著點A與圓盤質量中心的連線指向點A，且其值正比於其間之距離。
2. 若在圓盤質量中心處黏貼質量為的微小質點，並將圓盤放置在此光滑斜面上，且圓盤與斜面的接觸點與點O距離為*d*，則發現圓盤會靜止不動，試求得該吸引力的比例常數*k*。(4%)
3. 若小質點突然掉落，試證明圓盤將沿著斜面進行簡諧振動(4%)，並求出
4. 圓盤沿著斜面作簡諧振動的振幅(4%)以及
5. 振動角頻率。(3%)

**參考答案：**

(a)



(b) 根據牛頓第二運動定律，圓盤在處受沿著斜面的合力為

，

滿足虎克定律，因此圓盤沿著斜面進行簡諧振動。註：為平衡點如(c)中所示。

(c)

。

1. 圓盤沿著斜面進行簡諧振動時，可等效視之為作簡諧振動的質量-彈簧系統，其等效質量及等效力常數滿足虎克定律，結合牛頓第二運動定律得到

，

此時振動角頻率為 。

當圓盤在處，其系統的總動能為，

根據(b)可知 。因此，

1. 有一人造衛星在地球上空受重力以穩定的圓形軌道繞行，已知此一人造衛星受到地球的重力，為在地表時的0.900倍，若忽略人造衛星所受大氣層的阻力，且地球半徑為6380公里，地面之重力加速度為9.80 m/s2 ，則
   * 1. 推算此人造衛星距地表的高度為何？(3%)
     2. 此人造衛星繞行地球的週期為何？(3%)
     3. 透過太陽的反射，人們可以在黃昏時，在地面上用肉眼看見此人造衛星呈現微亮之光點，逐漸繞行。試推算此人造衛星，每繞行一周的過程，在地平線之範圍內，能被地面觀察者觀看的時間長度為何？(4%)

**參考答案：**

(a)  高度 *h* = 0.0541RE = 345 km

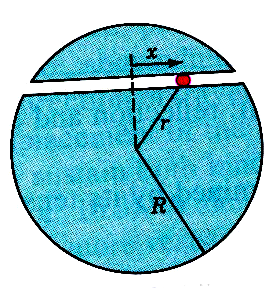
(b)  且  則  = 5486 sec

(c) θ= cos -1 (1/1+h) = 18.4°

地平線範圍: 2θ= 36.8°

可觀察時間: 5486×(36.8/360) = 561sec

1. 靜電學中的高斯定律是如此描述的:若考慮一淨電荷 包含在一個任意的封閉曲面內[，](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))則通過此封閉曲面的電通量等於 乘以封閉曲面內的淨電荷。亦即 。
   1. 請根據重力與電力對空間相依關係的相似性[，](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))寫出在重力學上的高斯定律。(5%)

如右[圖](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))所[示](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))[在](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[一個](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[半徑](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)為[*R*](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))、[質](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)量為*M* 且密度均勻的[星](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))球開了一條[隧道](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))[。](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[在](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)距離[中心](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))*r*的位置[，](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)有一質量為*m*的物體[。](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))

[(](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))b[)](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[請](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[找出該物體所受到](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))的[重力](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))[。](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)(5%)

[(](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))c[)](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)若星球為[地球](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[，](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)且假設隧道內無摩擦力，請估計該物體作簡諧運動[的](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))[振盪](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)週[期](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))? (5%)

[(](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))[提示](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[：](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[地球](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)的[平均](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km))[半徑](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[為](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[6371](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)[公里](http://cn.bing.com/dict/clienttranslate?mkt=zh-CN&setLang=ZH&form=BDVEHC&q=Figure%20shows%20a%20tunnel%20in%20a%20uniform%20planet%20of%20mass%20M%20and%20radius%20R.%20At%20a%20distance%20from%20the%20center%2C%20Please%20(a)%20find%20the%20gravitational%20attractive%20force%20at%20a%20distance%20r%20from%20the%20center%3B%20(b)%20find%20the%20period%20of%20the%20oscillation%20for%20the%20earth.%0A(Hint%3A%20The%20average%20radius%20of%20earth%20is%206371%20km)" \t "_blank)，質量為5.972 × 1024 *kg*，在地球表面的重力加速度為9.780 )

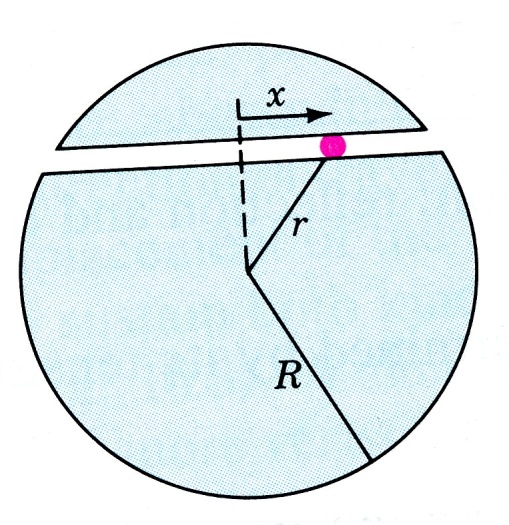
**參考答案：**

(a)

or

(b)

(c)

At *r=R* 

1. 今有一頻率為f0之標準音叉，小明在高塔頂上敲擊此音叉時，不慎將音叉從手中滑落而讓它垂直掉落至塔底，假設音叉在整個掉落過程中為自由落體，重力加速度為g，空氣中的聲速為v。若從音叉剛掉落的瞬間，小明按下碼錶開始計時，則在音叉掉落的過程中
   * 1. 當時間為t0時音叉恰好落至A點，請求出聲音由A點傳至塔頂所需的時間。(5%)
     2. 請推導出小明在塔頂所聽到從音叉所發出的聲音頻率f與時間t的關係。(提示：要考慮聲音從音叉傳至塔頂所需的時間)。(5%)

**參考答案：**

(a) 音叉落下之距離  

(b) 假設音叉發聲的時間為*t*0，而小明聽到聲音的時間為*t*，則

 ⇒  (只取”+”，“−“不合)

時間為*t*0時音叉落下之速度為 

因此小明在塔頂所聽到從音叉所發出的聲音頻率f為



1. 假設彈簧的彈力常數k與絕對溫度成正比。黃銅的熱膨脹係數為 1.9×10-5 /℃，木頭的熱膨脹係數為 8.0×10-6 /℃。
   * 1. 小明在夏天37℃以彈簧秤秤得體重60kg。若小明體重不變，在冬天7℃以相同彈簧秤，歸零後，秤得體重為若干kg? (3%)
     2. 若機械鐘是以彈簧的周期運動來控制快慢。試估計在夏天37℃校對好的精準時鐘，到了冬天7℃時，時鐘會走的較快或是較慢? 一天誤差約多少分鐘? (3%)
     3. 以一黃銅製的直尺量一木製桌子，在夏天37℃量得桌寬為90cm。試問到了冬天7℃時，以此黃銅尺量得桌寬將會增加或是減少? 改變多少cm? (5%)
     4. 若擺鐘是以黃銅製的單擺在重力下周期運動來控制快慢。試估計在夏天37℃校對好的精準時鐘，到了冬天7℃時，時鐘會走的較快或是較慢? 一天誤差約多少秒? (4%)

**參考答案：**

(a) 體重 w與彈簧變化量Δ*x*成正比 彈力常數 k 成反比，因此體重讀數與溫度成反比。 溫度降低，體重讀數增加。因此: 

(b) 彈簧周期與彈力常數根號成反比，因此與溫度根號成反比。溫度減小，周期變長、變慢。

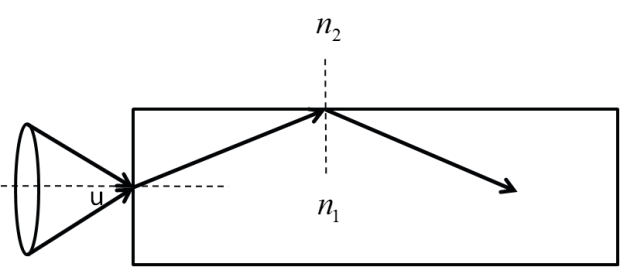


(c) 對尺而言，尺的長度與讀數成反比。黃銅縮的多，因此刻度變多、變長。



(d) 單擺周期與長度根號成正比。冬天時，單擺變短，周期變短、變快。



1. 如右圖所示，一透明圓柱管折射率為n1，浸入折射率為n2之透明液體中，且n1> n2。
   * 1. 為使光束能於透明圓柱管中順利傳播，試證明光束之最大孔徑角u滿足下列關係式，

。 (5%)

* + 1. 若n2之折射率為4/3，則透明圓柱管之折射率n1最少需為多少?(只寫答案不計分) (5%)

**參考答案：**

(a)

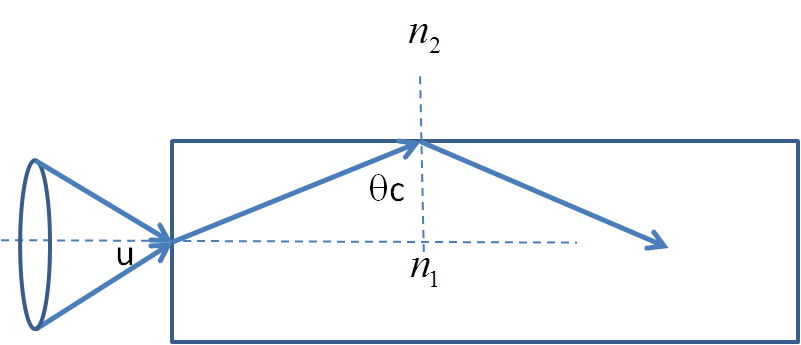
,

,

1+=

(b)

,



1. (a)如圖所示，一物體置於焦距5cm的凸透鏡前方5cm處，另一焦距-15cm的凹透鏡則置放於凸透鏡後方10cm處，請問最終成像位置與放大率為何? (5%)

物體

透鏡二

透鏡一

10cm

5cm

*f*1=5cm

*f*2= -15cm

(b)承上題，若將另一焦距4cm的凸透鏡取代凹透鏡並將之置放於前一凸透鏡後方4.5cm處，請問最終成像位置與放大率為何? (5%)

透鏡一

物體

透鏡二

4.5cm

5cm

*f*1=5cm

*f*2= 4cm

(c)承上題，若將圖中焦距4cm的凸透鏡置換為焦距3cm的凸透鏡後，但仍要維持成像面位置不變(即成像面與第二片凸透鏡的相對位置不改變)，在物體與透鏡二者均不能移動的情況下我們可以藉由將第一片凸透鏡往物體方向移動來達成此要求，請問此移動量*x*為多少? (5%)

*x*

*f*2= 3cm

*f*1=5cm

4.5cm

5cm

**參考答案：**

(a) 成像於透鏡一前方5cm處，放大倍率3

(b) 成像於透鏡二後方4cm處，放大倍率0.8

(c) 2.5cm