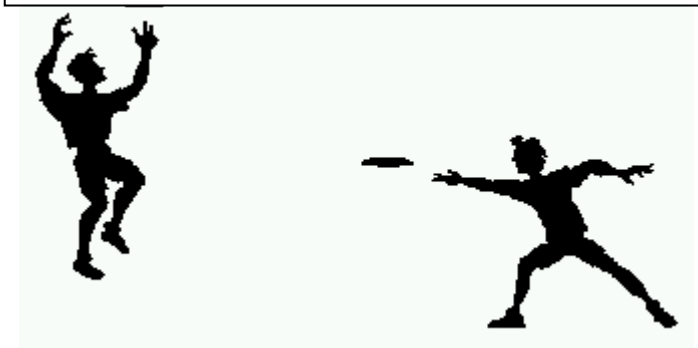
Motion Problems

NO CALCULATORS PLEASE !!!



Questions

1. What are the SI units (standard units) used to measure: (a) distance (b) mass (c) speed (d) acceleration (e) force (f) weight (g) work (h) energy?

2. (a) Define inertia. (b) Give an example of how mass affects inertia. (c) Explain the purpose of seat belts in relation to inertia.

3. What is the difference between distance and displacement? Give an example of each.

4. What is the difference between speed and velocity? Give an example of each.

5. The stopping distance is the sum of reaction distance and braking distance. Name 2 factors that affect the reaction distance and the braking distance.

6. What are the rules for: (a) speed (b) average speed (c) acceleration?

7. A motorbike travels 200 km in 2 hours and 15 minutes. How fast is it going?

8. What distance is travelled by a car going 80 km/h in a time of 4 hours 30 minutes?

9. How long will it take a rocket travelling at 8km/s to reach 20km?

10. Convert 100 km/h to m/s.

11. A sports car accelerates from rest (0 m/s) to 30 m/s in 4 seconds. What is its acceleration?

12. A Formula 1 racing car slows on approaching a corner from 80m/s to 32m/s in 2 seconds. What is its acceleration?

13. Examine the ticker tape below. Since ticker timers make dots at a rate of 50 dots per second, each set of 5 dots takes 0.1 seconds. Use this information, your ruler and your calculator to calculate the initial velocity, the final velocity and the acceleration.

Start..... . . . . . Finish

14. What is the rule for: (a) force (b) weight (force of gravity)?

15. If a truck with a mass of 2000 kg accelerates at 4m/s/s, what is its force in Newtons?

16. A 500kg motorbike accelerates from rest to 16m/s in 4 seconds. What force has it?

17. If a person's mass is 60kg. What is his weight? (Assume gravitational acceleration is 9.8m/s^2.)

18. A skydiver falls from an aircraft. What is his speed after 5 seconds?

19. Why are the forces said to be in balance on an object which is travelling at a constant speed?

20. When a balloon is blown up and then released, where are the forces of action and reaction acting?

21. State Newton's 1st, 2nd and 3rd Laws of Motion.

22. Why are both Energy and Work measured in the same unit of Joules?

23. The rule for Work is F x s. For what do 'F' and 's' stand?

24. A person with a mass of 90kg walks up a flight of stairs 2 metres high, what work has been done?

25. A 1 tonne truck moves a distance of 100 metres, what work has been done?

26. What is the main energy transformation that takes place in: (a) an electric fan (b) a television (c) wood fire?

27. What is the difference between energy transformation and energy transfer? Give an example of each.

28. What is the rule for: (a) Kinetic Energy (b) Gravitational Potential Energy?

29. A ball with a mass of 3 kg is kicked at a speed of 10 m/s, what is its kinetic energy?

30. A bullet with a mass of 10 grams is shot from a gun at a speed of 100m/s. Calculate its kinetic energy.

31. What is the gravitational potential energy of a loose 1 kg brick on top of 3 metre high brick wall?

32. The rule for power is Work done / Time taken. Power is measured in Watts or J/s. Using the information from Q 24, what is the person's power if he runs up the stairs in 2 seconds?

Answers

1. (a) m (b) kg (c) m/s (d) m/s^2 or m/s/s (e) N (f) N (g) J (H) J

2. (a) Inertia is the tendency of an object at rest to remain at rest or an object which is moving to keep moving unless acted on by a force. (b) The greater the mass of an object (e.g. a truck), the greater is the inertia. (c) If a car travels at 100 km/h and then suddenly brakes, the people in the car will also be travelling at 100km/h and will tend to keep moving through the windscreen unless seat belts restrain them.

3. Displacement is distance with direction. For example, a distance may be 5 metres but a displacement may be 5 metres to the east.

4. Velocity is speed with direction. For example, a speed may be 10m/s but a velocity may be 10m/s to the right.

5. Two factors affecting reaction distance are age of the driver and blood alcohol concentration of the driver. Two factors affecting braking distance are quality of brakes and dryness of the road.

6. (a) Speed = Distance / Time (b) Average Speed = Total Distance / Total Time (c) Acceleration = (Final Velocity – Initial Velocity) / Time Taken

7. S = D / T
   = 200 / 2.25
   = 88.9 km/h

8. D = S x T
   = 80 x 4.5
   = 360 km

9. T = D / S
   = 20 / 8
   = 2.5 s

10. 100 km/h = 100 km / 1 hour
    = 100 000 m / 3 600 s
    = 27.8 m/s

11. a = $(v_2 – v_1) / t$
    = (30 – 0) / 4
    = 7.5 m/s^2

12. a = $(v_2 – v_1) / t$
    = (32 – 80) / 2
    = - 48 / 2
    = - 24 m/s^2

13. You must measure the distance of the first 5 dots and work out the speed. Do the same for the last five dots. Count the number of dots to determine the overall time for the paper tape. Then use the acceleration rule to work out the acceleration. Remember that this answer may vary from yours due to paper stretching during printing.

Initial Velocity = Distance of initial 5 dots / 0.1 second
= 5 mm / 0.1 s
= 50 mm/s

Final Velocity = Distance of final 5 dots / 0.1 second
= 33 mm / 0.1 s
= 330 mm/s

Overall time = 0.6 second

Acceleration = $(v_2 – v_1) / t$
= (330 – 50) / 0.6
= 466.7 mm/s^2

14. (a) Force = mass x accel. (b) Weight = mass x grav. accel.

15. F = m a
= 2000 x 4
= 8000 N

16. Calculate the acceleration first and then the force.
a = $(v_2 – v_1) / t$
= (16 – 0) / 4
= 4 m/s^2

F = m a
= 500 x 4
= 2000 N

17. Weight = m g
= 60 x 9.8
= 588 N

18. For every second of his fall, his speed will increase by 9.8 m/s. Therefore after 5 seconds, his speed will be 49 m/s (9.8 x 5).

19. If an object is travelling at a constant speed, there is no acceleration and therefore no overall force on the object. For this to occur, the forces acting on the object must be in balance.

20. As the balloon is released, the air released from the balloon is the Action and the movement of the deflating balloon in the opposite direction is the Reaction.

21. *Newton's 1st Law of Motion* – If there is no net or overall force on an object, there can be no acceleration. Either the object is at rest or it is moving at a constant speed unless it is acted on by a force.

Newton's 2nd Law of Motion – A net or overall force on an object will accelerate it. The object will change speed.

Newton's 3rd Law of Motion – For every action, there must is an equal and opposite reaction.

22. Energy is defined as the capacity to do work. Both are then measured in the same unit of Joules.

23. F = Force and s = displacement

24. In Q 24 and 25, you must calculate the weight or force of gravity before calculating the work done.

Weight = m g
= 90 x 9.8
= 882 N

Work = F s
= 882 x 2
= 1764 J

25. Remember to convert tonnes to kilograms first.

Weight = m g
= 1000 x 9.8
= 9800 N

Work = F s
= 9800 x 100
= 980 000 J

26. (a) electrical energy to kinetic energy (b) electrical energy to sound and light energy (c) chemical potential energy to heat and light energy

27. An energy transformation occurs when there is a change from one form of energy to a different form of energy in the same object (e.g. In an electric light, electrical energy changes to light energy).

    An energy transfer occurs when the same type of energy moves from one object to a different object (e.g. When boiling water on a stove, heat energy is transferred from the hotplate to the saucepan of water).

28. (a) $KE = \frac{1}{2} mv^2$ (b) $PE = m\ g\ h$

29. $KE = \frac{1}{2} mv^2$
    $= 0.5 \times 3 \times 10 \times 10$
    $= 150$ J

30. Remember to convert grams to kilograms first.
    $KE = \frac{1}{2} mv^2$
    $= 0.5 \times 0.01 \times 100 \times 100$
    $= 50$ J

31. $PE = m\ g\ h$
    $= 1 \times 9.8 \times 3$
    $= 29.4$ J

32. P = Work / Time
    $= 1764 / 2$
    $= 882$ Watts