

PHYSICS



EXAM QUESTION PACK

TOPIC 8: ENERGY – FORCES DOING WORK (PACK 2)

SCORE

/64

PERCENTAGE

%

STEMUP

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Q1.

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.

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

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

(2)

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(Total for question = 2 marks)

Q2.

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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Q3.

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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Q4.

Figure 14 shows a demolition ball of mass 400 kg.

The ball is used to demolish a wall.

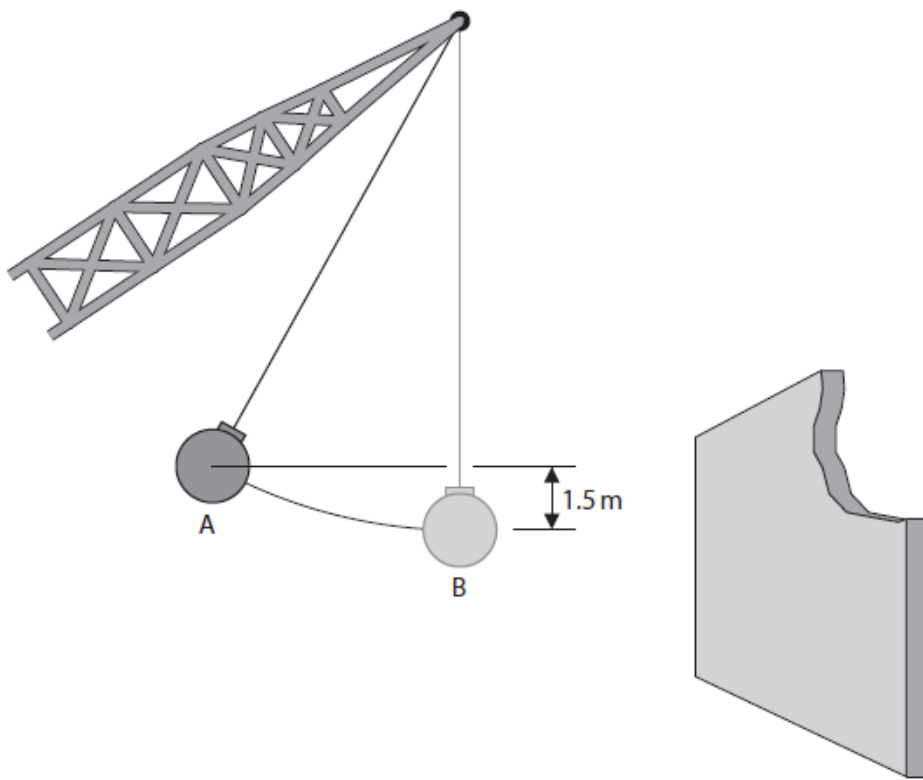


Figure 14

* 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.

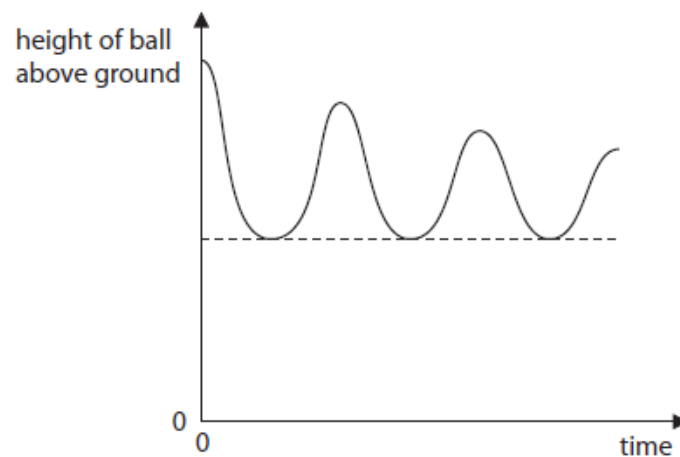


Figure 15

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)

Q5.

Figure 8 shows a demolition ball of mass 400 kg.

The ball is used to demolish a wall.

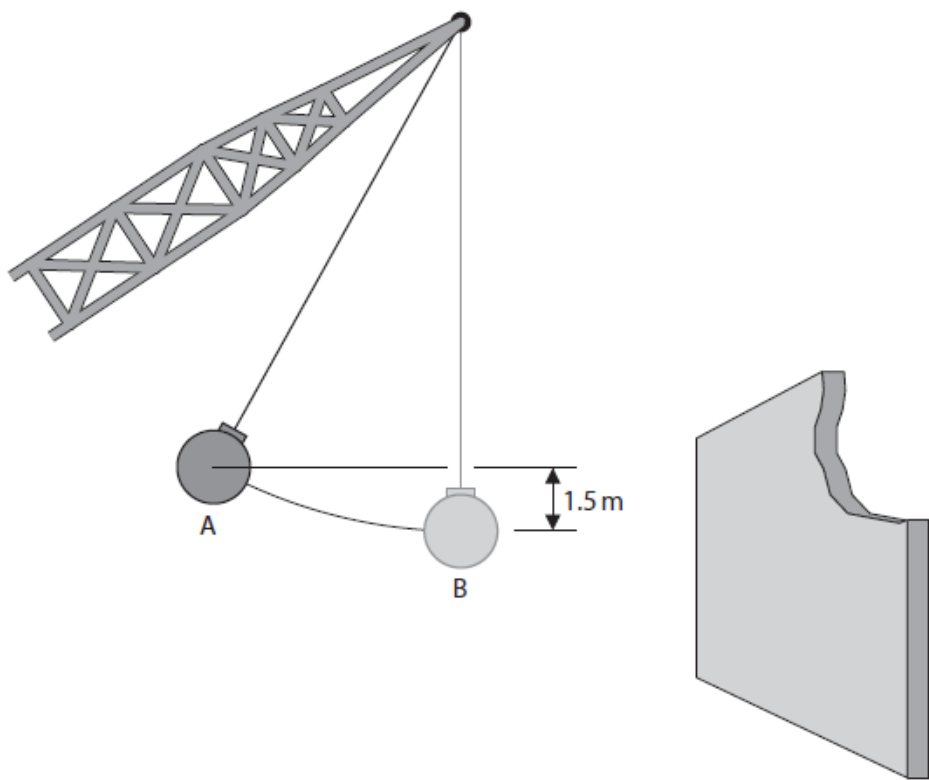


Figure 8

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

The graph in Figure 9 shows how the height of the ball above ground varies with time during three swings.

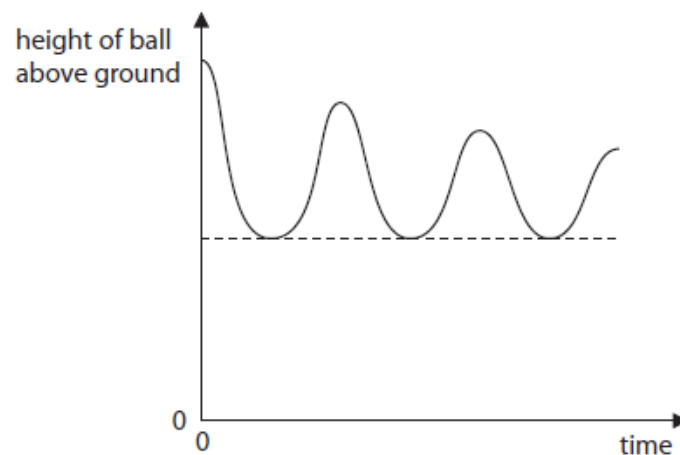


Figure 9

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)

Q6.

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

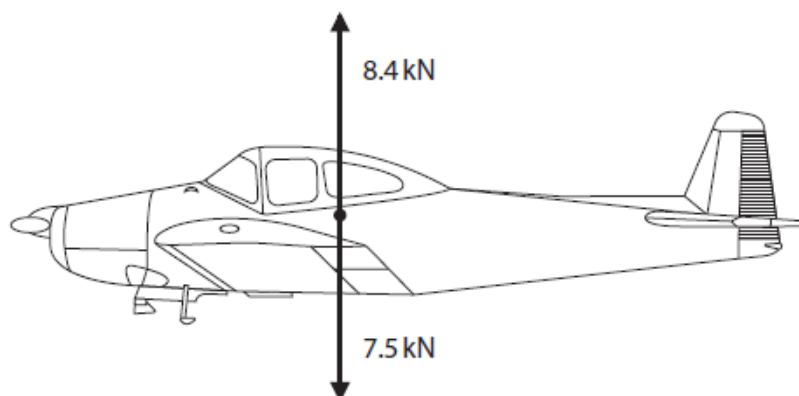


Figure 14

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.

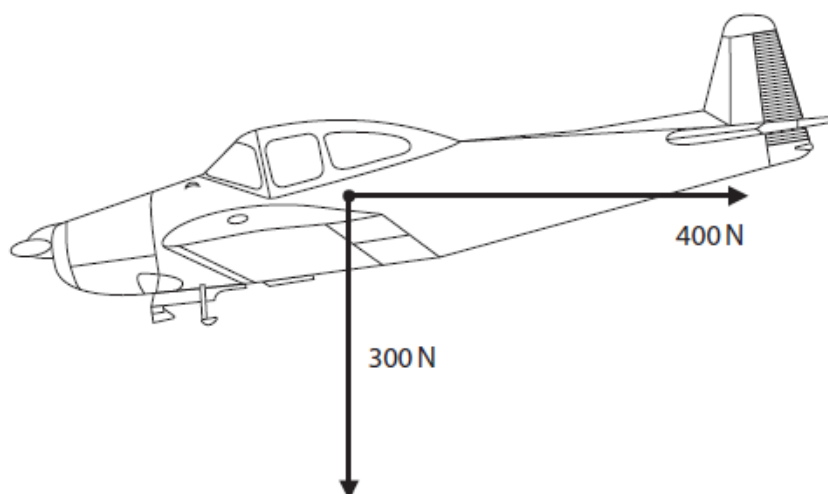


Figure 15

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)

Q7.

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

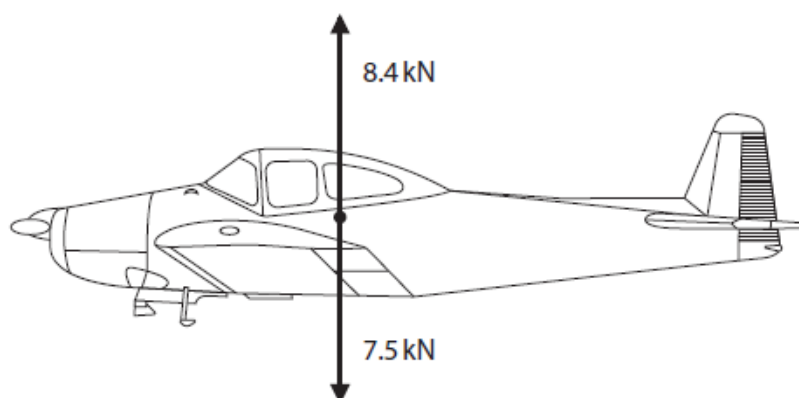


Figure 14

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.

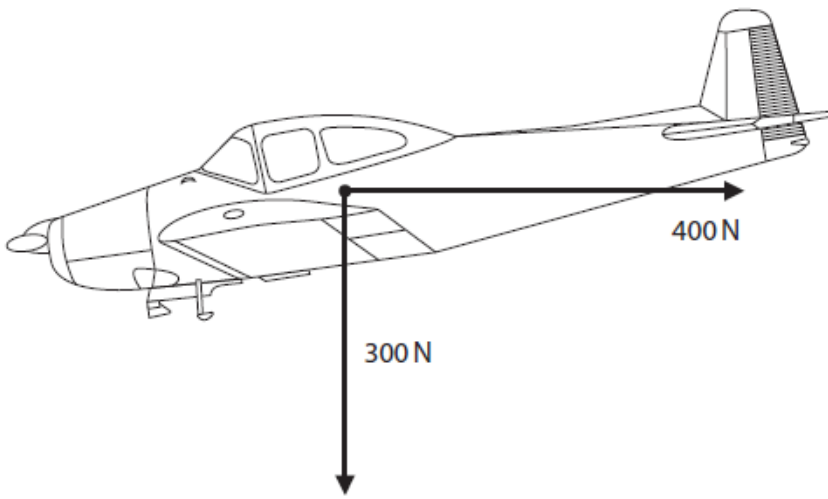


Figure 15

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)

Q8.

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.

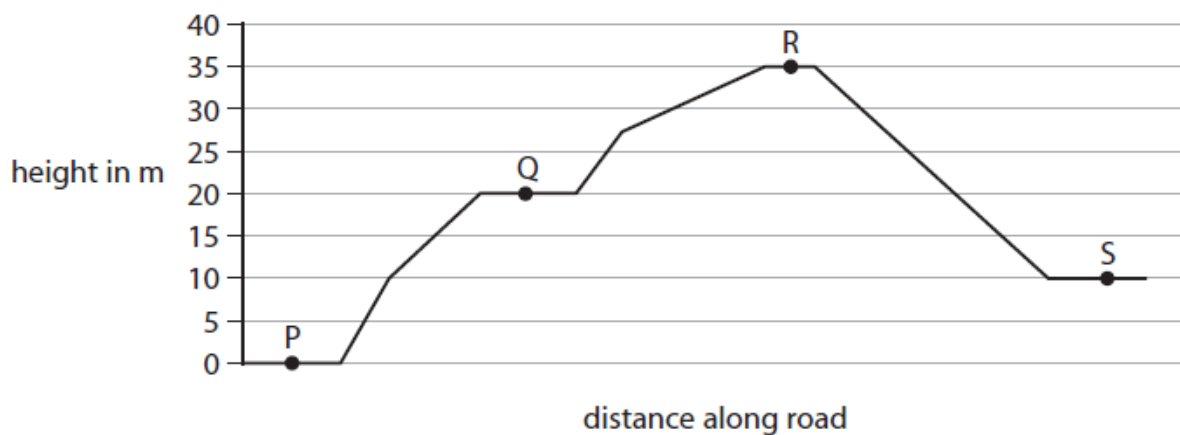


Figure 16

(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)

Q9.

Answer the questions with a cross in the boxes you think are 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 7 shows how the vertical height of the road changes during the journey from P to S.

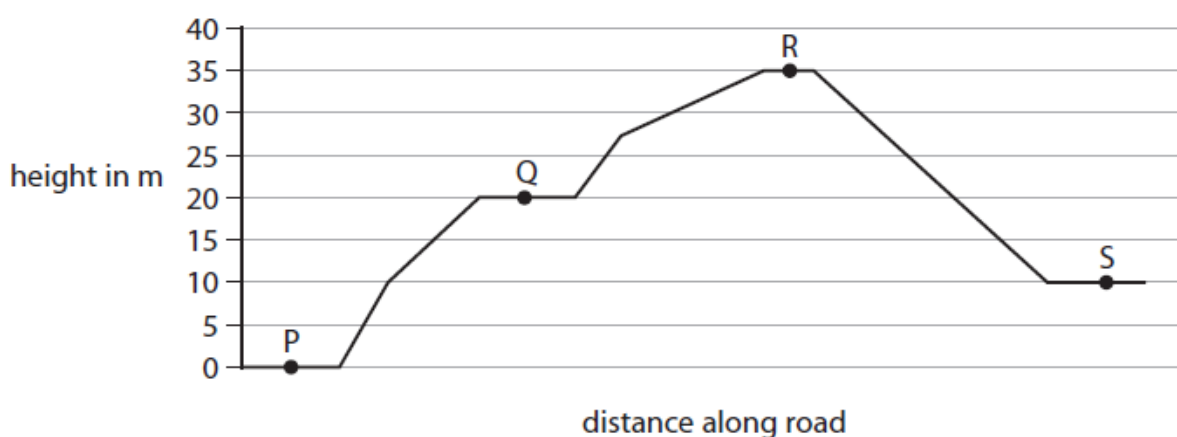


Figure 7

(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)

Q10.

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)

Q11.

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)

Q12.

(a) A father pushes his child in a cart. The cart starts to move.



Scientists can use many physical quantities to describe what is happening.

Four of these are shown in the box.

energy	momentum	power	work
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(i) Which one of these can be measured in joules per second?

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

(1)

- ☐ **A** energy
- ☐ **B** momentum
- ☐ **C** power
- ☐ **D** work

(ii) Complete the sentence using words from the box.

(1)

The transferred to the cart is equal to the done on the cart.

(iii) The child and cart have a total mass of 50 kg. They travel at a velocity of 4 m/s.

Calculate the momentum of the child and cart.

(2)

momentum = ... kg m/s

(iv) The father applies a steady force for a time of 1.5 s. The momentum of the child and cart increases by 450 kg m/s.

Calculate the force which the father applies.

(2)

force = ... N

(v) Momentum is a vector quantity.

State what is meant by a vector quantity.

(1)

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(b) The photograph shows a mother and her daughter stationary on an ice rink.



The mother and daughter push each other away.
They move in opposite directions with different speeds.

Explain why they have different speeds.

(3)

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(Total for Question = 10 marks)

Q13.

Figure 14 shows the vertical forces on an aeroplane.

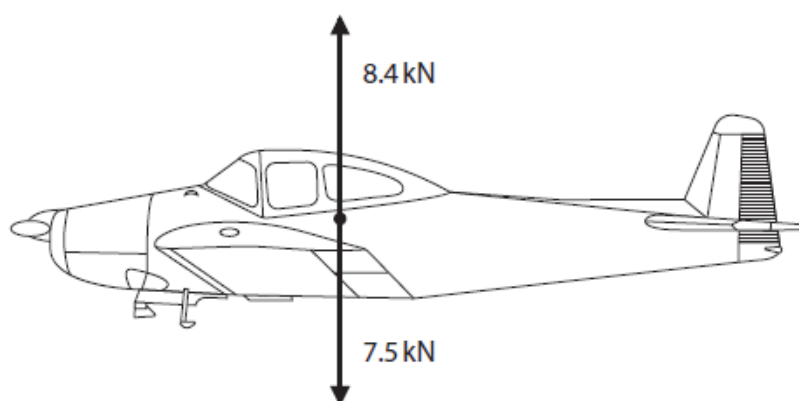


Figure 14

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)

Q14.

An 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)

Q15.

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

They drop balls into a tray filled with sand.

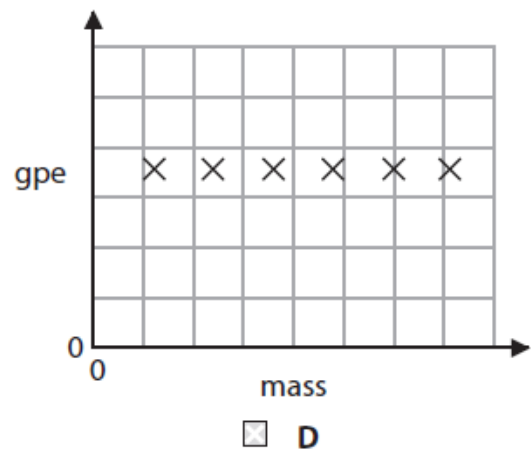
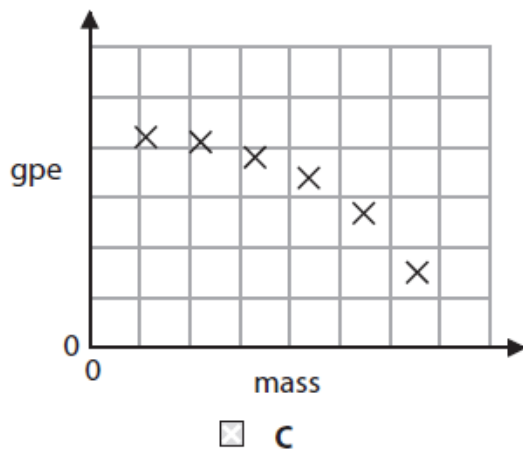
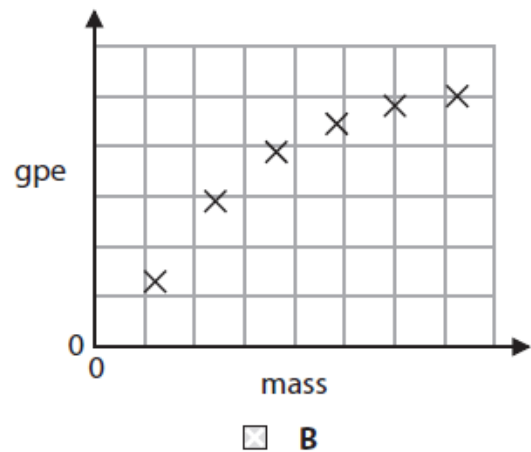
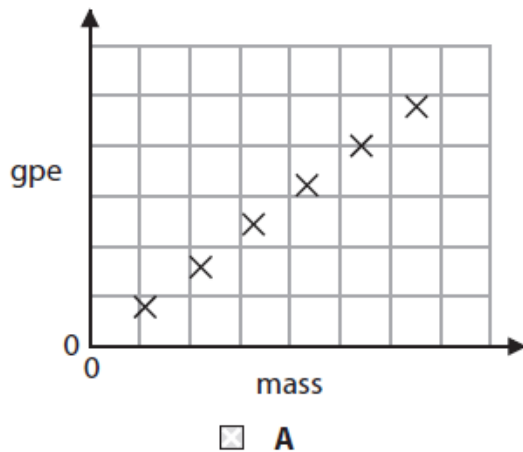
They use six balls with different masses.

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 (X) in the box next to your answer.

(1)



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

(2)

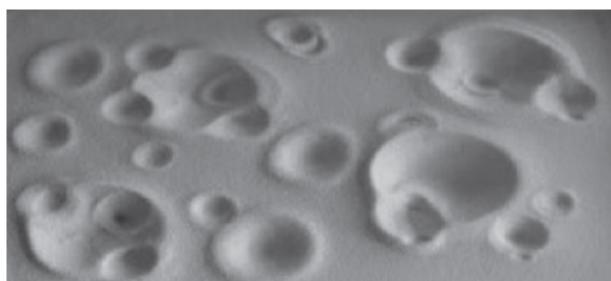
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(b) This photograph shows the sand after several balls have hit it.



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

Q16.

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

They drop balls into a tray filled with sand.

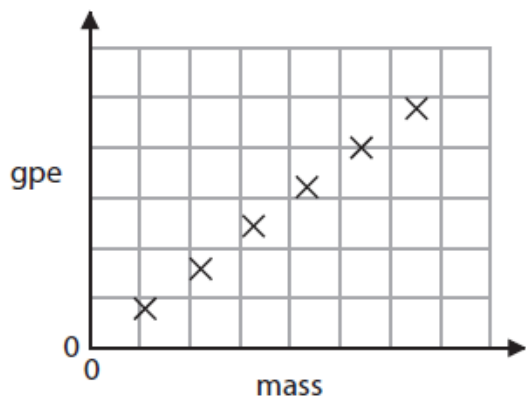
They use six balls with different masses.

They drop each ball from the same height.

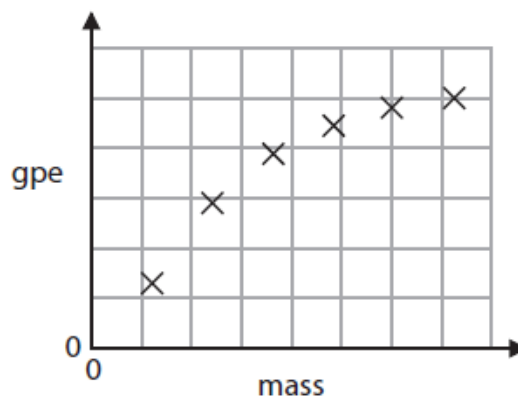
(a) (i) Which one of these graphs shows the relationship between the gravitational potential energy (gpe) of the balls and their mass when they are all at the same height?

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

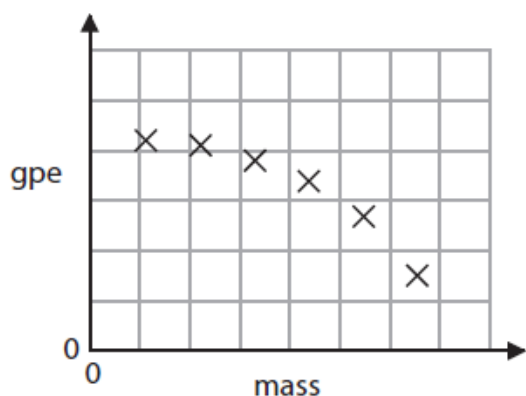
(1)



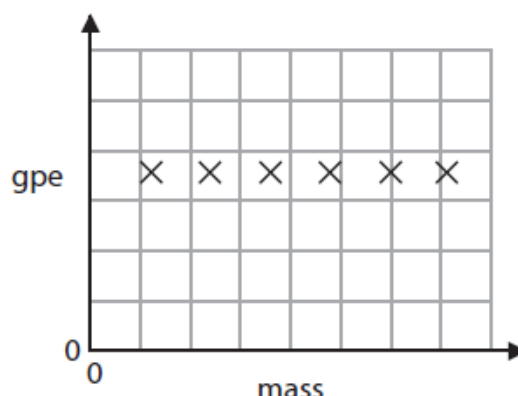
☐ A



☐ B



☐ C



☐ D

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

(2)

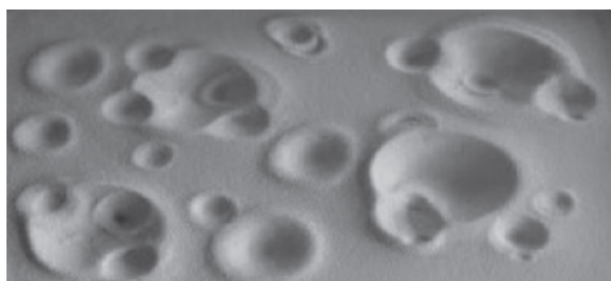
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(b) This photograph shows the sand after several balls have hit it.



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

Q17.

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)

Q18.

Figure 6 shows a 'Mars rover' descending to the surface of the planet Mars.

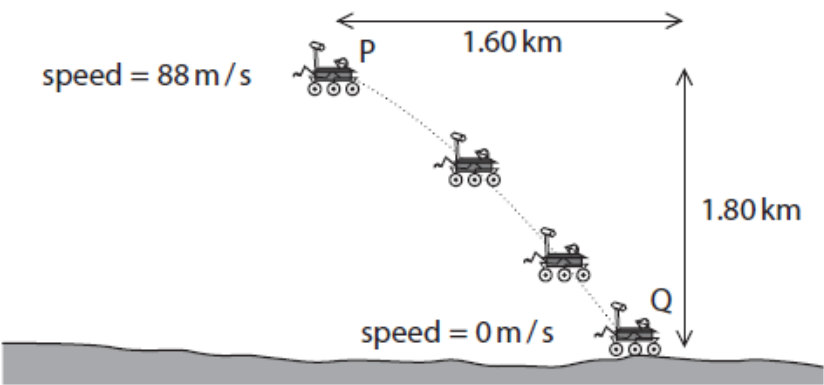


Figure 6

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)

Q19.

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)

Q20.

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 9 represents.

(2)

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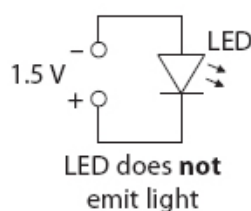
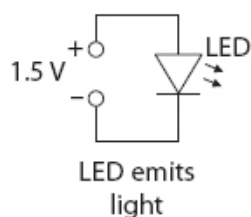
(Total for question = 2 marks)

Q21.

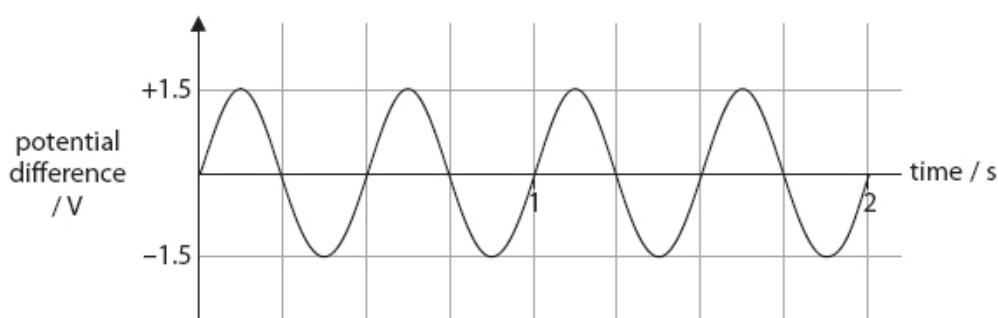
(a) What is the name of the device used to change the size of an alternating voltage?

(1)

(b) A light emitting diode (LED) can only emit light when connected correctly to a potential difference.



Use this information to suggest what happens when this alternating voltage is connected across the LED.



(c) A LED lamp has a power rating of 3 W.
The voltage across the lamp is 12 V.
Calculate the current in the lamp.

(3)

current in the lamp = ...A

*(d) Some research has been carried out into replacing fluorescent lamp fittings with LED fittings.



photo of stairwell
with fluorescent fitting



photo of stairwell
with LED fitting

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

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

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

(6)

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(Total for Question = 12 marks)

Mark Scheme

Q1.

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

Q2.

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

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

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

Q3.

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

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

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

Q4.

Question number	Indicative content	Mark
	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. 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. A03 (6 marks) • 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) ignore references to momentum	(6)

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• 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. (AO3)
Level 2	3-4	• 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. (AO3)
Level 3	5-6	• 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. (AO3)

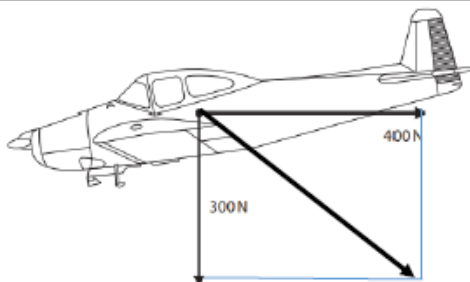
Q5.

Question number	Indicative content	Mark
	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. 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. A03 (6 marks) • 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) ignore references to momentum	(6)

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• 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	• 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	• 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)

Q6.

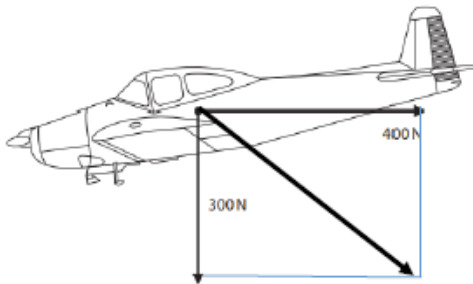
Question Number:	Answer	Additional guidance	Mark
(i)	0.9 (k N) (1) up / upwards / ascending (1)	accept .9 or 0.90 north N ↑	(2) AO 3 2a AO 3 2b

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)	recall and substitution (1) $GPE = 750 \times 10 \times 1300$ evaluation (1) (energy =) 9 800 000 (J)	no POT error (could have missed out g) allow answers in standard form 9.8 x 10⁶ allow answers that round to 9 800 000 e.g. 9 750 000 J allow 9800 kJ or 9.8MJ allow 9 555 000 J allow negative values award full marks for correct answer without working	(2) AO 2 1

Q7.

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

Q8.

Question number	Answer	Additional guidance	Mark
(i)	D R and S A, B and C are incorrect because the difference in vertical positions are all less than that shown by R and S		(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) = 700×20 award full marks for the correct answer without working	(2) AO1

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $11250 = m \times 10 \times 15$ 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)	C increase the efficiency of the cyclist and bicycle A is incorrect because lubrication has no effect on work done against gravity B is incorrect because lubrication will increase efficiency D is incorrect because the overall energy transfer will not increase		(1) AO1

Q9.

Question number	Answer	Additional guidance	Mark
(i)	D R and S A, B and C are incorrect because the difference in vertical positions are all less than that shown by R and S		(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) = 700×20 award full marks for the correct answer without working	(2) AO1

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $11250 = m \times 10 \times 15$ 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)	C increase the efficiency of the cyclist and bicycle A is incorrect because lubrication has no effect on work done against gravity B is incorrect because lubrication will increase efficiency D is incorrect because the overall energy transfer will not increase		(1) AO1

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

Q11.

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

Q12.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	C - power		(1)

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	energy work	Must be in correct order	(1)

Question Number	Answer	Acceptable answers	Mark
a(iii)	Substitution 50 x 4 (1) Evaluation 200 (kg m/s) (1)	Allow full marks for correct answer with no working shown	(2)

Question Number	Answer	Acceptable answers	Mark
a(iv)	Substitution 450 / 1.5 (1) Evaluation 300 (N) (1)	Allow full marks for correct answer with no working shown Allow (1) for 167 (N) obtained by 450-200 / 1.5	(2)

Question Number	Answer	Acceptable answers	Mark
(a)(v)	An explanation to include (quantity has) a size and a direction	ignore any named examples	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation which uses conservation of momentum to link three from Mother and daughter have different mass (1) Momentum is conserved / is zero to start with (1) Both have same size momentum (after the push) (1) so speed of the daughter is greater than that of the mother (1)	An explanation based on Newton's laws and linking three from Each have a different mass (1) Each experience the same size force / action and reaction are equal (1) Each experiences a different acceleration (1) so speed of the daughter is greater than that of the mother (1)	(3)

(Total for Question = 10 marks)

Q13.

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

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

Q14.

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

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

Q15.

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

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	A description to include any two of • Gravitational / potential energy reduces (1) • kinetic energy increases (1) • total energy remains constant (1)	Ignore energy changes resulting from impact with sand GPE reduces KE increases Allow GPE is transferred to KE for 2 mark	(2)

Question Number	Answer	Acceptable answers	Mark
(b)	A explanation linking • (work is done) displacing the sand (1) with EITHER • (as) <u>kinetic</u> energy of the ball(s) has been transferred (1) OR • by the force between the ball and the sand (1)	sand moving/ pushing/ blowing upwards OWTTE or ball sinking into sand	(2)

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

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

Q16.

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

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	A description to include any two of - Gravitational / potential energy reduces (1) - kinetic energy increases (1) - total energy remains constant (1)	Ignore energy changes resulting from impact with sand GPE reduces KE increases Allow GPE is transferred to KE for 2 mark	(2)

Question Number	Answer	Acceptable answers	Mark
(b)	A explanation linking (work is done) displacing the sand (1) with EITHER (as) <u>kinetic</u> energy of the ball(s) has been transferred (1) OR - by the force between the ball and the sand (1)	sand moving/ pushing/ blowing upwards OWTTE or ball sinking into sand	(2)

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

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

Q17.

Question number	Answer	Additional guidance	Mark
(i)	select and substitute (1) $(E = P \times t)$ = 1200 x 30 x 60 (in J)	all three numbers needed to show that allow 1800 (seconds) for 30x60 ignore evaluation	(1) A01.1

Question number	Answer	Additional guidance	Mark
(ii)	select, rearrange and substitute (1) (input energy supplied = $\frac{\text{energy provided by panel}}{\text{efficiency}}$) = $\frac{2.16 \text{ (MJ)}}{(0.)27}$ evaluation (1) $8(.0) \times 10^6 \text{ (J)}$	$\frac{2\ 160\ 000}{(0.)27}$ $8\ 000\ 000 \text{ (J)}$ $8(.0) \text{ MJ}$ award full marks for the correct answer without working $8(.0) \times 10^4 \text{ (J)}$ gains 1 mark (uses 27% incorrectly)	(2) A02.1

Q18.

Question number	Answer	Additional guidance	Mark
(i)	select and substitute (1) ($E = P \times t$) $= 1200 \times 30 \times 60 \text{ (in J)}$	all three numbers needed to show that allow 1800 (seconds) for 30x60 ignore evaluation	(1) A01.1

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

Q19.

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

Q20.

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

Q21.

	Answer	Acceptable answers	Mark
(a)	transformer	Step-up transformer Step-down transformer	(1)
(b)	A suggestion to include any 2 of the following • (LED) turns on and off • as voltage/current { changes direction/from +ve to -ve/ twice each second } (1) • (LED) on for (+ve) part of cycle (1) • (LED) off for (-ve) part of cycle (1)	Flash(es) / flicker(s) (on and off) current changes every 0.25 s / 4 times each second Turns on twice each second = 2 marks Only on when voltage/current is +ve gains both marks	(2)
(c)	substitute (1) $3 = I \times 12$ transformation (1) $I = 3 \div 12$ evaluation (1) 0.25 (A) Ignore any unit given by candidate	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition. Accept any number of sig. figs. that rounds to 0.25 (A) 250 <u>m</u>A gains 3 marks give full marks for correct answer, no working $2.5 \times$ any other power of ten = 2 marks eg	(3)

		Indicative Content	
QWC	*(d)	A discussion including some of the following points • improved lighting levels for LEDs • energy savings per year for LEDs or calculation of time • calculation of energy savings over lifetime of LEDs or calculation of monetary savings by using LEDs • link to savings in fossil fuels for LEDs or link to LEDs and reduced global warming • comparison of lifetimes and maintenance costs	
Level	0	No rewardable content	
1	1 - 2	• a limited discussion of benefits using some pieces of the information provided, e.g. LEDs last 40 000 hours longer and the lighting levels are 200% brighter. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	3 - 4	• a simple discussion of benefits using some pieces of the information and processing one of them OR 2 processed pieces of information. e.g. LEDs save 3000 kW h of energy each year and are much brighter. The money they save each year compared to fluorescents is £420. OR The payback time for the LEDs is about 5 years and in that time they would have to pay for the fluorescent lights to be replaced 5 times. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	5 - 6	• a detailed discussion of benefits using processed information covering more than half of the data points in the table e.g. LEDs use less energy each year and this means that fossil fuel reserves are not used up as quickly. The LEDs save £420 each year and have a payback time of about 5 years. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	