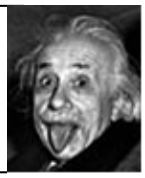
Gravitational field



1. Earth orbits the Sun in *1 year*. It is *1 A.U* from the star. a) *Neptune* is *30.6 AU* from the Sun. *How long* is the *year* for Neptune? b) *Mars* orbits the Sun in *1.87 Earth years. How far* is Mars from the Sun? ***Answer: a) 169 years. b) 1.52 AU.***

2. The moon Io orbits Jupiter in *1.77 days*, and is $4.2 \cdot 10^8$ *m* from the planet. The moon Europa also orbits Jupiter, and is $6.7 \cdot 10^8$ *m* from the planet. *How many days* does it take Europa to orbit once? ***Answer: 3.57 days.***

3. A satellite is in a circular orbit around an unknown planet. The satellite has a speed of $1.70 \cdot 10^4$ *m/s*, and the *radius of the orbit is* $5.25 \cdot 10^6$ *m*. A second satellite also has a circular orbit around this same planet. The *orbit of this second satellite has a radius of* $8.60 \cdot 10^6$ *m*. What is the *orbital speed of the second satellite*? ***Answer:*** $\mathbf{1.33 \cdot 10^4}$ ***m/s***

4. A distance of *2.0 m* separates two objects of equal mass. If the gravitational force between them is $1.04 \cdot 10^{-8}$ *N*, find the mass of each object. ***Answer:*** **25 kg.**

5. What is the *gravitational field strength* at a point $6.38 \cdot 10^6$ *m* above Earth's surface? At what *distance from Earth's surface* is the acceleration due to gravity *7.33* m/s^2? <u>*Data*</u>: *G,* M_{Earth} *and* R_{Earth}. ***Answer: a) 2.45*** $\mathbf{m/s^2}$***. b)*** $\mathbf{9.97 \cdot 10^5}$ ***m.***

6. At what altitude above the Earth's surface would your weight be one-half of what it is at the Earth's surface? <u>*Data*</u>: g_0 *and* R_{Earth}. ***Answer: 2650 km.***

7. On the surface of planet Y, which has a mass of $4.83 \cdot 10^{24}$ *kg*, a *30 kg object* weighs *50 N*. What is the *radius* of the planet? <u>*Data*</u>: *G.* ***Answer:*** $\mathbf{1.39 \cdot 10^7}$ ***m***

8. A satellite orbits at a height of *3185 km* above the surface of the Earth. Determine the *speed* and *orbital period* of the satellite. <u>*Data*</u>: *G,* M_{Earth} *and* $R_{Earth.}$ ***Answer: a) 6641 m/s. b) 2.6 h.***

9. NASA places a *100.0 kg* satellite in a circular orbit just above the surface of the Earth. How much *gravitation force* does the Earth exert on the satellite? What is the satellite's *orbital speed*? What is the satellite´s *orbital period*? <u>*Data*</u>: *G,* M_{Earth} *and* $R_{Earth.}$. ***Answer: a) 983 N. b) 7912 m/s. c) 5059 s.***

10. A satellite is in a circular orbit *300 km* above the surface of the Earth. Find its *speed* and its *period of revolution*. <u>*Data*</u>: g_0 *and* $R_{Earth.}$ ***Answer: a) 7721 m/s. b) 90,4 min.***

11. A *150 kg* object is launched into orbit at a height of *12800 km* above the Earth's surface. a) What is the *weight of the satellite on the surface of the Earth*? b) What is the *weight of the satellite in orbit*? c) What is the *speed* of the satellite in orbit? <u>*Data*</u>: $g_{0,}$ *G,* M_{Earth} *and* R_{Earth} ***Answer: a) 1470 N. b) 160 N c) 4500 m/s***

12. Given the following data: Mass of Mars: $6.42 \cdot 10^{23}$ *kg*, mass of the Sun: $1.991 \cdot 10^{30}$ *kg*, mars's distance from the Sun: $2.279 \cdot 10^{11}$ m a) Find the velocity with which Mars moves around the Sun. b) *How long* in days does it take Mars to make *one revolution* about the Sun? c) What is the *force of gravity* experienced by Mars from the Sun? Data: *G*. ***Answer: a) $2.4 \cdot 10^4$ m/s. b) 691 días. c)$1.64 \cdot 10^{21}$ N.***

13. A satellite is placed in orbit $6.00 \cdot 10^5$ *m* above the surface of Jupiter. Jupiter has a mass of $1.90 \cdot 10^{27}$ *kg* and a radius of $7.14 \cdot 10^7$ *m*. Data: *G*. Find the *orbital speed* of the satellite. ***Answer: $4.20 \cdot 10^4$ m/s.***

14. The *period of the Moon* is approximately *27.2 days*. Determine the *radius of the Moon's orbit* and the *orbital speed of the Moon*. Data: *G and* M_{Earth}. ***Answer: r = $3.82 \cdot 10^8$ m; v = $1.02 \cdot 10^3$ m/s***

15. Io, a satellite of Jupiter, has an orbital period of *1.77 days* and an orbital radius of $4.22 \cdot 10^5$ *km*. *From these data and G*, determine the *mass of Jupiter*. ***Answer: $1.9 \cdot 10^{27}$ kg.***

16. The Earth travels around the Sun once per year in an approximately circular orbit whose radius is $1.50 \cdot 10^{11}$ *m*. Determine: a) The *mass of the Sun*. b) The *orbital speed of the Earth* . Data: *G*. ***Answer: a) $2.00 \cdot 10^{30}$. b) $2.98 \cdot 10^4$ m/s.***

17. A *geosynchronous* satellite is one which stays above the same part of the Earth all of the time (in other words, it's period is the same as that of the earth). Data: *G,* M_{Earth} *and* R_{Earth}. *How high above the surface* of the *Earth* is this satellite? ***Answer: $3.59 \cdot 10^7$ m***.

18. *Venus* rotates slowly about its axis, the period being *243 days*. The mass of *Venus is* $4.87 \cdot 10^{24}$ *kg*. Determine the *radius for a geosynchronous orbit* around Venus. Data: *G*. ***Answer: $5.57 \cdot 10^6$ m***

19. At what *distance above the surface* of the Earth would a satellite have a *period of 5 h*? What would be the *satellite's linear speed* at this distance? Data: g_0 *and* R_{Earth}. ***Answer: a) $8.47 \cdot 10^6$ m. b) 5180 m/s.***

20. On July 19, 1969, Apollo 11's orbit around the Moon was adjusted to an average altitude of *111 km*. The radius of the Moon is *1785 km* and the *mass of the Moon is* $7.36 \cdot 10^{22}$ *kg*. Data: *G*. a) At what *velocity* did it orbit the Moon? b) How many *minutes* did it take to *orbit once*? ***Answer: a) 1610 m/s. b) 123 min.***

21. A satellite has a mass of *5850 kg* and is in a circular orbit $4.1 \cdot 10^5$ *m* above the surface of the planet. The *period* of the orbit is *two hours*. The *radius* of the planet is $4.15 \cdot 10^6$ *m*. What is the *weight of the satellite* when it is at rest *on the planet's surface*? Data: *G*. ***Answer: $2.45 \cdot 10^4$ N***

Data: $G = 6.67 \cdot 10^{-11}\ N \cdot m^2/kg^2$; $M_{earth} = 5.98 \cdot 10^{24}$ *kg*, $R_{earth} = 6.37 \cdot 10^6$ *m* $g_0 = 9.8\ m/s^2$