Yanbu University College

General Studies Department

Phsc001 Course (111)

Chapter2 (forces) Worksheet Solutions

Chapter 2 Worksheet

Part 1 Matching: Match the definitions with the given concepts.

1. Newton's third law 2. Mass 3. Acceleration 4. Force 5. Newton's first law
6. Weight 7. Inertia 8.Free fall 9. Mechanical Equilibrium 10. 9.8m/s^2 11. Friction
12. Normal force 13. Newton

A. **__9__** Is the condition where. $\vec{F}_{net} = 0$

B. **__2__** Is the amount of matter of an object or a measure of its inertia;

C. **_13__**Is the unit of force.

D. **_10_** Is how much is the acceleration of gravity.

E. **_5_** Is meant that a force causes acceleration.

F. **_6__** Is the downward pull of gravity on an object.

G. **_1_** For any action there is an opposite and equal in magnitude reaction.

H. **_3_** Is force divided by mass.

I. **_7_** Is the tendency to resists any attempt to change motion or acceleration

J. **_11_** Is the force that prevents any attempt to slide or the motion of an object.

K. **_8___** Is the motion under the force of gravity only.

L. **12__**Is the perpendicular force exerted by a surface on any object attached to it..

M. **_4___**Is any push or pull on an object.

Part 2: general review questions: write your answers on a separate sheet

1. Does a bicycle have more inertia than a truck? Explain

A bicycle has a less mass than a truck. Therefore, the bicycle has less inertia than the truck.

2. Use your own wards (do not look at the text), define Newton's first law.

If the net force acting on an object is zero, then the object is either at rest or move with constant velocity along straight line.

3. When the same force is applied to two different masses, which will have a greater acceleration? Explain?

The object with less mass will have large acceleration because the acceleration is inversely proportional to mass.

4. Explain how the weight of a person is different on the moon than on the earth. Would the person's mass be different? Explain

The mass of the moon is smaller than the mass of earth, therefore the force of gravity on the moon is less than that on earth. However, the mass of the sun is much greater than earth and we expect that the sun's force of gravity (weight) is much greater than earth. The mass does not depend on location (or gravity) it is the same on earth, moon, sun, and everywhere.

5. In your own words (do not look at text), define Newton's third law.

For each action there is a reaction equals in magnitude and opposite in direction.

6. Why do you move forward when your car comes to a stop? Refer to one of Newton's law.

According to Newton's first law (law of inertia), the car and everything's inside is moving forward with the same speed as the car. When the car is suddenly stopped, the object's inertia tends to oppose the stoppage by continuing moving forward. what happens if the car was initially moving backward and suddenly stopped?

7. The net force acting on an object is zero. Is it possible for the object to move with a velocity that is not zero? Explain
Yes. According to Newton's first law (law of inertia), If the net force is zero then the object will be at rest if initially was at rest or move with constant speed along straight line.

8. Is the free fall motion is under constant acceleration of $9.8 m/s^2$, or constant velocity of 9.8m/s? Explain?
Free fall motion is motion under force of gravity only. Therefore, the object will be accelerating either upward or downward with $g=9.8 m/s^2$. Each second in the air the speed is decreasing (if moving upward) by 9.8 m/sec or increasing (if moving downward) by 9.8 m/sec.

9. Newton's second law states that when a net force is applied on an object, it must accelerate. Does this means that when two or more forces act at the same time, it must accelerate? Explain

According to Newton's second law, the object will accelerate if the net force acting is not zero. This kind of force is called unbalanced force.

10. According to Newton's third law, when a person push on an object, the object pushes back on the person with an oppositely directed force of equal magnitude. If the object is a massive truck resting on the ground, it will probably not move. Some people think that the reason the truck does not move is that the two oppositely directed pushing forces cancel. Explain why this explanation is not correct and why the truck does not move?

The two forces do not cancel each other because they apply on different objects not one. The reason the truck is not moving is because the force of static friction is so big to slide it, or put it this way: the truck's huge inertia oppose any attempt to move it. The truck's inertia can, however, be overcome if a larger than friction force is applied.

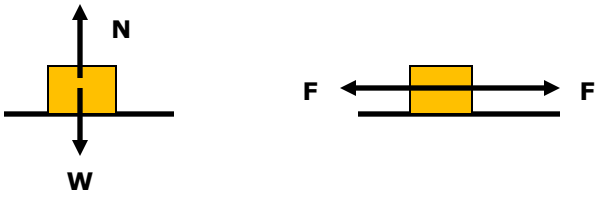
11. Assume air resistance exists and acts on object in the air. Draw a free body diagram showing all the forces acting on a ball thrown vertically upward in the air.

12. A stone is dropped from the top of a building. On its way down in the air is it in equilibrium? Explain (ignore air resistance)

No. The stone will be acted on by one force (gravity). Equilibrium requires at least two forces equal in magnitude and opposite direction.

13. If an object has no acceleration, is it correct to say that no forces are acting on the object? Explain

No. According to Newton's first law, no acceleration means the object is under balanced forces with a net force equals zero. Therefore, the object with be either at rest under gravity (weight) that pushes downward and normal force that reacts upward, or moving with constant speed along straight line.

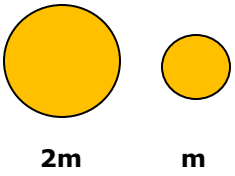


14. If the acceleration of an object is zero, does this means that there are no forces acting on it? Explain

No. It means the net force equals zero

15. The force of gravity on a 2kg rock is twice as great as that on a 1 kg rock. Why then doesn't the heavier rock fall faster? Explain

This can be explained according to Newton's second law as follows:



$$\because a = \frac{F_{net}}{m}$$

$$\therefore \ first\ object\ a = \frac{2mg}{2m} = g$$

$$second\ object a = \frac{mg}{m} = g$$

From this, we see that both rocks fall with same acceleration a=g (assuming air resistance ignored and gravity is the only force acting) meaning that their speed increases by 9.8m/sec each second in the air and therefore, they hit the ground at the same time and with same speed.

16. A person exerts an upward force of 60 N to hold a bowling ball. Describe the reaction force by stating (a) its magnitude, (b) its direction, (c) on what body it is exerted, and (d) by what object it is exerted.

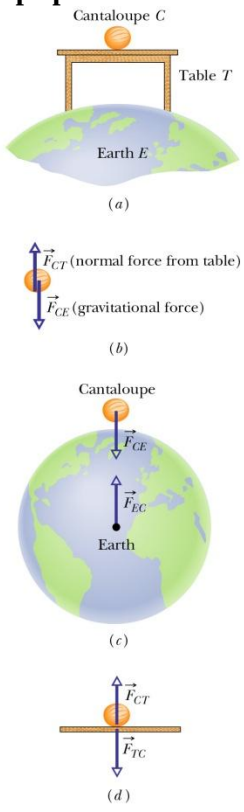
Remember action and reaction forces act on two different interacting objects (here the ball and the person's hand). Therefore, (a) its magnitude is the same as 60N, (b) its direction is downward, (c) acted on the person's hand, and (d) exerted by the ball on the hand.

17. When you stand still on the ground, how large a force does the ground exert on you? Why doesn't **this force make you rise up into the air? Explain**

The normal force (reaction) is exerted by the ground on the person whose weight is the action on the ground downward. This normal force equals to the person weight mg (N=mg). The person is acted by two forces one is his weight (w=mg) and the other is the normal force (N=mg). These two forces acting on the person in opposite direction. Therefore, their net force is zero and according to Newton's second law the person's acceleration is zero. will not move.

Look at the drawing of a cantaloupe placed on a table and study the

Forces act.



18. Ali's mass is 70 kg on earth. What are his (a) mass and (b) weight on Mars, where $g = 3.72 m/s^2$.

The mass does not change with changing location, therefore mass on Mars=70kg. The weigh changes with location therefore, his weight on Mars will be

$\because F_{net} = ma \Rightarrow \therefore F_{net} = W = (70kg)(3.72m/s^2) =$ **260.4N**

His weight on Earth is W= (70kg)(9.8m/s^2) = 686 N

19. Yasir has a mass of 45 kg on earth. What are his (a) mass and (b) weight on Jupiter, where $g = 25.9 m/s^2$.

His mass on Jupiter is the same as on Earth =45kg, but his weigh is different:

$\because W = F_{net} = mg \Rightarrow \therefore W = (45kg)(25.9m/s^2) = 1165.5N$

20. Why do objects that experience air resistance finally reach a terminal velocity?

Air resistance is not a constant force, it depends on the object's speed and grows from zero to a maximum value that equals the object's weight. When it equals the object's weight, the net force act on the object is zero and the object will move at constant speed called terminal speed and along a straight line according to Newton's first law.

Part3: Multiple Choices

1. If an object is moving with constant velocity along a straight line, then
- **A.** No forces are acting on the object.
- **B.** Single constant force acting on the object in the direction of motion.
- **A.** Single force acting on the object in the opposite direction.
- **B. A net force of zero acting on the object**.

2. Force
- **A.** Is a vector quantity.
- **B.** May be different from weight.
- **C.** Does not always cause motion.
- **D. All of the above is correct.**

3. Mass and weight
- **A.** Are the same.
- **B. Are different.**
- **C.** Do not change wherever you are.
- **D.** None of the above is correct.

4. According to Newton's second law
- **A. Force is equal to mass times acceleration**.
- **B.** Acceleration equals mass times force.
- **C.** Mass equals to force times acceleration.
- **D.** None of the above is correct.

5. Friction
   A. Always acts parallel to the surface of contact and opposite to the direction of motion.
   B. Acts in the direction of motion.
   C. Is smaller when starting than moving.
   D. In reality, there is no friction force.

6. Which matter property explains why tapping your toothbrush on the sink dry it off?
   A. Weight.
   B. Volume.
   C. Acceleration.
   D. Inertia.

7. When a car turns to the left, the loose cup on the dashboard will slide to the
   A. Left.
   B. Right.
   C. To the right and then to the left.
   D. None of the above is correct.

8. When you kick a football, the ball pushes on you
   A. Harder.
   B. Lesser.
   C. With zero force.
   D. None of the above is correct.

9. When a person begins to move forward, which force allows him to accelerate
   A. Weight.
   B. Normal force.
   C. Air resistance.
   D. Friction.

10. If the distance of separation between two masses is reduced into a half, then the force of gravity will be
    A. Reduced by 4 times.
    B. Reduced by 1/4
    C. Increased by 4 times.
    D. Increased by ¼.

Part4: True/False (If your answer is F, then try to correct the statement)

1. The action and reaction forces act on the same object and therefore they cancel each other.
   A. True
   B. False (action and reaction forces act on two different objects and therefore they do not cancel each other)

2. If net force acting on an object is not zero, then the object will accelerate.
   A. True
   B. False

3. Acceleration causes a net force.
   A. True

B. False (A net force causes acceleration)

4. G and g are the same.
A. True
B. False (G is the universal constant of Newton's universal law of gravity, g is the acceleration due to gravity. Their values are also different)

5. The mass is the downward pull on an object by gravity.
A. True
B. False (the weight not the mass is the downward pull on an object by gravity)

6. Weight is the amount of matter an object contains.
A. True
B. False (mass not the weight is the amount of matter an object contains)

7. Mass is the resistance of an object to acceleration.
A. True
B. False

8. $\vec{a} = 0$ is the condition for mechanical equilibrium.
A. True
B. False

9. A free- body diagram represents the object as a dot at the origin of a coordinate system.
A. True
B. False

10. Force is either a contact (push or pull) force or a non-contact (long-range) force.
A. True
B. False

Part 5: Exercises

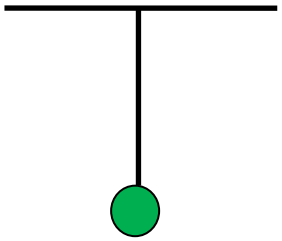
1. Two equal forces of 20 N acting on the object shown in the diagram below. In part (a) the two forces are acting horizontally and opposite to each other. In part (b), the two forces are perpendicular to each other. If these are the only forces acting, then in which part of the diagram (a) or (b) does the object accelerate?

(a) (b)

In part (a), the object if it moves with these two forces (each is 20N) it will not accelerate because the net force is zero. It will move with constant speed either to the left or to the right. In part (b), the net force will be exactly in between the two forces making 45^0 with F_1 line. If it is big enough, then the object will accelerate in the same direction of the net force according to Newton's second law.

2. A ball of mass m hangs from a rope attached to a ceiling, as shown in the diagram below. Draw a free body diagram and answer the following

(a) What forces act on the ball? How many?
(b) What is the net force acting on the ball? Explain
(c) For each force identified in part (a), what is the reaction force?

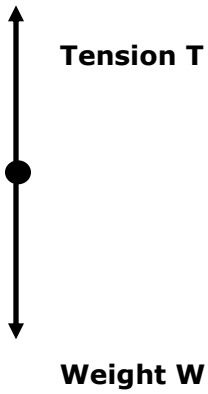


(a) weight W (down) and tension T (up)
(b) Zero (ball in equilibrium)

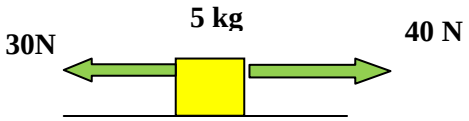
(c)ball's reaction to the rope is T (downward)

Ball's reaction to Earth's pull is a pull on earth

W (upward)



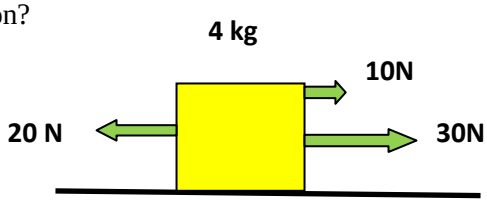
3. Two forces, one is 40 N and the other is 30 N act in opposite directions on a box whose mass is 5 kg. Find the box's acceleration.



$$\because a = \frac{F_{net}}{m} \Rightarrow \therefore a = \frac{(40N - 30N)}{5kg} = \frac{10N}{5kg} = 2N/kg$$

4. A 4 kg box is acted upon by three forces as shown in the diagram below.

(a) What is the net force acting on the box and in which direction?
(b) What is the acceleration of the box?



$(a)\ F_{net} = (30N + 10N - 20N) = 20N to\ the right$

$(b)\ a = \frac{F_{net}}{m} = \frac{20N}{4kg} = 5N/kg$

Part 6: Challenge Exercises

1. Suppose you travel into deep an empty space and throw a rock as shown in the drawing below.

The rock will (explain)

A. gradually stop, or

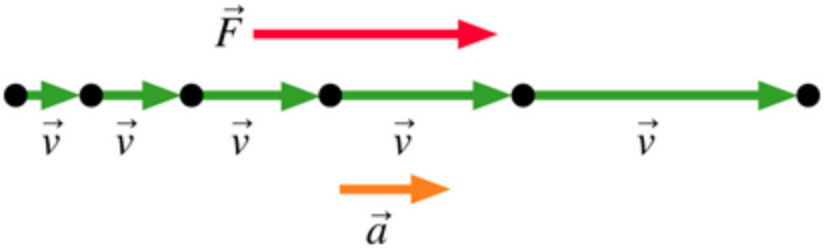
B. Continue in motion in the same direction at constant speed.

The rock in deep and empty space (empty of matter) is acted by no force (even its weight is zero) Therefore, it will continue in motion by the thrust given by the person and moves in straight line with constant speed (it will never stops).

2. Prove that in free fall motion all objects regardless of their mass accelerate with the same acceleration a = g.

   Look at solution to question #15 of part2.

3. An object whose free body diagram is shown in the diagram below is acted upon by a force **F.** According to the diagram is the object speeding up or slowing down? Explain

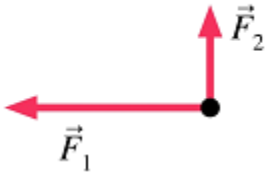


The free body diagram (FBD) shows the velocity increasing (length of v vector is increasing). Therefore, the object is accelerating with a positive a value i.e, it is speeding up.

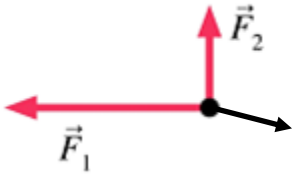
4. The drawing below shows a free body diagram of two forces acting on an object.

(a) Is the object in equilibrium? Explain

(b) If it is not in equilibrium, then add a third force and bring it into equilibrium.



(a) No. The forces are not equal in magnitude (the length of vectors are not the same)



(a) **(b)**

(a) The F_{net} is between F_1 and F_2 but closer to F_1 because it is the bigger. Therefore, to cancel this F_{net} a force of same magnitude and opposite in direction(shown as a dark arrow) must apply to bring the object into equilibrium.

(b) The net force F_{net} is the difference of F_1 and F_2 and it is in the direction of F_1 because it is the bigger. To cancel this, a force of same magnitude but opposite in direction (shown as a dark arrow) must apply to bring the object into equilibrium.