Name:_____ Class:_____ Date:_____

CHAPTER 3 - FORCES

1. The SI unit of force is the newton. Express the newton in terms of basic SI dimensions, mass M, length L, and time T.
   a. $L\ M^{-1}\ T^{-2}$
   b. $L^{-1}\ M^{-1}\ T^{2}$
   c. $L\ M\ T^{-2}$
   d. $L\ M^{-1}\ T^{2}$

ANSWER: c

2. Which of these forces is the weakest of all fundamental forces?
   a. the gravitational force
   b. the weak nuclear force
   c. the strong nuclear force
   d. the electromagnetic force

ANSWER: a

3. For two bodies gravitationally interacting with each other, if you double each mass and halve the distance between them, by how much would the gravitational force change?
   a. increase 8 times
   b. increase 16 times
   c. decrease 8 times
   d. decrease 16 times

ANSWER: b

Some bodies in our solar system are listed in Table 3.1, with masses and radii.

Table 3.1

Planet or Moon	Mass (kg)	Radius (m)
Mercury	3.30×10^{23}	2.44×10^{6}
Venus	4.87×10^{24}	6.05×10^{6}
Earth	5.97×10^{24}	6.38×10^{6}
Moon	7.35×10^{22}	1.74×10^{6}
Mars	6.42×10^{23}	3.40×10^{6}
Jupiter	1.90×10^{27}	7.15×10^{7}

4. Based on the data in Table 3.1, what is the relationship between the weights of the same object on Earth and the Moon?
   a. The weight of the object on Earth is 6 times the weight of the object on the Moon.
   b. The weight of the object on Earth is 6 times smaller than the weight of the object on the Moon.
   c. The weight is the same on Earth and the Moon.
   d. The weight of the object on Earth is 22 times the weight of the object on the Moon.

ANSWER: a

5. Based on the data in Table 3.1, what is the mass of an object on Jupiter, when its measured weight on Earth is 21 N?
   a. 2.1 kg
   b. 5.3 kg

c. 2.1 N

d. 53 N

ANSWER: a

6. A ball is thrown up in the air. Halfway to its maximal height, what is the net force acting on the ball? Assume that there is no air resistance.

a. The net force is 0 N.

b. The net force is less than its weight.

c. The net force is greater than its weight.

d. The net force is equal to its weight.

ANSWER: d

7. Gravity on the Moon's surface is less than gravity on Earth's surface. For two identical objects, one on Earth and the other on the Moon, how do the mass and weight compare?

a. The mass and the weight of the object on the Moon are larger than the mass and the weight of the object on Earth.

b. The masses of both objects are the same, but the weight of an object on the Moon is less.

c. The weights of both objects are the same, but the mass of an object on the Moon is less.

d. The objects in both places have the same mass and the same weight.

ANSWER: b

8. If you pull a sled up a slope, which one of these statements is correct for the magnitude of a normal force?

a. It is less than the weight of the sled.

b. It is larger than the weight of the sled.

c. It is equal to the weight of the sled.

d. It is zero.

ANSWER: a

9. Which of the following is NOT a fundamental force?

a. frictional force

b. electromagnetic force

c. weak nuclear force

d. gravitational force

ANSWER: a

10. Which of the following statements is correct for the force of static friction between two surfaces?

a. It depends on the contact area.

b. It is proportional to the normal force.

c. It is larger than the applied force.

d. It is smaller than the applied force.

ANSWER: b

11. The coefficient of static friction between a set of tires on a car and a steep road is 0.58. What is the steepest angle of the road on which the car can stay at rest without slipping downhill?

a. 15°
b. 30°
c. 45°
d. 60°

ANSWER: b

12. Two identical spheres are resting on a horizontal surface at a distance of 0.04 m from each other, each attached to an identical unstretched spring with a spring constant of 100 N/m. If we charge the spheres with a negative charge of –1.60 ìC each, what is the new spacing between the spheres? Coulomb's constant is $k = 9.0 \times 10^9$ N m^2/C^2.

a. 0.14 m
b. 0.18 m
c. 0.32 m
d. 0.36 m

ANSWER: c

13. Two identical spheres are resting on a horizontal surface at a distance of 0.01 m from each other, each attached to an identical unstretched spring with a spring constant of 100 N/m. If we charge the spheres with a negative charge of –1.60 µC each, what is the compression of each spring? Coulomb's constant is $k = 9.0 \times 10^9$ N m^2/C^2.

a. 0.14 m
b. 0.18 m
c. 0.32 m
d. 0.36 m

ANSWER: a

14. A 6 kg box on a 30° incline is held parallel to the incline by a spring attached to the wall. The box is NOT moving. What is the extension of the spring if the spring constant is 100 N/m?

a. 0.03 m
b. 0.06 m
c. 30 cm
d. 60 cm

ANSWER: c

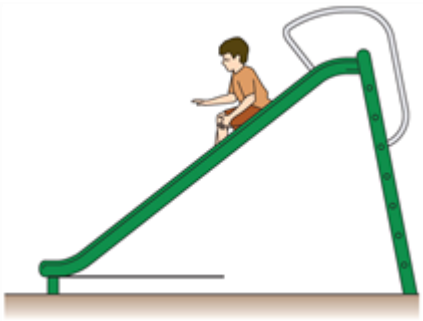
15. You drop two iron marbles into a jar of honey. The area of the larger marble is 9 times the area of the smaller one. If the velocity of the smaller marble is half the velocity of the large one, what is the ratio of the viscous forces on the two marbles?

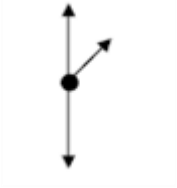
a. The viscous force on the large marble is 6 times greater than on the small marble.
b. The viscous force on the small marble is 6 times greater than on the large marble.
c. The viscous force on the large marble is 18 times greater than on the small marble.
d. The viscous force on the small marble is 18 times greater than on the large marble.

ANSWER: a

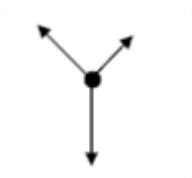
16. A child manages to use his feet to stop and rest on a slide before he starts gliding again. Choose the free body diagram from below that correctly describes the forces acting on the child while he is at rest.

CHAPTER 3 - FORCES



a. 

b. 

c. 

d. 

ANSWER: c

17. You push a chair across the floor and it moves with a constant velocity. Which of the following statements is true for the force of friction?

a. The force of friction is less than the force with which the chair is being pushed.

b. The force of friction is equal to the force with which the chair is being pushed.

c. There is not enough information for a conclusion.

d. The force of friction is zero.

ANSWER: b

18. A bird rests at the centre of a thin rope suspended between two poles 0.5 m apart. The rope sags 2 cm under the bird's weight, and the tension in each side is 5 N. What is the mass of this bird?

a. 200 g

b. 100 g

c. 50 g

d. 25 g

ANSWER: b

19. Two identical boxes are on an inclined plane. Box 1 slides down, while box 2 remains at rest on the incline. What of these statements can we correctly conclude?

a. The frictional force is the same for boxes 1 and 2.

b. The frictional force on box 1 is larger than on box 2.

c. The frictional force on box 2 is larger than on box 1.

d. We need to know the weights of the two boxes to draw a conclusion about frictional forces.

ANSWER: c

20. A 50 kg skier is pulled up a 28° slope at a constant speed by a friend applying a force of 300 N. What is the coefficient of kinetic friction between the snow and the skier?

a. 0.18

b. 0.30

c. 0.36

d. 0.63

ANSWER: a

21. The gravitational force with which Earth attracts you is larger than the force with which you attract Earth.

a. True

b. False

ANSWER: False

22. The origin of contact forces is electromagnetism.

a. True

b. False

ANSWER: True

23. You are standing on the floor, not moving. This means that there is no gravity acting on you.

a. True

b. False

ANSWER: False

24. If you are trying to push a crate along a rough floor and it does not move, there is static friction acting between the floor and the crate. The magnitude of static friction is always larger than the applied force; therefore, the object does not move.

a. True

b. False

ANSWER: False

25. We are trying to move a crate across a rough surface. We keep increasing the force until the crate starts moving. Since there is a range of magnitudes of a force, this means that kinetic friction has a range of values before the crate starts moving.

a. True

b. False

ANSWER: False

CHAPTER 3 - FORCES

26. Viscous force in a fluid is what is called drag in the air.
    a. True
    b. False
ANSWER: True

27. Since viscous forces in fluid and air drag are the same in nature, both depend linearly on the object's velocity.
    a. True
    b. False
ANSWER: False

28. Normal force is always a response of a surface to the entire weight of the body.
    a. True
    b. False
ANSWER: False

29. Although gravity accelerates you when you fall freely, it is possible to achieve a constant velocity after you jump from an airplane.
    a. True
    b. False
ANSWER: True

30. When a muscle contracts it can pull, and when it stretches it can push.
    a. True
    b. False
ANSWER: False

31. Can gravity act as a restoring force? Give an example.
ANSWER: yes; pendulum
RAT: We displace a pendulum from equilibrium, and weight (due to gravity) causes the pendulum to swing down.

32. Which one is stronger, the gravitational force with which you attract Earth or the gravitational force that Earth exerts on you?
ANSWER: The forces are the same.
RAT: Gravity is a mutual force between two bodies.

33. For the law of gravity equation, $F = Gm_1m_2/r^2$, to be dimensionally consistent, what must be the units of universal gravitational constant?
ANSWER: $\text{N m}^2/\text{kg}^2$
RAT: from substituting into the equation all the units for force, mass, and distance

Some bodies in our solar system are listed in Table 3.2, with masses and radii.

Table 3.2

Planet or Moon	Mass (kg)	Radius (m)
Mercury	3.30×10^{23}	2.44×10^{6}

CHAPTER 3 - FORCES

Venus	4.87×10^{24}	6.05×10^{6}
Earth	5.97×10^{24}	6.38×10^{6}
Moon	7.35×10^{22}	1.74×10^{6}
Mars	6.42×10^{23}	3.40×10^{6}
Jupiter	1.90×10^{27}	7.15×10^{7}

34. From the data for Earth and the Moon in Table 3.2, how many times stronger is Earth's gravitational field than the Moon's?

ANSWER: $g_{\text{Earth}}/g_{\text{Moon}} = 6$

RAT: $g_{\text{Earth}} = GM_{\text{Earth}}/R_{\text{Earth}}^2 \times g_{\text{Moon}} = GM_{\text{Moon}}/R_{\text{Moon}}^2$

35. What is the difference between mass and weight?

ANSWER: Mass is the amount of matter in you; weight is a force.

RAT: Weight is a force of gravity between an object and Earth (or any other body on which the object is located).

An atom consists of three types of particles: electrons, protons, and neutrons. Their charges and masses are given in Table 3.3.

Table 3.3

Particle	Mass (kg)	Charge (C)
Electron	9.11×10^{-31}	-1.602×10^{-19}
Proton	1.673×10^{-27}	1.602×10^{-19}
Neutron	1.673×10^{-27}	0

36. Using data from Table 3.3, calculate the ratio between the electrostatic force and the gravitational force between the proton and the electron in a hydrogen atom, if the distance between the electron and the proton is $r = 5.3 \times 10^{9}$ m. The universal gravitational constant $G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2}, and Coulomb's constant $k = 9.0 \times 10^{9}$ N m^2/C^2.

ANSWER: $F_{\text{el}}/F_{\text{grav}} \approx 10^{39}$ order of magnitude

$F_{\text{grav}} = Gm_{\text{proton}}m_{\text{electron}}/r^2 = 6.7 \times 10^{-47}$ N; $F_{\text{el}} = kq_{\text{proton}}q_{\text{electron}}/r^2 = 8.21 \times 10^{-8}$ N

37. The surface tension of water makes it possible for certain insects to walk on the surface of water. What is the origin of surface tension?

ANSWER: electromagnetic force

RAT: A molecule of water is a polar molecule, with strong bonds between molecules, so the surface acts as an elastic film.

38. If the weight of a chest is 560 N, and you try to push it along the floor with a force of 295 N, and the coefficient of static friction between the floor and the chest is $\mu = 0.5$, will the chest move?

ANSWER: yes

RAT: Maximal force of static friction is $f_s = i$Weight $= 0.5 \times 560$ N $= 280$ N; applied force, 295 N, is stronger.

39. We are trying to move a crate across a rough surface. We keep increasing the force until the crate starts moving. Since there is a range of magnitudes of force applied before the crate starts moving, does this mean that kinetic friction has a range of values as well?

Name:_____ Class:_____ Date:_____

CHAPTER 3 - FORCES

ANSWER: no
RAT: Static friction has a range of values before the crate starts moving; kinetic friction occurs during motion and has one value.

40. If a 50 kg skier is pulled by a rope up a 15° slope, what is the minimum tension in the rope? The coefficient of friction is 0.2.

ANSWER: 220 N
RAT: $T = mg\sin(15°) + \mu mg\cos(15°) = 220$ N