

AQA GCSE PHYSICS (HIGHER) • 8463

# PHYSICS



**EXAM QUESTION PACK**

**4.1.1.1 ENERGY STORES AND SYSTEMS (PACK 2)**

**SCORE**

**/67**

**PERCENTAGE**

**%**

**STEMUP**

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**Q1.**

The diagram below shows a cyclist riding along a flat road.



- (a) Complete the sentence.

Choose answers from the box.

|                 |                              |                                    |                |
|-----------------|------------------------------|------------------------------------|----------------|
| <b>chemical</b> | <b>elastic<br/>potential</b> | <b>gravitational<br/>potential</b> | <b>kinetic</b> |
|-----------------|------------------------------|------------------------------------|----------------|

As the cyclist accelerates, the \_\_\_\_\_ energy store in the cyclist's body decreases and the \_\_\_\_\_ energy of the cyclist increases.

(2)

- (b) The mass of the cyclist is 80 kg. The speed of the cyclist is 12 m/s.

Calculate the kinetic energy of the cyclist.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

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Kinetic energy = \_\_\_\_\_ J

(2)

- (c) When the cyclist uses the brakes, the bicycle slows down.

This causes the temperature of the brake pads to increase by 50 °C.

The mass of the brake pads is 0.040 kg.

The specific heat capacity of the material of the brake pads is 480 J/kg °C.

Calculate the change in thermal energy of the brake pads.

Use the equation:

change in thermal energy = mass  $\times$  specific heat capacity  $\times$  temperature change

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Change in thermal energy = \_\_\_\_\_ J

(2)

- (d) How is the internal energy of the particles in the brake pads affected by the increase in temperature?

Tick **one** box.

Decreased

☐

Increased

☐

Not affected

☐

(1)

(Total 7 marks)

## Q2.

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

**Figure 1**



- (a) Complete the sentences.

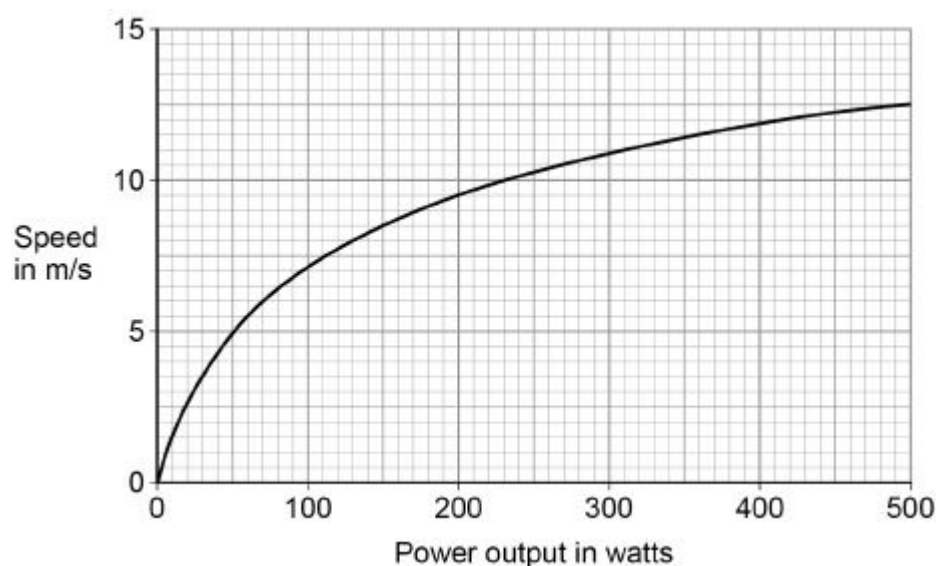
As the cyclist rides along the road, the \_\_\_\_\_ energy store in the cyclist's body decreases.

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.

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(3)  
(Total 11 marks)

**Q3.**

The photograph below shows a coffee machine. The coffee machine uses an electric element to heat water.



- (a) The coffee machine has a metal case.

Why would it be dangerous for the live wire of the electric cable to touch the metal case?

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(1)

- (b) The power output of the coffee machine is 2.53 kW.

The mains potential difference is 230 V.

Calculate the current in the coffee machine.

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Current = \_\_\_\_\_ A

(3)

- (c) The coffee machine heats water from 20 °C to 90 °C.

The power output of the coffee machine is 2.53 kW.

The specific heat capacity of water is 4200 J/kg °C.

Calculate the mass of water that the coffee machine can heat in 14 seconds.

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Mass = \_\_\_\_\_ kg

(5)

(Total 9 marks)

**Q4.**

The diagram below shows a wind turbine.



- (a) At a particular wind speed, a volume of  $2.3 \times 10^4 \text{ m}^3$  of air passes the blades each second.

The density of air is 1.2 kg/m<sup>3</sup>.

Calculate the mass of air passing the blades per second.

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Mass of air per second = \_\_\_\_\_ kg

(3)

- (b) The power output of the turbine is directly proportional to the kinetic energy of the air passing the blades each second.

Describe the effect on the power output when the wind speed is halved.

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(3)

- (c) At a different wind speed, the wind turbine has a power output of 388 kW.

The mass of air passing the wind turbine each second is 13 800 kg.

Calculate the speed of the air passing the blades each second.

Assume that the process is 100% efficient.

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Speed of air = \_\_\_\_\_ m/s

(3)

(Total 9 marks)

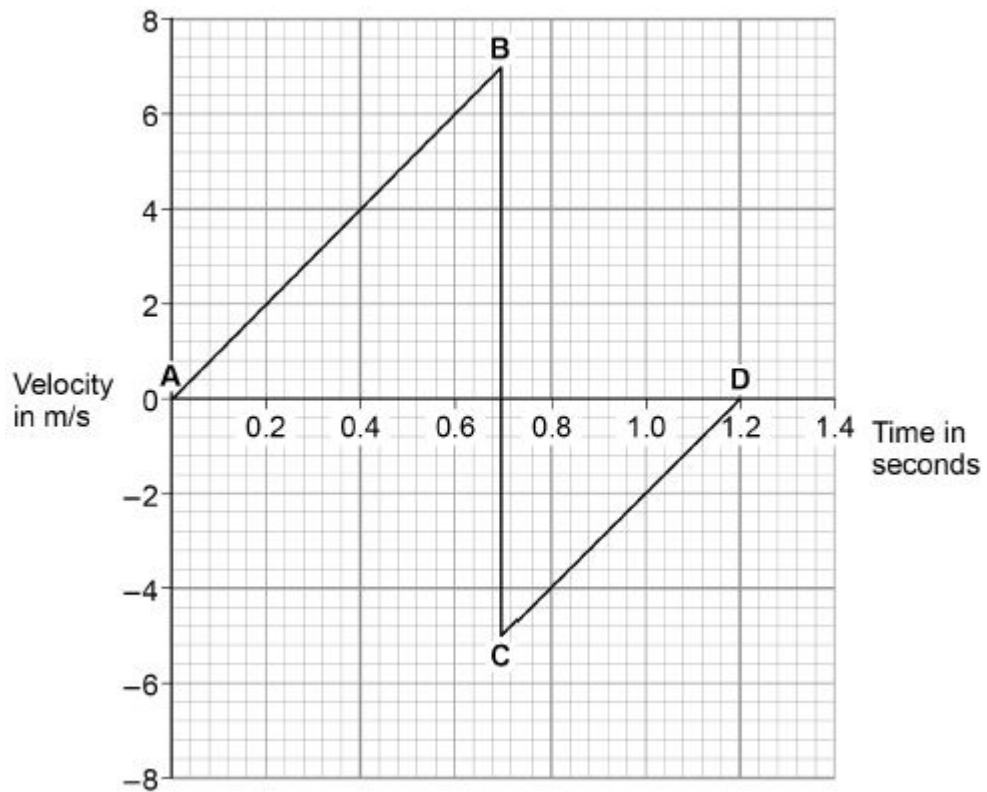
**Q5.**

A child drops a ball.

The ball hits the ground and bounces.

The graph below shows the velocity-time graph for the ball from when the ball is dropped until when the ball reaches the top of its first bounce.

Air resistance has been ignored.



- (a) Describe the motion of the ball between points **A** and **B** on the graph above.

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(2)

- (b) What direction is the ball moving between points **C** and **D** on the graph above?

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(1)

- (c) The ball and the Earth form a system.

What is meant by 'a system'?

Tick **one** box.

A group of objects that interact.

☐

Objects with big differences in mass.

☐

Objects with gravitational potential energy.

☐

(1)

- (d) When the ball hits the ground, energy is transferred from the ball to the Earth.

Explain how the data in the graph above shows this energy transfer.

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(4)

(Total 8 marks)

**Q6.**

The image shows a battery-powered drone.



- (a) Complete the sentences.

Choose the answers from the box.

|                                |                             |
|--------------------------------|-----------------------------|
| <b>chemical</b>                | <b>elastic potential</b>    |
| <b>gravitational potential</b> | <b>kinetic      nuclear</b> |

As the drone accelerates upwards

its \_\_\_\_\_ energy increases

and its \_\_\_\_\_ energy increases.

The \_\_\_\_\_ energy store

of the battery decreases.

(3)

- (b) In the USA, drones are not allowed to be flown too high above the ground.

Suggest **one** possible risk of flying a drone too high above the ground.

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(2)

- (c) Write down the equation that links energy transferred, power and time.

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(1)

- (d) The drone can fly for 25 minutes before the battery needs recharging.

The power output of the battery is 65.0 W

Calculate the maximum energy stored by the battery.

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Maximum energy = \_\_\_\_\_ joules

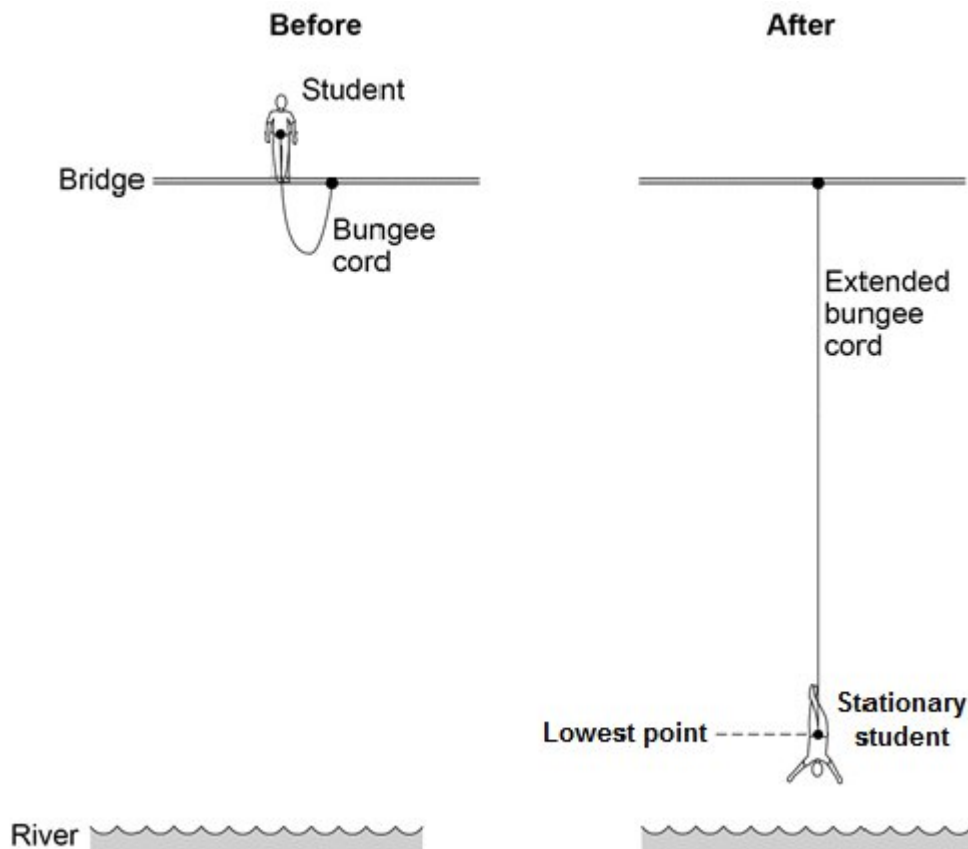
(3)

(Total 8 marks)

### Q7.

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.

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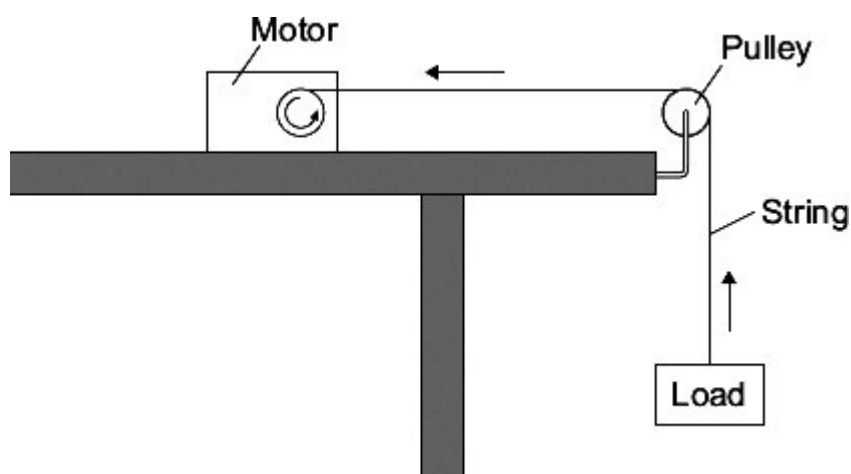
Energy = \_\_\_\_\_ J

(2)

(Total 7 marks)

### Q8.

A student uses an electric motor to lift a load.



In the motor, the electrical energy is transferred into other types of energy. Some of this energy is useful and the rest of the energy is wasted.

- (a) (i) Name the useful energy output from the electric motor.

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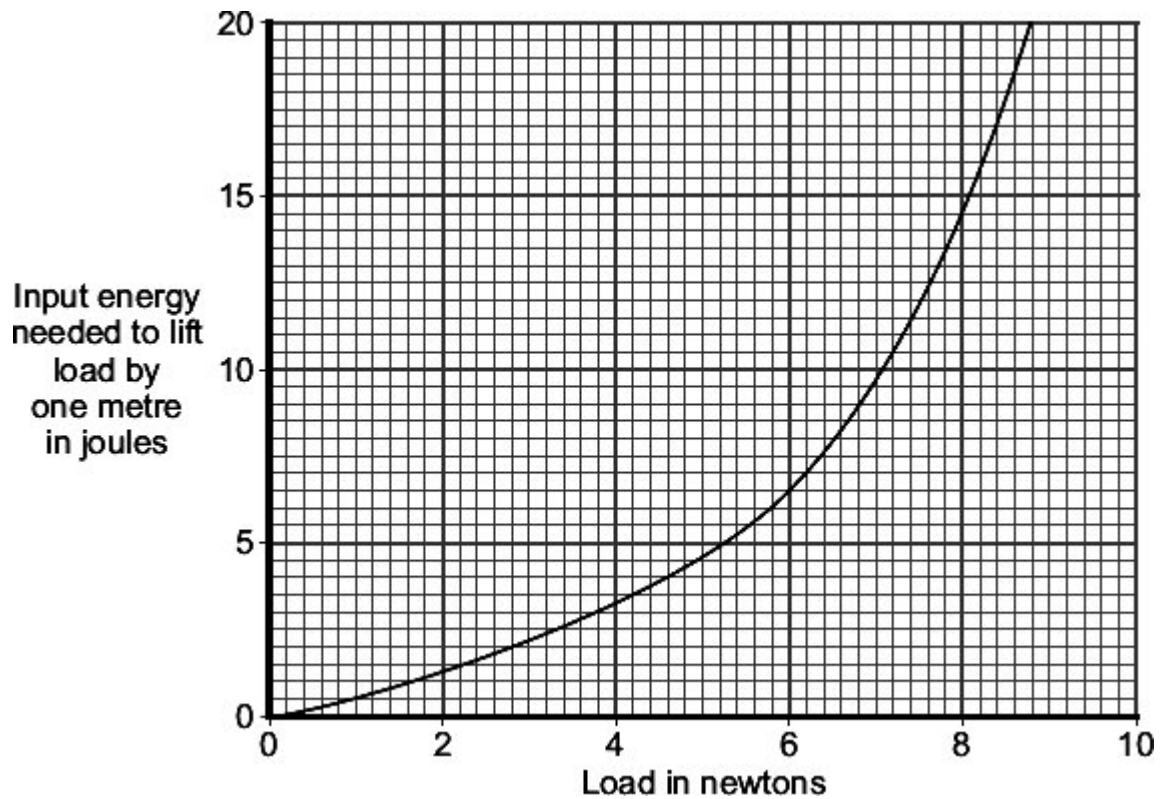
(1)

- (ii) What eventually happens to the wasted energy?

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(1)

- (b) The graph shows the input energy the motor needs to lift different loads by one metre.



What can you conclude from the graph about the relationship between the load lifted and the input energy needed?

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(2)

- (c) A shop uses escalators to lift customers to different floor levels. The escalators use electric motors. When the shop is not busy some escalators are turned off. A sign tells the customers that the escalators are turned off to save energy.



- (i) Each escalator has one motor with an average power of 4000 W. The motor is turned on for an average of 8 hours each day, 6 days each week. Electricity costs 15 pence per kilowatt-hour.

Calculate the cost of the electricity used in an average week to run **one** escalator.

Show clearly how you work out your answer.

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Cost = \_\_\_\_\_ pence

(3)

- (ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

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(1)

(Total 8 marks)

## Mark schemes

### Q1.

- (a) chemical 1
- kinetic 1
- in this order only*
- (b)  $E_k = 0.5 \times 80 \times 12^2$  1
- $E_k = 5760 \text{ (J)}$  1
- an answer of 5760 (J) scores 2 marks*
- (c)  $E = 0.040 \times 480 \times 50$  1
- $E = 960 \text{ (J)}$  1
- an answer of 960 (J) scores 2 marks*
- (d) increased 1
- [7]**

### Q2.

- (a) chemical 1
- equal to
- allow the same as*
- 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
- $W = 200 \times 1800$  1
- $W = 360\,000 \text{ (J)}$  1
- an answer of 360 000 (J) scores 3 marks*

- (d)  $11 - 9.5 = 1.5 \text{ (m/s)}$   
*allow a change in speed between 1.2 and 1.5 (m/s)*

1

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

*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]

### Q3.

- (a) risk of electric shock (if someone touched the case)  
*allow risk of electrocution (if someone touched the case)*

1

- (b)  $2530 = I \times 230$   
*this mark may be awarded if P is incorrectly / not converted*

1

$$I = \frac{2530}{230}$$

*this mark may be awarded if P is incorrectly / not converted*

1

$I = 11 \text{ (A)}$   
*this answer only*  
*an answer of 0.011 (A) scores 2 marks*  
*an answer of 11 (A) scores 3 marks*

1

- (c)  $E = 2530 \times 14$   
*this mark may be awarded if P is incorrectly / not converted*

1

$E = 35\,420 \text{ (J)}$   
*this answer only*

1

$$35\,420 = m \times 4200 \times 70$$

*allow their calculated  $E = m \times 4200 \times 70$*

1

$$m = \frac{35\,420}{4200 \times 70}$$

$$\text{allow } m = \frac{\text{their calculated } E}{4200 \times 70}$$

1

$$m = 0.12 \text{ (kg)}$$

*allow an answer that is consistent with their calculated value of  $E$*

1

[9]

**Q4.**

(a)  $1.2 = \frac{m}{2.3 \times 10^4}$

1

$$m = 1.2 \times 2.3 \times 10^4$$

1

$$m = 27\,600 \text{ (kg)}$$

*allow an answer of 28 000 (kg) or  $2.8 \times 10^4$  (kg)*

**or**

$$m = 2.76 \times 10^4 \text{ (kg)}$$

1

*an answer of 27 600 (kg) scores 3 marks*

- (b) mass of air passing the turbine blades is halved which decreases kinetic energy by a factor of two

1

(wind speed is halved) decreasing kinetic energy by a factor of four

1

so kinetic energy decreases by a factor of eight

1

*allow power output for kinetic energy throughout*

(c)  $388\,000 = 0.5 \times 13\,800 \times v^2$

*this mark may be awarded if  $P$  is incorrectly / not converted*

1

$$v^2 = \frac{(2 \times 388\,000)}{13\,800}$$

*this mark may be awarded if  $P$  is incorrectly / not converted*

**or**

$$v^2 = \frac{388\,000}{(0.5 \times 13\,800)}$$

**or**

$$v^2 = 56.2$$

1

$$v = 7.50 \text{ (m/s)}$$

*an answer that rounds to 7.50 (m/s) only*

1

**[9]**

### Q5.

- (a) uniform acceleration

*allow constant / steady acceleration  
allow velocity / speed increasing at a constant rate*

*ignore reference to direction  
acceleration scores 1 mark*

**or**

*velocity / speed is increasing scores 1 mark  
do **not** accept acceleration increases*

2

- (b) up(wards)

1

- (c) a group of objects that interact

1

- (d) velocity just after bounce is less than just before bounce

*allow velocity is less / decreases  
velocity decreases to zero – on its own scores zero*

**or**

the height at the top of the bounce is less than the height from which it was dropped

1

so the ball has lost energy

1

correct reference to (loss of) ke or (reduced) gpe

1

total energy of ball and Earth / ground is constant

*allow 'a system' for ball and Earth  
allow energy is conserved*

1

**[8]**

**Q6.**

- (a) gravitational potential 1
- kinetic 1
- chemical 1
- (b) flying drones may damage aircraft  
**or**  
 falling drones may injure people  
**or**  
 damage buildings / vehicles  
*allow any sensible suggestion of a hazard caused by a flying / falling drone* 1
- (c) energy transferred = power  $\times$  time  
*allow  $E = Pt$*  1
- (d)  $t = 25 \times 60 = 1500$  (s) 1
- $E = 65 \times 1500$  1
- $E = 97\,500$  (J)  
*an answer of 97 500 (J) scores 3 marks*  
*allow 2 marks for an answer of 1625 (J)* 1

**[8]****Q7.**

- (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)

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

1

[7]

**Q8.**

- (a) (i) kinetic (energy)

allow gravitational potential (energy) / gpe  
movement is insufficient

1

- (ii) dissipates into the surroundings

allow warms up the surroundings / air / motor  
accept lost to the surroundings  
accept lost as heat  
ignore reference to sound  
it is lost is insufficient

1

- (b) energy (required) increases with load

accept positive correlation  
do **not** accept (directly) proportional

1

further amplification eg increases slowly at first (or up to 4 / 5 N),  
then increases rapidly

simply quoting figures is insufficient  
an answer that only describes the shape  
of the line gains no marks

1

- (c) (i)  $E = P \times t$

2880

accept £28.80 for all 3 marks  
an answer £2880 gains 2 marks  
allow 1 mark for obtaining 48 h **or** converting to kW  
allow 2 marks for correct substitution  
ie  $4 \times 48 \times 15$   
note: this substitution may be shown as two steps  
an answer 2 880 000 gains 2 marks  
an answer £4.80 / 480 gains 2 marks  
an answer of 192 (ie calculation of energy without  
subsequent calculation of cost) gains 1 mark)

3

- (ii) any sensible suggestion eg

conserves fossil fuels

less (fossil) fuels burned

less pollutant gas (produced)  
*accept a named pollutant gas*

less greenhouse gas (produced)  
*saves energy is insufficient*

1

[8]