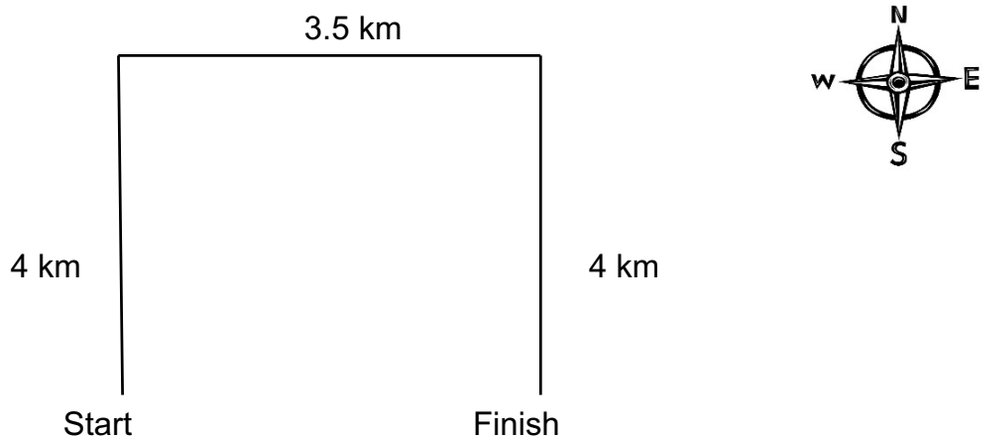
Physics Topic Test – Revision

Name: ANSWERS

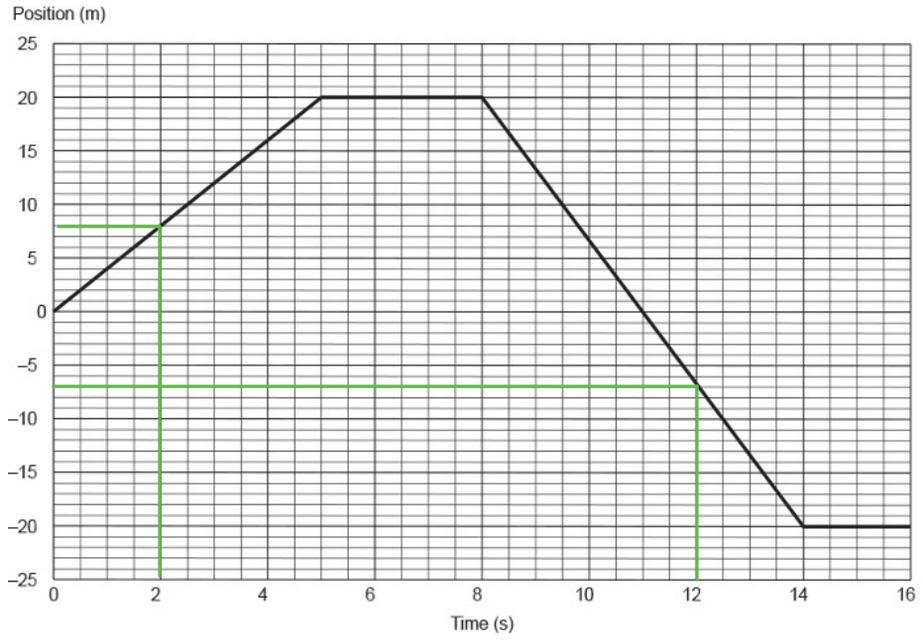
Answer on file paper unless space is allocated, and show full working out.
Use the "Physics Formulae and Data" page in your Booklet.

1. What are scalar and vector quantities? Give an example of each as part of your answer.
2. In relation to vehicles, define the terms: reaction time, reaction distance, braking distance, and stopping distance.
3. What is the difference between distance and displacement?
4. In the following scenario, work out the distance covered, and the displacement. (Remember displacement must have a *direction* as well).



5. A prisoner under house arrest with an ankle tracking bracelet left his house. He travelled 1.5 km east, then drove 12 km north along the main road. Because he had missed the turn off, he doubled back 3 km and then headed 1.5 km west to a friend's house where he was picked up by police. Draw a map (a vector diagram) of his movements and use vector addition to calculate his displacement.
6. From a campsite, a hiker walked 12 kilometres north and 5 kilometres west. She then walked 4 kilometres south and 5 kilometres east.
    a. Draw a vector diagram to represent the journey taken by the hiker. Remember to draw a vector for the resultant displacement.
    b. For the hiker, determine the (i) distance travelled; and (ii) the final displacement.
    c. If the journey took 90 minutes, determine the hiker's (i) average speed; and (ii) average velocity.
7. Explain the difference between speed and velocity.
8. This morning on my way to school, I looked down at my speedometer and it read 110 km/h. Was this my average velocity or my instantaneous velocity? Explain.

9. A girl riding her skateboard completed the journey shown by the graph below. Her initial direction of movement is north.



a. Describe the girl's motion as indicated by each of the different sections on the graph.

0-5 s constant velocity north

5-8 s stationary

8-14 s constant velocity south

14-16 s stationary

b. How far did the girl travel in 7 seconds? Give your answer in metres. 20m

c. What was the girl's *displacement* at each of the following times?

(i) t = 2 s 8m N (ii) t = 12 s 7m S

d. What does the shape of the graph between t = 8 and t = 14 seconds suggest about the girl's motion? **Explain** your answer.

e. During which part of the motion was velocity *least*? **Explain** your answer.

10. Find the average speed of a soccer ball kicked 50 m in 6 seconds.

11. Calculate the distance a person can run in 1 234 s with an average speed of 12 km/h.

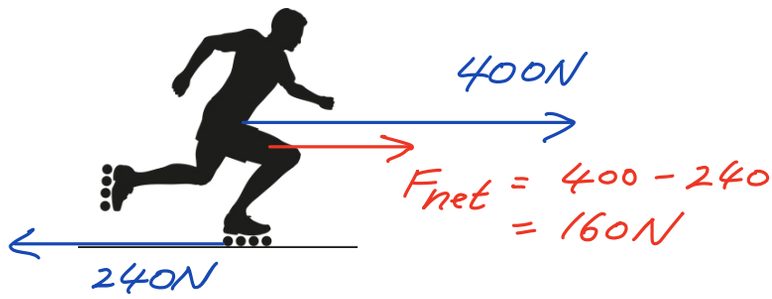
12. A car travels at 70 m/s. How long will it take the car to travel 1 250 m?

13. Define acceleration.

14. What is the average acceleration of a car that, from rest, reaches a speed of 27.8 m/s (100 km/h) in a time of 4.6 seconds? Give your answer in metres per second per second.

15. What would be the final speed of a car initially travelling at 72 km/h if it accelerated at 1.25 m/s^2 for 4.0 s? Give your answer in kilometres per hour.

16. A car increases its velocity from 5.2 m/s to 20.5 m/s in 2.7 seconds. What is the car's acceleration?
17. A distracted P-plate driver takes 0.7 seconds to respond to a hazard on the road. If the car's velocity before braking was 75 km/h, calculate the reaction distance travelled before braking and express your answer in car lengths (1 car length = 4.5 m).
18. Calculate the stopping distance of a car initially travelling at 120 km/h where the sleepy driver takes 1.8 s to react and needs 5.1 s of braking time to stop the vehicle.
19. A speed skater has a mass of 64 kg. She is providing a driving force of 400 N, and there is a frictional force of 240 N against her. Draw these two forces acting on her and then determine her acceleration.



20. A skydiver of mass 85 kg is falling through the air at terminal velocity (constant speed).
    a. What is the weight force acting on the skydiver?
    b. How much air resistance is acting on the skydiver?
21. Which one of the statements about forces is false?
    a. An unbalanced force is applied to an object if it changes speed.
    b. An unbalanced force is applied to an object if it is deformed.
    c. No force is applied to an object if there is no change in its motion.
    d. An unbalanced force is applied to an object if it changes direction but maintains a constant speed.
22. An aeroplane is flying at a constant speed and at a steady altitude. Which statement is **false**?
    a. The thrust exceeds the drag on the plane.
    b. The weight and lift of the plane are equal in size.
    c. The thrust equals the drag on the plane.
    d. The weight of the plane is equal to its mass x 9.80 m/s^2.
23. Define force and state the units it is measured in.
24. Identify four (4) changes that can tell you that a force is acting on an object.
25. What is the difference between mass and weight?

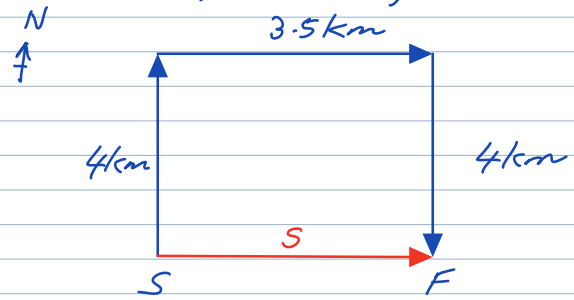
26. If your mass is 45 kg, what is your weight on Earth?
27. Write out Newton's three Laws of Motion from memory. Check your answers and repeat until you remember them accurately.
28. How much force is required to accelerate a 1 tonne SUV at 5 m/s^2? (1 tonne = 1 000 kg)
29. What acceleration would result from pushing a 80 kg crate with a force of 900 N?
30. Explain why:
    a. eggs fly off the back seat when you stop suddenly.
    b. you fall out of your seat as a bus takes the corner.
    c. you slip when you walk on a banana peel.
    d. when John jumped off a boat for the jetty he fell in the water.
    e. a gun experiences recoil.

1. Vectors are quantities that include direction, whereas scalar quantities do not.

2. reaction time: how long it takes a driver to start braking
reaction distance: how far the vehicle travels before the driver starts breaking
braking distance: how far the vehicle travels during braking to come to a complete stop
stopping distance = reaction distance + braking distance

3. Distance is the total length of path travelled.
Displacement is the straight line distance between start and finish points in that direction.
Distance is a scalar quantity (of measurement) because it doesn't involve direction, but displacement (or change of position) is a vector because it can only be described by including direction.

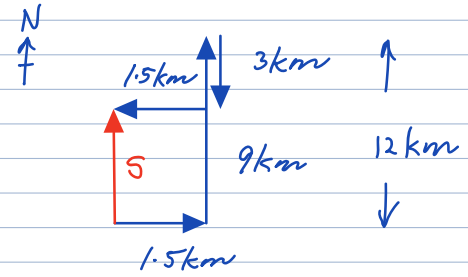
4.



$d = 4 + 3.5 + 4$
$= 11.5\ km$

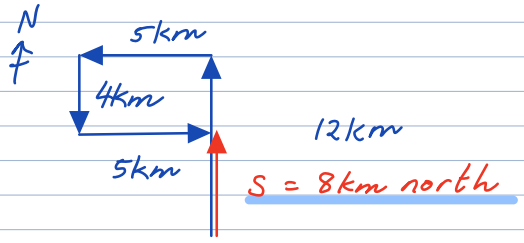
$s = 3.5\ km\ east$

5.



$s = 9\ km\ N$

6.



$s = 8\ km\ north$

$d = 12 + 5 + 4 + 5 = 26\ km$

$t = 90\ min$

$speed = \frac{d}{t} = \frac{26}{90} = 0.29\ km/h$

$v = \frac{s}{t} = \frac{8}{90} = 0.089\ km/h$

7. Speed is a scalar, velocity is a vector.

Speed is calculated using distance, but velocity is calculated using displacement (symbol "s" for displacement).

8. A speedo gives instantaneous speed, the speed at one particular moment in time, such as 110 km/h. Average speed, or velocity is the total time divided by the total distance, or displacement. The average is the same as if you travel at a constant speed for the whole journey.

9. d) straight line with negative slope means moving in the opposite direction at a constant speed. (NOT acceleration / deceleration!)

10. $d = 50m$, $t = 6s$

$$\text{speed} = \frac{d}{t} = \frac{50}{6} = 8.33 \text{ m/s}$$

11. $t = 1234$ s, speed = 12 km/h (÷ 3.6) = 3.33 m/s, $d = ?$

$$d = \text{speed} \times t = 3.33 \times 1234 = 4113 \text{ m} \quad (\text{or } 4.1 \text{ km})$$

12. speed = 70 m/s, $d = 1250$ m, $t = ?$

$$t = \frac{d}{\text{speed}} = \frac{1250}{70} = 17.9 \text{ s}$$

13. Acceleration is the rate of change of velocity, i.e. a measure of how quickly velocity is changing. Acceleration is usually involves speeding up, or slowing down (called deceleration) but it can simply be a change of direction without a change in speed.

$$a = \frac{\Delta v}{t} \quad \text{or} \quad a = \frac{v - u}{t}$$

(v: final velocity; u: initial velocity)

Standard units are "metres per second per second", i.e.

$$m/s/s = \frac{m/s}{s} = \frac{m/s^2}{} = ms^{-2}$$

(all mean the same thing) ← best!

14. $u = 0$
$v = 27.8\ m/s$
$t = 4.6\ s$
$a = ?$

$a = \frac{v-u}{t}$
$= \frac{27.8 - 0}{4.6}$
$= 6.04\ m/s^2$

15. $u = 72\ km/h\ (\div 3.6)$
$= 20\ m/s$
$a = 1.25\ m/s^2$
$t = 4.0\ s$
$v = ?$

$v = u + at$
$= 20 + 1.25 \times 4.0$
$= 25\ m/s\ (\times 3.6)$
$= 90\ km/h$

16. $u = 5.2\ m/s$
$v = 20.5\ m/s$
$t = 2.7\ s$
$a = ?$

$a = \frac{v-u}{t}$
$= \frac{20.5 - 5.2}{2.7}$
$= 5.67\ m/s^2$

17. $t_R = 0.7\ s$
$u = 75\ km/h\ (\div 3.6)$
$= 20.8\ m/s$
$s = ?$

$s = u t_R$ (from formula sheet)
$= 20.8 \times 0.7$
$= 14.6\ m\ (\div 4.5)$
$= 3.24$ car lengths

18. $u = 120\ km/h\ (\div 3.6)$
$= 33.3\ m/s$
$t_R = 1.8\ s$
$t_B = 5.1\ s$

reaction distance:
$s = u t_R$
$= 33.3 \times 1.8$
$= 60\ m$

braking distance:
$s = \frac{1}{2} u t_B$
$= 0.5 \times 33.3 \times 5.1$
$= 85\ m$

$\therefore$ stopping distance $= 60 + 85 = 145\ m$

19. $m = 64\ kg$
$F_{net} = 160\ N$
(see diagram)

$a = \frac{F}{m}$
$= \frac{160}{64}$
$= 2.5\ m/s^2$ forwards

20. $m = 85\ kg$
$g = 9.8\ m/s^2$

a) $W = mg$
$= 85 \times 9.8$
$= 833\ N$ down

b) Since it is terminal velocity, so falling at constant velocity, the air resistance must be exactly 833N up.

23. A force is a push or pull, measured in newtons (N).

24. An unbalanced force can cause an object to:
- speed up
- slow down
- change direction
- deform (i.e. change its shape)

25. Weight is the force of gravity acting on a mass and is measured in newtons, whereas mass is simply a measure of the amount of matter an object contains, measured in kg.

26. $m = 45\,kg$, $g = 9.80\,m/s^2$

$W = mg$
$= 45 \times 9.80$
$= 441\,N$

27. Newton's first law of motion (law of inertia) states that an object remains at rest or at a constant velocity, unless acted upon by an external, unbalanced force.

Newton's second law of motion states that if an object is subjected to an external, unbalanced force, the acceleration experienced in the direction of the force is inversely proportional to its mass and proportional to the force.

Newton's third law of motion states that for every action force there is an equal and opposite reaction force; and the action force and reaction force act on two different bodies.

Note: This wording is slightly different that your booklet. Memorise the wording that you find easiest.

28. $F = ?$, $m = 1\,t = 1000\,kg$, $a = 5\,m/s^2$

$F = ma$
$= 1000 \times 5$
$= 5000\,N$

29. $m = 80\,kg$, $a = ?$, $F = 900\,N$

$a = \frac{F}{m} = \frac{900}{80} = 11.25\,m/s^2$

30. a) Loose eggs do not experience the unbalanced force that slows the car, so their inertia carries them forward.

b) The force that turns the bus is not transferred to the person on the seat, apart from a small amount of that force due to friction. The person falls off the seat because their inertia keeps them moving at the same speed and in the same direction as they were before the bus turned.

c) Walking requires friction: person pushes backwards on ground (action); ground pushes forwards on person (reaction). Without friction to provide the reaction force, the person topples.

d) John pushes back on the boat and the boat pushes John forwards (Newton's 3rd Law). But the unbalanced force on the boat accelerates it away from the jetty while John is still pushing on it.

e) The bullet pushes back on the gun while the gun pushes the bullet forward. This is an action-reaction pair according to Newton's 3rd Law. Because there is an unbalanced force pushing the gun backwards, it recoils.