

Name: _____

Energy - Forces doing work

Separate Physics Question Pack

Date:

Time: 2 hours 4 minutes

Total marks available: 124

Total marks achieved: _____

Q1.

An athlete uses a training machine in a gym.

The display on the machine shows the time spent on the machine and the amount of energy transferred during a training session.

Figure 5 shows the displays for two different sessions by the same athlete.

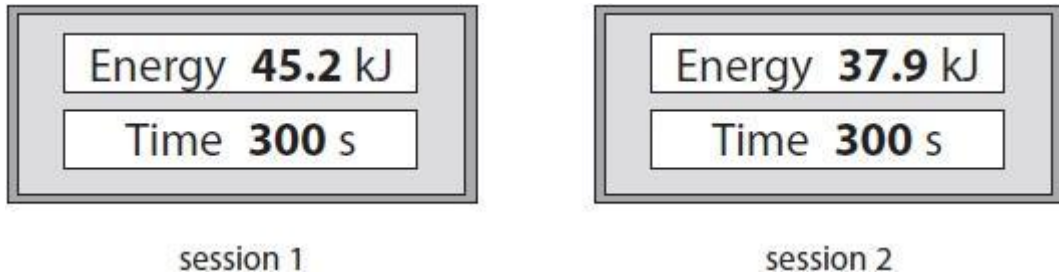


Figure 5

Explain what the displays show about the average power of the athlete in each of these two sessions.

(2)

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(Total for question = 2 marks)

Q2.

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.

The cyclist starts to cycle again.

The cyclist does 1600 J of useful work to travel 28 m.

Calculate the average force the cyclist exerts.

(3)

average force = N

(Total for question = 3 marks)

Q3.

A rock falls off the top of a cliff of height h .

Figure 3 shows the rock falling.

The Earth exerts a force of 150 N on the rock.

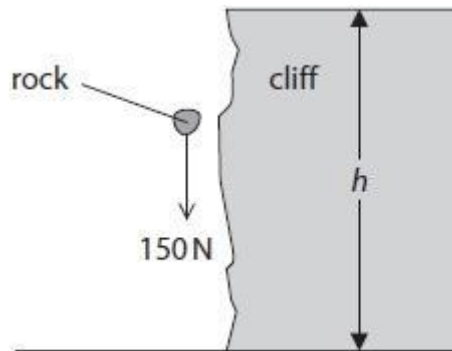


Figure 3

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)

$h = \dots\dots\dots$ m

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

(1)

kinetic energy = $\dots\dots\dots$ J

(iii) The mass of the rock in Figure 3 is 15 kg.

Calculate the velocity of the rock just before it reaches the bottom of the cliff.

(2)

velocity = m/s

(Total for question = 5 marks)

Q4.

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)

change in gravitational potential energy = J

(ii) The ball is released.

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

(3)

kinetic energy of the ball = J

(iii) The ball bounces several times.

Figure 4 shows how the height of the ball above the floor changes with time.

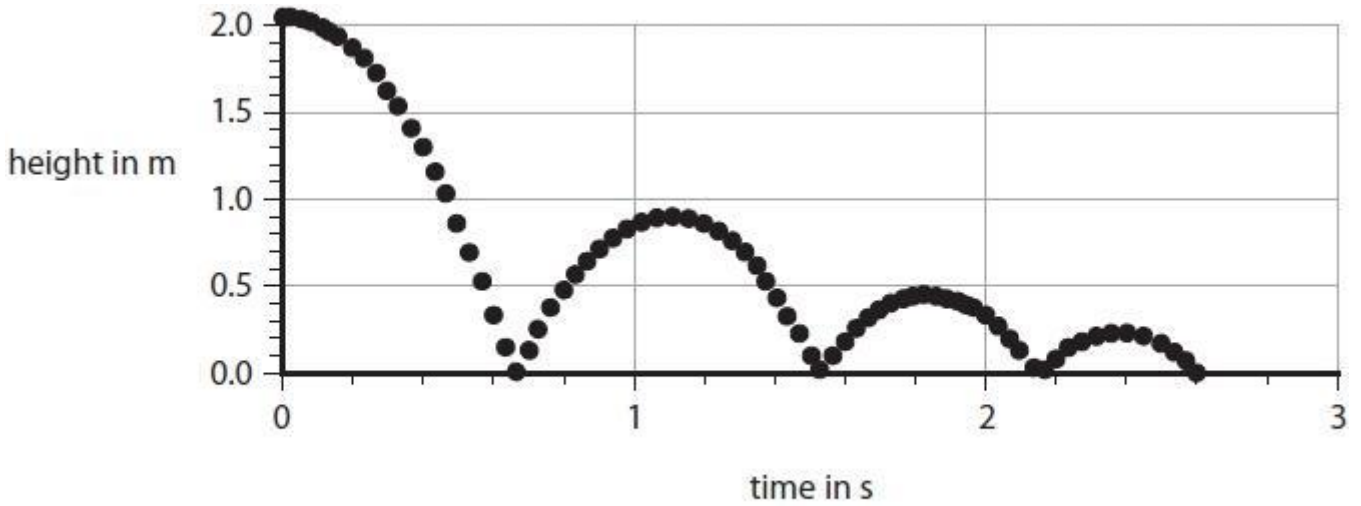


Figure 4

Use Figure 4 to estimate the maximum height that the ball reaches after the first bounce.

(1)

height after first bounce = m

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

(2)

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(Total for question = 8 marks)

Q5.

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 $g = 10\text{N/kg}$.

(2)

change in gravitational potential energy = J

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

(1)

useful work done = J

(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)

useful power developed = W

(Total for question = 5 marks)

Q6.

Figure 15 shows a 'Mars rover' descending to the surface of the planet Mars.

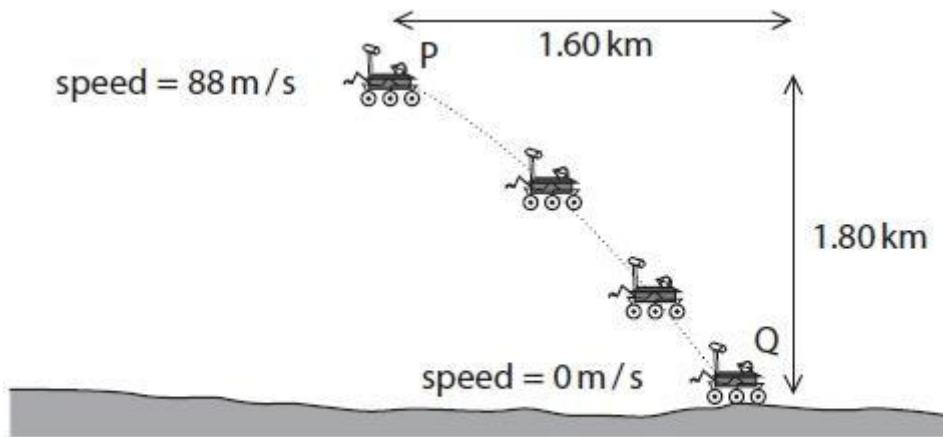


Figure 15

(i) Calculate the change in gravitational potential energy of the rover as it descends from position P to position Q.

Mass of rover = 1100 kg

Gravitational field strength on Mars = 3.7 N / kg

Give your answer to 2 significant figures.

(3)

change in gravitational potential energy = J

(ii) Use data from Figure 15 to calculate the change in kinetic energy of the rover as it descends from position P to position Q.

(2)

change in kinetic energy = J

(iii) The rover is slowed down safely using thrusters and a parachute (not shown in Figure 15).

The thrusters use jets of gas to control movements and the parachute is designed to be used in the atmosphere of Mars.

Describe the energy changes involved in terms of the work done by various forces as the rover descends.

(3)

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(Total for question = 8 marks)

Q7.

Figure 8 shows a bicycle.



Figure 8

(i) The rider uses the pedals to make the large gear wheel turn.

The large gear wheel moves the chain.

The chain turns the small gear wheel.

The large gear wheel has 48 teeth.

The small gear wheel has 12 teeth.

The large gear wheel turns 2 times each second.

Calculate the number of times that the small gear wheel turns each second.

(2)

..... turns each second

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 9.

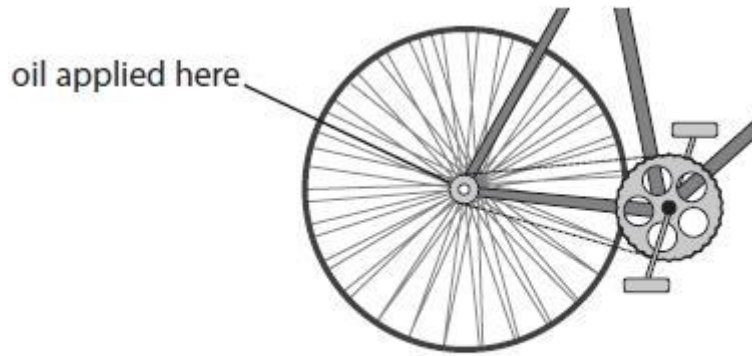


Figure 9

Explain how the oil improves the efficiency of the bicycle.

(3)

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(Total for question = 5 marks)

Q8.

Figure 14 shows an athlete using a fitness device.

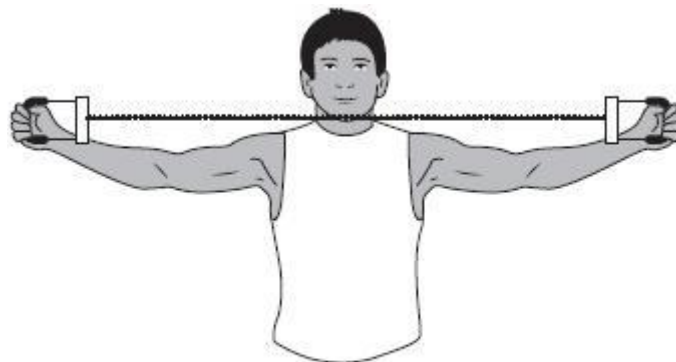


Figure 14

The athlete stretches the spring in the device by pulling the handles apart.

The spring constant of the spring is 140 N/m.

The athlete does 45 J of work to extend the spring.

The athlete takes 0.6 s to expand the spring.

(i) Calculate the useful power output of the athlete when stretching the spring.

(2)

useful power output of the athlete = W

(ii) Calculate the extension of the spring.

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

(3)

extension of the spring = m

(Total for question = 5 marks)

Q9.

The kinetic energy of another cyclist is 2800 J.

The mass of the cyclist is 85 kg.

Calculate the velocity of this cyclist.

Use the equation

$$KE = \frac{1}{2} \times m \times v^2$$

(3)

velocity = m / s

(Total for question = 3 marks)

Q10.

Fuel weighing 230 000 N is pumped into an aircraft.
This fuel moves upwards through a vertical height of 4.7 m.
The power developed by the pump is 1600 W.
Calculate the time needed to refuel the aircraft.

(3)

time = s

(Total for question = 3 marks)

Q11.

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.
Use the equation

$$KE = \frac{1}{2} \times m \times v^2$$

(2)

kinetic energy = J

(Total for question = 2 marks)

Q12.

Figure 14 shows a demolition ball of mass 400 kg.
The ball is used to demolish a wall.

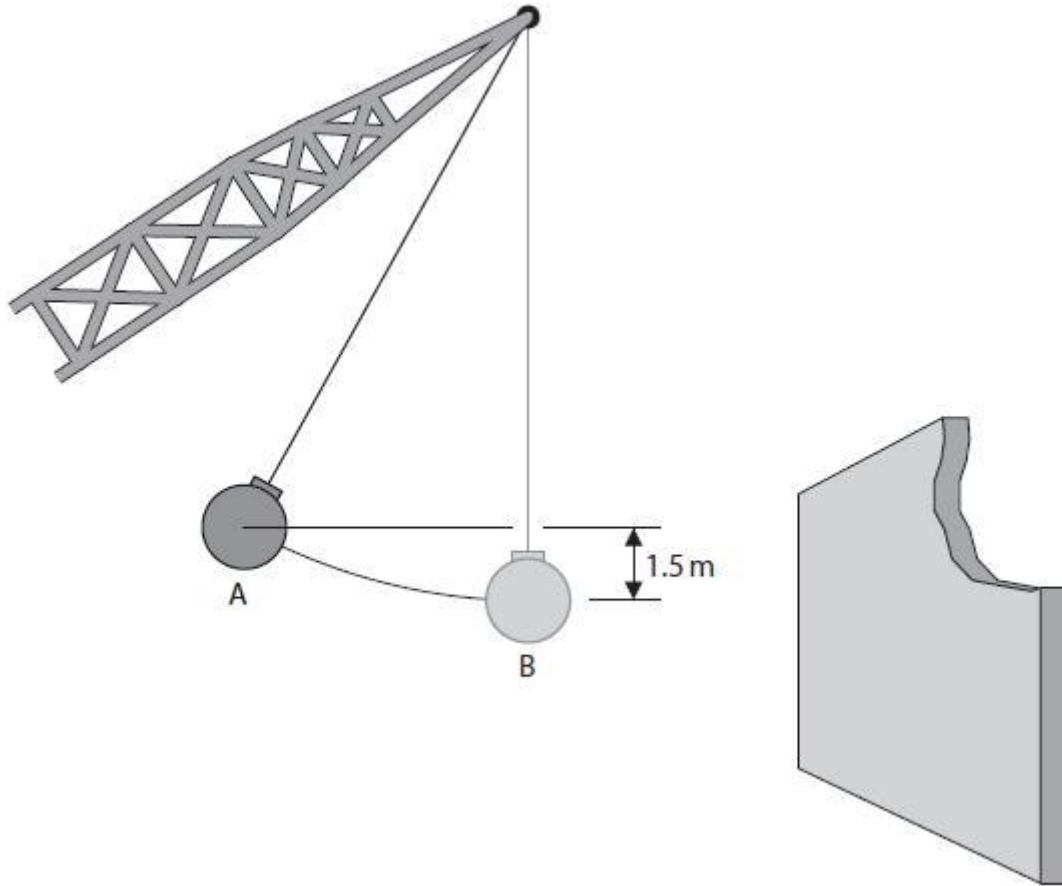


Figure 14

As the ball swings from A to B, it moves through a vertical height of 1.5 m.

(i) Calculate the change in gravitational potential energy.

Take gravitational field strength, g , to be 10 N/kg.

(3)

(ii) The heavy ball comes to rest soon after smashing into the wall. In doing this, the temperatures of the ball, wall and surroundings all increase slightly.

Explain this observation.

(2)

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(iii) Which of these quantities of the ball changes in **both** magnitude and direction while the ball is swinging?

Put a cross (☒) in the box next to your answer.

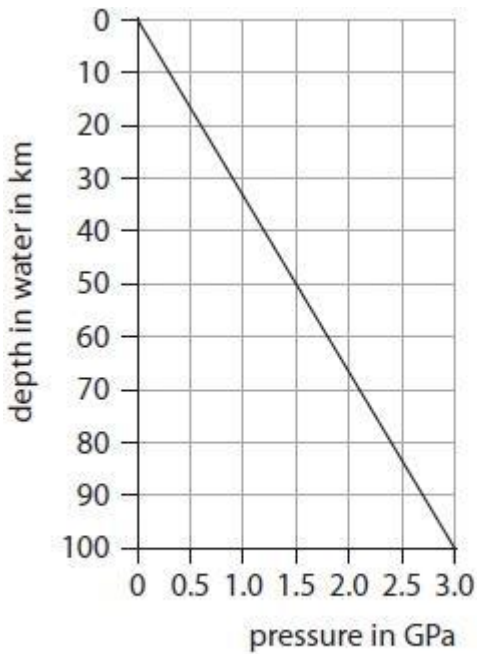
(1)

- A gravitational potential energy
- B velocity
- C the gravitational force acting
- D kinetic energy

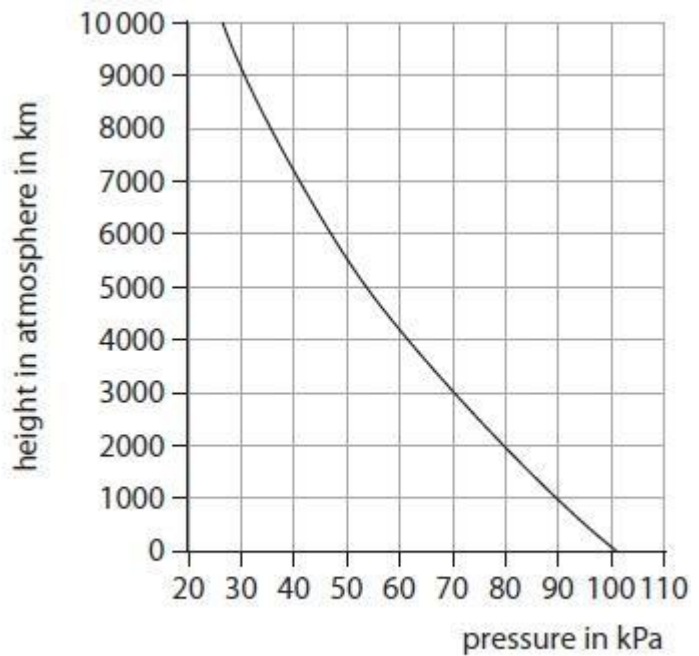
(Total for question = 6 marks)

Q13.

Figure 17 shows information about the pressures in the ocean and in the atmosphere of a distant planet. Graph A shows the variation of pressure as the depth in the ocean increases. Graph B shows the variation of pressure as the height in the atmosphere increases.



Graph A



Graph B

Figure 17

- (i) Use information from Graph A to obtain a value for the density of the ocean water. Use an equation selected from the list of equations at the end of this paper.

(4)

density = kg/m³

- * (ii) Explain the similarities and differences in the pressure variations shown in graphs A and B.

Your answer should refer to both the particle model (kinetic theory) and to density.

(6)

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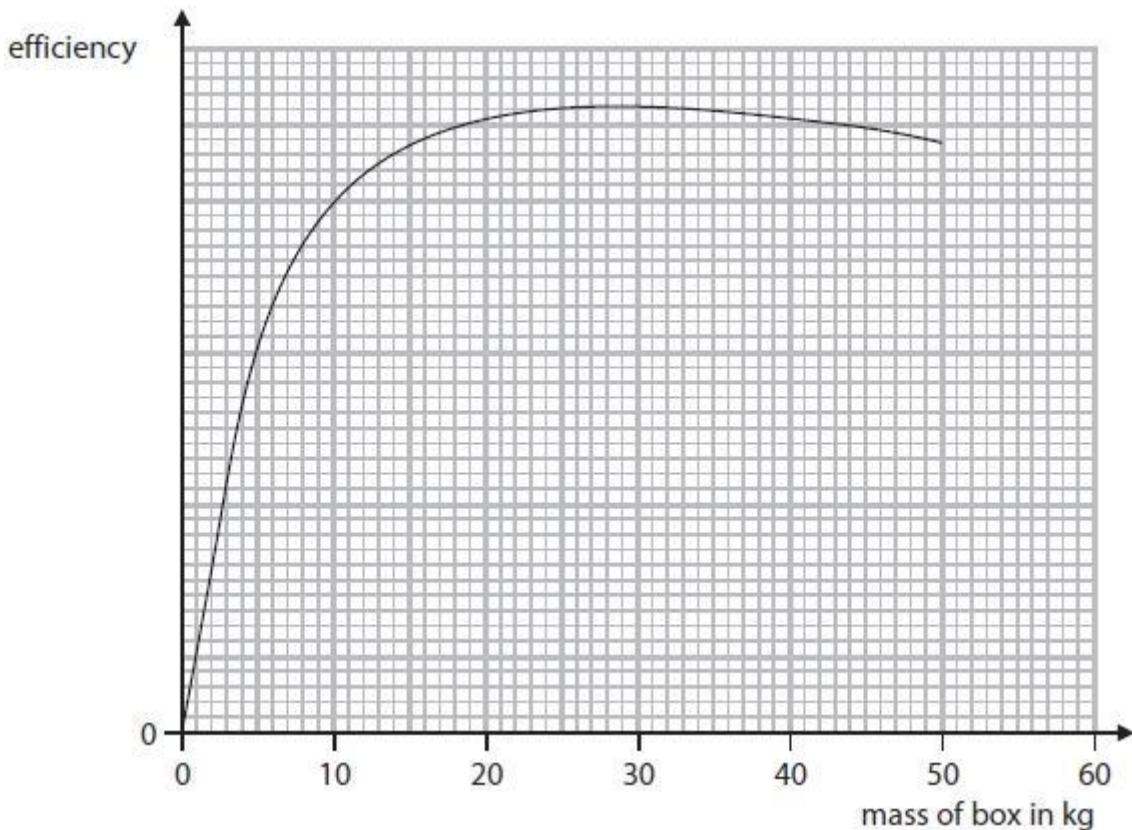
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(Total for question = 10 marks)

Q14.

An electric motor is used to lift a box.

Figure 4 shows how the efficiency of the electric motor changes as the mass of the box increases.



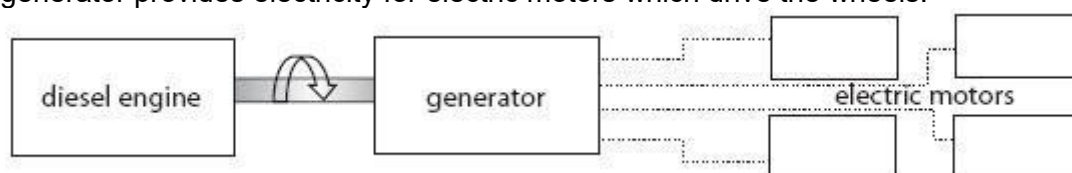
Describe how the efficiency of the electric motor depends on the mass of the box lifted.

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(Total for question = 2 marks)

Q15.

- (a) 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 useful energy transfer.

(3)

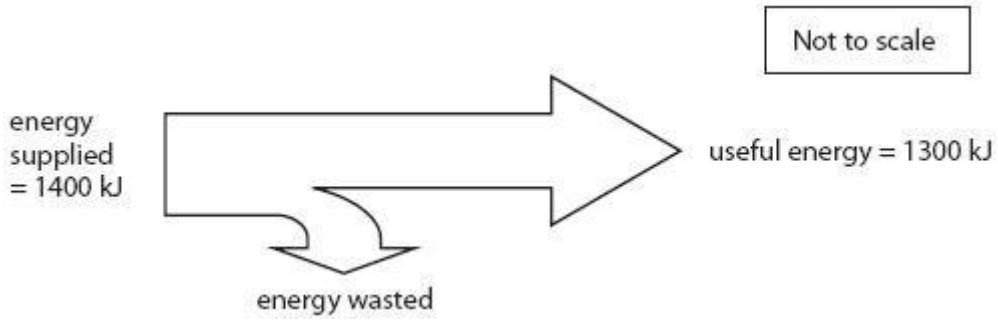
train part	useful energy transfer
<div style="border: 1px solid black; padding: 5px; display: inline-block;">diesel engine</div> ●	<div style="border: 1px solid black; padding: 5px; display: inline-block;">● chemical to electrical</div>
<div style="border: 1px solid black; padding: 5px; display: inline-block;">generator</div> ●	<div style="border: 1px solid black; padding: 5px; display: inline-block;">● chemical to kinetic</div>
<div style="border: 1px solid black; padding: 5px; display: inline-block;">motor</div> ●	<div style="border: 1px solid black; padding: 5px; display: inline-block;">● electrical to kinetic</div>
	<div style="border: 1px solid black; padding: 5px; display: inline-block;">● kinetic to chemical</div>
	<div style="border: 1px solid black; padding: 5px; display: inline-block;">● kinetic to electrical</div>

- (ii) State **one** example of a non-useful energy transfer in the motor.

(1)

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- (b) 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.

(1)

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(ii) Calculate the efficiency of the generator.

(2)

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(c) The electric motors which drive the wheels are painted black.
Suggest why the motors are painted black.

(1)

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(Total for Question is 8 marks)

Q16.

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)

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(Total for question = 2 marks)

Q17.

The International Space Station (ISS) has several solar panels called wings.



(a) The wings convert energy from the Sun into a form useful in the ISS.

(1)

- A** transverse and electromagnetic
- B** electromagnetic but not transverse
- C** transverse but not electromagnetic
- D** neither transverse nor electromagnetic

(b) In one second, the useful energy available from one wing is 34.3 kJ. The energy incident on the wing from the Sun is five times this amount.

What is the percentage efficiency of the wing?

(3)

efficiency = %

(c) A wing is in direct sunlight. The ISS is not receiving energy from the wing. The temperature of the wing remains constant.

Explain why the temperature of the wing remains constant in these conditions.

(2)

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Q18.

Figure 14 shows a demolition ball of mass 400 kg. The ball is used to demolish a wall.

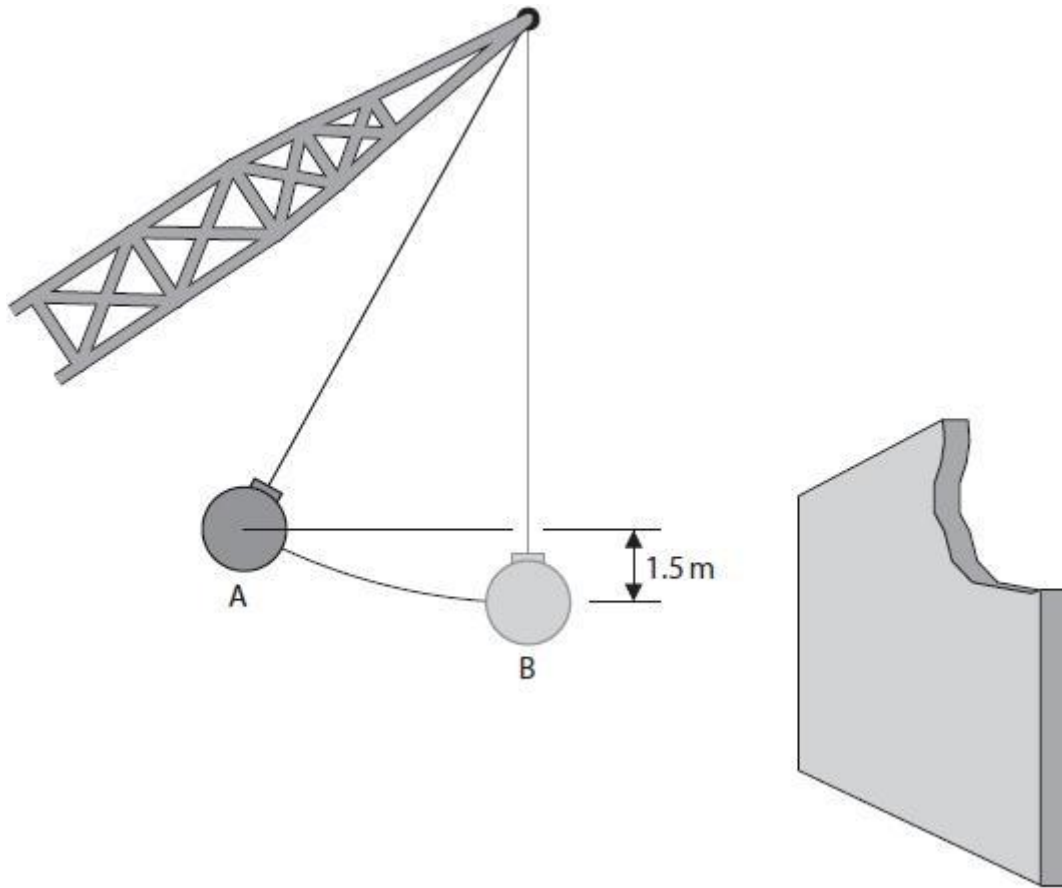


Figure 14

* After knocking down the wall, the ball will swing **freely**.

The graph in Figure 15 shows how the height of the ball above ground varies with time during three swings.

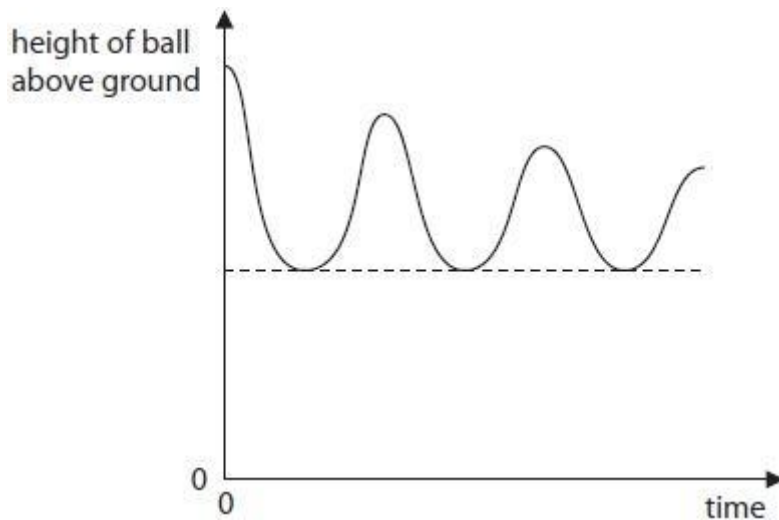


Figure 15

Explain how the energy within the system changes during this time.

The system consists of the swinging ball and its surroundings.

(6)

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(Total for question = 6 marks)

Q19.

(i) Figure 14 shows the vertical forces on an aeroplane.



Figure 14

Use information from the diagram to determine the size and direction of the resultant vertical force on the aeroplane.

(2)

size = kN, direction is

(ii) The aeroplane is descending.

Figure 15 shows a diagram of the resultant vertical and horizontal forces on the aeroplane as it is descending.

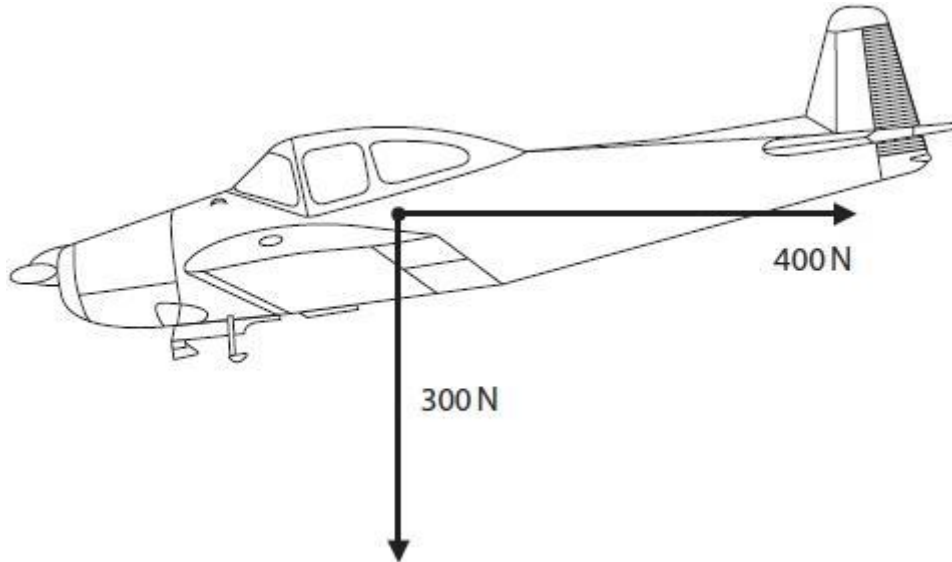


Figure 15

Complete the diagram to show the resultant of these two forces.

(1)

(iii) The mass of the aeroplane is 750 kg.

Calculate the change in gravitational potential energy of the aeroplane as it descends from 1300 m to the ground.

Gravitational field strength (g) = 10 N/kg

(2)

energy = J

(Total for question = 5 marks)

Q20.

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 .

Two cyclists ride on a hilly road and go through points P, Q, R and S.

The diagram in Figure 16 shows how the vertical height of the road changes during the journey from P to S.

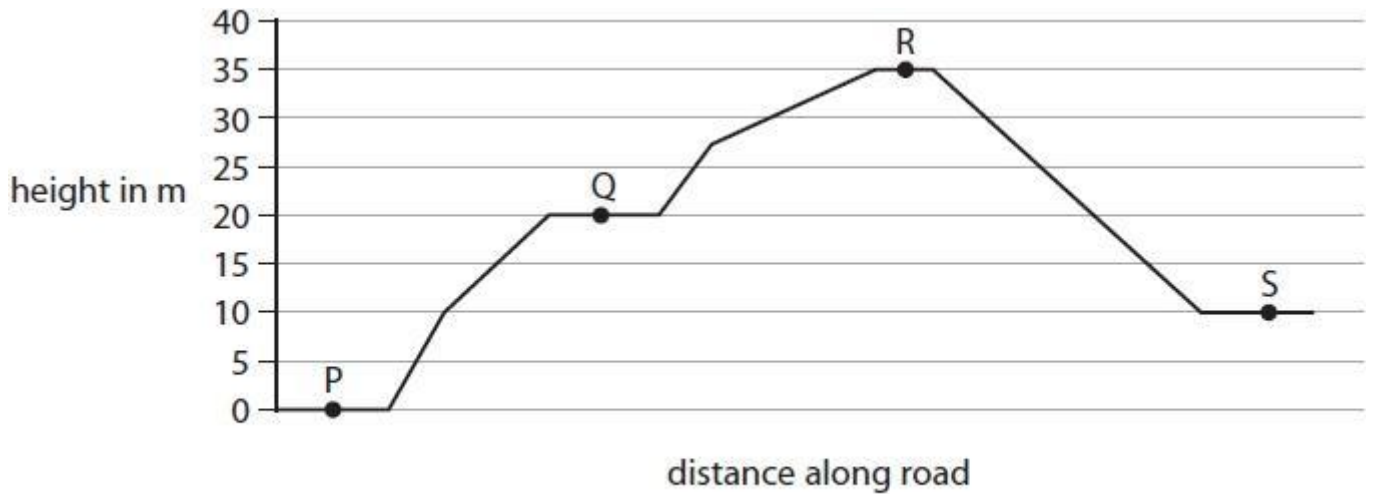


Figure 16

(i) The greatest overall change in gravitational potential energy for each cyclist is between which two points on the journey?

(1)

- A P and Q
- B Q and R
- C P and S
- D R and S

(ii) The total weight of one cyclist and bicycle is 700 N.

Calculate the total amount of work done against gravity when the cyclist travels from point P to point Q in the journey.

(2)

work done = J

(iii) The gravitational potential energy of the other cyclist changes by 11 250 J when travelling from point Q to point R.

Calculate the mass of this cyclist.
 Gravitational field strength = 10 N / kg
 Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

(2)

mass = kg

(iv) Explain why the total amount of work done by a cyclist between points Q and R is different from the change in gravitational potential energy of the cyclist between points Q and R.

(2)

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(v) The cyclists lubricated the chains and the wheel bearings of their bicycles before setting off.

Lubricating the chains and wheel bearings helps to

(1)

- A decrease the amount of work done against gravity
- B decrease the efficiency of the cyclist and bicycle
- C increase the efficiency of the cyclist and bicycle
- D increase the overall amount of energy transferred by the cyclist

(Total for question = 8 marks)

Q21.

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 \div distance moved in direction of force
- B work done = force \times distance moved in direction of force
- C work done = force \div distance moved at right angles to direction of force
- D work done = force \times distance moved at right angles to direction of force

(Total for question = 1 mark)

Q22.

Figure 14 shows the vertical forces on an aeroplane.

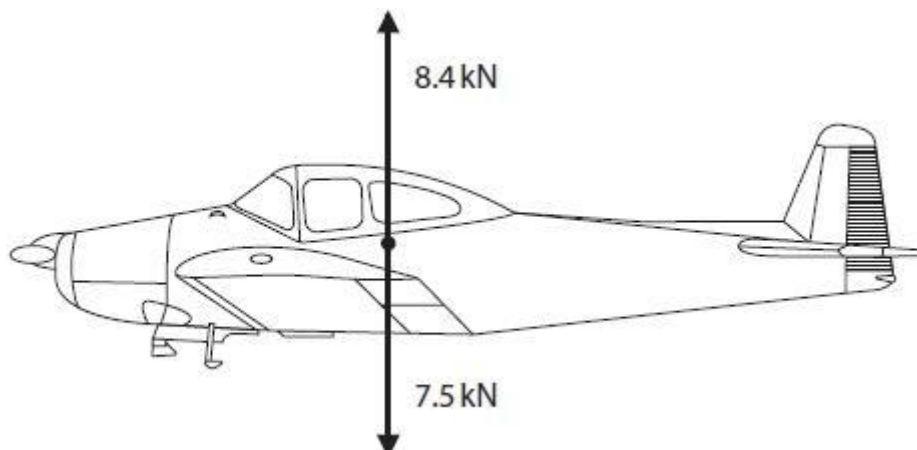


Figure 14

The aeroplane is powered by an engine that burns fuel.
The fuel supplies a total of 6500 kJ of energy every minute.
The efficiency of the engine is 0.70 (70%).

(i) Calculate the power output of the engine.

Give your answer in kW.

(4)

power = kW

(ii) Explain why the efficiency of the engine is less than 1 (100%).

(2)

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(Total for question = 6 marks)

Q23.

Some students investigate a model of the craters produced by meteorite impacts.

They drop balls into a tray filled with sand.

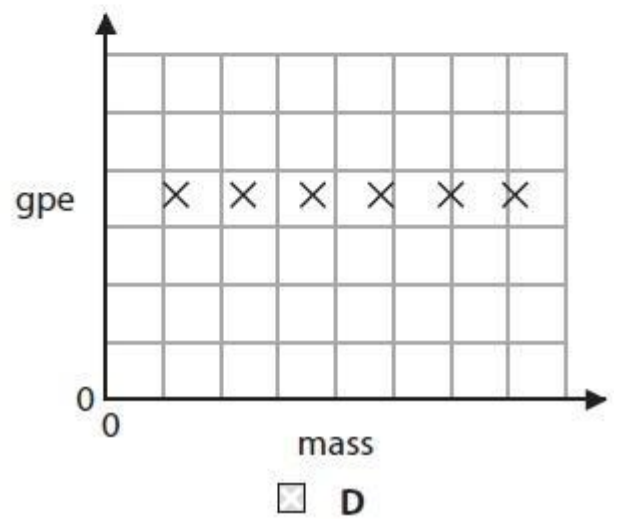
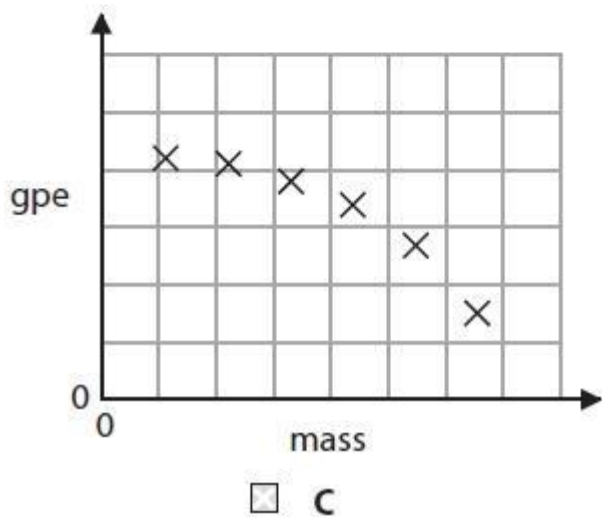
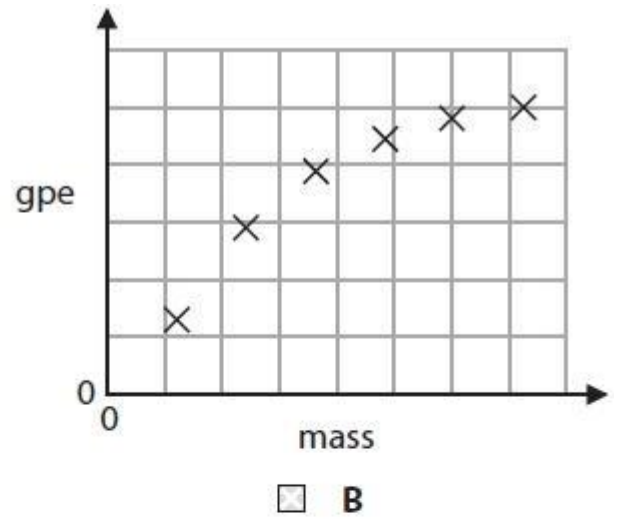
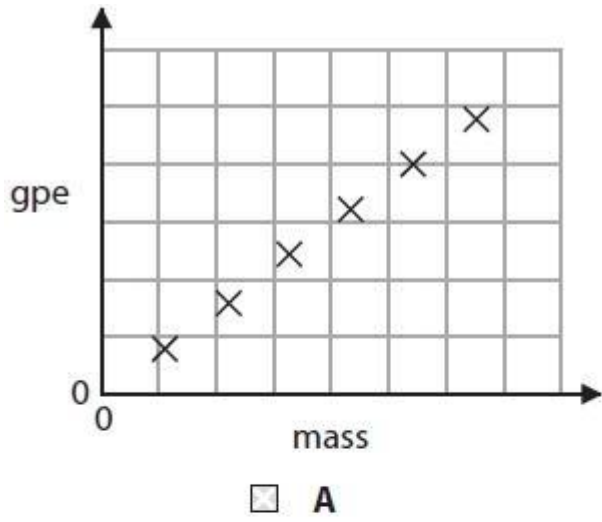
They use six balls with different masses.

They drop each ball from the same height.

(a) (i) Which one of these graphs shows the relationship between the gravitational potential energy (gpe) of the balls and their mass when they are all at the same height?

Put a cross (☒) in the box next to your answer.

(1)



(ii) Describe how the energy of a ball changes as it drops towards the sand.

(2)

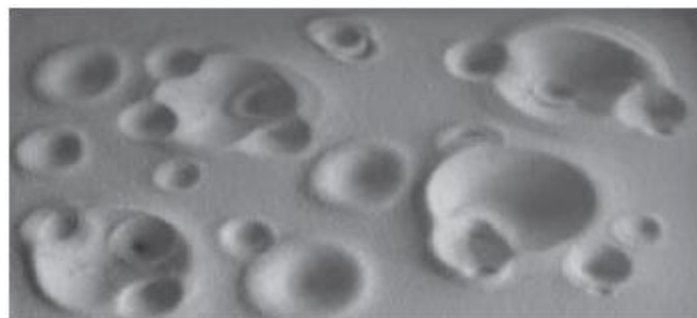
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(b) This photograph shows the sand after several balls have hit it.



The students read this information in a textbook:

'When work is done, energy is transferred.'

Explain how work is done when the balls impact on the sand.

(2)

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(c) When one ball hits the sand, it has a velocity of 6.2 m/s.

It has a momentum of 0.46 kg m/s.

(i) Calculate the mass of the ball.

(3)

mass of ball = kg

(ii) The ball takes 0.17 s to come to rest after it hits the sand.

Calculate the average impact force.

(2)

average impact force = N

Q24.

The rover uses solar panels for its power needs.

The solar panels can provide 1200 W of power.

(i) Show that the solar panels can provide 2.16 MJ of energy in 30 minutes.

(1)

(ii) The solar panels convert 27% of the energy they receive from the Sun into electricity. Calculate the solar energy received by the panels that provides the 2.16 MJ of energy.

(2)

energy received = J

(Total for question = 3 marks)

Q25.

The area between the curve and the extension axis of a force/extension graph corresponds to work done or energy transferred.

Suggest what the shaded area of the graph in Figure 16 represents.

(2)

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(Total for question = 2 marks)

Mark Scheme

Q1.

Question Number:	Answer	Additional Guidance	Mark
	<p>an explanation linking:</p> <p>over the same time / in 300s, more work done / energy transferred in session 1 than in session 2 (1)</p> <p>(therefore) more power (developed) in session 1 (1)</p>	<p>allow reverse argument</p> <p>power in session 1 = $\frac{45.2}{300} = 0.15$ (kW) or 150(W)</p> <p>allow statement that power = $\frac{\text{work}}{\text{time}}$</p> <p>or</p> <p>power = $\frac{\text{energy(transferred)}}{\text{time}}$</p> <p>for MP1</p> <p>power in session 2 = $\frac{37.9}{300} = 0.13$ (kW) or 126(W)</p>	<p>(2)</p> <p>AO 3 2a</p> <p>AO 3 2b</p>

Q2.

Question Number:	Answer	Additional Guidance	Mark
	<p>recall and substitution (1)</p> $1600 = \text{force} \times 28$ <p>rearrangement (1)</p> $(\text{force}) = \frac{1600}{28}$ <p>evaluation (1)</p> <p>57 (N)</p>	<p>substitution and rearrangement in either order</p> <p>accept f, F or ? for force</p> <p>accept values that round down to 57 e.g. 57.14</p> <p>award full marks for correct answer without working</p> <p>award 1 mark for answers of 44800 or 0.0175 and a correct expression relating work, force and distance</p>	(3) AO 2 1

Q3.

Question number	Answer	Additional guidance	Mark
(i)	<p>rearrangement of work = force \times distance to give distance = work \div force (1)</p> <p>substitution and evaluation (1)</p> <p>18 (m)</p>	<p>seeing $2700 \div 150$</p> <p>Award full marks for correct answer without working</p>	(2)
Question number	Answer		Mark
(ii)	2700 (J)		(1)

Question number	Answer	Additional guidance	Mark
(iii)	rearrangement of $KE = \frac{1}{2}mv^2$ $v = \sqrt{2 \times KE \div m}$ (1) substitution and evaluation (1) 19 (m/s)	$v = \sqrt{2 \times 2700 \div 15}$ $v^2 = (2 \times 2700 \div 15)$ allow answers that round to 19 award full marks for correct answer without working allow alternative route using $v^2 - u^2 = 2ax$ for full marks	(2)

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	substitution (1) $(\Delta GPE =) (0.0)46 \times 10 \times 2.05$ evaluation (1) 0.94(3) (J)	allow $g = 9.8(1) \text{ m/s}^2$ 0.9 (J) values that round to 0.92 or 0.93 (from using $g = 9.8$ or 9.81) do not award for 1(J) no POT error in evaluation award full marks for the correct answer without working.	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>recall (1) $(KE =) \frac{1}{2} \times m \times v^2$</p> <p>substitution (1) $(KE =) \frac{1}{2} \times (0.046) \times 3.5^2$</p> <p>evaluation (1) 0.28 (J)</p>	<p>allow answers that round to 0.28 e.g. 0.28175 (J)</p> <p>allow max 2 marks for POT error e.g. 0.00028</p> <p>award full marks for the correct answer without working</p>	(3)

Question Number	Answer	Additional guidance	Mark
(iii)	Any value between 0.8 (m) and 0.95 (m) inclusive		(1)

Question Number	Answer	Additional guidance	Mark
(iv)	<p>An explanation linking (the ball) has lost energy (1)</p> <p>identification of what has happened to that energy (1)</p>	<p>accept (energy) dissipated or (transferred to) surroundings / ground or thermal energy or heat / sound or system is not 100% efficient or bounce is not (100%) elastic or squashing (the ball or the ground)</p>	(2)

Q5.

Question number	Answer	Additional guidance	Mark
(i)	recall and substitution into (1) $gpe = m \times g \times h$ $(gpe) = 4.5 \times 10 \times 20$ evaluation (1) 900(J)	allow 90(J) for 1 mark award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
ii	900(J)	allow ecf from i	(1)

Question number	Answer	Additional guidance	Mark
iii	recall and substitution (1) $power = work\ done / time\ taken$ $(power =) 900 / 4$ evaluation (1) 200 (W)	allow ecf from i or ii accept 230(W), 225(W) award full marks for the correct answer without working	(2)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	<p>select and substitute (1)</p> $(\Delta GPE = m \times g \times \Delta h)$ $= 1100 \times 3.7 \times 1.8 \times 10^3$ <p>)</p> <p>evaluation (1)</p> <p>7 326 000 (J)</p> <p>evaluation to 2 s.f. (1)</p> <p>7 300 000 (J)</p>	<p>any number rounding to 7 300 000</p> <p>7326 scores 1 mark</p> <p>independent mark - any final answer stated to 2 s.f.</p>	(3) A02.1

Question number	Answer	Additional guidance	Mark
(ii)	<p>select and substitute (1)</p> $(\Delta KE = \frac{1}{2} m \times v^2)$ $= \frac{1}{2} 1100 \times 88^2$ <p>evaluation (1)</p> <p>4 300 000 (J)</p>	<p>ignore minus signs</p> <p>accept numbers that round to 4 300 000 (J) e.g. 4 259 200 (J)</p> <p>award full marks for the correct answer without working</p>	(2) A02.1

Question number	Answer	Additional guidance	Mark
iii	<p>A description linking three from:</p> <ol style="list-style-type: none"> 1. work is done against / by gravity (1) 2. idea of work done by the thrusters / jets (on the rover) (1) 3. (work done) by air/atmospheric resistance on the parachute (and rover) (1) 4. this reduces the kinetic energy (store) (1) 5. (there is a) decrease in the gravitational potential energy (store) of the rover (1) 6. (there is a) transfer of chemical energy from the thrusters (1) 7. energy transferred to thermal energy (store) (1) 8. (transfer) mechanically (to the thermal store) (1) 	<p>KEY: attempt to explain <u>how work done</u> contributes towards the energy changes / conservation of energy</p> <p>if no other mark scored allow one mark for work = force x distance</p>	(3) A02.1

Q7.

Question Number	Answer	Additional guidance	Mark
(i)	<p>(In every second), distance moved by chain around large gear = distance moved by chain around small gear (1)</p> <p>$2 \times 48 = \text{turns} \times 12$</p> <p>rearrangement and evaluation (1)</p> <p>8 (turns each second)</p>	<p>accept use of gear ratio seen or implied e.g. 4:1 or 4/1 or 48:12 or 48/12 or converse e.g. 1:4</p> <p>award full marks for the correct answer without working</p>	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking</p> <p>reduces friction/amount of thermal energy transferred (1)</p> <p>extra useful energy is available/less input energy is required (1)</p> <p>efficiency = useful energy transferred (by the bicycle) ÷ total energy supplied (to the bicycle) (1)</p>	<p>(oil provides) lubrication</p> <p>less energy wasted</p> <p>allow for the last two mark points; either less input energy is required to produce the same output for 2 marks or more output energy is available for the same input energy for 2 marks</p>	(3)

Q8.

Question Number	Answer	Additional guidance	Mark
(i)	recall (1) $(P =) \frac{E}{t}$ substitution and evaluation (1) (P=) 75 (W)	$P = \text{work done} \div \text{time}$ $P = \frac{45}{0.6}$ award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	substitution into $E = \frac{1}{2} \times k \times x^2$ (1) $45 = \frac{1}{2} \times 140 \times x^2$ rearrangement (1) $(x =) \sqrt{\frac{2 \times 45}{140}}$ evaluation (1) 0.8(0) (m)	allow substitution and rearrangement in either order $x^2 = \left(\frac{E}{0.5k} =\right) \frac{2 \times 45}{140}$ $x^2 = 0.64(28571)$ accept values that round to 0.80 e.g. 0.80178 award full marks for the correct answer without working	(3)

Question number	Answer	Additional guidance	Mark
	substitution (1) $2,800 = \frac{1}{2} \times 85 \times v^2$ rearrangement (1) $(v^2 =) \frac{2800 \times 2}{85}$ evaluation (1) $v = 8.1 \text{ (m/s)}$	allow substitution and rearrangement in either order 66 or 65.88 seen allow values that round to 8.1 e.g 8.1168 award full marks for the correct answer without working	(3) AO2

Q10.

Question number	Answer	Additional guidance	Mark
	Equating energy in both equations (1) $E = \text{weight} \times \text{height} = \text{power} \times \text{time}$ Rearrangement (1) $\text{time} = \frac{(\text{weight} \times \text{height})}{\text{power}}$ Substitution and evaluation (1) $\text{time} = 230\,000 \times \frac{4.7}{1600}$ $\text{time} = 680 \text{ (s)}$	allow answers which round to 680, e.g. 675.6	(3)

Q11.

Question Number:	Answer	Additional Guidance	Mark
	substitution (1) $(KE =) \frac{1}{2} \times 68 \times 12^2$ evaluation (1) 4900 (J)	$\frac{1}{2} \times 68000 \times 12^2$ scores 1 mark accept values that round to 4900(J) e.g. 4896(J) award full marks for correct answer without working	(2) AO 2 1

Q12.

Question number	Answer	Additional guidance	Mark
(i)	Recall GPE = $m \times g \times \Delta h$ (1) Substitution = $400 \times 9.8 \times 1.5$ (1) Evaluation = 5900 (J) (1) (which is nearly 6000 J)	accept 5880 (J)	(3)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that combines identification – knowledge (1 mark) and reasoning (1 mark) <ul style="list-style-type: none"> • energy is dissipated/scattered (1) • into the surroundings (1) 	energy from a loss of ball's PE / its gain in KE ends up as (kinetic) energy of molecules (of ball / wall / air)	(2)

Question number	Answer	Mark
(iii)	B velocity	(1)

Q13.

Question number	Answer	Additional guidance	Mark
(i)	<p>rearrange $p = \rho g h$ to give $\rho = p / (g h)$ (1)</p> <p>substitution using any point from graph (1)</p> <p>e.g. depth = 50km and pressure = 1.5 GPa $\rho = p / (g h)$ $= 1.5 \times 10^9 / (10 \times 50 \times 10^3)$</p> <p>Evaluation (2) $= 3000 \text{ (kg/m}^3\text{)}$</p>	<p>rearrangement and substitution in any order</p> <p>allow any combination from the graph and ignore 'pot' error here</p> <p>'pot' error scores 2 marks maximum</p>	(4)

Question number	Indicative content	Mark
(ii)	<p>Answers will be credited according to the candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all of the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">A02 (3 marks) A03 (3 marks)</p> <p>A03 Interpretation and evaluation from the graph</p> <p>Similarities:</p> <ul style="list-style-type: none"> • both show increasing pressure with depth • both show a range of pressures over kilometre depths / heights <p>Differences:</p> <ul style="list-style-type: none"> • ocean water shows a linear relationship (straight line) but atmosphere gives a non-linear (curved) relationship • density of ocean water not changing with depth but density of atmosphere changes as you go higher • The pressures in the ocean recorded are much bigger (GPa compared with kPa) <p>The depth of the ocean shown is up to 100km whereas the height of the atmosphere involved is only up to 10km</p> <p>A02 Link between graph shapes and underlying physics</p> <p>Similarities:</p> <ul style="list-style-type: none"> • pressure is due to (increasing) weight of fluid (liquid / gas) above • more molecules above <p>Differences:</p> <ul style="list-style-type: none"> • atmosphere becomes thinner the higher you go molecules in the ocean stay (on average) the same distance apart but in the atmosphere they get further apart (on average) as you go higher up 	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> No awardable content
Level 1	1-2	<ul style="list-style-type: none"> Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	<ul style="list-style-type: none"> Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	<ul style="list-style-type: none"> Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Q14.

Question number	Answer	Additional guidance	Mark
	<p>An answer that combines points of interpretation/evaluation to provide a logical description:</p> <p>efficiency increases (at first) (1)</p> <p>to maximum efficiency (for mass of about 25 kg) (1)</p>	e.g. decreases for larger masses	(2)

Q15.

	Answer	Acceptable answers	Mark
(ai)	<p>A line connecting a train part with a useful energy transfer as shown below (1)</p> <p>The diagram shows three boxes on the left labeled 'Train part transfer': 'diesel engine', 'generator', and 'motor'. On the right, under 'useful energy', are five boxes: 'chemical to electrical', 'chemical to kinetic', 'electrical to kinetic', 'kinetic to chemical', and 'kinetic to electrical'. Lines connect 'diesel engine' to 'chemical to electrical' and 'chemical to kinetic'. 'generator' connects to 'electrical to kinetic'. 'motor' connects to 'kinetic to chemical' and 'kinetic to electrical'.</p>	<p>Lines need not be straight Ignore any arrow heads drawn Note: if more than one line is drawn from a train part then zero mark for that train part.</p>	(3)
(aii)	(transfer of energy to) thermal (1)	heat/sound	(1)
(bi)	1400 – 1300 (= 100) (kJ) (1)		(1)
(bii)	Substitution (1) 1300 / 1400 × 100 Evaluation (1) 93(%) or 0.93	A value which rounds to 93(%) or 0.93 Correct answer with no working scores 2 marks	(2)
(c)	Any one from black is a good thermal radiator (1) (helps to) prevent motors overheating (1)	(good) emitter (helps to) remove wasted energy/ heat (from the motor)	(1)

Q16.

Question Number:	Answer	Additional Guidance	Mark
	<p>a description to include:</p> <p>kinetic energy (store) (of cyclist and /or bicycle) decreases / is transferred into(1)</p> <p>thermal energy (store) (of brakes / surroundings) increases (1)</p>	<p>KE for kinetic energy</p> <p>allow heat for thermal allow brakes get hotter ignore sound energy</p> <p>accept kinetic (energy) to heat (energy) for 2 marks in this context</p>	(2) AO 1 1

Q17.

Question Number	Answer	Acceptable answers	Mark
(a)	A transverse and electromagnetic		(1)

Question Number	Answer	Acceptable answers	Mark
(b)	<p>Evaluation 171.5 (1)</p> <p>Substitution (34.3/171.5) x 100 (1)</p> <p>Evaluation 20 (%) (1)</p>	<p>award full marks for correct answer with no working</p> <p>34.3 x 5</p> <p>[34.3 / (34.3 x 5)] x 100</p> <p>[34.3 / (34.3 x 5)]</p> <p>[34.3 / 171.5]</p> <p>Allow 0.2 or 1/5 for 3 marks</p>	(3)

Question Number	Answer	Acceptable answers	Mark
(c)	<p>rate of {energy/heat} (from the Sun){absorbed/taken in} (1)</p> <p>equals rate of {energy/heat} {radiated/emitted/given out}(1)</p>	<p>Allow 'energy in = energy out' for 1 mark</p> <p>'power in = power out' for 2 marks</p>	(2)

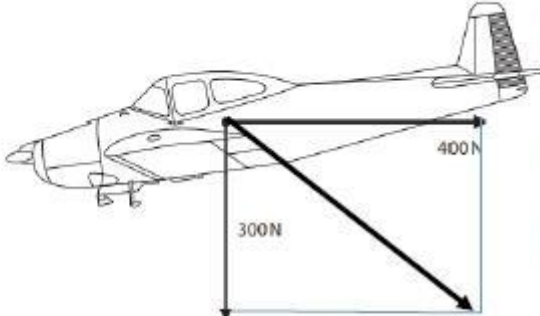
Q18.

Question number	Indicative content	Mark
	<p>Answers will be credited according to the candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all of the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">A03 (6 marks)</p> <ul style="list-style-type: none"> • the varying height shows a varying gravitational potential energy(gpe) during the swings • when the height is a maximum the gpe is a maximum-at top of swing • when the height is a minimum the gpe is a minimum-at bottom of swing • kinetic energy varies during swing • kinetic energy maximum at bottom of swing • kinetic energy minimum at top of swing • (continuous) interchange of KE and gpe • total amount of energy is constant during one swing • over a number of swings max KE and max PE decreases • energy is dissipated/'lost' to surroundings • because of air resistance / friction • amplitude/size of swings decrease (as energy 'lost' to surroundings) <p>ignore references to momentum</p>	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> • No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> • Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. • Judgements are supported by limited evidence. (A03)
Level 2	3-4	<ul style="list-style-type: none"> • Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently. • Judgements are supported by evidence occasionally. (A03)
Level 3	5-6	<ul style="list-style-type: none"> • Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. • Judgements are supported by evidence throughout. (A03)

Q19.

Question Number:	Answer	Additional guidance	Mark
(i)	0.9 (k N) (1) up / upwards / ascending (1)	accept .9 or 0.90 north N ↑	(2) AO 3 2a AO 3 2b

Question Number:	Answer	Additional guidance	Mark
(ii)		judge length and direction by eye construction lines need not be shown magnitude need not be stated allow missing arrowhead if direction and length are correct reject answers which have any additional vectors drawn	(1) AO 3 2b

Question Number:	Answer	Additional Guidance	Mark
(iii)	<p>recall and substitution (1)</p> <p>GPE = $750 \times 10 \times 1300$</p> <p>evaluation (1)</p> <p>(energy =) 9 800 000 (J)</p>	<p>no POT error (could have missed out g)</p> <p>allow answers in standard form 9.8×10^6</p> <p>allow answers that round to 9 800 000 e.g. 9 750 000 J</p> <p>allow 9800 kJ or 9.8MJ</p> <p>allow 9 555 000 J</p> <p>allow negative values</p> <p>award full marks for correct answer without working</p>	(2) AO 2 1

Q20.

Question number	Answer	Additional guidance	Mark
(i)	<p>D R and S</p> <p>A, B and C are incorrect because the difference in vertical positions are all less than that shown by R and S</p>		(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	recall (1) work done = force x distance substitution and evaluation (1) (work done =) 14,000 (J)	(work done) = 700 x 20 award full marks for the correct answer without working	(2) AO1

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) 11250 = m x 10 x 15 rearrangement and evaluation (1) (mass=) 75 (kg)	 award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers of 0.013 (substitution mark using h = 15)	(2) AO2

Question number	Answer	Additional guidance	Mark
(iv)	An explanation linking some work is done to overcome friction/air resistance (1) energy is dissipated /transferred to the environment (1)	 allow energy is lost thermal energy	(2) AO1

Question number	Answer	Additional guidance	Mark
(v)	<p>C increase the efficiency of the cyclist and bicycle</p> <p>A is incorrect because lubrication has no effect on work done against gravity</p> <p>B is incorrect because lubrication will increase efficiency</p> <p>D is incorrect because the overall energy transfer will not increase</p>		(1) AO1

Q21.

Question Number	Answer	Mark
	<p>The only correct answer is B: work done= force x distance moved in direction of force</p> <p>A is incorrect because the equation would be dimensionally inconsistent</p> <p>C is incorrect because the equation would be dimensionally inconsistent</p> <p>D is incorrect because the direction of the distance moved is incorrect</p>	(1)

Q22.

Question Number:	Answer	Additional Guidance	Mark
(i)	<p>recall efficiency equation (1)</p> $\text{efficiency} = \frac{\text{useful output}}{\text{input}}$ <p>rearrangement (1)</p> <p>output energy = 0.70 x 6500</p> <p>recall power equation (1)</p> $\text{power} = \frac{\text{energy}}{\text{time}}$ <p>evaluation (1)</p> <p>(power =) 76 (kW)</p>	$\text{efficiency} = \frac{\text{power output}}{\text{power input}}$ <p>4550 (kJ) seen scores 2 marks (from 0.7 x 6500 (kJ))</p> $\frac{4550}{60}$ <p>accept ecf from output energy</p> <p>accept values that round up to 76 (kW) e.g. 75.8</p> <p>award full marks for correct answer without working</p>	<p>(4) AO 1 1 AO 2 1</p>

Question Number:	Answer	Additional Guidance	Mark
(ii)	<p>an explanation linking:</p> <p>(useful) output energy is less than input energy (1)</p> <p>some energy is transferred to less useful forms (1)</p>	<p>input energy is greater than output energy</p> <p>(only) 70% of the input energy is useful</p> <p>energy is dissipated / wasted / lost (to surroundings)</p> <p>energy is lost / transferred as thermal / heat</p> <p>30% is lost /dissipated / wasted / lost for 2 marks</p>	(2) AO 1 1

Q23.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	A		(1)

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	<p>A description to include any two of</p> <ul style="list-style-type: none"> Gravitational / potential energy reduces (1) kinetic energy increases (1) total energy remains constant (1) 	<p>Ignore energy changes resulting from impact with sand</p> <p>GPE reduces</p> <p>KE increases</p> <p>Allow GPE is transferred to KE for 2 mark</p>	(2)

Question Number	Answer	Acceptable answers	Mark
(b)	<p>A explanation linking</p> <ul style="list-style-type: none"> • (work is done) displacing the sand (1) <p>with EITHER</p> <ul style="list-style-type: none"> • (as) <u>kinetic</u> energy of the ball(s) has been transferred (1) <p>OR</p> <ul style="list-style-type: none"> • by the force between the ball and the sand (1) 	<p>sand moving/ pushing/ blowing upwards OWTTE or ball sinking into sand</p>	(2)

Question Number	Answer	Acceptable answers	Mark
(c)(i)	<p>transposition mass = momentum / velocity (1)</p> <p>substitution mass = 0.46 / 6.2 (1)</p> <p>evaluation 0.074 (kg) / 74g (1)</p>	<p>Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition.</p> <p>Give full marks for correct answer with no working.</p> <p>Answers that round to 0.074 (kg) 0.07 (kg)</p>	(3)

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	<p>substitution (impact) force = 0.46 / 0.17 (1)</p> <p>evaluation 2.7 (N) (1)</p>	<p>Give full marks for correct answer with no working.</p> <p>Ignore power of ten error until evaluation</p> <p>Answers which round to 2.7</p> <p>Allow ECF if candidate has used mass from part (i) in $F = m(v-u) / T$</p> <p>$F = \frac{6.2 - 0}{0.17} \times 0.074$ (1)</p> <p>= 2.7 (N) (1)</p>	(2)

Q24.

Question number	Answer	Additional guidance	Mark
(i)	<p>select and substitute (1)</p> <p>($E = P \times t$) = 1200 x 30 x 60 (in J)</p>	<p>all three numbers needed to show that</p> <p>allow 1800 (seconds) for 30x60</p> <p>ignore evaluation</p>	(1) AO1.1

Question number	Answer	Additional guidance	Mark
(ii)	<p>select, rearrange and substitute (1)</p> <p>(input energy supplied = $\frac{\text{energy provided by panel}}{\text{efficiency}}$)</p> <p>= $\frac{2.16 \text{ (MJ)}}{(0.)27}$</p> <p>evaluation (1)</p> <p>$8(.0) \times 10^6 \text{ (J)}$</p>	<p>$\frac{2\ 160\ 000}{(0.)27}$</p> <p>$8\ 000\ 000 \text{ (J)}$ $8(.0) \text{ MJ}$</p> <p>award full marks for the correct answer without working</p> <p>$8(.0) \times 10^4 \text{ (J)}$ gains 1 mark (uses 27% incorrectly)</p>	(2) AO2.1

Q25.

Question Number	Answer	Additional guidance	Mark
	<p>An answer that includes</p> <p>difference in energy transferred / work done (when loading and unloading) (1)</p> <p>transferred to thermal energy (store in the rubber) (1)</p>	<p>(thermal) energy is dissipated to the surroundings</p>	(2)