Explaining motion – 2021/20 GCSE 21st Physics Combined Science B

1. Nov 2021/Paper_J260/03/No.7

(a) Li is driving his car. The car travels at a constant speed.

Complete the sentence to describe the driving force on the car.

Put a (ring) around the correct answer.

The driving force on the car is **equal to** / **greater than** / **smaller than** the friction forces on the car. **[1]**

(b) Li brakes to a stop. The car decelerates at 5 m/s^2.

(i) Calculate the braking force.

The mass of the car is 1200 kg.

Use the equation: force = mass × acceleration

Braking force = ... N **[2]**

(ii) The car travels 55 m while braking.

Calculate the work done by the braking force.

Use the equation: work done = force × distance

Work done = ... J **[2]**

(c) Li wants to estimate the acceleration of the car on a racetrack. He uses two posts, post 1, and post 2.

Li starts the car from point **X** and accelerates steadily.

(i) Calculate the average speed of the car between the posts.

Distance between posts = 12 m

Time to travel between posts = 0.4 s

Use the equation: average speed = distance ÷ time

Average speed = ... m/s **[2]**

(ii) It takes Li 10 seconds to travel from point **X** to the posts.

Calculate the average acceleration of the car from point **X** to the posts.

Use your answer from **(c)(i)**.

Average acceleration = ... m/s^2 **[3]**

(d) Li drives the car home at 54 km/h.

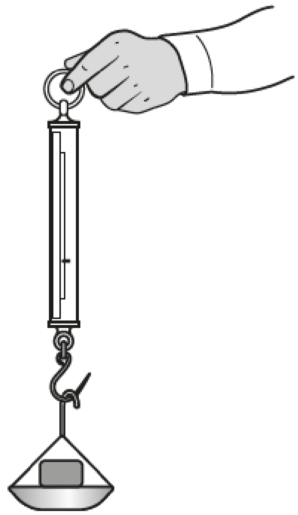
Calculate this speed in **m/s**.

Speed = ... m/s **[3]**

2. Nov 2021/Paper_J260/03/No.10

(a) Amir wants to know the weight of a stone.

He puts the stone in a pan and hangs the pan from a forcemeter as shown in the diagram. He then records the measurement shown on the forcemeter.



Amir's measurement is not accurate.

How can the experiment be improved to get a more accurate value for the stone's weight?

....

....

....

.... **[2]**

(b) Amir researches four different planets.

Table 10.1 shows some of the data he finds.

Planet	Gravitational field strength of planet (N/kg)	Average density of planet ($\times 10^3$ kg/m^3)	Mass of planet ($\times 10^{24}$ kg)
Mars	4	3.9	0.64
Venus	9	5.2	4.9
Earth	10	5.5	6.0
Jupiter	23	1.3	1900

Table 10.1

(i) On which of the planets in **Table 10.1** would the stone have the greatest weight?

.... **[1]**

(ii) Explain what conclusions Amir can make from the data in **Table 10.1**.

....

....

....

....

....

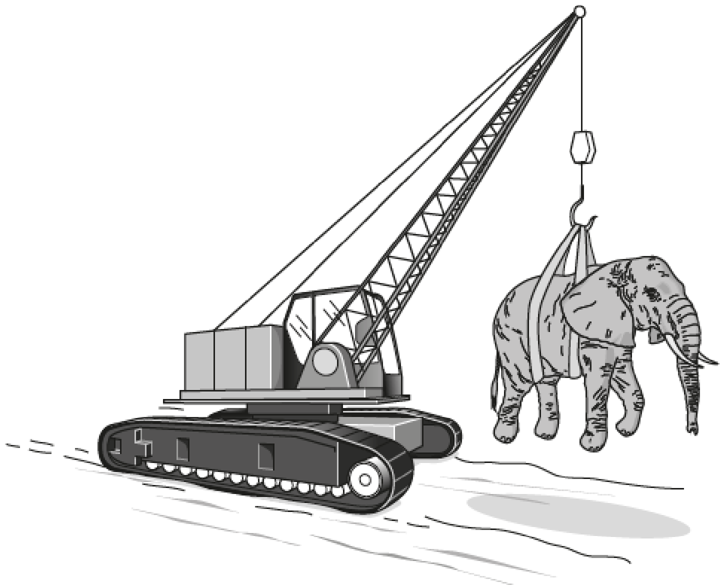
....

....

.... **[4]**

3. Nov 2020/Paper_J260/03/No.6

Cranes can be used to safely lift and move elephants.



(a) Complete the definition for the weight of an elephant.

Tick (✓) **one** box.

The weight of an elephant acts towards the centre of the Earth and is:

The acceleration of gravity on the elephant. ☐

The gravitational force on the elephant. ☐

The magnetic force on the elephant. ☐

The mass of the elephant. ☐

[1]

(b) A 60 000 N elephant was lifted a height of 5 m.

Calculate the gravitational potential energy gained by the elephant.

Use the equation: gravitational potential energy = weight × height

Gravitational potential energy = ... J **[2]**

(c) The crane engine transferred 750 000 J lifting the elephant.

Calculate the efficiency of the crane engine.

Use your answer to part **(b)**.

Use the equation: $\text{efficiency} = \dfrac{\text{useful energy transferred}}{\text{total energy transferred}} \times 100\%$

Efficiency of the crane engine = ... % **[2]**

(d) The crane engine transferred more energy than the energy needed to lift the elephant.

Describe what has happened to the energy that was **not** used to lift the elephant.

....

.... **[1]**

4. Nov 2020/Paper_J260/03/No.7

The table shows examples of objects interacting.

Example of objects interacting	**Type of force involved in the interaction**
A balloon rubbed with a cloth sticks to a wall.	electrostatic
A compass needle points to the North pole.	....
A ball falls to the ground.	....

(a) Complete the **table** by filling in the blank spaces. **[1]**

Use words from the list.

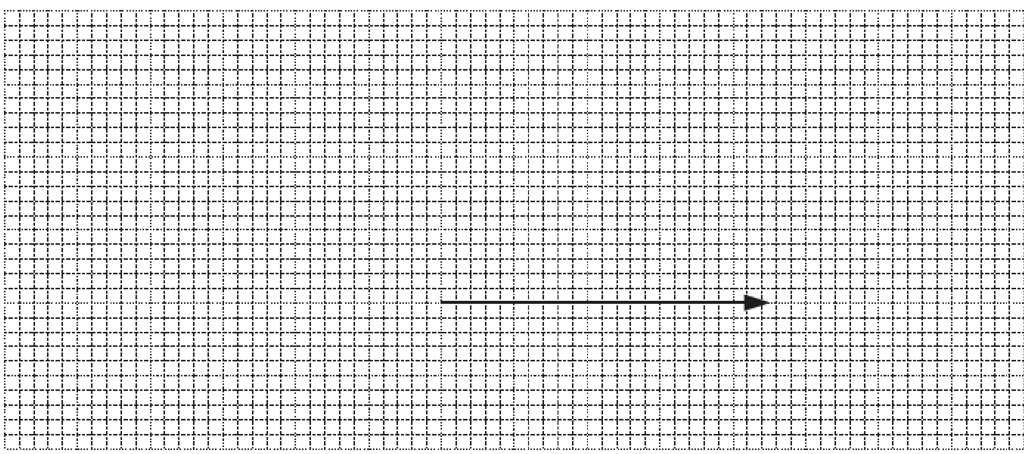
You can use each word once, more than once, or not at all.

electrostatic **frictional** **gravitational** **magnetic**

One has been done for you.

(b) A train is travelling on a level track.

Fig. 7.1 shows a vector diagram for the driving force on the train. It is drawn to scale.



Scale: 1cm = 100 kN.

Fig. 7.1

(i) Use **Fig. 7.1** to calculate the size of the driving force on the train.

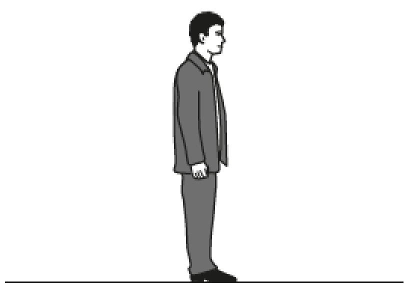
Driving force = ... kN **[1]**

(ii) The train is travelling at a constant speed.

Draw **one** vector on **Fig. 7.1** to represent the friction forces on the train. **[2]**

(c) James jumps upwards through the air from the ground, and then falls back down through the air.

He does not fall through the ground when he lands.



Describe the interaction that stops James from falling through the ground when he lands.

....

....

....

....

....

.... **[3]**

5. Nov 2020/Paper_J260/03/No.8

Scientists did an experiment to see how the acceleration of a car changed when the accelerating force was changed.

The table shows some of their data.

	Accelerating force (N)	**Mass (kg)**	**Acceleration (m/s^2)**
With driver only	2400	1200	2.0
With driver and passengers	2400	1500	1.6
With driver only	4800	1200	4.0
With driver and passengers	4800	1500	3.2

(a) Describe how the acceleration changed when the accelerating force changed.

....

.... **[2]**

(b) In one situation, when there were no passengers, the driver changed the accelerating force again.

The new acceleration of the car was $2.5 m/s^2$.

(i) Calculate the new accelerating force.

Accelerating force = ... N **[3]**

(ii) The car accelerated at 2.5 m/s^2 for 9 s from stationary. After 9 s, the car was travelling at a constant speed.

Calculate the speed of the car after 9 s.

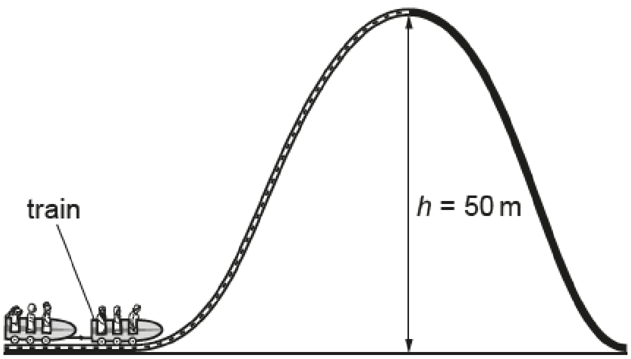
Use the equation: acceleration = change in speed ÷ time taken

Give your answer in **km/h**.

Speed = ... km/h **[4]**

6. Nov 2020/Paper_J260/03/No.11

The diagram shows a rollercoaster ride.



(a) **(i)** A motor pulls the train to the top of the track, 50 m above the ground. The weight of the train is 9000 N.

Calculate the potential energy gained by the train as it moves from the ground to the top of the track.

Give your answer in **standard form**.

Potential energy = ... J **[4]**

(ii) It takes 15 s for the train to travel to the top of the track.

Calculate the useful power output of the motor.

Useful power output = ... W **[3]**

(b) What is meant by the term power output when discussing the train motor used in the rollercoaster?

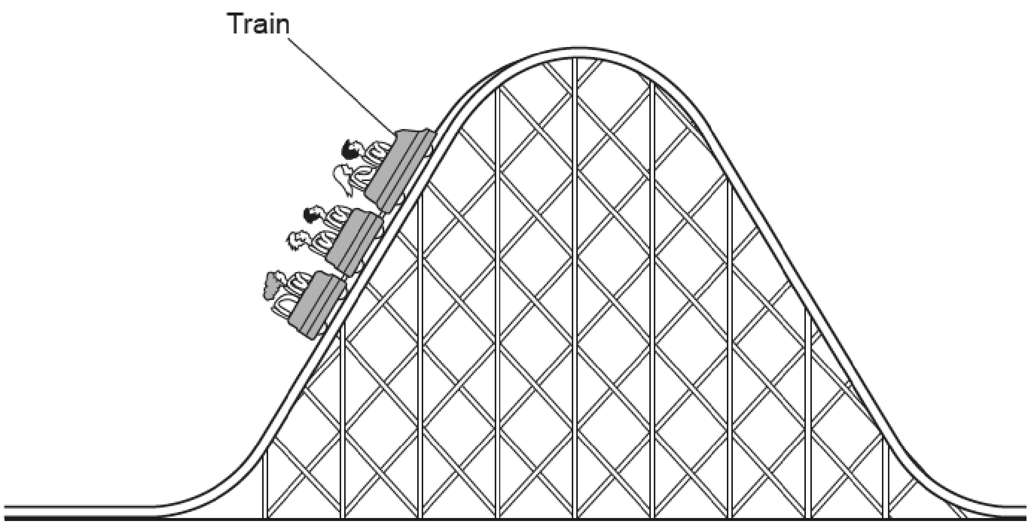
Put a (ring) around the correct words to complete the sentence.

The power output of the motor is equivalent to the **rate / time / voltage** at which energy is transferred **electrically / mechanically / by heating** from the **elastic / chemical / kinetic** energy store of the motor to the potential energy store of the train and to the **atmospheric / chemical / thermal** energy store of the surroundings.

[2]

7. Nov 2020/Paper_J260/04/No.6

The diagram shows part of a rollercoaster ride.



(a) Complete the sentences about the energy transfers in a rollercoaster ride.

Use words from the list.

You can use each word once, more than once or not at all.

sound	**kinetic**	**electrical**
gravitational potential	**thermal**	**increases**
decreases	**speed**	**distance travelled**

As work is done by an electric motor to move the train to the top of the rollercoaster ride, the .... energy store of the train increases. As the train starts moving down, this energy store .... The .... of the train increases as the train starts moving down, which causes the .... energy store of the train to increase. Some energy is dissipated into the inaccessible thermal energy store of the surroundings. **[4]**

(b) (i) Which equation should be used to calculate gravitational potential energy?

Tick (✓) **one** box.

(mass × gravitational field strength) ÷ height	☐
mass × gravitational field strength × height	☐
mass × gravitational field strength × $(\text{height})^2$	☐
(mass × height) ÷ gravitational field strength	☐

[1]

(ii) At the highest point of the rollercoaster ride, the train is 40 m from the ground.

The train has a mass of 1400 kg when it is full of passengers.

Calculate the gravitational potential energy stored in the train when it is at the highest point of the rollercoaster ride.

Gravitational field strength = 10 N / kg

Gravitational potential energy = ... J **[2]**

(c) The train reaches a maximum speed of 90 **km / h**.

Calculate the maximum kinetic energy of the train when it is full of passengers.

Use the equation: kinetic energy = 0.5 × mass × speed^2

Kinetic energy = ... J **[4]**

(d) The electric motor that provides the energy to lift the train to the top of the rollercoaster ride has an efficiency of 0.40.

An empty train has 360 000 J of gravitational potential energy at the highest point of the rollercoaster ride.

Calculate the total energy transferred by the electric motor.

Use the equation: efficiency = useful energy transferred ÷ total energy transferred

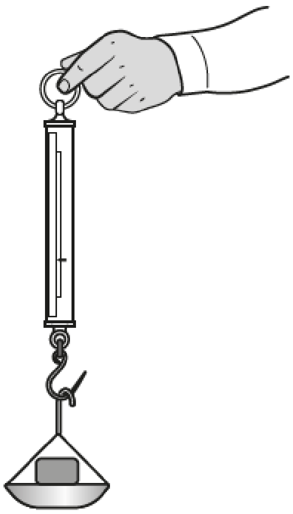
Give your answer in **kJ**.

Total energy transferred = ... kJ **[3]**

8. Nov 2021/Paper_J260/07/No.2

(a) Amir wants to know the weight of a stone.

He puts the stone in a pan and hangs the pan from a forcemeter as shown in the diagram. He then records the measurement shown on the forcemeter.



Amir's measurement is not accurate.

How can the experiment be improved to get a more accurate value for the stone's weight?

....

....

....

.... **[2]**

(b) Amir researches four different planets.

Table 2.1 shows some of the data he finds.

Planet	**Gravitational field strength of planet (N/kg)**	**Average density of planet ($\times 10^3$ kg/m^3)**	**Mass of planet ($\times 10^{24}$ kg)**
Mars	4	3.9	0.64
Venus	9	5.2	4.9
Earth	10	5.5	6.0
Jupiter	23	1.3	1900

Table 2.1

(i) On which of the planets in **Table 2.1** would the stone have the greatest weight?

.... **[1]**

(ii) Explain what conclusions Amir can make from the data in **Table 2.1**.

....

....

....

....

....

....

....

.... **[4]**

9. Nov 2021/Paper_J260/07/No.5(a, b)

Two tug boats, tug **A** and tug **B**, are pulling a ship as shown in **Fig. 5.1**.

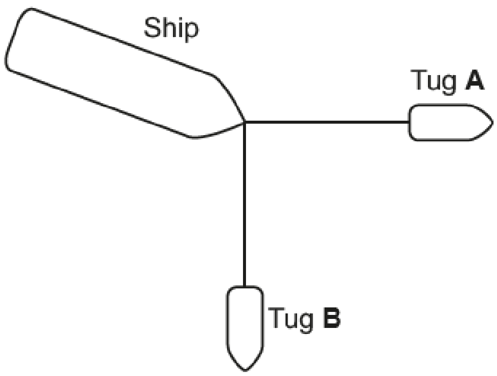


Fig. 5.1

The force of tug **A** on the ship is shown on the vector diagram in **Fig. 5.2**.

Scale: 1 cm = 100 kN.

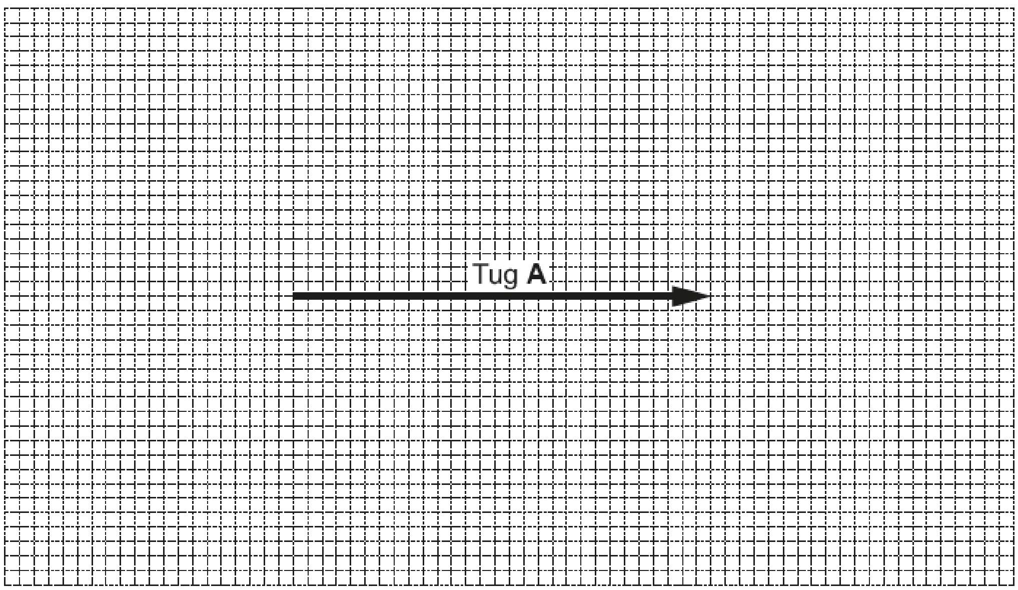


Fig. 5.2

(a) **(i)** Determine the magnitude of the force of tug **A** on the ship, using **Fig. 5.2**.

Force = ... kN **[1]**

(ii) The force of tug **B** on the ship is 240 kN.

Complete the vector diagram to show:

- the force of tug **B** on the ship
- the resultant force on the ship. **[2]**

(iii) Determine the magnitude of the resultant force on the ship.

Resultant force = ... kN **[1]**

(b) The tugs start pulling the ship when the ship has an initial speed of 0.40 m/s. After the ship is pulled 65 m, it has a speed of 3.8 m/s.

The direction of the ship does not change.

Calculate the acceleration of the ship.
Give your answer to **2** significant figures.

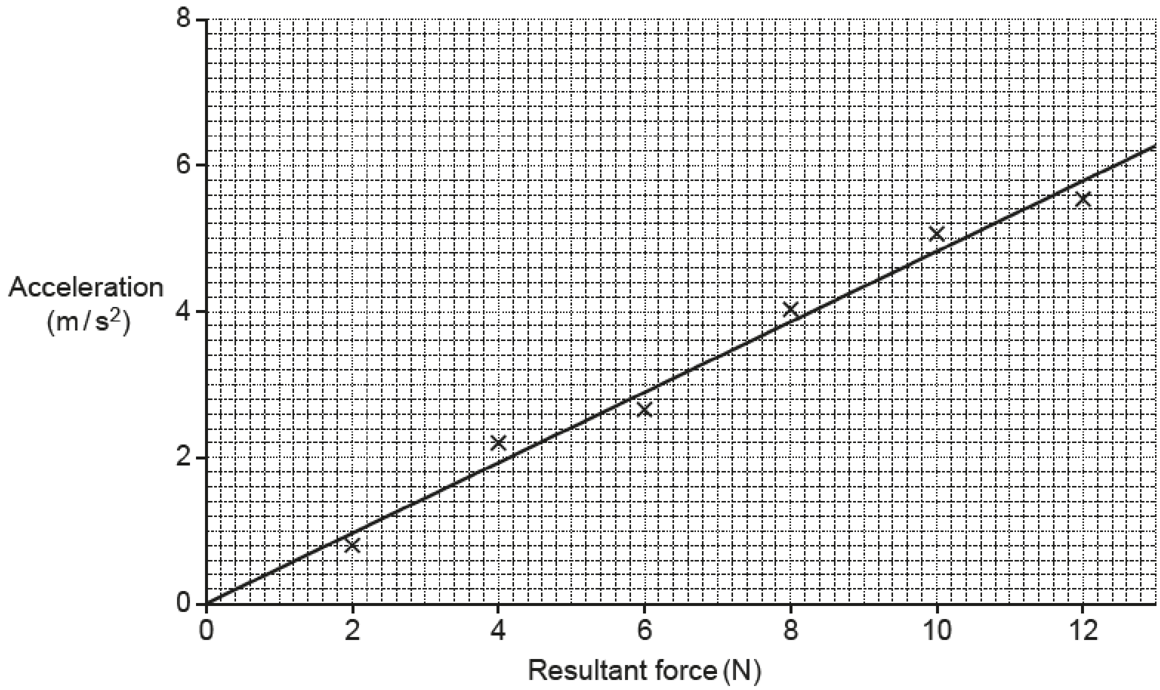
Use the Data Sheet.

Acceleration = ... m/s^2 **[3]**

10. Nov 2021/Paper_J260/07/No.6

Sundip does an experiment to investigate how the acceleration of a trolley depends on the resultant force acting on it when the mass of the trolley is kept constant.

She plots a graph of acceleration against resultant force, as shown.



(a) **(i)** Sundip writes this conclusion:

My graph shows that acceleration $\propto$ resultant force.

Do you agree with Sundip's conclusion?

Yes ☐

No ☐

Explain your answer.

....

....

....

.... **[2]**

(ii) Determine the mass of the trolley, using the graph.

Use the equation: force = mass × acceleration

Give your answer to **1** decimal place.

Mass = ... kg **[3]**

(b)* Describe a method that Sundip could have used to accurately investigate how the acceleration of the trolley depends on the resultant force acting on it when the mass of the trolley is kept constant.

Include in your answer any safety considerations.

....

....

....

....

....

....

....

....

....

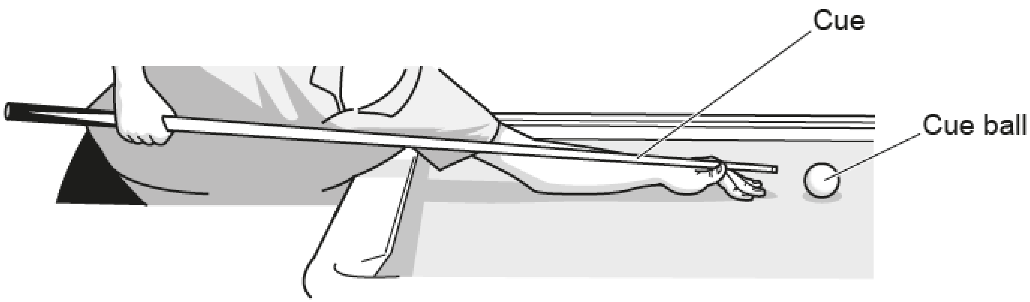
....

....

.... **[6]**

11. Nov 2021/Paper_J260/07/No.9

Kai is playing pool. The diagram shows the cue aimed at the cue ball.



(a) The cue hits the stationary cue ball with a force of 795 N.

The cue ball then starts to move with a momentum of 1.53 kg m/s.

(i) Calculate the time that the cue was in contact with the cue ball.

Give your answer to **3** significant figures.

Use the Data Sheet.

Time = ... s **[3]**

(ii) Calculate the speed of the cue ball.

Mass of the ball = 170 g

Speed = ... m/s **[3]**

(b) The cue ball strikes another ball which is stationary.
The two balls then continue in a straight line.

Explain what happens to the momentum of the two balls in the collision.

....

....

....

.... **[2]**

12. Nov 2021/Paper_J260/08/No.3

(a) (i) Complete the sentences about typical speeds.

Put a (ring) around the correct answers.

The typical speed for walking is **0.5 m/s / 1.5 m/s / 8 m/s**.

The typical speed for cycling is **7 m/s / 20 m/s / 35 m/s**.

The typical speed for a car is **9 km/h / 90 km/h / 150 km/h**.

[3]

(ii) Sarah cycles 20 km to work each day.

It takes her 49 minutes and 45 seconds to get to work.

Calculate Sarah's average speed, in **m/s**.

Average speed = ... m/s **[4]**

(iii) Sarah and her bike have a combined mass of 60 kg.

Calculate Sarah's momentum when she is cycling downhill at 12 m/s.

Momentum = ... kg m/s **[2]**

(b) Large decelerations when cycling can be dangerous. Sarah decides to wear a bike helmet.

Complete each sentence about how a bike helmet can reduce head injuries in a collision.

Use the words.

You can use each word once, more than once, or not at all.

decreases **distance** **duration** **force** **increases** **mass** **speed**

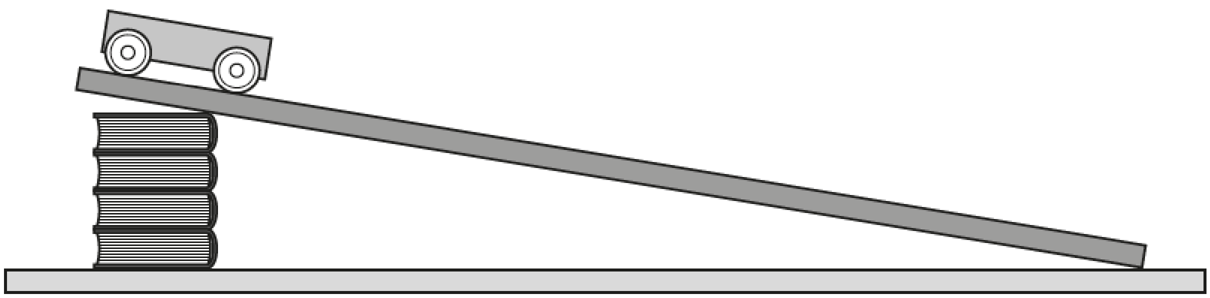
The cycle helmet .... the .... of the impact.

This reduces the .... on the cyclist's head and helps to prevent head injuries.

[3]

(c) Sarah is using the equipment in the diagram to investigate how the speed of a trolley is affected by the gradient of the ramp.

She measures the time it takes for the trolley to travel a certain distance, using a stopwatch.



How can Sarah improve her investigation to get more accurate **and** precise values for the speed down the ramp?

....

....

....

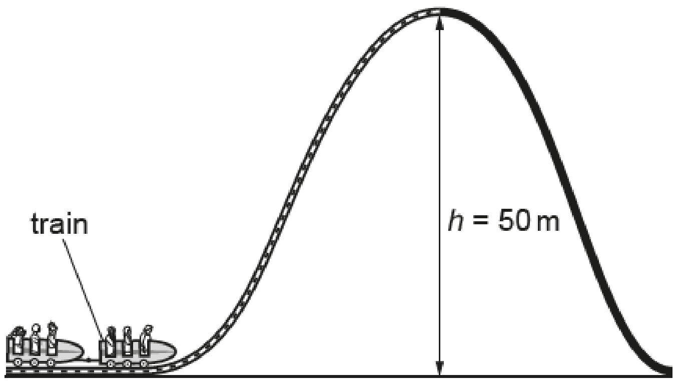
....

....

.... **[3]**

13. Nov 2020/Paper_J260/07/No.1

The diagram shows a rollercoaster ride.



(a) **(i)** A motor pulls the train to the top of the track, 50 m above the ground. The weight of the train is 9000 N.

Calculate the potential energy gained by the train as it moves from the ground to the top of the track.

Give your answer in **standard form**.

Potential energy = ... J **[4]**

(ii) It takes 15 s for the train to travel to the top of the track.

Calculate the useful power output of the motor.

Useful power output = ... W **[3]**

(b) What is meant by the term power output when discussing the train motor used in the rollercoaster?

Put a (ring) around the correct words to complete the sentence.

The power output of the motor is equivalent to the **rate / time / voltage** at which energy is transferred **electrically / mechanically / by heating** from the **elastic / chemical / kinetic** energy store of the motor to the potential energy store of the train and to the **atmospheric / chemical / thermal** energy store of the surroundings.

[2]

14. Nov 2020/Paper_J260/07/No.9

(a) Geostationary satellites are used for communications and television broadcasting.

They travel in a circular orbit around Earth with a constant speed of 3 km/s.

Explain how a geostationary satellite can have constant speed but changing velocity.

....

....

....

.... **[2]**

(b) A planet such as Earth has a large inertial mass.

Explain what is meant by **inertial mass**.

....

.... **[1]**

(c)* This is a statement of Newton's First Law:

When there is no resultant force on a stationary object it does not move. When there is no resultant force on a moving object it continues to move with constant velocity.

This equation represents Newton's Second Law:

Force = mass × acceleration

A space probe is travelling through space to a distant star. It is travelling through a vacuum and is not affected by any other objects. The space probe is on course to crash into the star.

Explain the motion of the space probe as it travels towards the star, and why it then crashes into the star.

You should apply Newton's first law and Newton's second law in your answer.

....

....

....

....

....

....

....

....

....

....

....

.... **[6]**