

Q1.

* A class of students investigate the power output of each student in the class.
The class must decide whether they use a method using steps or a method using weights.
The whole class must use the same method.
Plan what measurements the students should take and how these can be used to calculate and compare the power output of each student.
You may draw a diagram to help with your plan. (6)

Q2.

Three students carry out an investigation to determine their powers when running up stairs.
They take turns to run up the stairs and use a stopwatch to measure the time taken.
The students estimate their own weight.
Figure 8 shows a table of their results.
The table is not complete.

student	student estimate of weight in N	distance in m	work done	time taken in s	power in W
A	550	4.0	2200	5.0	440
B		4.0	1960	4.5	436
C	510	4.0	2040		425

Figure 8

- (i) State the unit for work done. (1)
- (ii) Use the data for student B to calculate his estimated weight. (2)
- (iii) Use the data for student C to calculate the time she takes. (2)
- (iv) Use the data for all three students to calculate the average power of the students. (2)

Q3.

A cyclist starts to cycle.
The cyclist does 1600 J of useful work to travel 28 m.
Calculate the average force the cyclist exerts. (3)



Q4.

A 60 kg student weighs 600 N. He does a bungee jump.
The bungee cord becomes straight and starts to stretch when he has fallen 50 m.
He first stops moving (1)

- ☐ A before all the energy has disappeared
- ☐ B before the bungee cord starts to stretch
- ☐ C when the bungee cord is stretched the most
- ☐ D when the elastic potential energy is zero

Q5.

The bungee cord becomes straight and starts to stretch when he has fallen 50 m.
He first stops moving (1)

- ☐ A before all the energy has disappeared
- ☐ B before the bungee cord starts to stretch
- ☐ C when the bungee cord is stretched the most
- ☐ D when the elastic potential energy is zero

(b) When his speed is 10 m/s his momentum is (1)

- ☐ A 600 kg m/s
- ☐ B 3 000 kg m/s
- ☐ C 6 000 N m/s
- ☐ D 30 000 N m/s

(c) (i) Calculate the change in gravitational potential energy as the student falls 50 m.
Give the unit. (3)

(ii) State at what point in the bungee jump the student has maximum kinetic energy. (1)

(iii) Explain why his maximum kinetic energy is likely to be less than your answer to (c)(i). (2)

Q6.

This question is about energy changes. Figure 8 shows a water slide.
A person travels from the top to the bottom of the water slide.

- (i) The mass of the person, $m = 72$ kg.
The change in vertical height, $h = 7.0$ m
Calculate the change in gravitational potential energy for the person.
Use the equation
change in gravitational potential energy = $m \times g \times h$ (2)

(ii) The person comes to rest after the end of the water slide.
Explain what happens to the energy as the person comes to rest after the end of the water slide. (2)

Q7.

Figure 8 shows the rock falling.
The Earth exerts a force of 150 N on the rock.

The work done by this force when the rock falls from the top to the bottom of the cliff is 2700 J.

(i) Calculate the height, h , of the cliff. (2)

(ii) State the value of the kinetic energy of the rock just before it hits the ground. (1)

(iii) The mass of the rock in Figure 8 is 15 kg.
Calculate the velocity of the rock just before it reaches the bottom of the cliff.

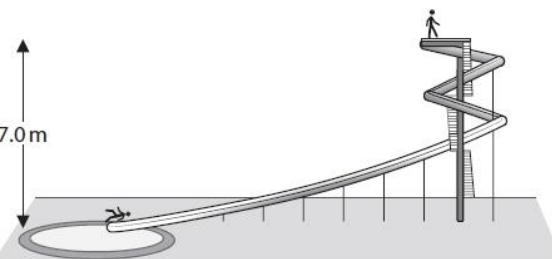
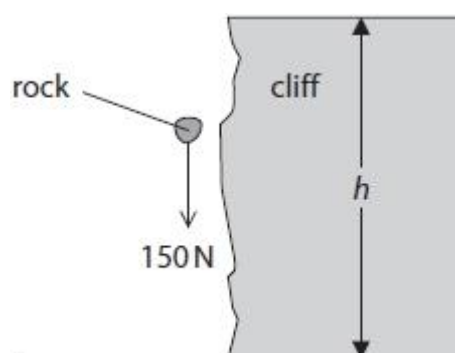


Figure 8

Gravitational field strength, $g = 10$ N / kg person.



Q8.

A ball has a mass of 0.046 kg.

(i) Calculate the change in gravitational potential energy when the ball is lifted through a vertical height of 2.05 m. Use the equation $\Delta GPE = m \times g \times \Delta h$

(2)

(ii) The ball is released.

Calculate the kinetic energy of the ball when the speed of the ball is 3.5 m/s.

(2)

(iii) The ball bounces several times.

Figure 7 shows how the height of the ball above the floor changes with time.

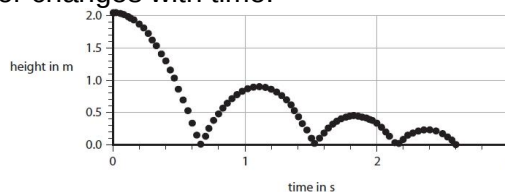


Figure 7

Use Figure 7 to estimate the maximum height that the ball reaches after the first bounce.

(1)

(iv) Explain why the ball does not bounce back to its starting height of 2.05 m.

Q9.

A drone has a mass of 4.5 kg. This drone rises from the ground to a height of 20 m.

(i) Calculate the change in gravitational potential energy when the drone rises through a height of 20 m. The gravitational field strength $g = 10 \text{ N/kg}$.

(ii) State the amount of useful work done by the blades as the drone rises through 20 m.

(iii) It takes 4 s for the drone to rise through 20 m.

Calculate the useful power developed by the blades in this time of 4 s.

(2)



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Figure 13

Figure 13 shows a drone. A different drone rises through a height of 20 m. The

(2)

(1)

(2)

Q10.

This question is about using the mains electricity supply.

(i) An electric kettle is used to boil some water. The mains supply voltage is 230 V. The power supplied to the kettle is 1.9 kW. Calculate the current in the kettle. Use the equation

$$I = \frac{P}{V}$$

(2)

(ii) A coffee machine takes 120 s to heat some water.

Mains supply voltage = 230 V

Current in this coffee machine = 7.4 A

Calculate the energy transferred to the coffee machine in 120 s.

Use an equation selected from the list of equations at the end of the paper.

(2)

Q11.

Calculate the kinetic energy of a tennis ball travelling at 28 m/s. The mass of the tennis ball = 58 g.

Q12.

Figure 3 shows a toy used to launch a ball.

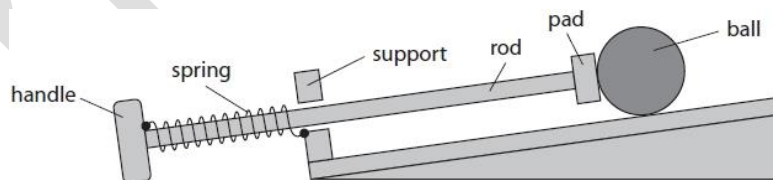


Figure 3

One end of the spring is fixed to the handle.

The other end of the spring is fixed to the support.

The child pulls the handle until the pad is against the support as shown in Figure 5.

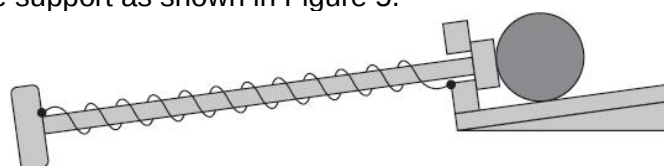


Figure 5

(i) The extension of the spring is 0.09 m.

The spring constant (k) is 20 N/m.

Calculate the work done in extending the spring by 0.09 m.

(2)

The ball starts to move.

The spring returns to its original length.

Describe the energy transfer that takes place when the ball starts to move.

(2)

(iii) The child can only stretch the spring until the pad is pressing against the support.

Explain how the design of the toy prevents the spring from becoming damaged.

(2)

Q13.

A man pulls a suitcase with a horizontal force, F , as shown in Figure 10.

Two other forces acting on the suitcase are labelled P and Q .

(a) The man pulls the suitcase for 80 m along a horizontal path.

The mass of the man and the suitcase is 85 kg.

The man does 1200 J of work on the suitcase as he pulls the suitcase

along. He walks with an average velocity of 1.5



Not to scale

- m/ s.
- (i) Calculate the kinetic energy of the man and the suitcase. (2)
- (ii) Calculate the horizontal force, F , that the man exerts on the suitcase. (2)
- (b) The man runs up a set of stairs carrying his suitcase.
Explain whether he does more total work if he walks up the same stairs instead of running. (2)
- (c) The man lifts his suitcase.
The increase in gravitational potential energy of the suitcase is 264 J. The mass of the suitcase is 12 kg. Calculate the vertical height the suitcase is raised. (gravitational field strength, $g = 10 \text{ N/kg}$) (2)

Q14.
A cyclist is riding a bicycle at a steady velocity of 12 m/s. The cyclist and bicycle have a total mass of 68 kg. Calculate the kinetic energy of the cyclist and bicycle. (2)

Q15.
inside a padded box from a height. He is investigating to see if the padding stops the egg from breaking.
The weight of the egg is 0.6 N. Calculate the work done on the egg to lift it (3)



The photograph shows a man dropping an egg the egg from breaking.
up by 20 m. State the unit.

Q16.
replacing fluorescent lamp fittings with LED fittings.

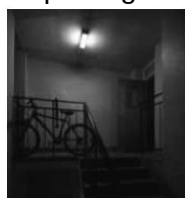


photo of stairwell with fluorescent fitting



photo of stairwell with LED fitting

total energy saved each year by using LEDs	3 000 kW h
LED fitting cost	£2 000
CO ₂ saving each year by using LEDs	1.6 tonnes
change in lighting levels by using LEDs	200%
average price of electrical energy	14 p / kW h
average lifetime of LED fittings	50 000 hours
average lifetime of fluorescent fittings	10 000 hours

The data in the table is taken from the report of a trial using LEDs to light stairwells and corridors in a large building.

Use the information to discuss the benefits of replacing fluorescent fittings with LED fittings. (6)

Q17.
Figure 9 shows how the efficiency of the electric motor changes as Describe how the efficiency of the electric motor depends on the (2)

Q18.
the start and the maximum height reached after each bounce. Figure 8 shows the student's graph.

Describe how the maximum height reached changes with the (2)

Q19.



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Figure 13

Figure 13 shows a drone. The blades on the drone are The electric motors are powered Figure 15 represents the energy ground.

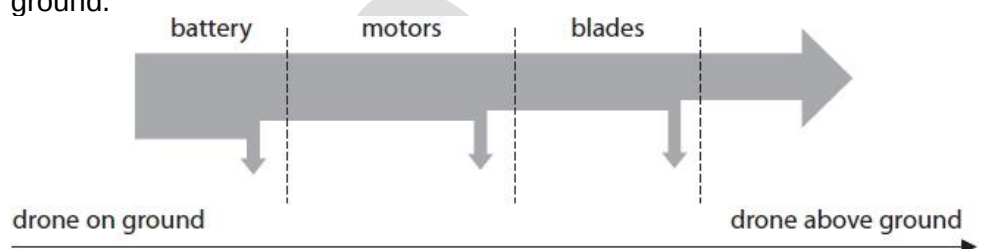
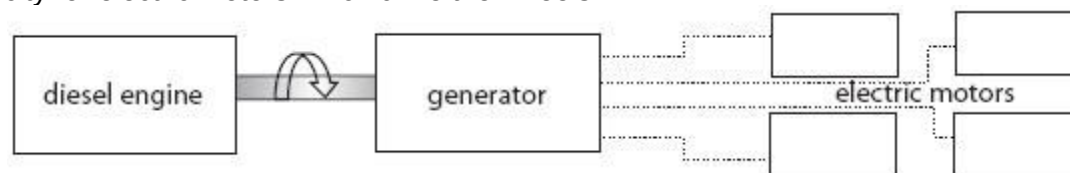


Figure 15

Describe the changes in the way energy is stored when the drone rises from the ground. Your answer should refer to energy transfers.

Q20.

A train is powered by a diesel engine. The diesel engine is used to turn a generator. The generator provides electricity for electric motors which drive the wheels.



(i) Draw one straight line from each train part to its (3)

(ii) State **one** example of a non-useful energy transfer in (1)

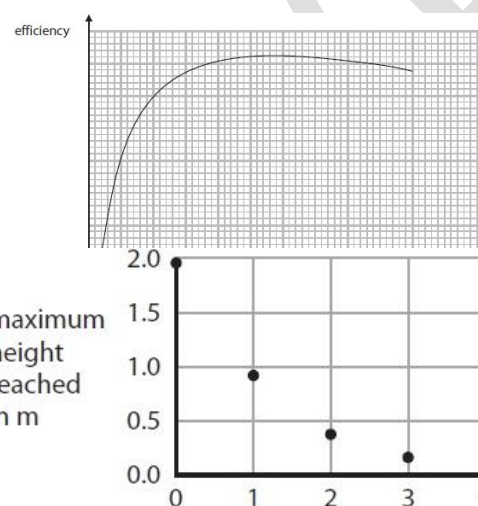
Q21.
electric motors. One of the students states that all of the other forms.

This statement is one example of the idea of (1)

- ☐ A renewable energy
- ☐ B conservation of energy
- ☐ C non-renewable energy
- ☐ D sustainable energy

Q22.

A pilot begins to land an aircraft.



An electric motor is used to lift a box. the mass of the box increases mass of the box lifted.

A student plots a graph showing the height at bounce number in Figure 8.

turned by electric motors. by a battery. transfers involved when the drone rises from the

turned by electric motors. by a battery. transfers involved when the drone rises from the

- (a) The height of the aircraft decreases from 200 m above the ground to 100 m. (1)
- (i) What happens to the gravitational potential energy of the aircraft?
- ☐ A it becomes zero
- ☐ B it decreases
- ☐ C it does not change
- ☐ D it increases
- (ii) The velocity of the aircraft remains constant. What happens to the kinetic energy



- ☐ A it becomes zero
- ☐ B it decreases
- ☐ C it does not change
- ☐ D it increases

(b) The aircraft lands with its wheels on the runway as shown. (1)

The aircraft is moving forwards.

- (i) Draw an arrow on the diagram to show the direction of the momentum of the aircraft. (1)

- (ii) The velocity of the aircraft when it lands is 75 m/s. (2)

The mass of the aircraft is 130 000 kg.
Calculate the momentum of the aircraft.

- (iii) The aircraft comes to a stop. (1)
- State the momentum change of the aircraft from when it lands to when it stops.

(c) When the aircraft lands, the momentum of each passenger also changes. (1)

- (i) Explain why it is more comfortable for a passenger if the aircraft takes a longer time to slow down. (2)
- (ii) Suggest why some aircraft need a very long runway to land safely. (2)

Q23.

The photograph shows a man dropping an egg inside a padded box from a height.



He is investigating to see if the padding stops the egg from breaking.

- (a) State the type of energy which the egg gains as it falls. (1)
- (b) The weight of the egg is 0.6 N. (3)
- Calculate the work done on the egg to lift it up by 20 m. State the unit.

- (c) The velocity of the container was 18 m/s as it hit the floor. (2)
- The mass of the container was 0.5 kg.
Calculate the momentum of the container.

- *(d) A student stands on the ground with an egg in his hand. (6)
- He throws the egg vertically upwards.
The egg rises to a height of 10 m.
Then the egg falls and lands on the ground.
Describe the energy changes of the egg during this sequence of events.



Q24.

Andrew skis down a hill.

Andrew starts from the top of the hill and his speed increases as he goes downhill.
He controls his speed and direction by using his skis.
He brings himself to a stop at the bottom of the hill.
Describe the energy changes that happen between starting and stopping. (3)

Q25.

- (i) Complete the equation that relates efficiency, useful energy transferred by a device and total energy supplied to the device. (1)

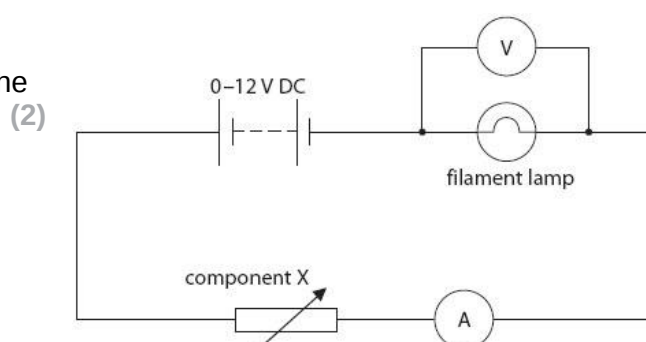
- (ii) In one second an engine has a total energy input of 7500 J. (1)
- In one second 3200 J is transferred to the surroundings as wasted energy.
Calculate the useful energy transferred by the engine.

- (iii) Calculate the efficiency of this engine. (2)

Q26.

A student sets up an experiment to measure the potential difference (voltage) across a filament lamp.
She changes the current through the lamp.
The diagram shows the circuit she used.

- (d) Describe the energy transfer that takes place in the (2)

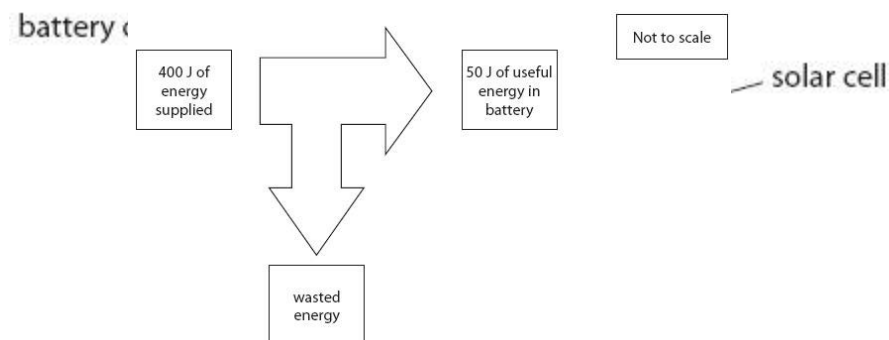


lamp.

charge some batteries.

Q27.

A student uses a solar powered battery charger to



The diagram shows how much energy is usefully transferred by the battery charger.

(i) Calculate the amount of wasted energy.

(1)

(ii) Calculate the efficiency of the battery charger.

(2)

Q28.

A cyclist is riding a bicycle at a steady velocity of 12 m/s.

The cyclist and bicycle have a total mass of 68 kg.

Describe the energy transfers that happen when the cyclist uses the brakes to stop.

(2)

Q29.

This photograph shows a fan.

The blades of the fan are turned by an electric motor.

In one second, the motor gets 200 J of electrical energy from the mains supply.

Only 180 J of this energy is used to turn the blades of the fan.

The rest of the energy is wasted.

(i) Calculate how much of the 200 J of energy is wasted.

(1)

wasted energy = J

(ii) State what happens to the wasted energy.

(1)

(iii) Calculate the efficiency of the motor.

(2)

Q30.

An electric water pump is powered by the 230 V mains supply.

The system transfers 8400 J of useful kinetic energy to the water passing through the pump in 1 minute.

Figure 6 shows a diagram of the energy transfers.

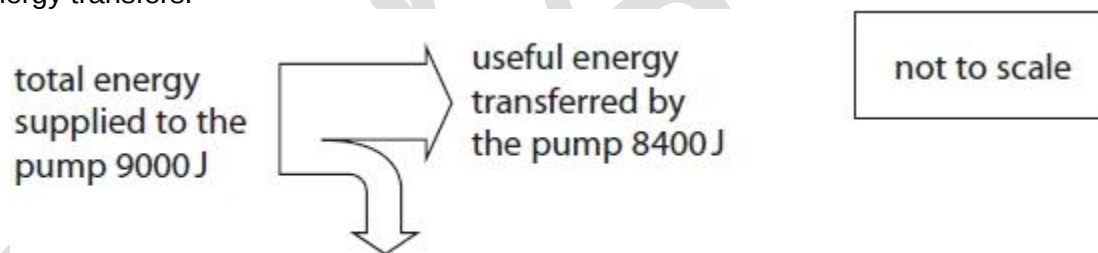


Figure 6

(i) Explain why the useful energy transferred to the water is different from the total energy supplied to the pump.

(2)

(ii) Calculate the efficiency of the pump.

Use the equation

$$\text{efficiency} = \frac{\text{useful energy transferred by the pump}}{\text{total energy supplied to the pump}}$$

(2)

Q31.

Figure 9 shows a person pushing a box from the bottom of a slope to the top of the slope.

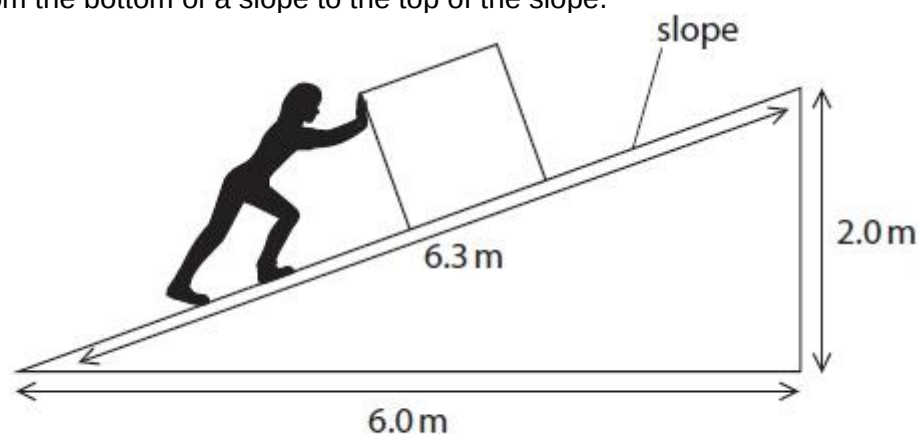


Figure 9

Explain which one of the three distances shown in Figure 9 should be used to calculate the work done against the force of friction between the box and the slope.

(2)

.....

Q32.

(a) Which of these situations can increase the reaction time of a driver?

(1)

- ☐ A an icy road
- ☐ B worn tyres on his car
- ☐ C stopping for a cup of coffee
- ☐ D driving for a long time without taking a break

(b) (i) A car engine produces an average driving force of 1200 N.
The car travels 8.0 m.
Calculate the work done by the force over this distance.

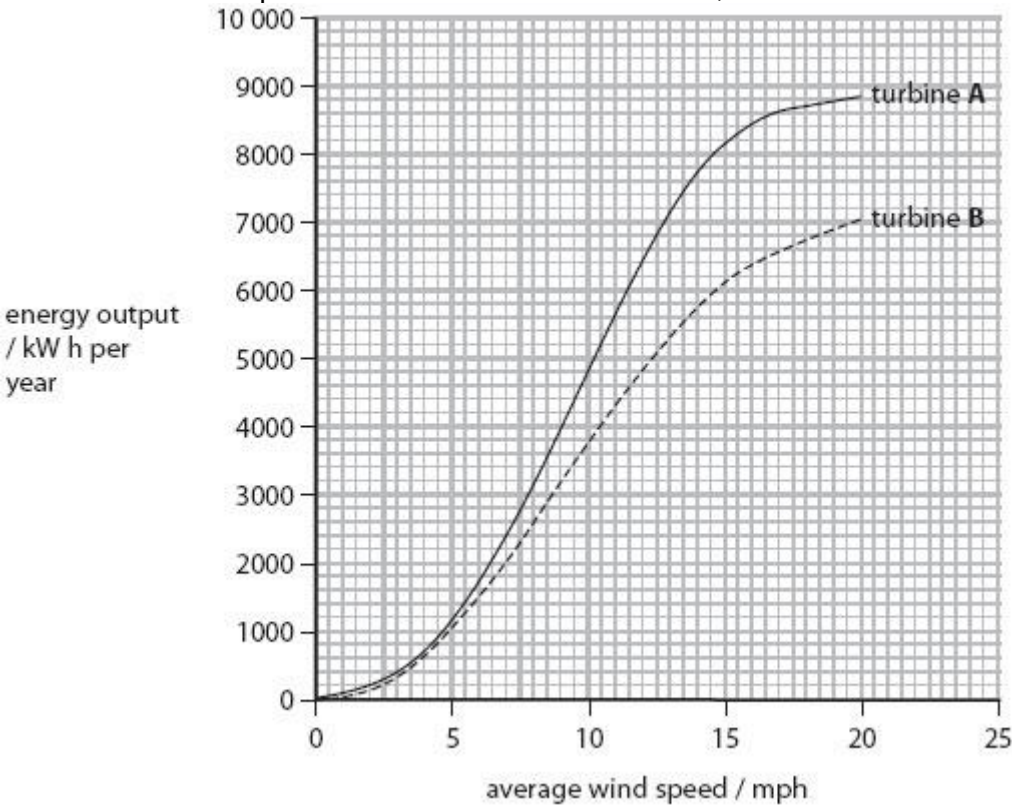
(2)

(ii) The car has a mass of 1400 kg and travels at a velocity of 25 m/s.
Calculate the kinetic energy of the car.

(3)

Q33.

(a) Eric owns a small farm where chicks are hatched from eggs.
He is considering generating his own electricity to heat and light a barn rather than using electricity from the National Grid.
This graph shows how the energy output varies with wind speed for two different wind turbines, **A** and **B**.



The average wind speed at Eric's farm is 13 mph.
The total heating and lighting in the barn requires 6000 kW h of electrical energy each year.

(i) Use the data in the graph to recommend the best turbine for Eric's barn.

(1)

(ii) Eric pays 14p per kW h for electrical energy supplied by the National Grid.
Calculate how much he could expect to save each year by using the energy from this wind turbine to heat and light the barn.

(2)

(iii) Eric looks at the cost of installing the turbine.
State how he should work out the payback time.

(1)

(iv) The chicks need to be kept warm at all times.
Eric uses halogen lamps to provide heat and light for most of the day.
Eric thinks about changing his halogen lamps for energy saving lamps.
Suggest why this might not actually be a benefit.

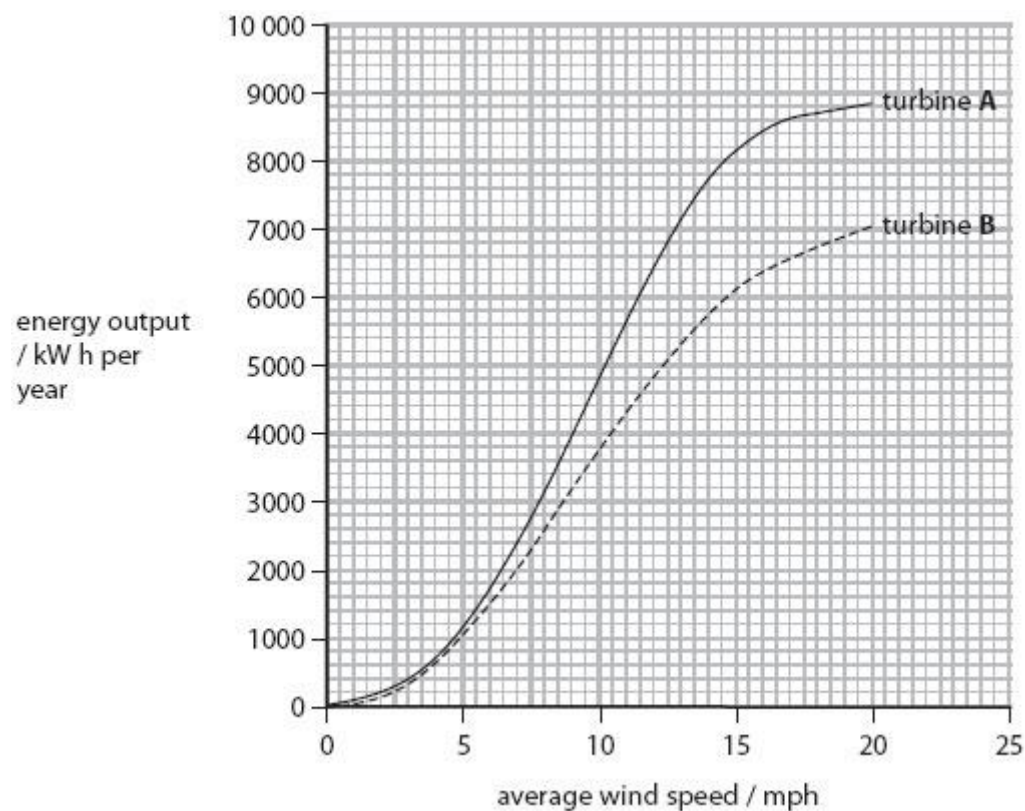
(2)

*(b) There are several large-scale energy resources which are suitable alternatives to fossil fuels in some situations.
Two of these alternatives are hydro-electric power and solar power.
Compare hydro-electric power with solar power as energy resources for the large-scale generation of electricity.

(6)

Q34.

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(2)

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(1)

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Eric uses halogen lamps to provide heat and light for most of the day.

Eric thinks about changing his halogen lamps for energy saving lamps.

Suggest why this might not actually be a benefit.

(2)

Q35.

Andrew skis down a hill.



(a) Andrew starts from the top of the hill and his speed increases as he goes downhill.

He controls his speed and direction by using his skis.

He brings himself to a stop at the bottom of the hill.

Describe the energy changes that happen between starting and stopping.

(3)

(b) Andrew returns to the top of the hill and starts again.

(i) His mass is 67 kg.

Show that his momentum is about 2000 kg m/s when his velocity is 31 m/s.

(2)

(ii) He falls over when his momentum is 2000 kg m/s.

After he falls over, he slows down by sliding across the snow.

It takes 2.3 s for his momentum to reduce to zero.

Calculate the average force on Andrew as he slows down.

(2)

(iii) Andrew is not injured by the fall even though he was moving quickly.

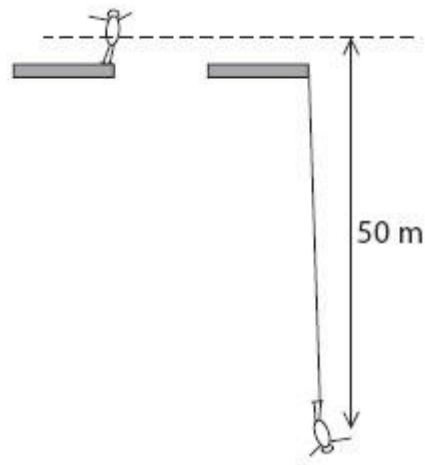
Use ideas about force and momentum to explain why he is not injured.

(2)

Q36.

A 60 kg student weighs 600 N.

He does a bungee jump.



- The bungee cord becomes straight and starts to stretch when he has fallen 50 m.
- (i) Calculate the change in gravitational potential energy as the student falls 50 m.
Give the unit.
- (ii) State at what point in the bungee jump the student has maximum kinetic energy.
- (iii) Explain why his maximum kinetic energy is likely to be less than your answer to (c)(i).

(3)

(1)

(2)

Q37.

- A pilot begins to land an aircraft.
The height of the aircraft decreases from 200 m above the ground to 100 m.
- (i) What happens to the gravitational potential energy of the aircraft?
Put a cross (■) in the box next to your answer.

(1)

- ☐ A it becomes zero
- ☐ B it decreases
- ☐ C it does not change
- ☐ D it increases

- (ii) The velocity of the aircraft remains constant.
What happens to the kinetic energy of the aircraft?
Put a cross (■) in the box next to your answer.

(1)

- ☐ A it becomes zero
- ☐ B it decreases
- ☐ C it does not change
- ☐ D it increases

Q38.

Three students carry out an investigation to determine their powers when running up stairs.
They take turns to run up the stairs and use a stopwatch to measure the time taken.
The students estimate their own weight.
Figure 8 shows a table of their results.
The table is not complete.

student	student estimate of weight in N	distance in m	work done	time taken in s	power in W
A	550	4.0	2200	5.0	440
B		4.0	1960	4.5	436
C	510	4.0	2040		425

Figure 8

Identify a significant source of error in the investigation and state how this error can be reduced.

(2)

source of error

.....

can be reduced by

.....

Q39.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

Which of these is the equation for work done?

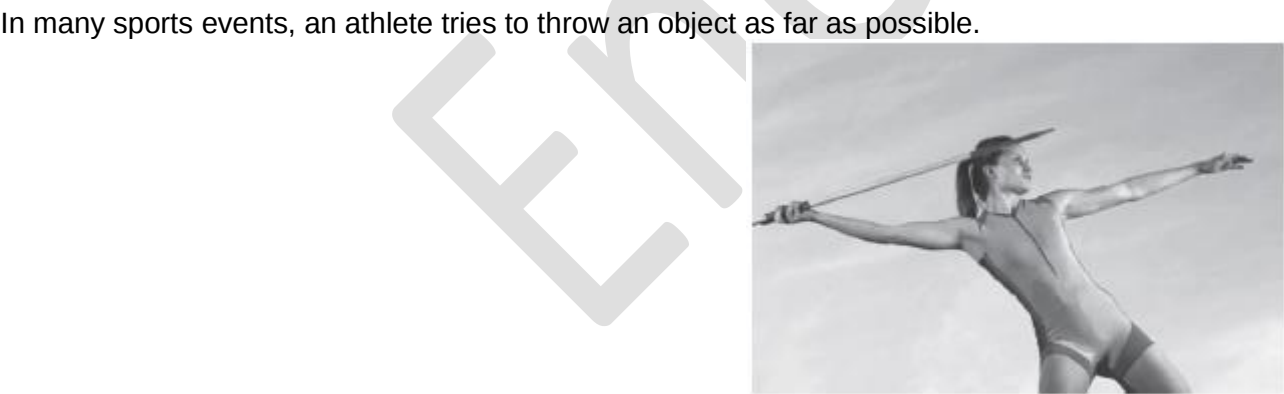
(1)

- ☐ A work done = force ÷ distance moved in direction of force
- ☐ B work done = force × distance moved in direction of force
- ☐ C work done = force ÷ distance moved at right angles to direction of force
- ☐ D work done = force × distance moved at right angles to direction of force

Q40.

- Some students investigate the efficiency of electric motors.
- (a) (i) The students find that one electric motor has an efficiency of 60%.
Explain in terms of energy what is meant by an efficiency of 60%. (2)
- (ii) The students use some motors to lift weights.
The students measure the input power and output power of two motors.
Complete the sentence by putting a cross (☒) in the box next to your answer.
The power of a motor is the rate at which it transfers (1)
- ☒ A current
☒ B energy
☒ C voltage
☒ D charge
- (iii) The first motor has a power rating of 20 W.
The motor is used for 15 s.
Calculate the energy supplied to the motor. (2)
- energy supplied to the motor = J
- (iv) In the second motor, the useful output power was 18 W when the input power was 24 W.
Calculate the efficiency of this motor. (2)
- efficiency = %
- (b) One of the students states that all of the energy supplied to a motor is transferred into other forms.
Complete the following sentence by putting a cross (☒) in the box next to your answer.
This statement is one example of the idea of (1)
- ☒ A renewable energy
☒ B conservation of energy
☒ C non-renewable energy
☒ D sustainable energy

Q41.



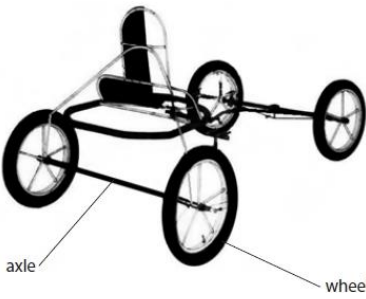
- (a) Sport scientists can use many words to describe the throwing of an object.
Four of these words are shown in the box.
Only one of these is a vector.
- | | | | |
|--------|----------|-------|-------|
| energy | momentum | power | speed |
|--------|----------|-------|-------|
- (i) Complete the sentence by putting a cross (☒) in the box next to your answer.
The vector is (1)
- ☒ A energy
☒ B momentum
☒ C power
☒ D speed
- (ii) Complete the sentence by using a word from the box above. (1)
- The rate of doing work is called
- (b) A javelin has a mass of 0.8 kg. In one throw, the javelin left the athlete's hand at a velocity of 25 m/s.
- (i) Calculate the kinetic energy of the javelin as it left the athlete's hand. State the unit. (3)
- (ii) State the amount of work done by the athlete on the javelin to get it to a velocity of 25 m/s.

(1)

(iii) A good javelin thrower will try to extend their arm as much as possible before releasing the javelin.
Explain why this allows them to do more work on the javelin.

(2)

(2)



turn.

(1)

Q42.

Figure 8 shows part of a cart.
When the wheels turn the axles become warm.
(i) Explain why the axles become warm when the wheels turn.

(ii) Give **one** way of reducing the heating of the axles when the wheels

Q43.

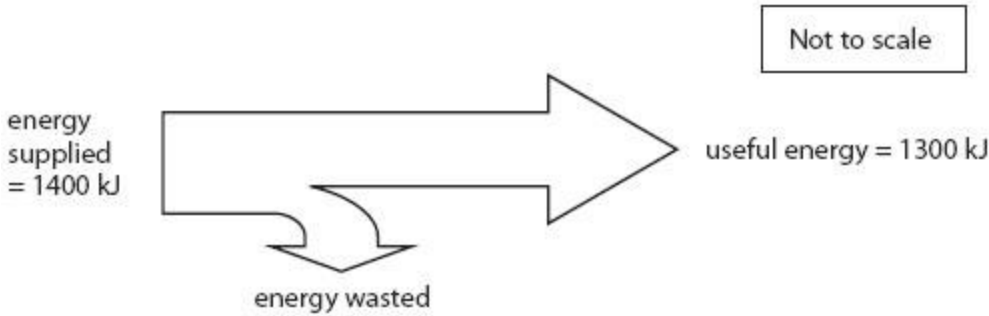
Some students investigate the efficiency of electric motors.
(i) The students find that one electric motor has an efficiency of 60%.
Explain in terms of energy what is meant by an efficiency of 60%.
(ii) The students use some motors to lift weights.
The students measure the input power and output power of two motors.
Complete the sentence by putting a cross (X) in the box next to your answer.
The power of a motor is the rate at which it transfers

- ☐ A current
- ☐ B energy
- ☐ C voltage
- ☐ D charge

(iii) The first motor has a power rating of 20 W.
The motor is used for 15 s.
Calculate the energy supplied to the motor.
(iv) In the second motor, the useful output power was 18 W when the input power was 24 W.
Calculate the efficiency of this motor.

Q44.

The diagram represents the energy transfer in one second in the generator.



(i) Calculate the amount of energy wasted in one second in the generator.
(ii) Calculate the efficiency of the generator.

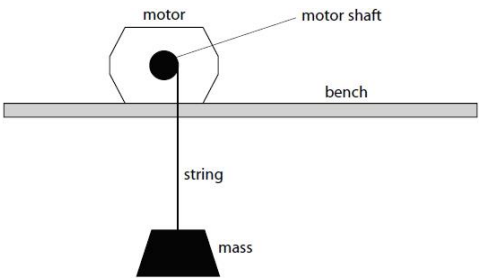
Q45.

The efficiency of an electric motor is investigated as shown in Figure 11.
The motor lifts a mass at a constant speed.

(a) Which of these best shows the energy stores as the mass is lifted?

	kinetic energy of the mass	potential energy of the mass
☐ A	constant	increasing
☐ B	constant	decreasing
☐ C	decreasing	increasing
☐ D	decreasing	decreasing

motor is energy Q46. water.



current in motor	1.9 A
voltage across motor	10.0 V
time taken to lift mass	9.0 s

The results are shown in Figure 12.

(b) D 70%.

An electr

Figure 8 used.

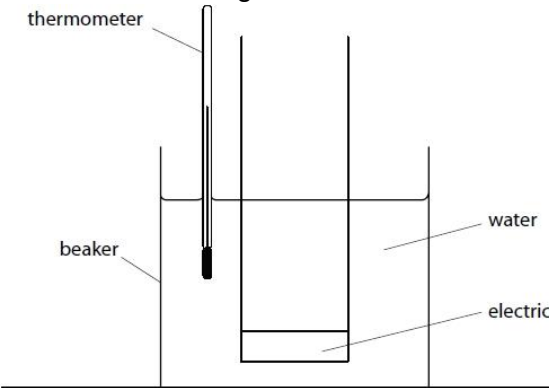


Figure 9 shows the energy transferred by

the electric heater in 1 second.

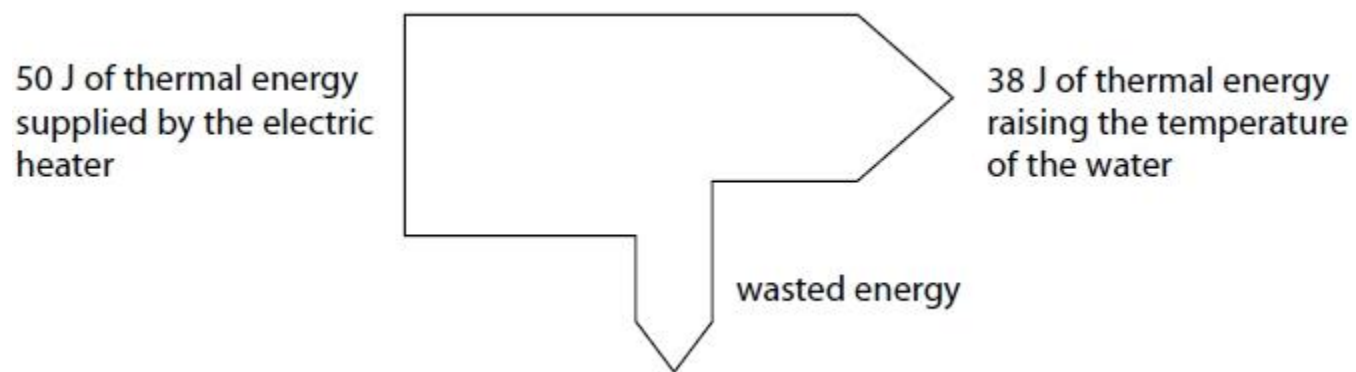


Figure 9

(i) How much energy is wasted each second?

(1)

- ☐ A 12 J
- ☐ B 38 J
- ☐ C 50 J
- ☐ D 88 J

(ii) Describe what happens to the wasted energy.

(2)

Q47.

Three students carry out an investigation to determine their powers when running up stairs. Figure 7 shows a diagram of the stairs with four distances, A, B, C and D, marked.

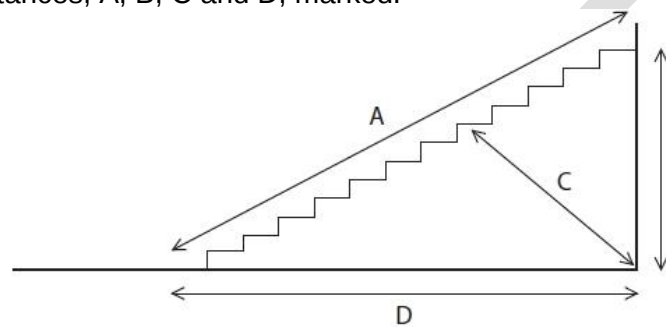


Figure 7

The students need to calculate the work done against gravity. Which distance should be used in the calculation?

(1)

- ☐ A A
- ☐ B B
- ☐ C C
- ☐ D D