Explaining motion – 2022 GCSE 21st Physics B

1. June/2022/Paper_ J259/01/No.7

Fig. 7.1 shows a hole puncher.

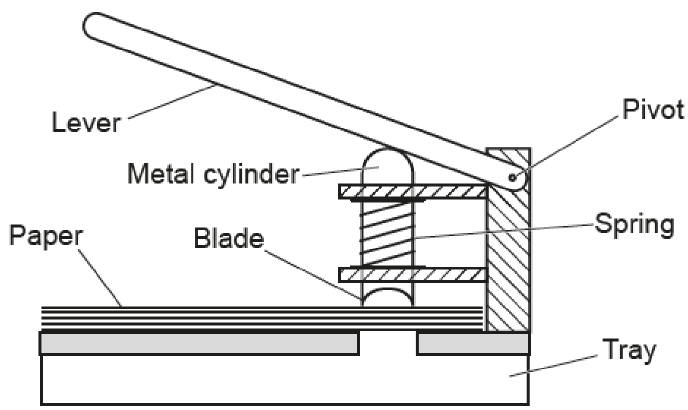


Fig. 7.1

The lever is pushed down to punch a hole in some paper.

Fig. 7.2 shows two of the forces on the lever when it has been pushed down. The force arrows **P** and **Q** have not been drawn to scale.

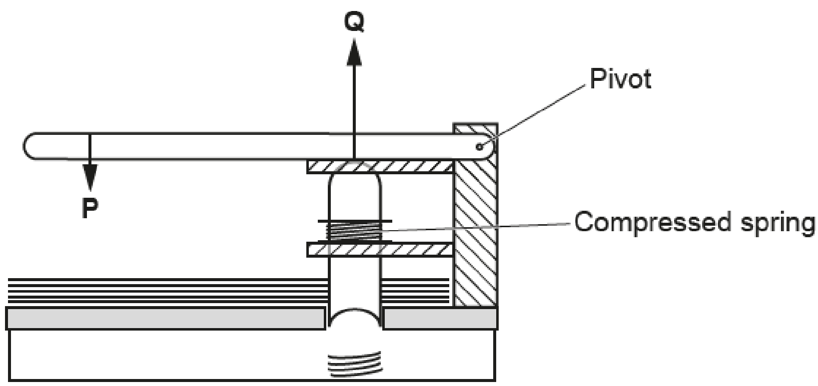


Fig. 7.2

(a) The size of force **P** is 30 N.

The distance from the pivot to force **P** is 6.0 cm.

Calculate the moment of the force.

Use the equation: moment of a force = force × distance (normal to direction of the force)

Moment = ... Nm **[3]**

(b) **(i)** The force **Q** is caused by the metal cylinder pushing against the lever.

Which statement describes how to increase **Q** without increasing **P**?

Tick (✓) **one** box.

Push closer to the pivot.	☐
Push further from the pivot.	☐
Push sideways instead of down.	☐
Push up instead of down.	☐

[1]

(ii) The lever exerts a force **R** on the metal cylinder. The force **R** and force **Q** are an interaction pair.

Compare and contrast force **P** to the force **Q**.

....

.... **[2]**

(c) Explain how the lever returns to its original position when **P** is removed.

....

....

.... **[1]**

2. June/2022/Paper_ J259/01/No.8

Jack is a sprinter. He uses a parachute when he trains, as shown in **Fig. 8.1**.

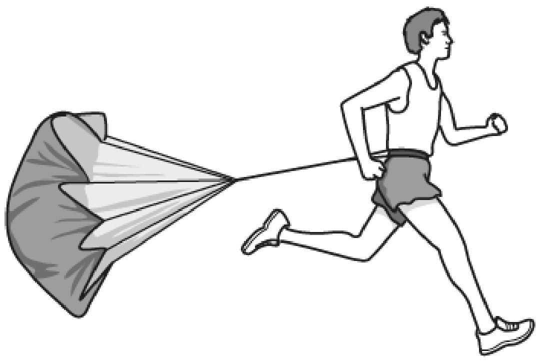


Fig. 8.1

(a) **Fig. 8.2** shows the forces acting on Jack when he is training.

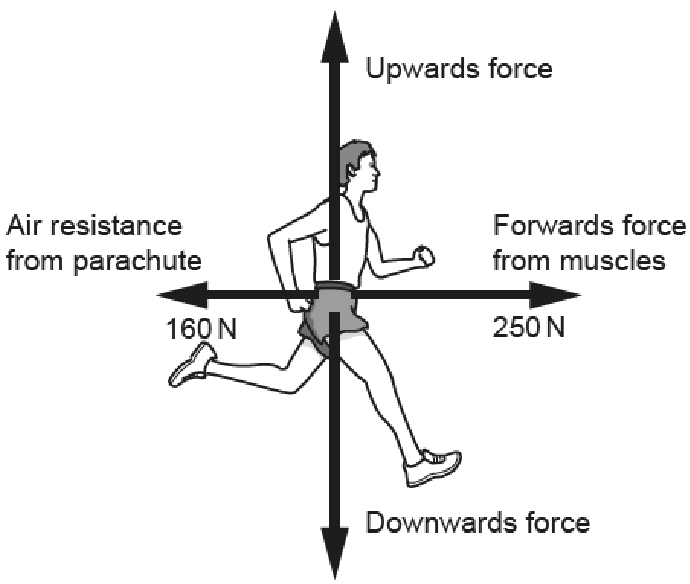


Fig. 8.2

(i) Name the upwards and downwards forces acting on Jack.

Upwards force ....

Downwards force ....
[2]

(ii) Jack's mass is 60 kg.

Calculate Jack's acceleration.

Use information from **Fig. 8.2**.

Use the equation: acceleration = force ÷ mass

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

(b) **Fig. 8.3** shows the horizontal forces acting on Jack a few moments later. Jack is still running.

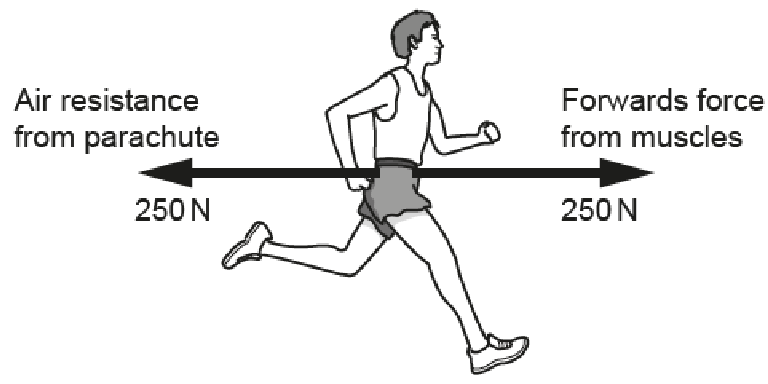


Fig. 8.3

Describe Jack's velocity, and explain your answer using information from **Fig. 8.3**.

....

....

....

.... **[2]**

(c) Jack wants to buy a new training parachute. He wants a parachute that will give the biggest possible air resistance.

The table shows information about three parachutes.

Parachute	Diameter (cm)	Mass (kg)	Cost
A	42	0.32	£9
B	48	0.29	£15
C	56	0.30	£12

Suggest which parachute Jack should buy.

....

....

.... **[2]**

3. June/2022/Paper_ J259/01/No.12

Jamal, Sara and Jack are playing rounders.

Rounders is a game played with a bat and ball. **Fig. 12.1** shows the layout of the pitch. The bowler stands at X and throws the ball towards the batter at Y.

The batter hits the ball and then tries to run to third base, from Y to Z.

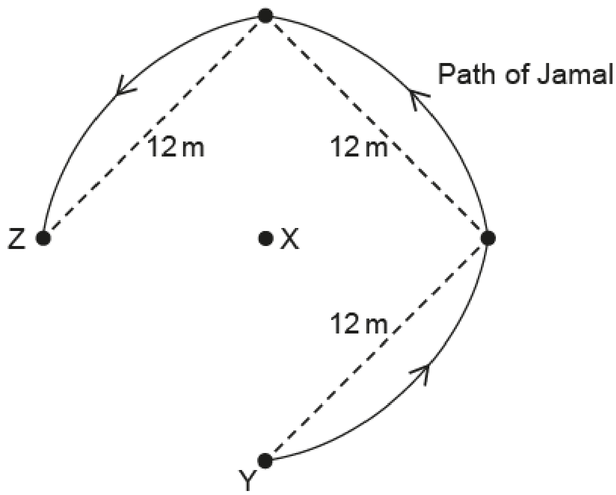
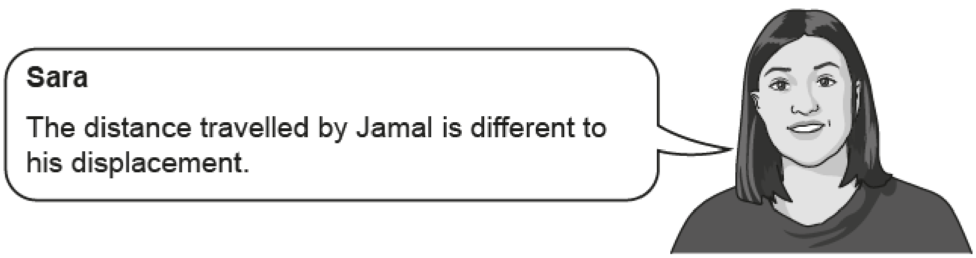


Fig. 12.1

(a) Jamal hits the ball and runs along the path from Y to Z shown in **Fig. 12.1**.



Explain why Sara is correct. Use information from **Fig. 12.1** in your answer.

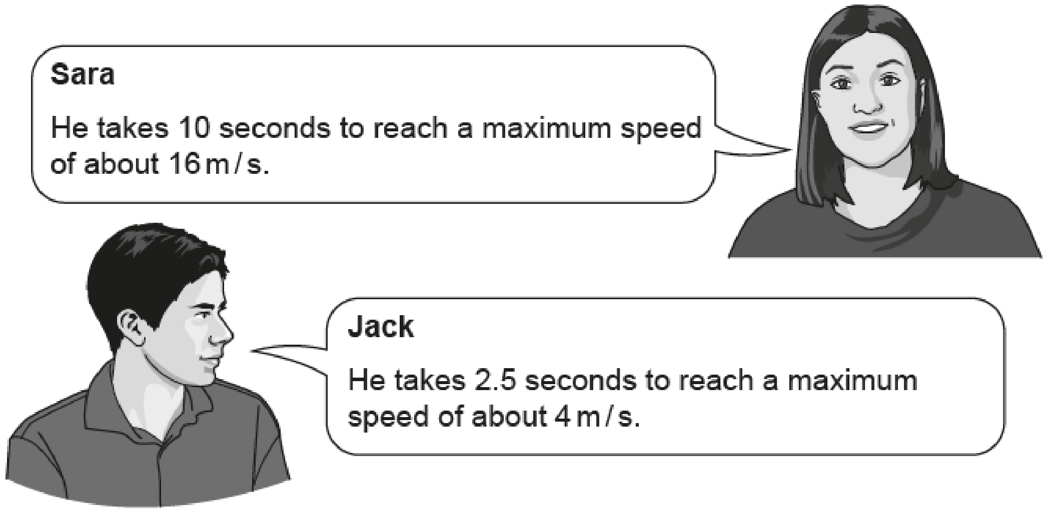
....

....

....

.... **[2]**

(b) Sara and Jack try to estimate how quickly Jamal speeded up.



(i) Which is the better estimate? Explain your answer.

Tick (✓) **one** box.

Sara ☐

Jack ☐

....

.... **[1]**

(ii) Use **either** estimate to calculate Jamal's acceleration.

Use the Data Sheet.

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

4. June/2022/Paper_ J259/02/No.1

The table shows some information from the Highway Code.

Speed (mph)	**Thinking distance (m)**	**Braking distance (m)**	**Stopping distance (m)**
30	9	14	....
40	....	24	36

(a) Complete the missing values in the table.

Use the equation: stopping distance = thinking distance + braking distance

[2]

(b) Different factors affect stopping distance.

Draw lines to connect each factor with either thinking distance, braking distance, or both thinking distance and braking distance.

Factor	
Wet road	Thinking distance
Alcohol	Braking distance
Speed	Both thinking distance and braking distance
Mobile phone use	

[4]

5. June/2022/Paper_ J259/02/No.7

In November 2020 a space company carried out a test flight of a rocket. The rocket reached a height of 12.5 km before falling back to Earth.

(a) Complete the sentences about the change in the energy stores for the test flight of the rocket.

Use words from the list.

chemical	**kinetic**	**nuclear**	**thermal**	**electromagnetic**	**elastic**

The fuel in the rocket provided a .... energy store.

As the rocket accelerated, the useful .... energy store increased.

[2]

(b) Describe **one** energy transfer as the rocket returned to Earth.

....

.... **[1]**

(c) The rocket reached a maximum height above the surface of the Earth of 12.5 km.
The rocket had a mass of 120 000 kg.

Calculate its gravitational potential energy store at its maximum height.

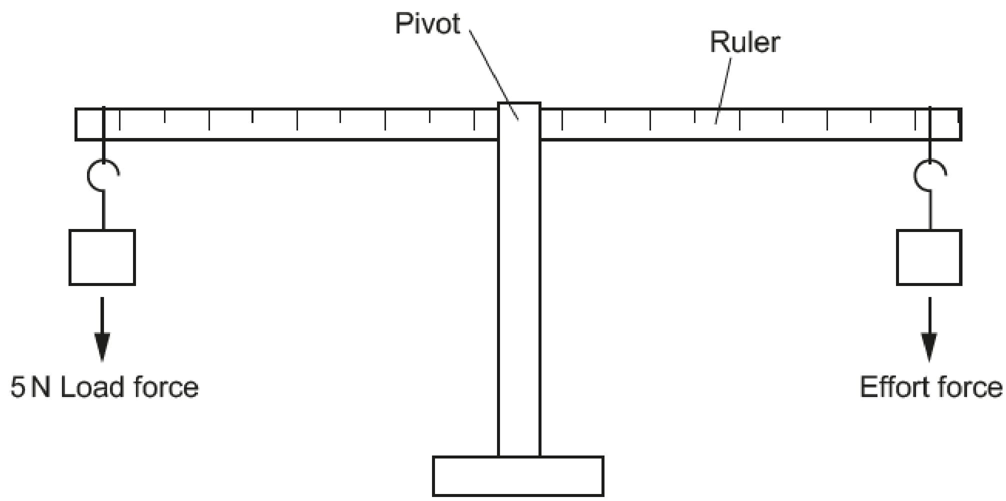
Use the equation: gravitational potential energy = mass × gravitational field strength × height

Gravitational field strength = 10 N/kg

Gravitational potential energy = ... J **[3]**

6. June/2022/Paper_ J259/02/No.10

Amir is using a ruler and pivot to balance a 5 N load and an effort force, as shown in the diagram.



He makes some measurements and records them in the table.

He uses this equation: moment of a force = force × distance

Measurement	Load force (N)	Distance from load to the pivot (cm)	Anticlockwise moment (Ncm)	Effort force (N)	Distance from effort to the pivot (cm)	Clockwise moment (Ncm)
A	5	20	100	5	20	100
B	5	30	150	7.5	20	150
C	5	40	200	6	30	180
D	5	50	250	10	25	250

(a) In which measurement, **A**, **B**, **C** or **D**, is the ruler unbalanced?

Tick (✓) **one** box

A ☐

B ☐

C ☐

D ☐

[1]

(b) Give **one** reason for your answer to **(a)**.

....

.... **[1]**

(c) Amir replaces the load force with an unknown weight, W, and places it 45 cm from the pivot.

He finds that the ruler balances when a 6 N effort force is placed 35 cm from the pivot.

Calculate the size of the unknown weight, W.

Give your answer to **2** decimal places.

Weight, W = ... N **[4]**

7. June/2022/Paper_ J259/03/No.2

Jamal, Sara and Jack are playing rounders.

Rounders is a game played with a bat and ball. **Fig. 2.1** shows the layout of the pitch. The bowler stands at X and throws the ball towards the batter at Y.

The batter hits the ball and then tries to run around the pitch once, from Y to Z.

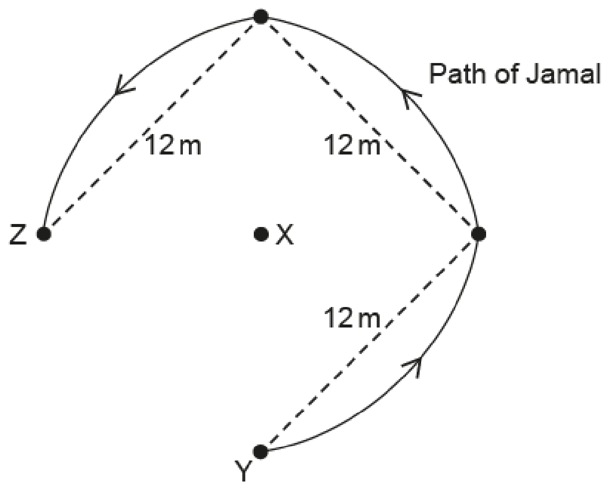
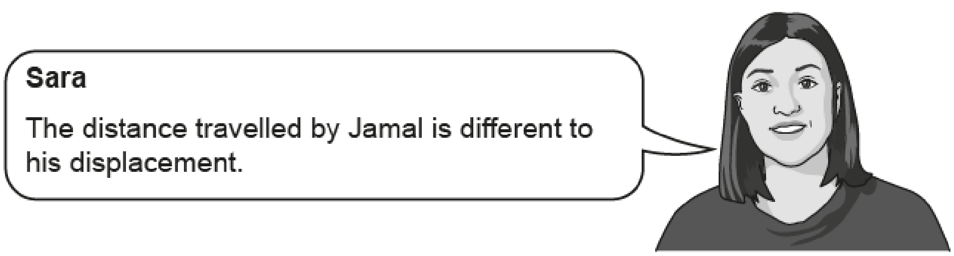


Fig. 2.1

(a) Jamal hits the ball and runs along the path from Y to Z shown in **Fig. 2.1**.



Explain why Sara is correct. Use information from **Fig. 2.1** in your answer.

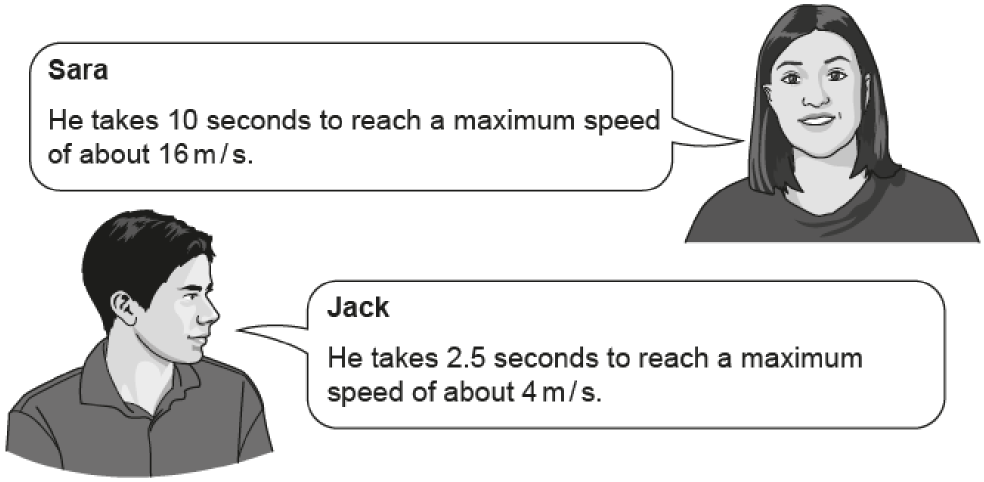
....

....

....

.... **[2]**

(b) Sara and Jack try to estimate how quickly Jamal speeded up.



(i) Which is the better estimate? Explain your answer.

Tick (✓) **one** box.

Sara ☐

Jack ☐

....

.... **[1]**

(ii) Use **either** estimate to calculate Jamal's acceleration.

Use the Data Sheet.

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

8. June/2022/Paper_ J259/03/No.9

Gears are used in many household appliances.

(a) **Fig. 9.1** shows two gears A and B.

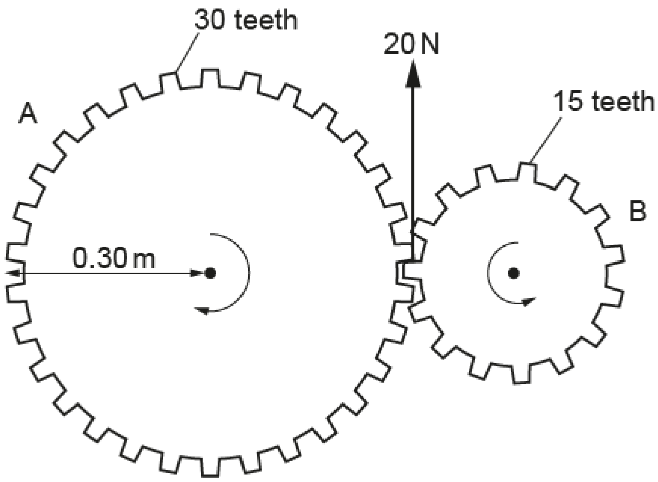


Fig. 9.1

Use the information in **Fig. 9.1** to answer these questions.

Use the Data Sheet.

(i) Gear B exerts a 20 N force on Gear A.

Calculate the moment of the 20 N force on Gear A.

Moment = ... Nm **[3]**

(ii) Gear A also exerts a force on Gear B.

Compare the forces and moments acting on Gear A and Gear B.

....

....

....

.... **[2]**

(b) Gear C is added, as shown in **Fig. 9.2**.

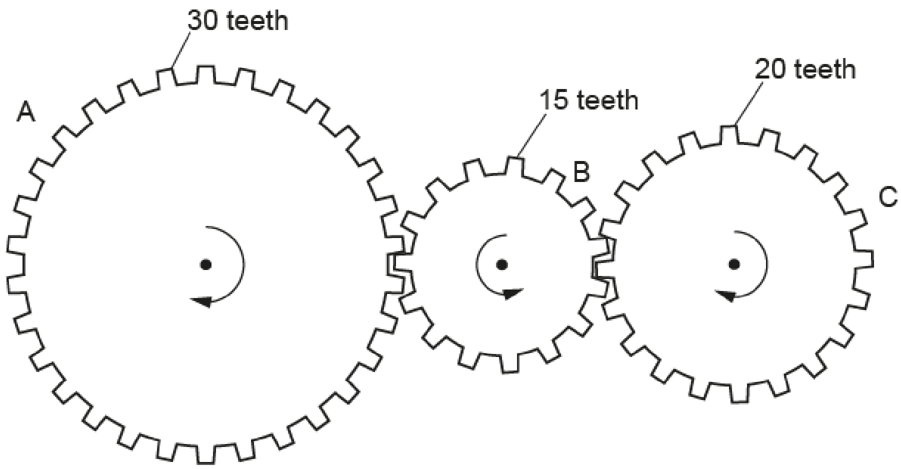


Fig. 9.2

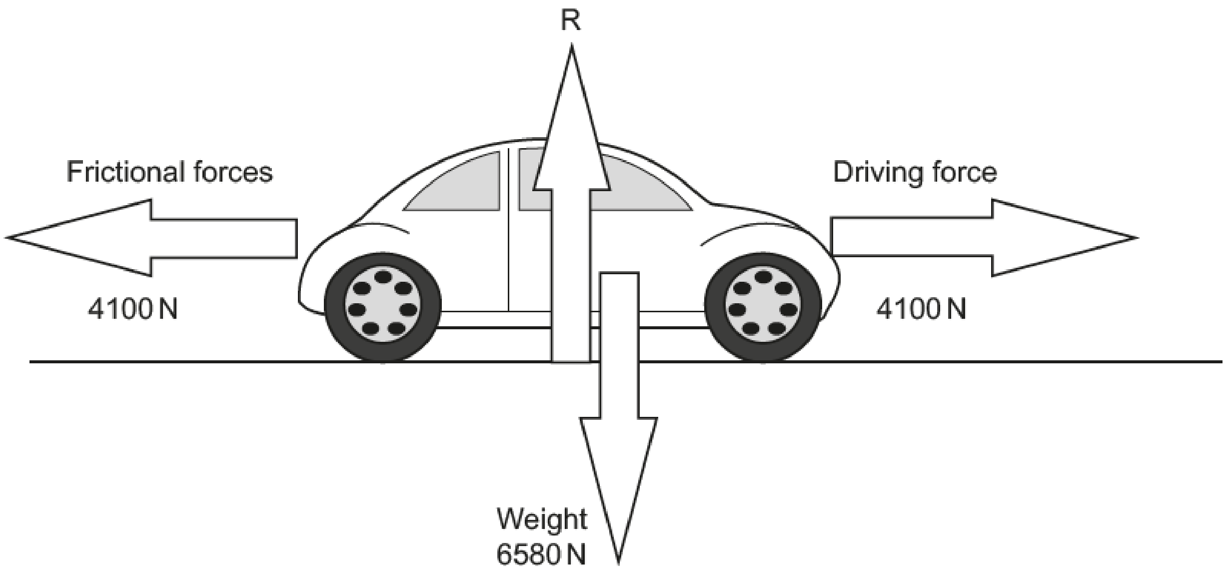
Gear A rotates 24 times in one minute.

How many times does **gear C** rotate in one minute?

Rotations in one minute = ... **[2]**

9. June/2022/Paper_ J259/04/No.3

The diagram shows the forces acting on a car travelling at a constant speed in a straight line.



(a) **(i)** Calculate the mass of the car.
Use the Data Sheet.

Gravitational field strength = 10 N / kg

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

(ii) What is the magnitude of the total reaction force, R?

.... **[1]**

(iii) The driving force is increased to 4500 N and the car accelerates.

State the resultant force acting on the car as the car accelerates.

.... **[1]**

(b) Explain how the magnitude of the resultant force changes as the car accelerates to its maximum speed.

....

....

....

....

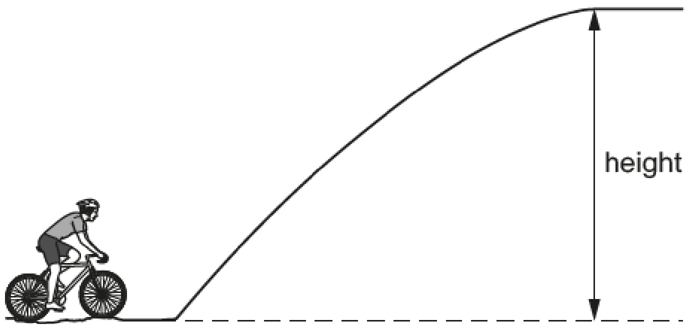
....

.... **[3]**

10. June/2022/Paper_ J259/04/No.5

Alex is cycling up a hill as shown in the diagram.

The mass of Alex and the bicycle is 95 kg.



(a) **(i)** At the top of the hill, the gravitational potential energy store of Alex and the bicycle has increased by 7600 J.

Calculate the height at the top of the hill.

Use the equation:
gravitational potential energy = mass × gravitational field strength × height

Gravitational field strength = 10 N / kg

Height = ... m **[2]**

(ii) Alex transfers 9000 J of energy to reach the top of the hill.

Explain why the amount of energy transferred by Alex is different to the increase in the gravitational potential energy store.

....

....

....

....

....

.... **[3]**

(iii) Calculate the efficiency of Alex to get to the top of the hill.

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

Efficiency = ... **[2]**

(b) Alex goes back down the hill without pedalling.

Calculate the maximum speed that Alex can reach.

Assume that no energy is lost going back down the hill.

Use the equation: kinetic energy = 0.5 × mass × $(\text{speed})^2$

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

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

(c) Alex buys an electric bike which assists pedalling by supplying 11 A of current from a 24 V battery. It takes Alex 30 seconds to reach the top of the hill.

A total of 9000 J of energy needs to be transferred by Alex and the battery to reach the top of the hill.

Calculate the energy supplied by the battery, and use this to calculate the energy that Alex needs to supply by pedalling.

Use the equations: power = current × potential difference **and** power = energy ÷ time

Energy supplied by Alex = ... J **[4]**

(d) Alex says 'If I cycle more slowly, I will use less power to reach the top of the hill'.

Explain why Alex is correct.

....

....

....

.... **[3]**

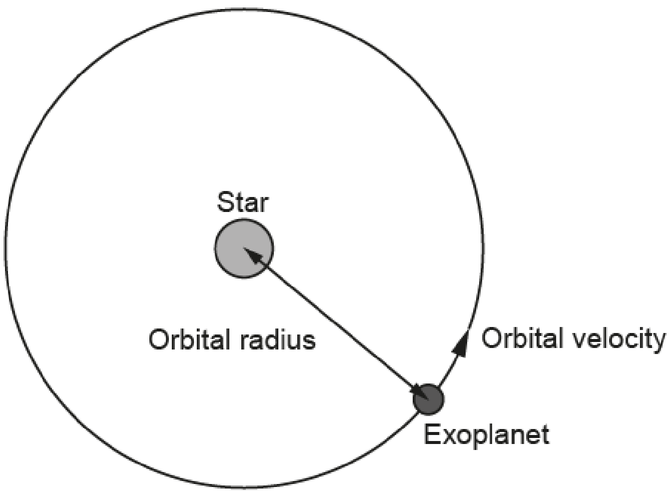
11. June/2022/Paper_ J259/04/No.10

Exoplanets are planets that orbit stars outside our Solar System. The table shows details on some exoplanets that could sustain life.

Exoplanet	Star	Mass of star compared to the Sun	Orbital period (days)	Orbital radius ($\times 10^9$ m)	Orbital velocity (m/s)
Gilese 667 c	Gilese 667	3.8	28	225	5.8×10^5
Kepler 452 b	Kepler 452	1.2	384	225	4.2×10^4
Earth	Sun	1	365	150	3×10^4

(a) The force needed to keep an object moving in a circle depends on the speed of the object and the radius of the circle. The greater the speed and/or the smaller the radius, the greater the force needed.

The diagram shows an exoplanet orbiting a star.



Explain why Gilese 667 c has a higher orbital velocity than Kepler 452 b.
Use the idea that the weight of an object is proportional to its mass.

....

....

....

.... **[2]**

(b) Another exoplanet is discovered in orbit around a star.

The star has the same mass as Kepler 452. The orbital velocity of the planet is approximately the same as the Earth's orbital velocity.

What is the possible range of values for the orbital radius of this exoplanet?

Explain your answer.

Orbital radius is **between** .... $\times 10^9$ m **and** .... $\times 10^9$ m

Explanation ....

....

....

....

[3]