1 **Figure 1** shows a cyclist riding along a straight, level road at a constant speed.

Figure 1

(a) Complete the sentences.

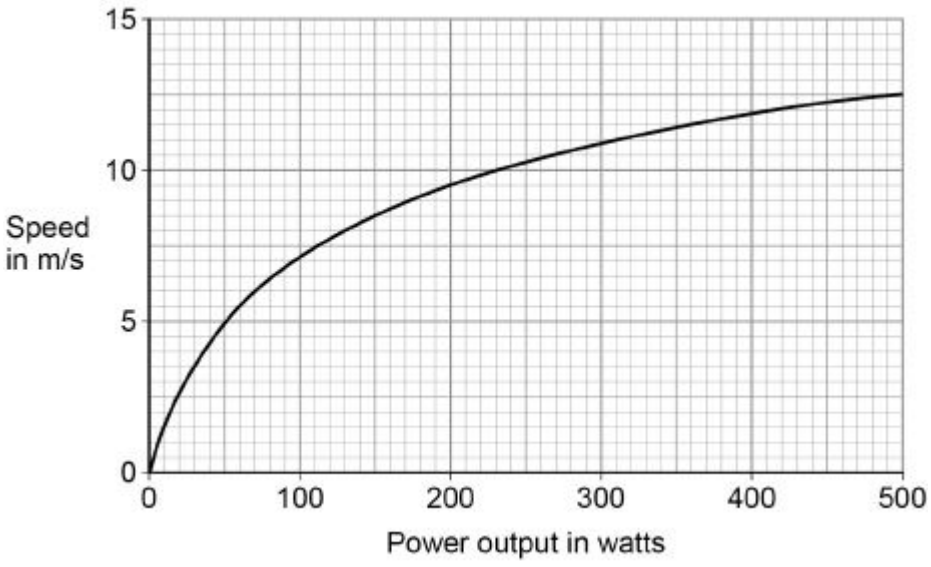
As the cyclist rides along the road, the _____ energy store in the cyclist's body decreases.

The speed of the cyclist is constant when the work done by the cyclist is _____ the work done against air resistance.

(2)

Figure 2 shows how the speed changes as the power output of the cyclist changes.

Figure 2



(b) Write down the equation that links power, time and work done.

_____

(1)

(c) Calculate the work done by the cyclist when his power output is 200 W for 1800 seconds.

Work done = _____ J

(3)

(d) Calculate the percentage increase in speed of the cyclist when the power output changes from 200 W to 300 W.

Percentage increase in speed = _____

(2)

(e) The maximum speed this cyclist can travel on a level road is 14 m/s.

How does cycling uphill affect the maximum speed of this cyclist?

Explain your answer.

(3)

(Total 11 marks)

2 The diagram shows a tennis ball thrown vertically into the air.

At position **C**, the ball has just left the tennis player's hand at a speed of 5.0 m/s

The tennis ball has a mass of 0.058 kg

(a) Write down the equation that links kinetic energy, mass and speed.

_____

(1)

(b) Calculate the kinetic energy of the tennis ball at position **C**.

_____

_____

Kinetic energy = _____ J

(2)

(c) At position **A** the tennis ball is at maximum height.

What is the gravitational potential energy of the tennis ball at position **A**?

Ignore the effect of air resistance.

_____

(1)

At position **B** the tennis ball has 0.38 J of gravitational potential energy.

(d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

_____

(1)

(e) Calculate the height of the tennis ball above the tennis player's hand when at position **B**.

gravitational field strength = 9.8 N/kg

_____

_____

_____

_____

_____

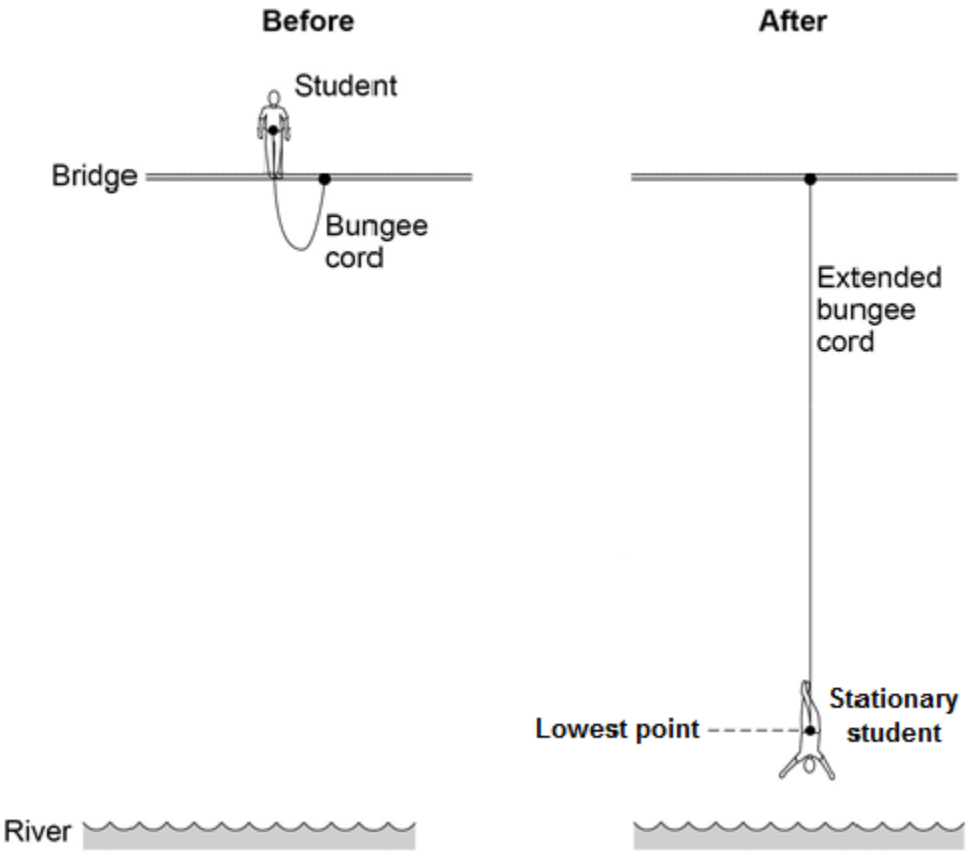
Height = _____ m

(3)

(Total 8 marks)

3 The image below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.



(a) For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(b) The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential	**gravitational potential**	**kinetic**	**sound**	**thermal**

Before the student jumps from the bridge he has a store of

_____ energy.

When he is falling, the student's store of _____

energy increases.

When the bungee cord is stretched, the cord stores energy as

_____ energy.

(3)

(c) At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Energy = _____ J

(2)

(Total 7 marks)

Mark schemes

1

(a) chemical

1

equal to

allow the same as

1

in this order only

(b) $\text{power} = \frac{\text{work done}}{\text{time}}$

allow $P = \frac{W}{t}$

1

(c) $200 = \frac{W}{1800}$

1

W = 200 × 1800

1

W = 360 000 (J)

1

*an answer of 360 000 (J) scores **3** marks*

(d) 11 − 9.5 = 1.5 (m/s)

allow a change in speed between 1.2 and 1.5 (m/s)

1

$\left(\frac{1.5}{9.5}\right) \times 100 = 15.8\,(\%)$

allow an answer consistent with their change in speed

*an answer of 16 (%) scores **2** marks*

1

*an answer that rounds to 15.8 (%) scores **2** marks*

(e) maximum speed is lower

1

because maximum power output of cyclist is constant

allow maximum force on pedals is constant

1

(but) additional work is done (against gravity)

*do **not** accept additional work done against friction or air resistance*

or

gravitational potential energy (of cyclist) is increased

1

[11]

2

(a) kinetic energy = 0.5 × mass × speed^2

allow E_k = 1/2 mv^2

1

(b) $E_k = 0.5 \times 0.058 \times 5^2$

1

$E_k = 0.725$ (J)

*an answer of 0.725 (J) scores **2** marks*

1

(c) 0.725 (J)

allow ecf from (b)

allow the same amount of E_k as at A

1

(d) gravitational potential energy = mass × gravitational field strength × height

allow Ep = mgh

1

(e) $0.38 = 0.058 \times 9.8 \times h$

1

$$h = \frac{0.38}{(0.058 \times 9.8)}$$

1

h = 0.67 (m)

*an answer that rounds to 0.67 scores **3** marks*

1

[8]

3 (a) any **two** from:

- bungee rope may snap
- rope may extend too much
- student may land in the river

2

(b) gravitational potential

correct order only

1

kinetic

1

elastic potential

1

(c) $\frac{1}{2} \times 40 \times 35^2$

1

24 500 (J)

accept 25 000 (J) (2 significant figures)

1

*allow 24 500 (J) with no working shown for **2** marks*

[7]