Lecture 2 - The Universal law of gravitation

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A baseball is located at the surface of the earth. Which statements about it are correct? (There may be more than one correct choice.) 1) _____
   A) The gravitational force on the ball is independent of the mass of the earth.
   B) The gravitational force on the ball due to the earth is exactly the same as the gravitational force on the earth due to the ball.
   C) The gravitational force on the ball is independent of the mass of the ball.
   D) The earth exerts a much greater gravitational force on the ball than the ball exerts on the earth.
   E) The ball exerts a greater gravitational force on the earth than the earth exerts on the ball.

2) A very small round ball is located near a large solid sphere of uniform density. The force that the large sphere exerts on the ball 2) _____
   A) is exactly the same as it would be if all the mass of the sphere were concentrated at the center of the sphere.
   B) is independent of the mass of the sphere.
   C) is approximately the same as it would be if all the mass of the sphere were concentrated at the center of the sphere.
   D) can only be calculated using calculus.
   E) is independent of the mass of the ball.

3) Planet Z-34 has a mass equal to 1/3 that of Earth, a radius equal to 1/3 that of Earth, and an axial spin rate 1/2 that of Earth. With g representing, as usual, the acceleration due to gravity on the surface of Earth, the acceleration due to gravity on the surface of Z-34 is 3) _____
   A) $g/9$. B) $3g$. C) $6g$. D) $g/3$. E) $9g$.

4) Suppose you lived on the Moon. Which of the following would be true? 4) _____
   A) Both your weight and your mass would be the same as they are on Earth.
   B) Both your weight and your mass would be less than they are on Earth.
   C) Your mass would be less than your mass on Earth, but your weight would be the same as it is on Earth.
   D) Your weight would be less than your weight on Earth, but your mass would be the same as it is on Earth.

5) Why are astronauts weightless in the Space Station? 5) _____
   A) because there is no gravity in space
   B) because the Space Station is traveling so fast
   C) because the Space Station is moving at constant velocity
   D) because the Space Station is constantly in free–fall around Earth

6) A certain planet has an escape speed V. If another planet of the same size has twice the mass as the first planet, its escape speed will be 6) _____
   A) $2V$. B) $V/\sqrt{2}$. C) $\sqrt{2}V$. D) $V/2$. E) V.

7) A certain planet has an escape speed V. If another planet has twice size and twice the mass of the first planet, its escape speed will be 7) _____

A) $V/2$. B) $V/\sqrt{2}$. C) $2V$. D) V. E) $\sqrt{2}V$.

8) A satellite is orbiting the earth. If a payload of material is added until it doubles the satellite's mass, the earth's pull of gravity on this satellite will double but the satellite's orbit will not be affected. 8) _____

A) True B) False

9) An astronaut is in equilibrium when s/he is positioned 140 km from the center of asteroid X and 581 km from the center of asteroid Y, along the straight line joining the centers of the asteroids. What is the ratio of the masses X/Y of the asteroids? 9) _____

A) 0.241 B) 4.15 C) 0.0581 D) 17.2

10) Three identical very small 50-kg masses are held at the corners of an equilateral triangle, 0.30 m on each side. If one of the masses is released, what is its initial acceleration if the only forces acting on it are the gravitational forces due to the other two masses? ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 10) _____

A) 2.5×10^{-8} m/s^2

B) 3.7×10^{-8} m/s^2

C) 4.2×10^{-8} m/s^2

D) 6.4×10^{-8} m/s^2

E) 1.9×10^{-8} m/s^2

11) A small planet having a radius of 1000 km exerts a gravitational force of 100 N on an object that is 500 km above its surface. If this object is moved 500 km farther from the planet, the gravitational force on it will be closest to 11) _____

A) 56 N. B) 75 N. C) 25 N. D) 71 N. E) 50 N.

12) The gravitational acceleration on a planet's surface is 16.0 m/s^2. What is the gravitational acceleration at an altitude of one planet diameter above the SURFACE of the planet? 12) _____

A) 1.60 m/s^2

B) 5.33 m/s^2

C) 4.00 m/s^2

D) 8.00 m/s^2

E) 1.78 m/s^2

13) The weight of spaceman Speff at the surface of planet *X*, solely due to its gravitational pull, is 389 N. If he moves to a distance of 1.86 $\times 10^4$ km above the planet's surface, his weight changes to 24.31 N. What is the mass of planet *X*, if Speff's mass is 75.0 kg? ($G = 6.67 \times 10^{-11}$ N · m^2/kg^2) 13) _____

A) 2.99 $\times 10^{18}$ kg
B) 1.59 $\times 10^{18}$ kg
C) 2.99 $\times 10^{24}$ kg
D) 2.99 $\times 10^{17}$ kg

14) From what height above the surface of the earth should an object be dropped to initially experience an acceleration of 0.9200*g*? The radius of the earth is 6.38×10^6 m. 14) _____

A) 260 km B) 554 km C) 510 km D) 272 km

15) Ekapluto is an unknown planet that has two spherical moons in circular orbits. The table summarizes the hypothetical data about the moons. Both moons have low axial spin rates. ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 15) _____

	Mass	*Radius*	*Orbital radius*	*Orbital period*
Moon A	4.0×10^{20} kg		2.0×10^8 m	4.0×10^6 s
Moon B	1.5×10^{20} kg	2.0×10^5 m	3.0×10^8 m	

The acceleration due to gravity at the surface of Moon *B* is

A) 0.30 m/s^2.
B) 0.10 m/s^2.
C) 0.15 m/s^2.
D) 0.25 m/s^2.
E) 0.20 m/s^2.

16) What is the ratio of the escape speed of a rocket launched from sea level to the escape speed of one launched from Mt. Everest (an altitude of 8.85 km)? The radius of the earth is 6.38×10^6 m. 16) _____

A) 0.9986 B) 1.0001 C) 1.0007 D) 1.0014 E) 0.9993

17) A huge cannon is assembled on an airless planet having insignificant axial spin. The planet has a radius of 5.00×10^6 m and a mass of 3.95×10^{23} kg. The cannon fires a projectile straight up at 2000 m/s. An observation satellite orbits the planet at a height of 1000 km. What is the projectile's speed as it passes the satellite? ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 17) _____

A) 1500 m/s B) 1280 m/s C) 1610 m/s D) 1380 m/s

18) A meteoroid, heading straight for Earth, has a speed of 14.8 km/s relative to the center of Earth as it crosses our moon's orbit, a distance of 3.84×10^8 m from the earth's center. What is the meteroid's speed as it hits the earth? You can neglect the effects of the moon, Earth's atmosphere, and any motion of the earth. ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2, $M_{earth} = 5.97 \times 10^{24}$ kg) 18) _____

A) 18.5 km/s B) 21.5 km/s C) 32.4 km/s D) 87.3 km/s

19) A certain spherical asteroid has a mass of 3.5×10^{16} kg and a radius of 8.8 km. What is the minimum speed needed to escape from the surface of this asteroid? ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 19) _____

A) 520 m/s B) 16 m/s C) 730 m/s D) 23 m/s

20) A 910-kg object is released from rest at an altitude of 1200 km above the north pole of the earth. If we ignore atmospheric friction, with what speed does the object strike the surface of the earth? ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2, $M_{earth} = 5.97 \times 10^{24}$ kg, the polar radius of the earth is 6357 km) 20) _____

A) 4.5 km/s
B) 4.8 km/s
C) 2.2 km/s
D) 2.7 km/s
E) 3.2 km/s

21) A satellite is in circular orbit at an altitude of 2300 km above the surface of a nonrotating asteroid with an orbital speed of 5.9 km/s. The minimum speed needed to escape from the surface of the asteroid is 14.6 km/s, and $G = 6.67 \times 10^{-11}$ N • m^2/kg^2. The mass of the asteroid is closest to 21) _____

A) 8.9×10^{23} kg.
B) 2.7×10^{24} kg.
C) 3.6×10^{24} kg.
D) 1.3×10^{24} kg.
E) 1.8×10^{24} kg.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

22) A small-sized 155-kg mass is located 1.50 m from a small-sized 275-kg mass, with both masses fixed in place. Where should you place a third small-sized mass so that the net gravitational force on it due to the original two masses is zero? 22) _____

23) Using the known radius of the Earth and that g=9.80 m/s² at the Earth's surface, find the average density of the Earth. 23) _____