



GuideMyGrades

— YOUR GOALS. OUR EXPERTISE. —

EDEXCEL COMBINED SCIENCE PHYSICS: QUESTIONS BY TOPIC

Energy - Forces Doing Work (8)

Combined Science Physics (Higher) Topic 8

8 questions · 83 marks · Mark schemes included

Pearson Edexcel Combined Science (9-1) Physics 1SC0, Higher Tier, June 2018 - June 2025

 [guidemygrades.com](https://www.guidemygrades.com)

 [@Guidemygrades](https://www.instagram.com/Guidemygrades)

 [@Guidemygrades](https://www.twitter.com/Guidemygrades)

 [@Guidemygrades](https://www.youtube.com/Guidemygrades)

 info@guidemygrades.com

 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
1. Q2	Paper 2 June 2018	9	4
2. Q1	Paper 2 June 2025	9	6
3. Q4	Paper 2 June 2024	10	10
4. Q4 <i>also Topic 9</i>	Paper 2 June 2018	11	14
5. Q4	Paper 2 November 2021	11	17
6. Q4	Paper 2 June 2022	11	20
7. Q5 <i>also Topic 13</i>	Paper 2 June 2023	11	22
8. Q6	Paper 2 June 2023	11	25



QUESTIONS

8 questions · 83 marks · lowest tariff first



9-MARK QUESTIONS

2 questions in this booklet



- 2 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.

- (a) 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

- (b) Describe the energy transfers that happen when the cyclist uses the brakes to stop. (2)

.....

.....

.....

.....

- (c) 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



(d) 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 3 shows the displays for two different sessions by the same athlete.

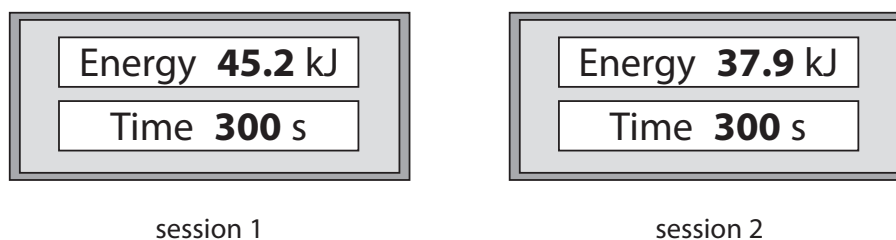


Figure 3

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

(2)

.....

.....

.....

.....

(Total for Question 2 = 9 marks)

- 1 (a) A student places a trolley at the top of a runway, as shown in Figure 1.

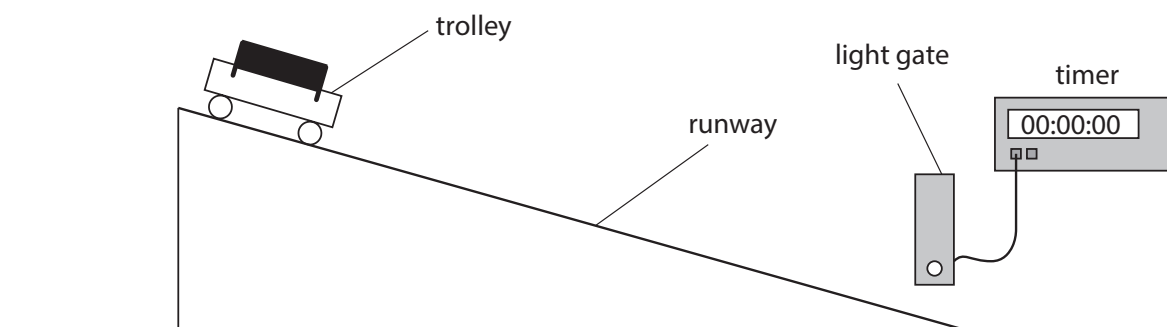


Figure 1

The student had to lift the trolley through a height of 26 cm to put it at the top of the runway.

The gravitational potential energy, ΔGPE , of the trolley increases by 4.1 J when lifted to the top of the runway.

The gravitational field strength, g , = 10 N/kg.

- (i) Show that the mass of the trolley is about 1.6 kg.

Use the equation

$$m = \frac{\Delta GPE}{g \times \Delta h}$$

(2)

- (ii) The student releases the trolley and the trolley moves down the runway.

The student assumes that all the extra gravitational potential energy, ΔGPE , stored at the top of the runway is transferred to kinetic energy at the end of the runway.

Calculate the expected value of the velocity of the trolley at the end of the runway.

Use the equation

$$v^2 = \frac{2 \times \Delta GPE}{m}$$

(3)

expected velocity = ... m/s

- (iii) The light gate, shown in Figure 1, is used to determine the actual velocity of the trolley at the end of the runway.

The actual velocity at the end of the runway is less than the expected velocity as calculated in (ii).

Suggest **one** way to reduce the difference between the actual velocity and the expected velocity.

(1)

.....

.....



- (b) A different student finds out how much power can be generated by running up some stairs in a measured amount of time.

The following quantities are measured:

mass of student = 48 kg

total height of stairs = 2.9 m

time to run up stairs = 3.4 s

Calculate the power the student generated.

Give the answer to 2 significant figures (2 s.f.).

Use the equation

$$\text{power} = \frac{\text{weight of student} \times \text{height of stairs}}{\text{time to run up stairs}} \quad (3)$$

power = ... W

(Total for Question 1 = 9 marks)



10-MARK QUESTIONS

1 question in this booklet



- 4 (a) Figure 8 shows an athlete training with a push sled.

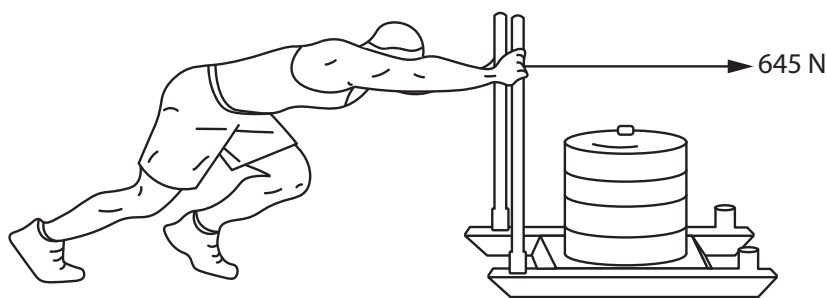


Figure 8

The athlete pushes the sled with a force of 645 N.

Calculate the distance the sled moves when the force of 645 N does 7440 J of work on the sled.

Give your answer to an appropriate number of significant figures.

(3)

distance moved = ... m

(b) Figure 9 shows an electric motor lifting a set of masses.

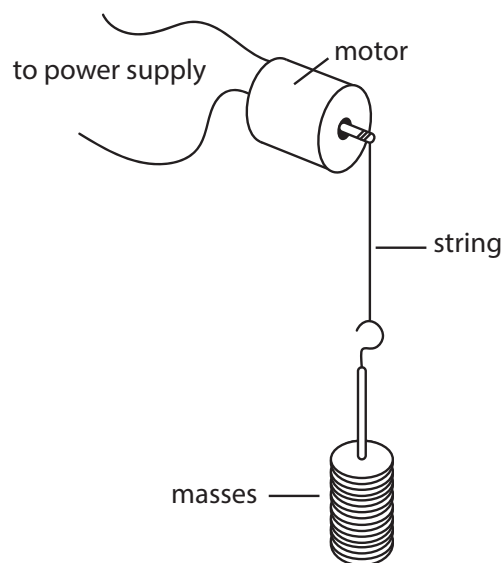


Figure 9

- (i) Describe an experiment, using the apparatus in Figure 9, to determine the gravitational potential energy gained by the masses as they are lifted.

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 9 if it helps your answer.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

- (ii) In one experiment, the change in gravitational potential energy of the masses was 5.8 J.

The total mass lifted was 320 g.

Calculate the vertical height the masses travelled through.

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

(2)

height = ... m

- (iii) The efficiency of the motor was 59%.

State **one** reason why the motor was not 100% efficient.

(1)

.....

.....

(Total for Question 4 = 10 marks)



11-MARK QUESTIONS

5 questions in this booklet



- 4 (a) (i) Figure 5 shows the vertical forces on an aeroplane.

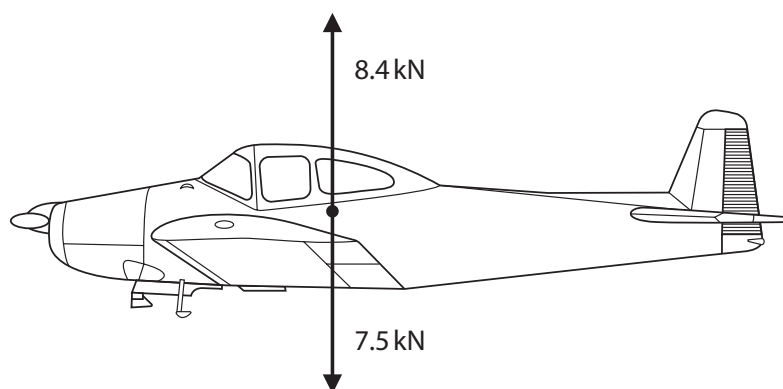


Figure 5

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

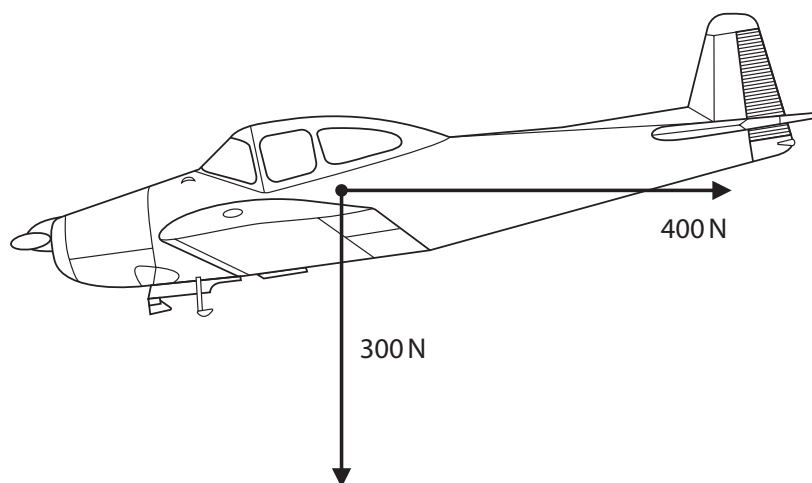


Figure 6

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



(b) 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)

.....

.....

.....

.....

(Total for Question 4 = 11 marks)



- 4 (a) 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.

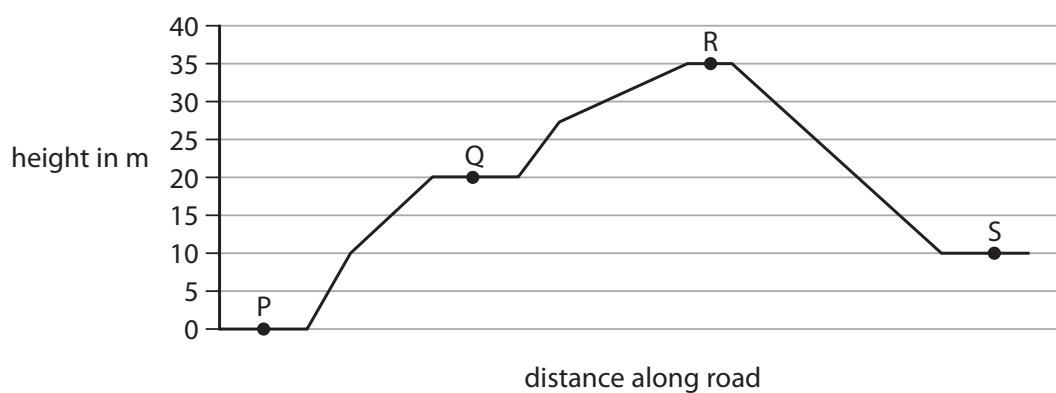


Figure 7

- (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

$$\Delta GPE = m \times g \times \Delta h \quad (2)$$

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)

.....

.....

.....

.....

- (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

(b) 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 4 = 11 marks)



- 4 (a) Figure 6 shows a 'Mars rover' descending to the surface of the planet Mars.

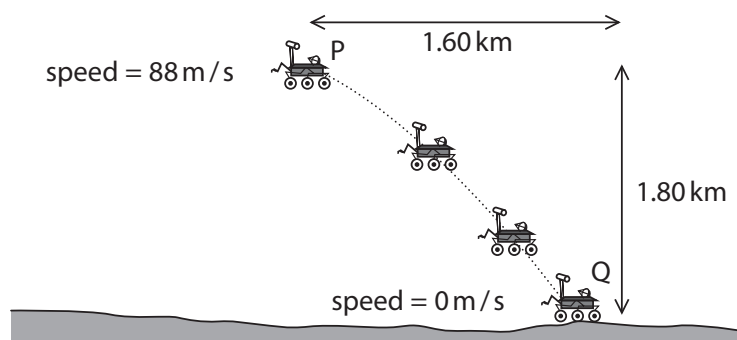


Figure 6

- (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 6 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 6).

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)

.....

.....

.....

.....

.....

- (b) The rover uses solar panels for its power needs.

The solar panels can provide 1200W 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 4 = 11 marks)



- 5 (a) An electric car is travelling at a speed of 16.0 m/s .

The total mass of the car is 1200 kg .

- (i) Calculate the kinetic energy, in kJ , of the car.

(2)

kinetic energy = ... kJ

- (ii) On a journey, the car transfers energy from the battery at an average rate of 17.5 kW .

The battery in the car transfers a total of 126 MJ of energy before it becomes discharged.

Calculate the time taken for the battery to become discharged on this journey.

Give your answer in hours.

(2)

time taken = ... hours



- (iii) Figure 10 shows an electrical device connected to the wheels of an electric car.

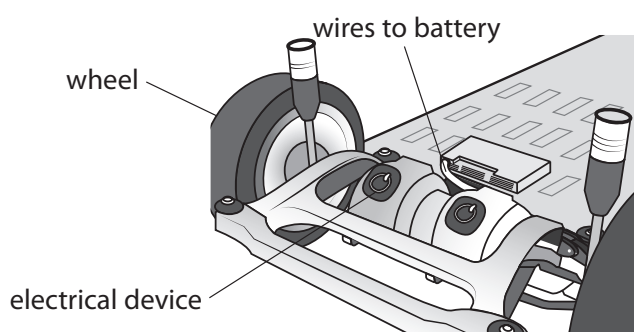


Figure 10

The electrical device is used as a motor when the car accelerates and as a dynamo when the car decelerates.

Explain how using the device can help to increase the time that the car can be driven before the battery becomes discharged.

(2)

.....

.....

.....

.....

- (b) The battery can be recharged at a charging point.

The charging point provides an average current of 15.0 A to the battery, at a potential difference (voltage) of 400 V.

It is claimed that 126 MJ of energy can be transferred to the battery in less than 6 hours.

- (i) Comment on this claim.

Use this equation to support your answer

$$t = \frac{E}{I \times V} \quad (3)$$

- (ii) Calculate the total charge that moves into the battery while it is being recharged.

Use the equation

$$E = Q \times V \quad (2)$$

charge = ... C

(Total for Question 5 = 11 marks)



- 6 (a) Figure 11 shows a pulley system that enables a person to lift a heavy barrel.

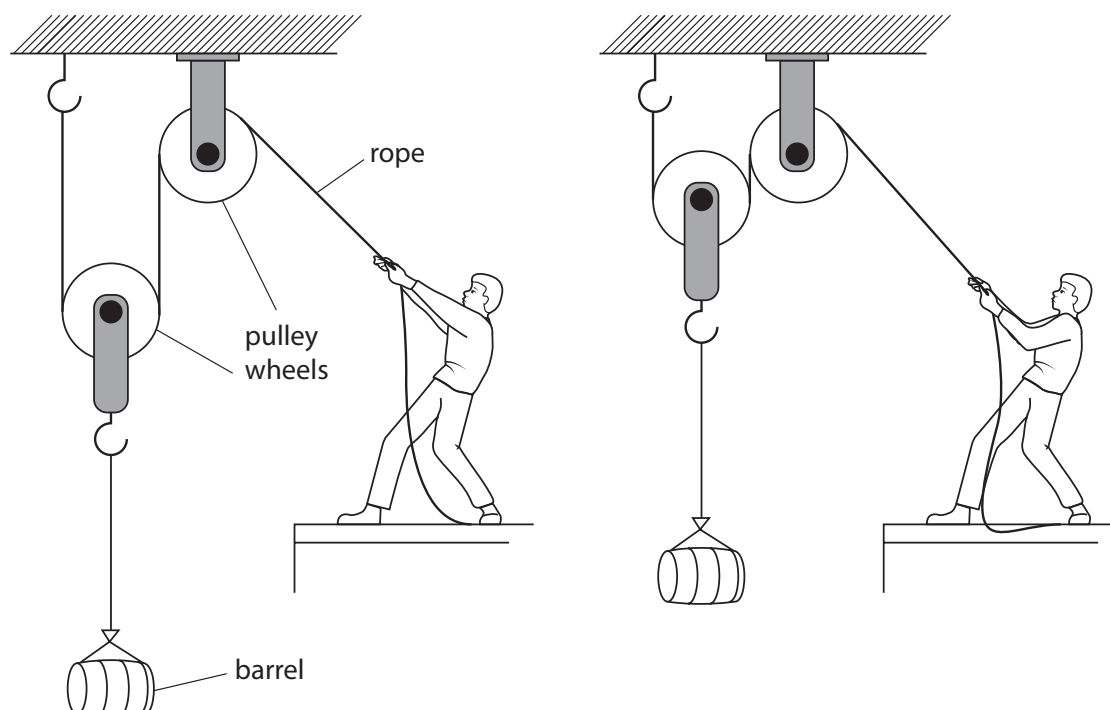


Figure 11

The person pulls down on the rope to make the barrel rise through 1.2 m.

The work done against gravity on the barrel is 1800 J.

- (i) Calculate the weight of the barrel.

Use the equation

$$\text{work done} = \text{force} \times \text{distance moved in the direction of the force}$$

(2)

weight of the barrel = ... N

- (ii) The efficiency of the system is 64%.

Calculate the total work done by the person.

Use the equation

$$\text{efficiency} = \frac{(\text{work done against gravity on the barrel})}{(\text{total work done by the person})} \times 100\% \quad (2)$$

work done = ... J

- (iii) Some energy is wasted due to friction.

Suggest **another** reason why some energy is wasted in using this pulley system.

(1)

.....

.....

MARK SCHEMES

official Pearson Edexcel mark schemes



Question Number:	Answer	Additional Guidance	Mark
2(a)	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

Question Number:	Answer	Additional Guidance	Mark
2(b)	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

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

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

(Total for Question 2 = 9 marks)



Question Number	Answer	Additional guidance	Mark
1(a)(i)	substitution with conversion (2) $(m =) \frac{4.1}{10 \times 0.26}$ $(=1.58)$	accept 9.8(1) instead of 10 for g throughout alternative method substitution and rearrangement with conversion (2) e.g. $\Delta g_{pe} = 10 \times 0.26 \times 1.6$ $(=4.1)$ Allow for 1 mark: $(m =) \frac{4.1}{10 \times 26}$ allow 26 to any power of 10 for this mark OR $\Delta g_{pe} = 10 \times 26 \times 1.6$ allow 26 to any power of 10 for this mark OR height converted to m 0.26 (m) or 26×10^{-2} (m)	(2) AO 2.1

Question Number	Answer	Additional guidance	Mark
1(a)(ii)	substitution (1) $(v^2 =) \frac{2 \times 4.1}{1.6}$ evaluation of v^2 (1) 5.1(25) evaluation of v (1) 2.3 (m/s)	ecf from part a(i) throughout accept use of 1.58 accept 5.2 (use of 1.58) accept values that round to 2.3 e.g. 2.264 award full marks for the correct answer without working	(3) AO2.1

Question Number	Answer	Additional guidance	Mark
1(a)(iii)	addition of any lubricant / oil / grease	make runway steep(er) use an air track instead streamline trolley	(1) AO 3.3b

Question Number	Answer	Additional guidance	Mark
1(b)	substitution (1) $(P =) \frac{48 \times 10 \times 2.9}{3.4}$ evaluation (1) 409 (W) to 2 s.f. (1) 410 (W)	accept 9.8(1) instead of 10 for g throughout $\frac{480 \times 2.9}{3.4}$ OR $\frac{1392}{3.4}$ accept values that round to 409 accept values that round to 402 (used g = 9.81) accept the result of any calculation to 2s.f. for this mark accept 400 (W) if 402 seen (used g = 9.81) award full marks for the correct answer without working	(3) AO 2.1

Total for Question 1 = 9 marks



Question number	Answer	Additional guidance	Mark
4 (a)	substitution (1) $7440 = 645 \times \text{distance}$ rearrangement (1) $(\text{distance} =) \frac{7440}{645}$ evaluation and rounding to 3sf (1) 11.5 (m)	rearrangement and substitution in either order allow substitution of correct values into a visible, incorrectly rearranged algebraic equation for this mark only (distance =) $\frac{\text{work done}}{\text{force}}$ 11.53 (m) scores 2 marks only award full marks for the correct answer without working	(3) AO2.1

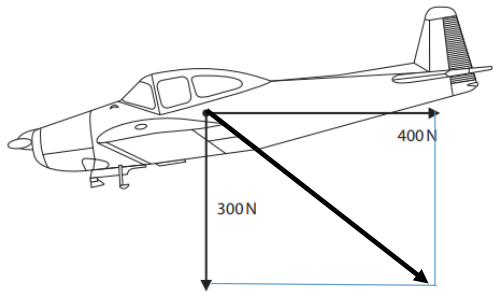
Question number	Answer	Additional guidance	Mark
4 (b) i	a description to include two clear statements of what is measured plus further details use scales / a balance to measure mass(es) (1) use a (metre) rule to measure a	marks may be scored from the diagram allow counts up the total mass on the hanger allow use newton meter / scale / balance to measure weight	(4) AO1.2

Question number	Answer	Additional guidance	Mark
4 (b) ii	rearrangement and substitution (1) $\frac{5.8}{320 \times 10^{-3} \times 10}$ evaluation (1) 1.8 (m)	$\frac{5.8}{0.320 \times 10}$ any number rounding to 1.8 e.g. 1.8125 award full marks for the correct answer without working	(2) AO2.1

Question number	Answer	Additional guidance	Mark
4 (b) iii	award one mark for any stated reason from: friction (in the motor) (1) heating (electrical or from frictional effects) (1)	other valid answers possible allow 'it needs oiling' etc. to thermal (energy store) / energy transferred to surroundings / energy dissipated allow it gets hot ignore sound	(1) AO1.1

Total for Question 4= 10 marks

Question Number:	Answer	Additional Guidance	Mark
4(a)(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
4(a)(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
4(a)(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

Question Number:	Answer	Additional Guidance	Mark
4(b)(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)	$\text{efficiency} = \frac{\text{power output}}{\text{power input}}$ 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
4(b)(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

(Total for Question 4 = 11 marks)



Question number	Answer	Additional guidance	Mark
4 (a) (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
4 (a) (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
4 (a) (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
4 (a)(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
4 (a)(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	Additional guidance	Mark
4 (b)	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

Total for question 4 = 11 marks



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

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

Question number	Answer	Additional guidance	Mark
4 (a) iii	A description linking three from: 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)	KEY: attempt to explain <u>how work done</u> contributes towards the energy changes / conservation of energy if no other mark scored allow one mark for work = force x distance	(3) AO2.1

Question number	Answer	Additional guidance	Mark
4(b) (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) AO1.1

Question number	Answer	Additional guidance	Mark
4(b) (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

TOTAL 11 marks

Question number	Answer	Additional guidance	Mark
5 (a) (i)	selection and substitution (1) (KE =) $\frac{1}{2} \times 1200 \times 16(.0)^2$ evaluation in kJ (1) (KE =) 150 (kJ)	(KE =) $\frac{1}{2} \times 1200 \times 16(.0)^2 \times 10^{-3}$ accept any value that rounds to 150 e.g. 153.6 award full marks for correct answer without working. award 1 mark for 153.6 or 150 to any other power of ten	(2) AO2

Question number	Answer	Additional guidance	Mark
5 (a) (ii)	selection and substitution (1) $17.5 (x 10^3) = \frac{126 (x 10^6)}{t}$ re-arrangement and evaluation (1) (t=) 2(.0) (h)	alternative method selection and rearrangement (1) (t =) $\frac{E(nergy)}{P(ower)}$ or (t=) $\frac{126 (x 10^6)}{17.5 (x 10^3)}$ (substitution and) evaluation (1) (t=) 2(.0) (h) award full marks for correct answer without working. allow 1 mark for 7(.2) to any power of ten (incorrect time conversion) allow 1 mark for 2(.0) to any power of 10 (POT error)	(2) AO2

Question number	Answer	Additional guidance	Mark
5 (a) (iii)	an explanation linking (energy transfers when the car is decelerating) (from) kinetic energy (store) (1) (to) chemical energy (store) (1)	idea of energy that would be otherwise wasted uses an electrical pathway {electric current / electricity / emf} produced allow mechanical for kinetic in this context recharges battery increases available energy store of battery more useful energy available	(2) AO2

Question number	Answer	Additional guidance	Mark
5(b) (i)	either calculation of time: substitution (1) $(t =) \frac{126 \times 10^6}{15 \times 400 \times 3600}$ evaluation (1) (t=) 5.8(3) (h) conclusion (1) claim is justified as the time is less (than 6 hours) or calculation of energy: substitution (1) $6 \times 3600 = \frac{E}{15 \times 400}$ rearrangement and evaluation (1) E = 130 MJ conclusion (1) claim is justified as energy (in 6 hours) is more than (126 MJ) required.	accept correct time conversion e.g. 5h 50 min 350 min 21 000 s award 2 marks for correct answer without working. award 1 mark for answer of either 2.1 or 5.8(3) to any other power of ten allow relevant comment based on incorrectly calculated time (independent mark) accept 129.6 MJ accept 129 600 000 J allow relevant comment based on incorrectly calculated energy (independent mark)	(3) AO3

Question number	Answer	Additional guidance	Mark
5 (b) (ii)	substitution (1) $126 (\times 10^6) = Q \times 400$ re-arrangement and evaluation (1) $(Q =) 315\,000 \text{ (coulombs)}$	alternative method re-arrangement (1) $(Q =) \frac{E}{V}$ or $(Q =) \frac{126 (\times 10^6)}{400}$ (substitution and) evaluation (1) $(Q =) 315\,000 \text{ (coulombs)}$ accept answers rounding to 320 000 (coulombs) allow one mark for answers rounding to 3.2 to any other power of ten award two marks for correct answer without working.	(2) AO2

Total 11 marks

Question number	Answer	Additional guidance	Mark
6 (a) (i)	substitution into work done = force x distance (1) 1800 = force x 1.2 rearrangement and evaluation (1) (force =) 1500 (N)	alternative method rearrangement (1) (force =) $\frac{\text{work (done)}}{d(\text{istance moved})}$ or (force =) $\frac{1800}{1.2}$ (substitution and) evaluation (1) (force =) 1500 (N) if no other marks scored allow one mark for answer of 500 (N) or 4500 (N) award full marks for correct answer without working.	(2) AO2

Question number	Answer	Additional guidance	Mark
6 (a) (ii)	substitution (1) $64 = \frac{1800 \times 100}{\text{total work done}}$ or $0.64 = \frac{1800}{\text{total work done}}$ rearrangement and evaluation (1) (work done =) 2800 (J)	alternative method re-arrangement (1) (total work done =) $\frac{\text{work done on barrel} \times 100}{\text{efficiency}}$ or (work done=) $\frac{1800 \times 100}{64}$ or (work done=) $\frac{1800}{0.64}$ (substitution and) evaluation (1) (work done =) 2800 (J) allow values that round to 2800; e.g. 2812.5 award full marks for correct answer without working.	(2) AO2

Question number	Indicative content	Mark
*6 (b)	Answers will be credited according to 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 the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Use of equipment • Provide a measurable load; for example hang a cube on one end of the system / on spring (balance) • Provide a measurable effort; for example hang spring balance on other end of system • Method to measure distances moved; for example use metre rule Obtaining relevant data • Measure weight of cube with spring balance • Take reading of spring balance when being pulled • Measure height by which the cube is raised • Measure distance moved by (end of) spring balance. Processing results • calculate work done on cube = obtained weight x obtained distance • calculate work done by student = obtained force x obtained distance • calculate efficiency as (calculable) work done on cube / (calculable) work done by student • inspect results to look for relationship between weight of cube and efficiency • plot graph of efficiency against weight	(6) AO3

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• Analyses the scientific information but understanding and connections are flawed. (AO3) • An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (AO3) • A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• Analyses the scientific information and provide logical connections between scientific enquiry, techniques and procedures. (AO3) • A well-developed plan that synthesises relevant understanding coherently. (AO3)



Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> At least two uses of equipment	<u>Possible candidate responses</u> Hang cubes on hook Spring balance on ring
Level 2	3–4	<u>Additional guidance</u> At least two methods of obtaining relevant data from use of equipment.	<u>Possible candidate responses</u> Measure weight of cube with spring balance. Hang cube on hook. Pull on other end. Measure how far cube has gone up. OR Put cube on hook. Put spring balance on ring. Pull and read force. Measure how far spring balance moves.
Level 3	5–6	<u>Additional guidance</u> At least two methods of obtaining relevant data from correct use of equipment and at least two descriptions of processing that data.	<u>Possible candidate responses</u> Use spring balance to measure weight of cube and force needed by student. Measure height that cube was raised by. Calculate work done by multiplying force and distance moved in each case.

Total 11 marks