5- Forces

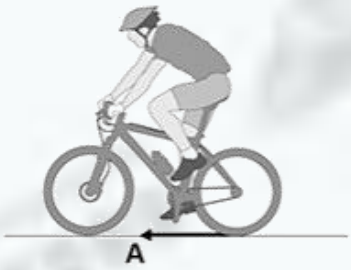
Total mark – 17

Question: 1

Figure 1 shows a cyclist riding a bicycle.

Force **A** causes the bicycle to accelerate forwards.

Figure 1



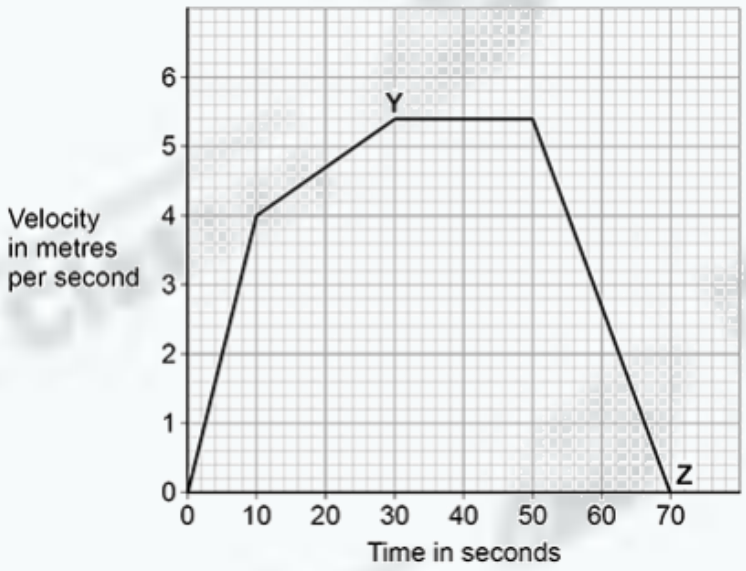
(a) What name is given to force **A**?

_____

(1)

Figure 2 shows how the velocity of the cyclist changes during a short journey.

Figure 2



(b) Determine the distance travelled by the cyclist between **Y** and **Z**.

_____

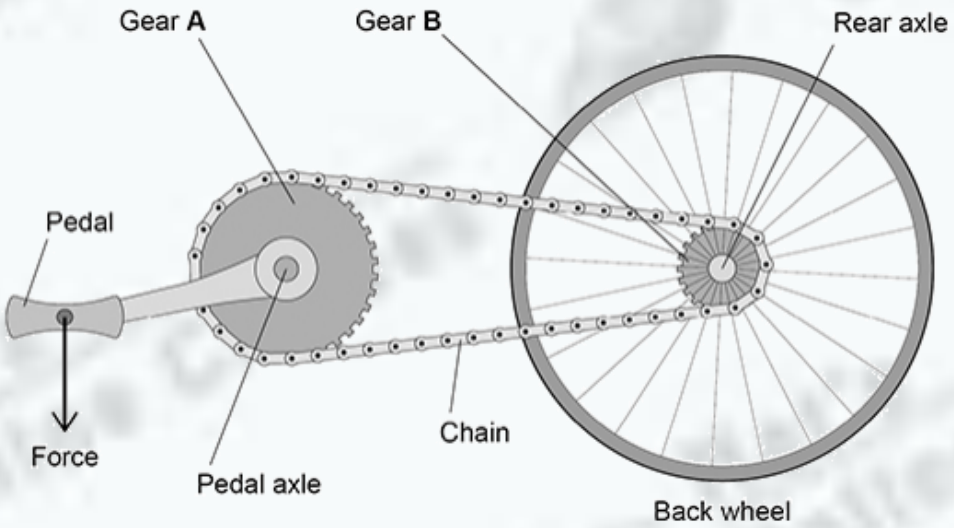
_____

Distance travelled by the cyclist between **Y** and **Z** = _____ m

(3)

(c) **Figure 3** shows the gears on the bicycle.

Figure 3

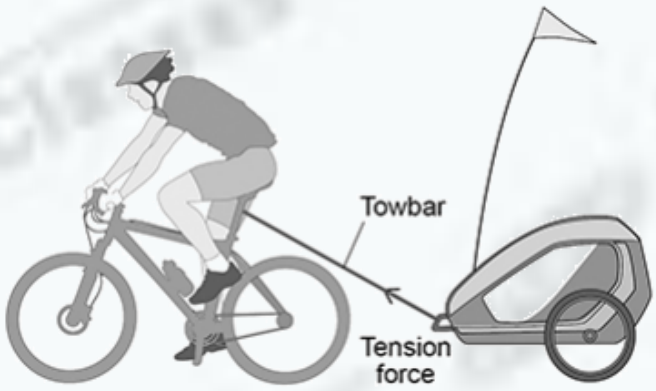


Describe how the force on the pedal causes a moment about the rear axle.

(2)

Figure 4 shows a different cyclist towing a trailer.

Figure 4



(d) The speed of the cyclist and trailer increased uniformly from 0 m/s to 2.4 m/s.

The cyclist travelled 0.018 km while accelerating.

Calculate the initial acceleration of the cyclist.

_____

_____

Acceleration = _____ m/s^2

(3)

Mark Scheme

(a) friction

1

(b) (area of rectangle =) 108 (m)

1

(area of triangle =) 54 (m)

1

(total area / distance =) 162 (m)

allow a correctly calculated total area / distance from an incorrectly calculated area of rectangle and / or triangle

1

(c) (the force on the pedal) causes a moment about the pedal axle

1

which causes a force on the chain (which causes a moment about the rear axle)

allow gear B for chain

1

(d) $2.4^2 (- 0^2) = 2 \times a \times 18$

1

$a = \frac{2.4 \times 2.4}{36}$

1

$a = 0.16 (m/s^2)$

1

alternative method

$t = 18 / 1.2$
$t = 15 (s)$ (1)

$a = 2.4 / 15$ (1)

this mark may be awarded if the time is incorrectly calculated

$a = 0.16 (m/s^2)$ (1)

allow a correctly calculated acceleration from an incorrectly calculated time 1

Question: 2

The image below shows two ice hockey players moving towards each other.

They collide and then move off together.

Before the collision

Player A
Mass = 78 kg
Velocity = +7.5 m/s

Player B
Mass = 91 kg
Velocity = –5.5 m/s

During the collision, the total momentum of the players is conserved.

(a) What is meant by 'momentum is conserved'?

_____

_____

(1)

(b) Immediately after the collision the two players move together to the right.

Calculate the velocity of the two players immediately after the collision.

_____

_____

Velocity = _____ m/s

(4)

(c) The ice hockey players wear protective pads filled with foam.

Explain how the protective pads help to reduce injury when the players collide.

_____

_____

(3)

Mark Scheme

(a) (total) momentum before = (total) momentum after

allow (total) momentum stays the same

1

(b) momentum of player A = 585 (kg m/s)

1

momentum of player B = –500.5 (kg m/s)

1

$\frac{(-500.5 + 585)}{(78 + 91)}$

OR

$\frac{84.5}{169}$

allow $\frac{1085.5}{169}$

1

= 0.5 (m/s)

this answer only

1

(c) (protective pads) increase the time taken to stop (during the collision)

allow increases impact / contact / collision time
*do **not** allow slows down time*

1

so the rate of change of momentum decreases

allow reduces acceleration/deceleration

*allow increases the time to reduce the momentum to zero for **2** marks*

1

reducing the force (on the ice hockey player)

allow impact for force

*do **not** allow if linked to an incorrect explanation*

1