

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.1.1.2 CHANGES IN ENERGY (PACK 2)

SCORE

/130

PERCENTAGE

%

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Q1.

Figure 1 shows a lift inside a building.

Figure 1



- (a) The motor in the lift does 120 000 J of work in 8.0 seconds.

Calculate the power output of the motor in the lift.

Use the equation:

$$\text{Power output} = \frac{\text{work done}}{\text{time}}$$

Power output = _____ W

(2)

- (b) The power input to the motor is greater than the power output.

Tick **two** reasons why.

Energy is transferred in heating the surroundings.

☐

Friction causes energy to be transferred in non-useful ways.

☐

The motor is connected to the mains electricity supply.

☐

The motor is more than 100% efficient.

☐

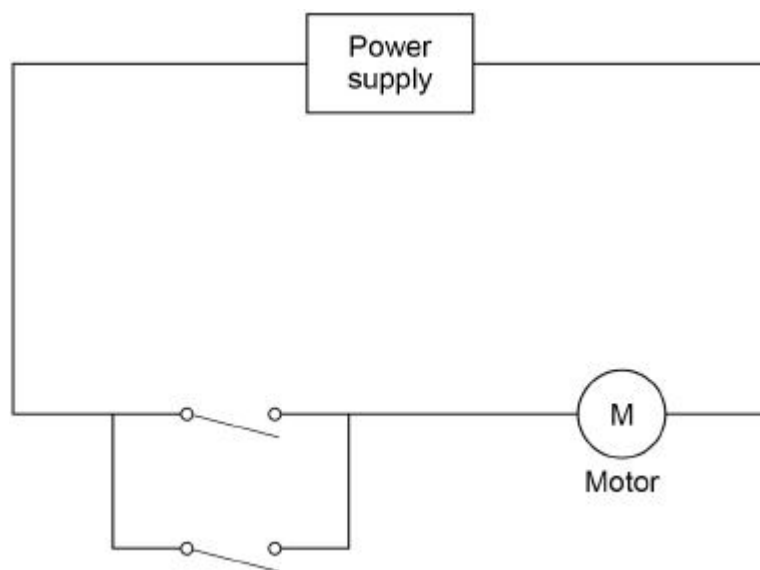
There are only four people in the lift.

☐

(2)

- (c) **Figure 2** shows part of the circuit that operates the lift motor.

Figure 2



The lift can be operated using either of the two switches.

Explain why.

(2)

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

(1)

- (e) The lift goes up 14 m. The total mass of the people in the lift is 280 kg.

gravitational field strength = 9.8 N/kg

Calculate the increase in gravitational potential energy of the people in the lift.

Give your answer to 2 significant figures.

Increase in gravitational potential energy = _____ J

(3)

(Total 10 marks)

Q2.

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^3 .

Calculate the mass of air passing the blades per second.

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.

(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.

Speed of air = _____ m/s

(3)

(Total 9 marks)

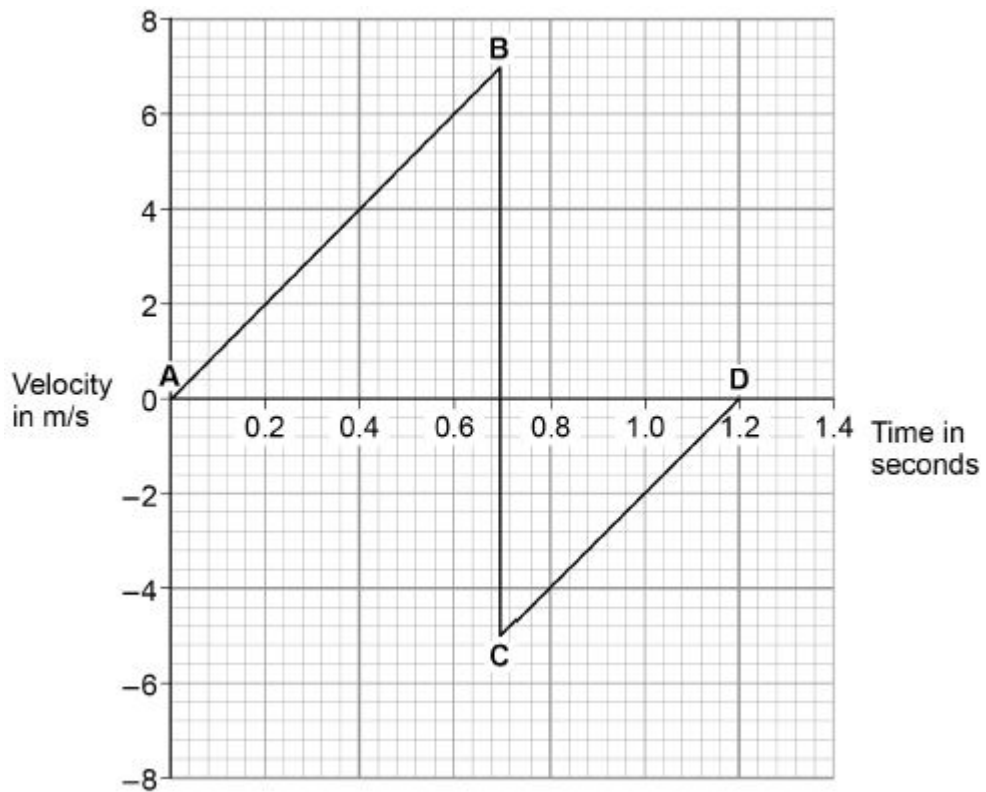
Q3.

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.

(2)

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

(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.

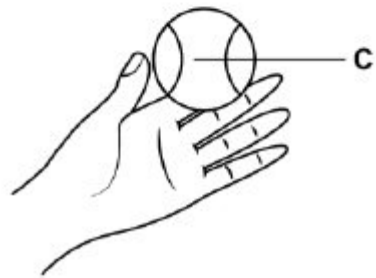
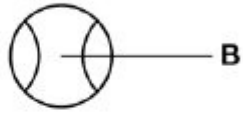
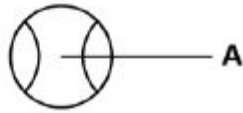
Explain how the data in the graph above shows this energy transfer.

(4)

(Total 8 marks)

Q4.

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**.

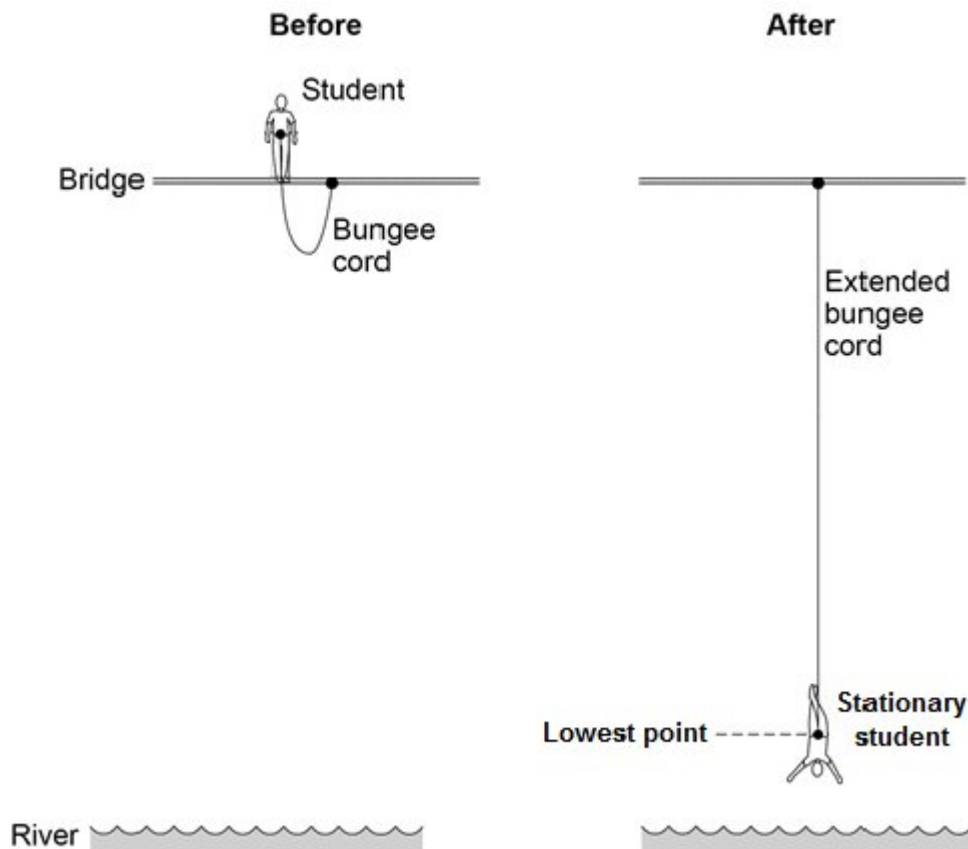
gravitational field strength = 9.8 N/kg

Height = _____ m (3)
(Total 8 marks)

Q5.

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

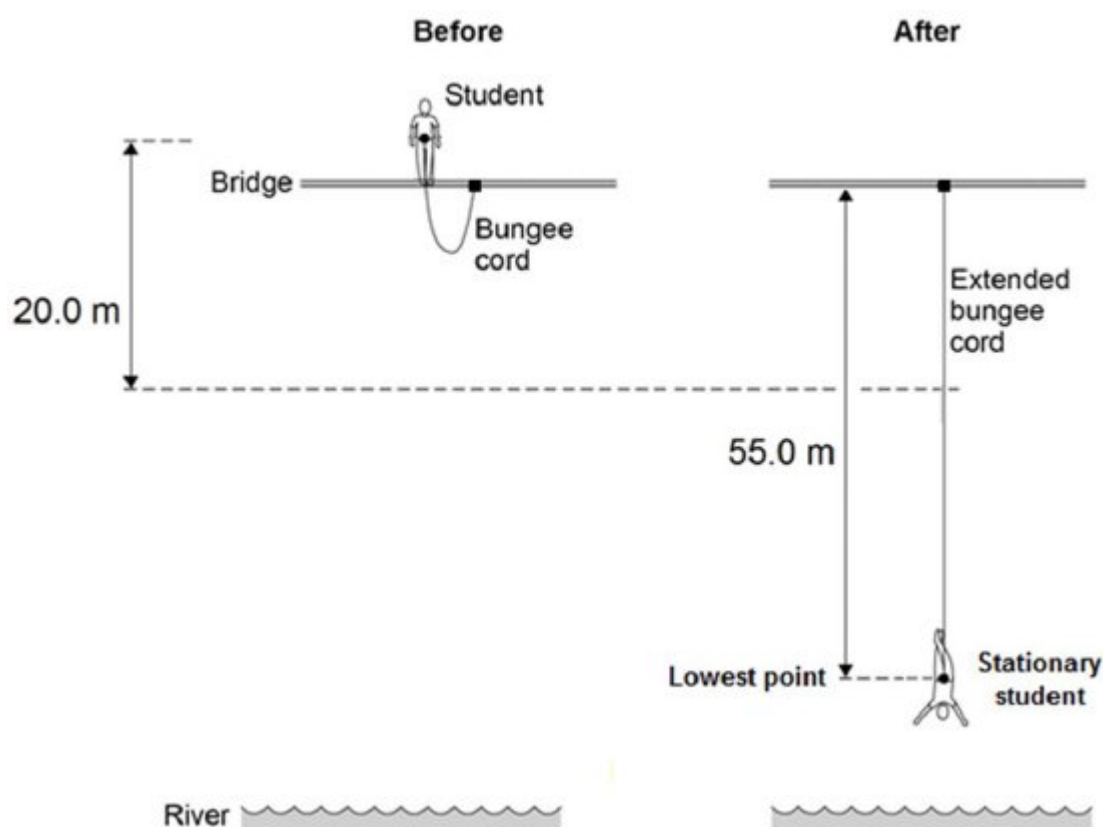
(2)

(Total 7 marks)

Q6.

The figure below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m .



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N / kg.

- (a) Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

_____ (1)

- (b) Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

Change in gravitational potential energy = _____ J (2)

- (c) 80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

Kinetic energy gained = _____ J (1)

- (d) Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

Speed = _____ m / s (4)

- (e) At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

Spring constant = _____ N / m

(3)

(Total 11 marks)

Q7.

The figure below shows the horizontal forces acting on a car.



- (a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down.

☐

It will be stationary.

☐

It will have a constant speed.

☐

It will be speeding up.

☐

(1)

- (b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time

☐

distance travelled = speed $\times$ time

☐

distance travelled = speed - time

☐

distance travelled = speed $\div$ time

☐

(1)

- (c) During a different part of the journey the car accelerates from 9 m/s to 18 m/s in 6 s.

Use the following equation to calculate the acceleration of the car.

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$\text{acceleration} = \underline{\hspace{4cm}} \text{ m/s}^2$$

(2)

- (d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration

☐

resultant force = mass $\times$ acceleration

☐

resultant force = mass - acceleration

☐

resultant force = mass $\div$ acceleration

☐

(1)

- (e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

$$\text{Resultant force} = \underline{\hspace{4cm}} \text{ N}$$

(2)

- (f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

$$\text{Distance} = \underline{\hspace{4cm}} \text{ m}$$

(3)

- (g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

(4)

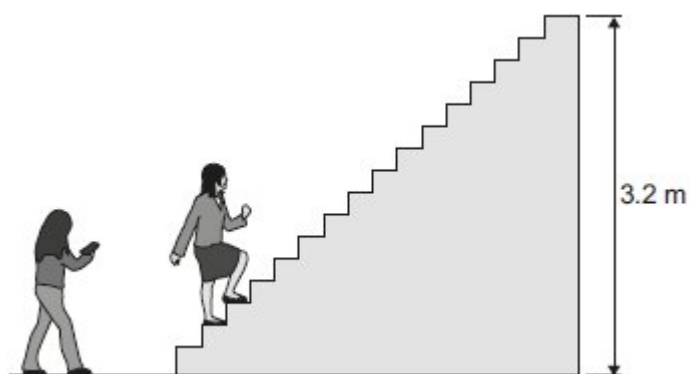
(Total 14 marks)

Q8.

A student did an experiment to calculate her power.

The diagram below shows how she obtained the measurements needed.

The student first weighed herself and then ran up a flight of stairs. A second student timed how long it took her to go from the bottom to the top of the stairs. The height of the stairs was also measured.



- (a) Complete the following sentence.

To run up the stairs the student must do work against
the force of _____ .

(1)

- (b) The student did 2240 J of work going from the bottom of the stairs to the top of the stairs.

The student took 2.8 seconds to run up the stairs.

- (i) Calculate the power the student developed when running up the stairs.

Power = _____ W

(2)

- (ii) How much gravitational potential energy did the student gain in going from the bottom to the top of the stairs?

Tick (✓) **one** box.

much more than 2240 J

☐

2240 J

☐

much less than 2240 J

☐

(1)

- (c) Another four students did the same experiment.

The measurements taken and the calculated values for power are given in the table.

Student	Weight in newtons	Time taken in seconds	Power in watts
A	285	3.8	240
B	360	2.4	480
C	600	3.4	560
D	725	4.0	580

- (i) To make a fair comparison of their powers the students kept **one** variable in the experiment constant.

What variable did the students keep constant?

(1)

- (ii) From the data in the table a student wrote the following conclusion.

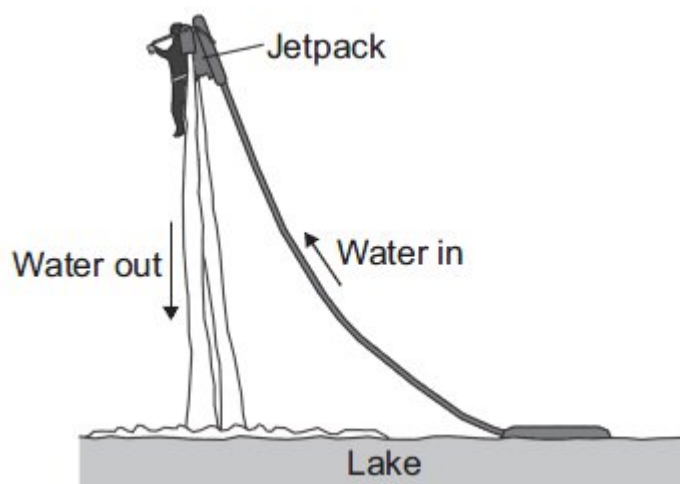
'The greater the weight of the student the greater the power developed.'

Suggest why this conclusion may **not** be true for a larger group of students.

(1)
(Total 6 marks)

Q9.

The diagram below shows a person using a device called a jetpack. Water is forced downwards from the jetpack and produces an upward force on the person.



- (a) State the condition necessary for the person to be able to remain stationary in mid-air.

(1)

- (b) The person weighs 700 N and the jetpack weighs 140 N.

- (i) Calculate the combined mass of the person and the jetpack.

Gravitational field strength = 10 N/kg

Combined mass = _____ kg

(2)

- (ii) Increasing the upward force to 1850 N causes the person to accelerate upwards.

Calculate the acceleration of the person and the jetpack. Give the unit.

Acceleration = _____ Unit _____

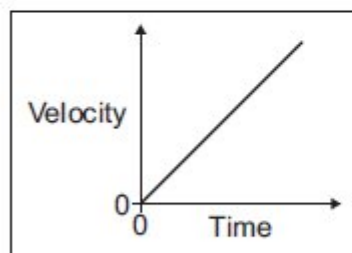
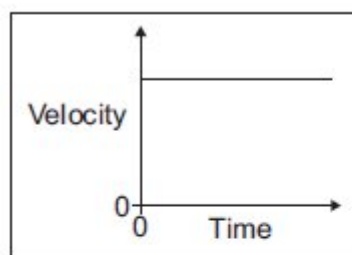
(3)

(Total 6 marks)

Q10.

- (a) Draw **one** line from each velocity–time graph to the statement describing the motion shown by the graph.

Velocity–time graph



Motion shown by graph

Constant acceleration

Not moving

Constant deceleration

Constant velocity

(2)

- (b) Use the correct answer from the box to complete the sentence.

energy momentum speed

The velocity of an object includes both the _____ of the object and the direction the object is moving.

(1)

- (c) At the start of a race, a horse accelerates from a velocity of 0 m/s to a velocity of 9 m/s in 4 seconds.

- (i) Calculate the acceleration of the horse.

Acceleration = _____ m/s²

(2)

- (ii) When the horse accelerates, what, if anything, happens to the air resistance acting against the horse?

Tick (✓) **one** box.

The air resistance decreases

☐

The air resistance is constant

☐

The air resistance increases

☐

(1)

- (d) A horse and a pony walk across a field at the same constant speed.

The horse has 4000 joules of kinetic energy.

The pony is **half** the mass of the horse.

What is the kinetic energy of the pony?

Draw a ring around the correct answer

2000 J

4000 J

8000 J

Give a reason for your answer.

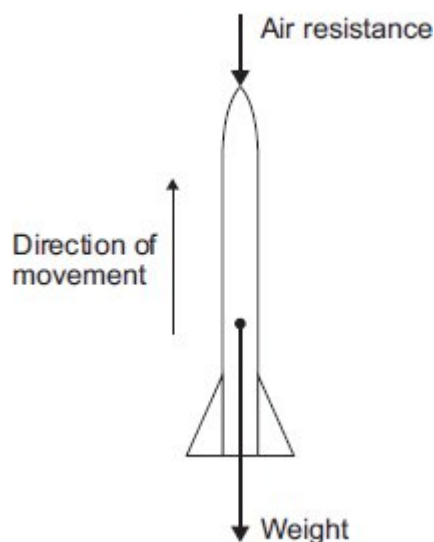
(2)

(Total 8 marks)

Q11.

- (a) **Figure 1** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 1



- (i) How does the velocity of the rocket change as the rocket moves **upwards**?

Give a reason for your answer.

(2)

- (ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

(1)

- (b) The speed of the rocket just after being launched is 12 m / s .
The mass of the rocket is 0.05 kg .

- (i) Calculate the kinetic energy of the rocket just after being launched.

Kinetic energy = _____ J

(2)

- (ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

Maximum gravitational potential energy = _____ J

(1)

(iii) Calculate the maximum height the rocket will reach.

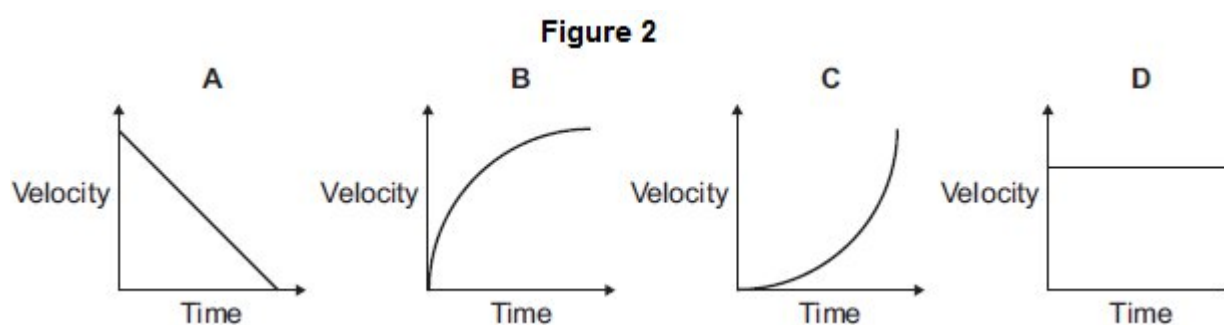
Ignore the effect of air resistance.

Gravitational field strength = 10 N/kg.

Maximum height = _____ m

(2)

(iv) **Figure 2** shows four velocity–time graphs.



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

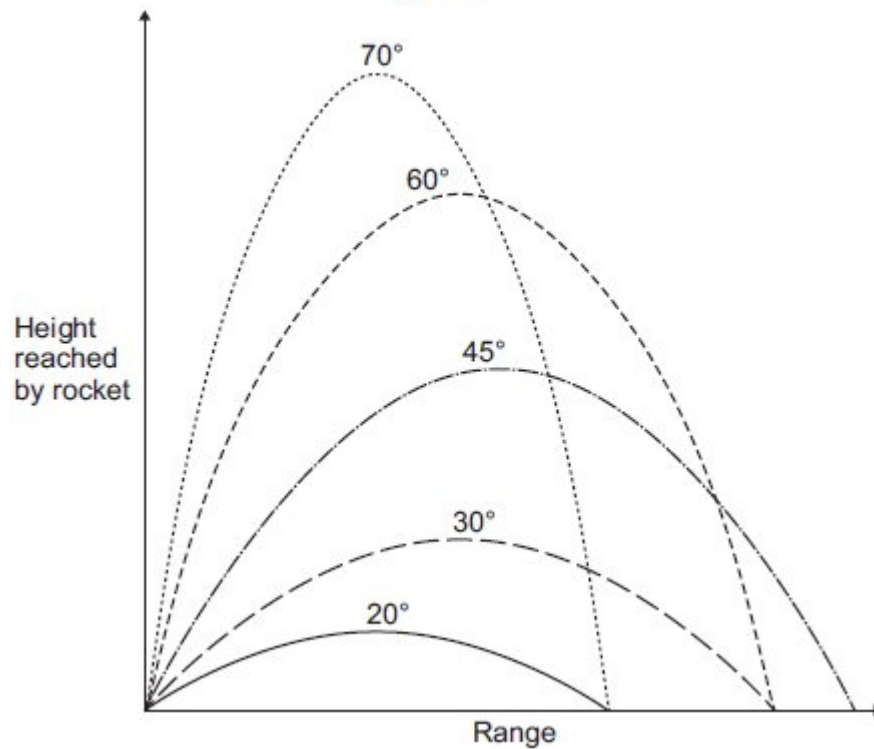
Write the correct answer in the box.

(1)

- (c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 3 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 3



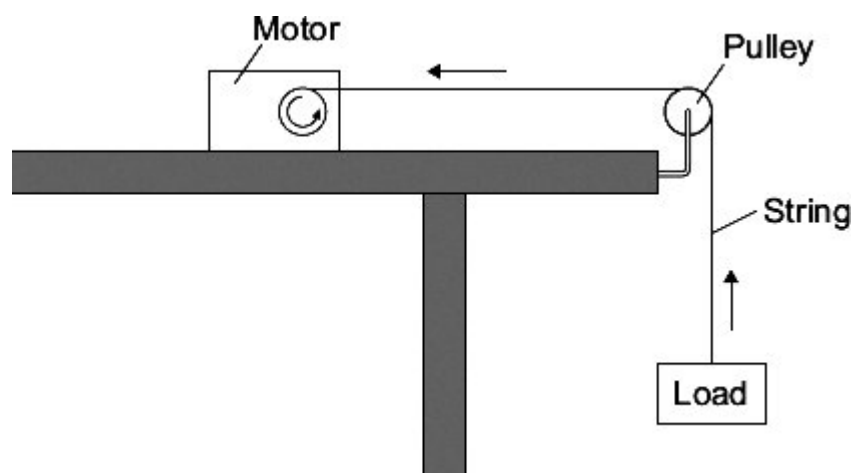
What pattern links the angle at which the rocket is launched and the range of the rocket?

(2)

(Total 11 marks)

Q12.

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.

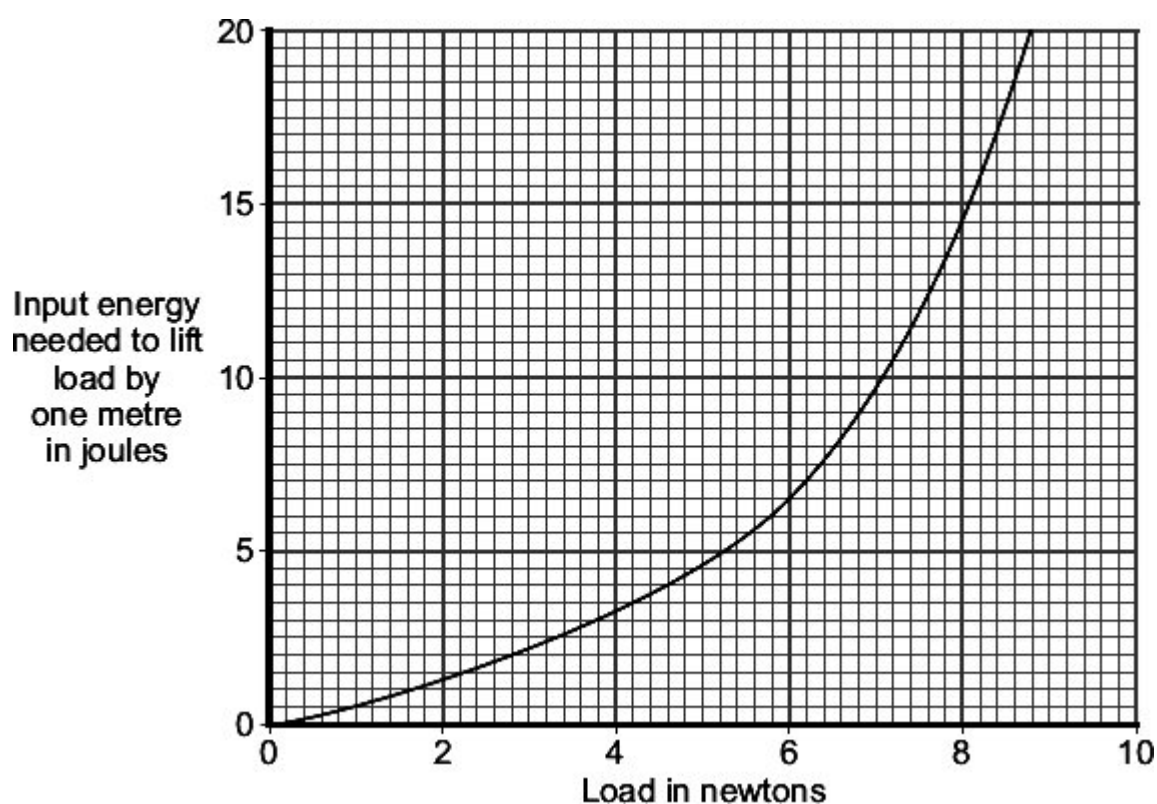
- (a) (i) Name the useful energy output from the electric motor.

(1)

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

(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?

(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.

Cost = _____ pence

(3)

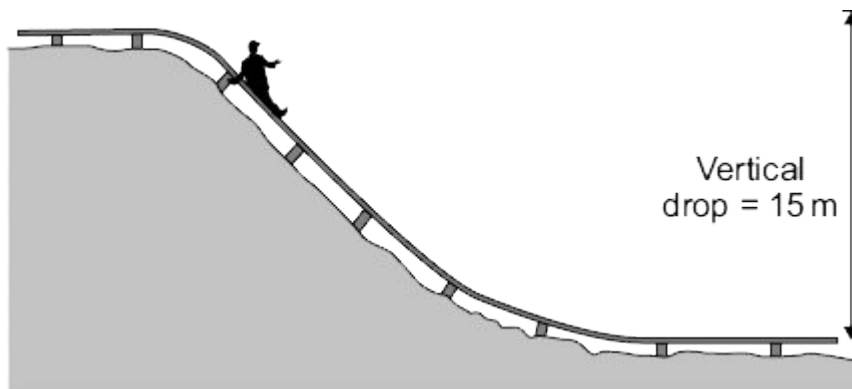
- (ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

(1)

(Total 8 marks)

Q13.

The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.



- (a) A miner of mass 90 kg travels down the slide.

Calculate the change in gravitational potential energy of the miner when he moves 15 m vertically downwards.

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

Change in gravitational potential energy = _____ J

(2)

- (b) Calculate the **maximum** possible speed that the miner could reach at the bottom of the slide.

Show clearly how you work out your answer.

Give your answer to an appropriate number of significant figures.

Maximum possible speed = _____ m/s

(3)

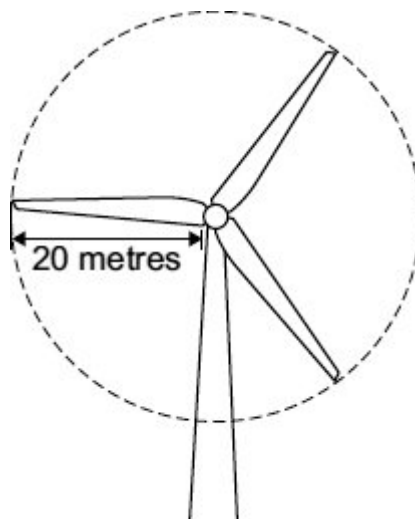
- (c) The speed of the miner at the bottom of the slide is much less than the calculated maximum possible speed.

Explain why.

(3)
(Total 8 marks)

Q14.

The diagram shows a wind turbine.



- (a) The blades of the turbine are 20 metres long. On average, 15 000 kg of air, moving at a speed of 12 m/s, hit the blades every second.

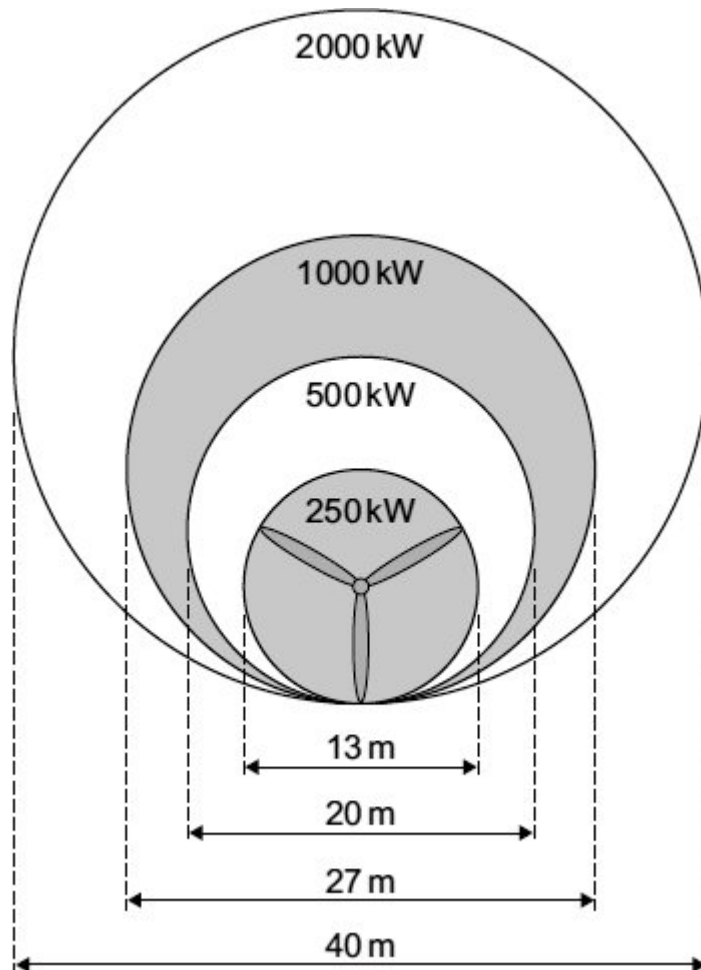
Calculate the kinetic energy of the air hitting the blades every second.

Show clearly how you work out your answer.

Kinetic energy = _____ J

(2)

- (b) Part of the kinetic energy of the wind is transformed into electrical energy. The diagram shows that, for the same wind speed, the power output of a turbine, in kilowatts, depends on the length of the turbine blades.



Give a reason why doubling the diameter of the blades more than doubles the power output of a turbine.

(1)

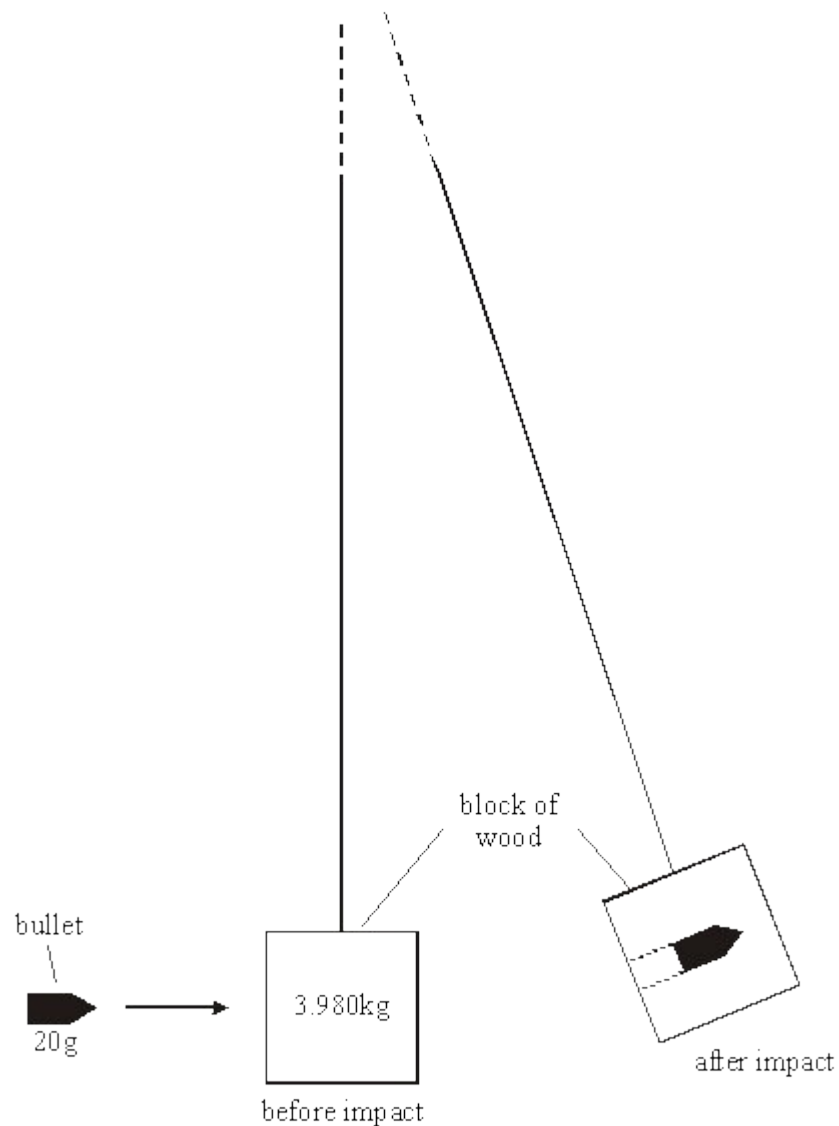
(Total 3 marks)

Q15.

- (a) When an object is moving it is said to have momentum.
Define momentum.

(1)

- (b) The diagram below shows one way of measuring the velocity of a bullet.



A bullet is fired into a block of wood suspended by a long thread.
 The bullet stops in the wooden block.
 The impact of the bullet makes the block swing.
 The velocity of the wooden block can be calculated from the distance it swings.

In one such experiment the block of wood and bullet had a velocity of 2 m/s **immediately after** impact. The mass of the bullet was 20 g and the mass of the wooden block 3.980 kg.

- (i) Calculate the combined mass of the block of wood and bullet.

_____ Mass _____

(1)

- (ii) Calculate the momentum of the block of wood and bullet **immediately after** impact.

_____ Momentum _____
(3)

- (iii) State the momentum of the bullet **immediately before** impact.

(1)

- (iv) Calculate the velocity of the bullet **before** impact.

_____ Velocity _____ m/s
(3)

- (v) Calculate the kinetic energy of the block of wood and bullet **immediately after** impact.

_____ Kinetic energy _____ J
(3)

- (vi) The kinetic energy of the bullet before the impact was 1600 joules. This is much greater than the kinetic energy of the bullet and block just after the impact.
What has happened to the rest of the energy?

(1)

(Total 13 marks)

Mark schemes

Q1.

- (a) $P = \frac{120\,000}{8.0}$ 1
- $P = 15\,000 \text{ (W)}$ 1
- an answer of 15 000 (W) scores 2 marks*
- (b) energy is transferred in heating the surroundings 1
- friction causes energy to be transferred in non-useful ways 1
- (c) the switches are in parallel 1
- (so) closing either switch completes the circuit 1
- (d) gravitational potential energy = mass $\times$ gravitational field strength $\times$ height
allow $E_p = m g h$ 1
- (e) $E_p = 280 \times 9.8 \times 14$ 1
- $E_p = 38\,416 \text{ (J)}$ 1
- $E_p = 38\,000 \text{ (J)}$
an answer that rounds to 38 000 scores 2 marks 1
an answer of 38 000 scores 3 marks
- [10]**

Q2.

- (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 $2.8 \times 10^4 \text{ (kg)}$
- 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]

Q3.

- (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]

Q4.

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

allow $E_k = 1/2 mv^2$

1

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

1

$E_k = 0.725 \text{ (J)}$

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 $\times$ gravitational field strength $\times$ height

allow $E_p = mgh$

1

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

1

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

1

$h = 0.67 \text{ (m)}$

an answer that rounds to 0.67 scores 3 marks

1

[8]

Q5.

(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]

Q6.

(a) g.p.e. = mass $\times$ gravitational field strength $\times$ height

accept $E_p = mgh$

1

(b) $E_p = 50 \times 9.8 \times 20$

1

9800 (J)

allow 9800 (J) with no working shown for 2 marks

answer may also be correctly calculated using $W = Fs$

ie allow $W = 490 \times 20$ for 1 mark

or answer of 9800 (J) using this method for 2 marks

1

(c) 7840 (J)

allow ecf from '11.2'

1

(d) $7840 = \frac{1}{2} \times 50 \times v^2$

1

$$v = \sqrt{\frac{7840}{\frac{1}{2} \times 50}}$$

allow $v^2 = \frac{7840}{(\frac{1}{2} \times 50)}$ for this point

1

$$17.7(0875) \text{ (m / s)}$$

1

$$18 \text{ (m / s)}$$

allow ecf from '11.3' correctly calculated for 3 marks

allow 18 (m / s) with no working for 2 marks

answer may also be correctly calculated using $v^2 - u^2 = 2as$

1

- (e) extension = 35 (m) and conversion of 24.5 kJ to 24500 J

1

$$24\,500 = \frac{1}{2} \times k \times 35^2$$

1

$$40$$

1

allow 40 with no working shown for 3 marks

an answer of '16.2' gains 2 marks

[11]

Q7.

- (a) It will have a constant speed.

1

- (b) distance travelled = speed $\times$ time

1

- (c) $a = \frac{18 - 9}{6}$

$$6$$

1

$$a = 1.5$$

allow 1.5 with no working shown for 2 marks

1

- (d) resultant force = mass $\times$ acceleration

1

- (e) $F = (1120 + 80) \times 1.5$

1

$$F = 1800 \text{ (N)}$$

allow 1800 with no working shown for 2 marks

1

accept their 10.3×1200 correctly calculated for 2 marks

- (f) $18^2 - 9^2 = 2 \times 1.5 \times s$

1

$$s = \frac{18^2 - 9^2}{2 \times 1.5}$$

1

$$s = 81 \text{ (m)}$$

1

allow 81 (m) with no working shown for 3 marks

*accept answer using their 10.3 (if not 1.5) correctly
calculated for 3 marks*

(g) **Level 2 (3–4 marks):**

A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):

Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:

No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]

Q8.

(a) gravity

*accept weight for gravity
air resistance is insufficient*

1

(b) (i) 800

allow 1 mark for correct substitution ie

$$P = \frac{2240}{2.8}$$

provided no subsequent step

2

(ii) 2240 J

1

(c) (i) (vertical) height

accept (height of) stairs

1

(ii) a fast / short time (for a lighter student) may give the greatest power

accept time is a factor

or

a slow / long time (for a heavy student) may give the least power

fitness is insufficient

1

[6]

Q9.

- (a) resultant force = zero

or

upward force = downward force

accept forces are balanced

accept weight for downward force

1

- (b) (i) 84

allow 1 mark for correct substitution ie $840 = m \times 10$

2

- (ii) 12

accept 12.02 for both marks

or

1010 ÷ their (b)(i) correctly calculated

a resultant force of 1010 (N) gains 1 mark

an answer 22(.02) gains 1 mark

2

m/s²

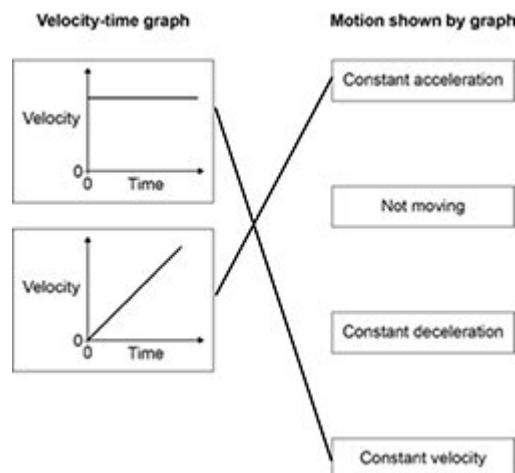
accept m/s/s

1

[6]

Q10.

- (a)



if more than one line is drawn from a graph then all those lines are wrong allow 1 mark for 1 correct line

2

- (b) speed

1

- (c) (i) 2.25

allow 1 mark for correct substitution i.e.

$$a = \frac{9 - 0}{4} \text{ or } a = \frac{9}{4}$$

provided no subsequent step

		2
	(ii) the air resistance increases	1
(d)	2000 J	1
	mass is half or kinetic energy depends on mass <i>do not accept weight for mass</i>	1
		[8]
Q11.		
(a)	(i) decreases (to zero)	1
	resultant force acts in opposite direction to motion <i>accept air resistance and weight for resultant force</i> <i>accept resultant force acts downwards</i> <i>do not accept air resistance increases</i>	1
	(ii) velocity includes direction or velocity is a vector (quantity)	1
(b)	(i) 3.6 <i>allow 1 mark for correct substitution i.e.</i> <i>$\frac{1}{2} \times 0.05 \times 12^2$ provided no subsequent step</i>	2
	(ii) 3.6 or their (i)	1
	(iii) 7.2 or their (ii) $\div 0.5$ correctly calculated <i>allow 1 mark for correct substitution i.e.</i> <i>3.6 or their (ii) = $0.05 \times 10 \times h$</i>	2
	(iv) B	1
(c)	range increases up to 45°	1
	range decreases from 45° <i>the range is a maximum at 45° gains both marks</i> <i>for any two angles that add up</i> <i>to 90° the range is the same gains both marks</i> <i>the range increases then decreases gains 1 mark</i>	

Q12.

- (a) (i) kinetic (energy)
allow gravitational potential (energy) / gpe
movement is insufficient
- (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

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]

Q13.

- (a) 13 500 (J)

allow 1 mark for correct substitution, ie $90 \times 10 \times 15$ provided
no subsequent step shown

2

- (b) 17

or

$$\sqrt{\frac{\text{their (a)}}{45}}$$

correctly calculated and answer given to 2 or 3 significant figures

accept 17.3

allow 2 marks for an answer with 4 or more significant
figures, ie 17.32

or

allow 2 marks for correct substitution, ie $13\,500 / \text{their (a)} = \frac{1}{2}$
 $\times 90 \times v^2$

or

allow 1 mark for a statement or figures showing $KE = GPE$

3

- (c) work is done

1

(against) friction (between the miner and slide)

accept 'air resistance' or 'drag' for friction

1

(due to the) slide not (being perfectly) smooth

accept miners clothing is rough

or

causing (kinetic) energy to be transferred as heat/internal energy of surroundings

accept lost/transformed for transferred

accept air for internal energy of surroundings

1

[8]

Q14.

- (a) 1 080 000

allow 1 mark for correct substitution

ie $\frac{1}{2} \times 15\,000 \times 12 \times 12$

2

- (b) any one from:

- KE (of wind) more than doubles
- mass of air (hitting blades) more than doubles
- area swept out by blades more than doubles
*do **not** accept blades are larger / have a bigger area*
- area swept out by blades increases $\times 4$

1

[3]

Q15.

- (a) product of mass and velocity

1

- (b) (i) 4kg or 4000g

1

- (ii) $M = 8\text{kgm/s}$ or Ns
for 3 marks

else $M = 8$
for 2 marks

else $M = mv$ or 4×2
for 1 mark

3

- (iii) 8 kgm/s (watch e.c.f.)

1

- (iv) $v = 400$
for 3 marks

else $v = 8/0.02$
for 2 marks

else $M = mv$, $v = M/m$ or $8 = 0.02v$
for 1 mark

3

- (v) $ke = 8$
for 3 marks

else $ke = 1/2 (4 \times 2^2)$
for 2 marks

else $ke = 1/2 (mv^2)$
for 1 mark

3

- (vi) transferred to heat and sound
or does work against wood/pushing wood aside/deforming bullet

1

[13]