Types of Forces

Questions

Q1.

Figure 23 shows a drone.
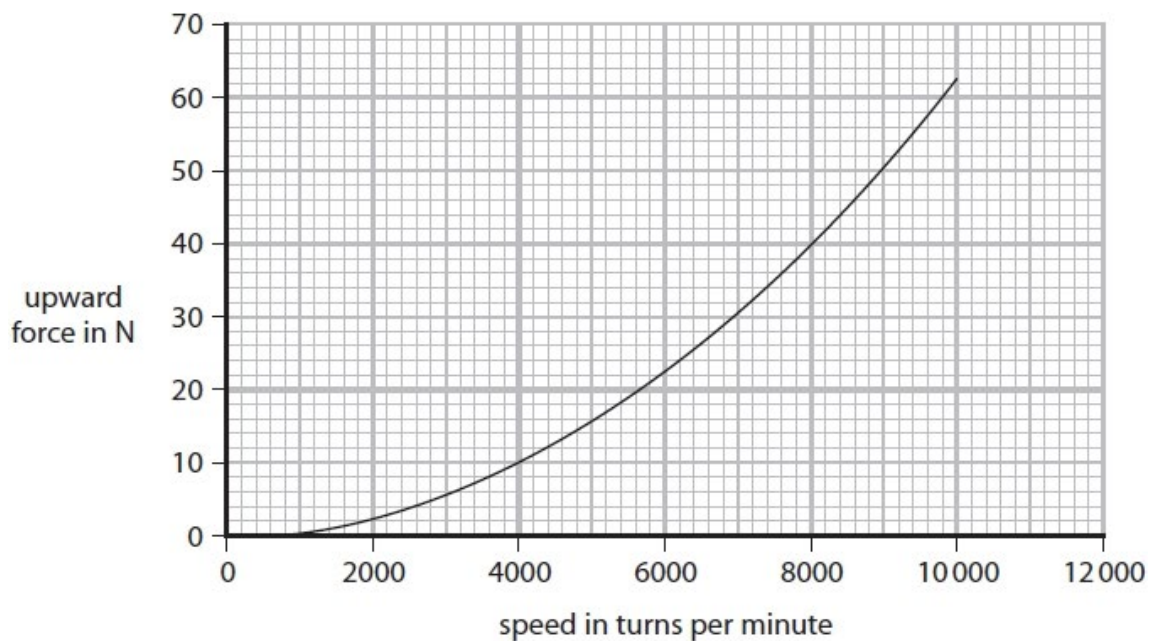
© Liubov Kotliar/123RF

Figure 23

The drone has four spinning blades.

The upward force produced enables the drone to rise in the air.

The speed at which the blades spin is measured in turns per minute.

Figure 24 shows how the upward force produced by the four blades depends on the speed at which the blades spin.

Figure 24

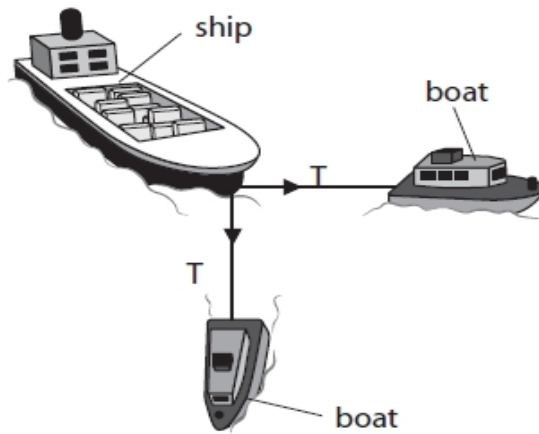Describe the relationship between upward force and speed shown by this graph.

(2)

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(Total for question = 2 marks)

Q2.

Figure 23 shows two small boats pulling a much larger ship.

Figure 23

The ship is connected to the boats with ropes.

The tension, T, in each of the ropes has a magnitude of 20 kN.

The ropes are at right angles to each other.

Draw a vector diagram and use it to determine the resultant force that the boats exert on the ship.
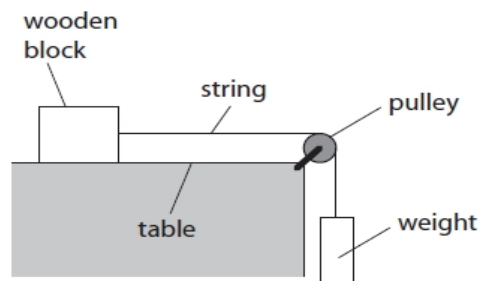
(4)

magnitude of resultant force on the ship = ... kN

(Total for question = 4 marks)

Q3.

*Figure 24 shows a wooden block connected to a weight by a string.
The string goes over a pulley.

The surfaces of the table and the wooden block are both rough.

Figure 24

The wooden block moves across the table at a constant horizontal velocity.

Several vertical and horizontal forces act on the wooden block as it moves.

Explain how the forces keep the wooden block moving across the table at a constant horizontal velocity.

Your answer should refer to all forces acting on the wooden block.

You may add to the diagram to help with your answer.

(6)

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(Total for question = 6 marks)

Q4.

(i) Which of these forces keeps the Moon moving around the Earth?

(1)

☒ **A**   contact

☒ **B**   electrostatic

☒ **C**   gravitational

☒ **D**   magnetic

(ii) Which of these is a scalar quantity?

(1)

☒ **A**   velocity

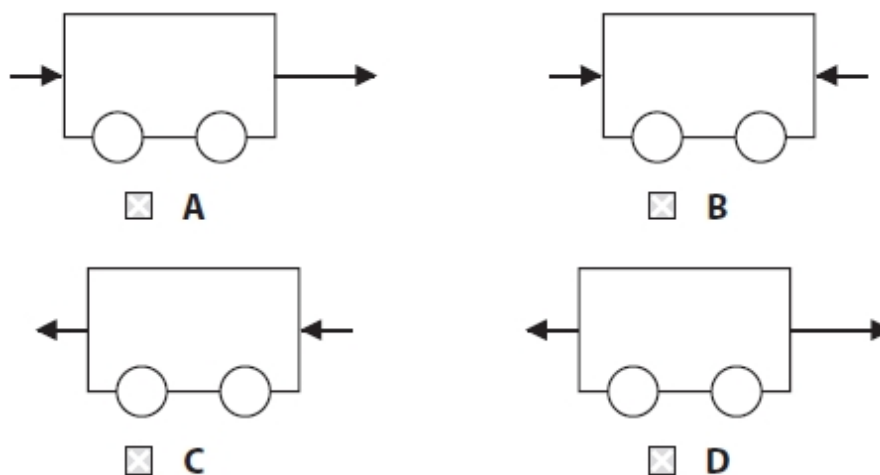☒ **B**   momentum

☒ **C**   energy

☒ **D**   acceleration

(Total for question = 2 marks)

Q5.

The magnitude and direction of a force can be represented by a vector.
Figure 22 shows the forces acting on four identical trolleys. The arrows show the magnitude and direction of the forces.

Which diagram shows a pair of forces that will produce zero acceleration?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

Figure 22

(Total for question = 1 mark)

Q6.

Which of these statements is true for a vector quantity?

(1)

☒ **A** It has size only

☒ **B** It has direction only

☒ **C** It has direction and size

☒ **D** It does not have direction or size

(Total for question = 1 mark)

Q7.

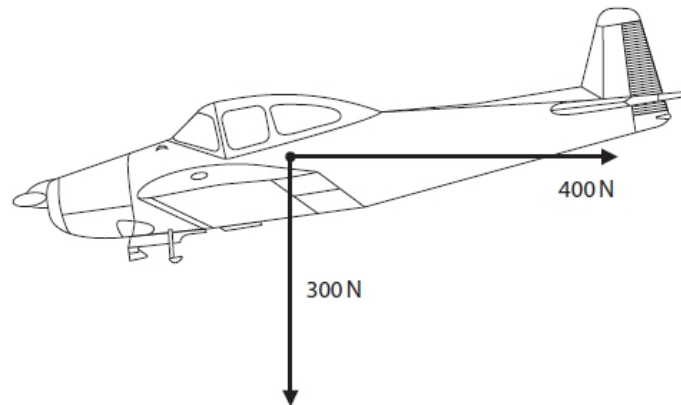(i) Figure 14 shows the vertical forces on an aeroplane.
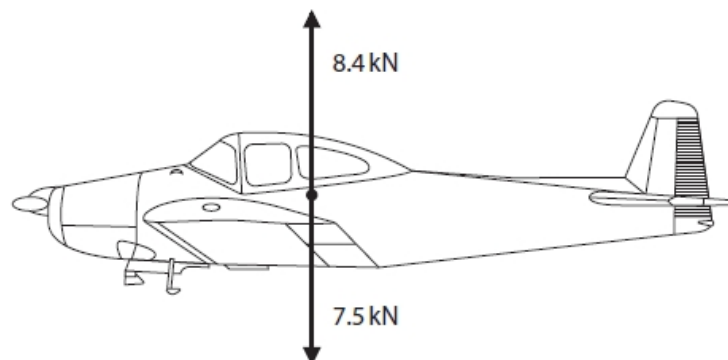
Figure 14

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.

400 N

300 N

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.
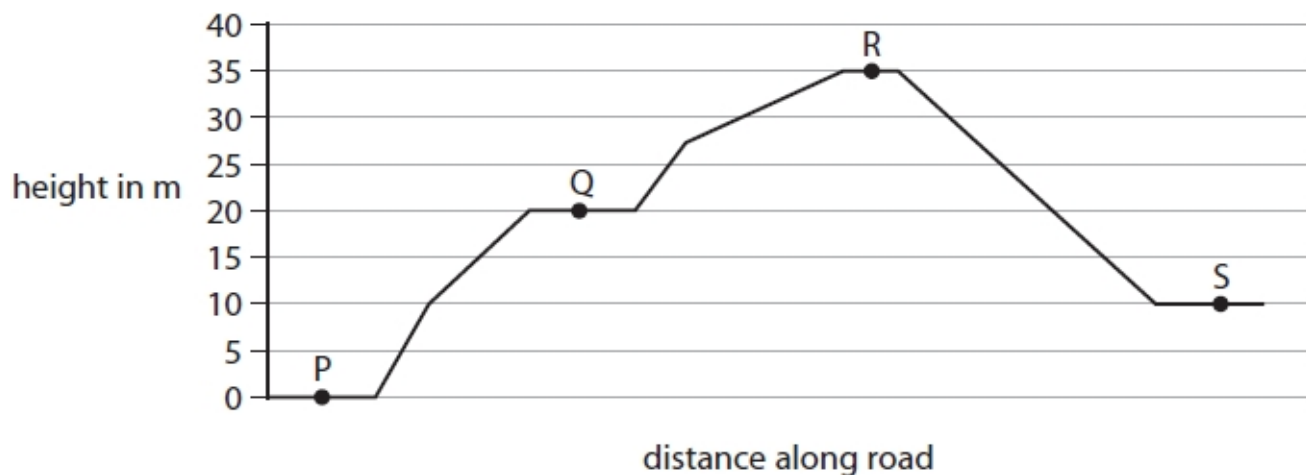Gravitational field strength (*g*) = 10 N/kg

(2)

energy = ... J

(Total for question = 5 marks)

Q8.

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
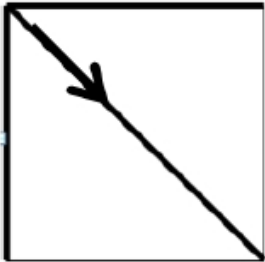
(Total for question = 8 marks)

Mark Scheme - Types of Forces

Q1.

Question number	Answer	Additional guidance	Mark
	(upward) force increases with speed (1)	allow reverse argument	**(2)**
	relationship is non-linear (1)	changing rate / increases exponentially/ initially no upward force (until 1000 turns per minute)	

Q2.

Question number	Answer	Additional guidance	Mark
	Scale drawing two lines at right angles (1)		**(4)**
	a correct scaling (for example 10kN equivalent to 1 cm) / a completed square or triangle(1) diagonal in correct direction (1) 28 kN (1)	judge by eye accept answers from 25 kN to 30 kN accept use of Pythagoras award full marks for correct answer without working.	

Q3.

Question number	Indicative content	Mark
	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. A01 **Horizontal forces** • tension in the string/pull of the string • tension is one of the horizontal forces acting on the wooden block • friction between the table and the wooden block • friction acts in the opposite direction to the tension • friction opposes motion • the force due to friction is equal to the force provided by the tension • the forces are balanced /equal and opposite • no resultant force, so the block moves at a constant (horizontal) velocity	**(6)**

| | **Vertical forces**
• (normal) reaction (force) upwards between the table and the wooden block
• contact force
• weight of block downwards
• the weight (force of gravity) and the (normal) reaction are equal and opposite / balanced
• the block does not move up or down
• tension caused by the force due to gravity on the weight
• vertical forces on the block do not affect horizontal velocity.

 labels on the diagram should be considered when marking
 candidates do not have to indicate the forces as horizontal and vertical | |

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

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	Additional guidance Elements of physics present i.e. isolated knowledge of principles **two** unconnected statements from any section	Possible candidate responses contact force weight pulls block friction tension in string weight acts downward reaction
Level 2	3–4	Additional guidance Some knowledge of principles with a logical connection made in one section and statement from the other section OR Detailed knowledge of principles with logical connections made in one section	Possible candidate responses There is friction between the table and the block and this opposes motion weight of block acts downwards

Level 3	5–6	Additional guidance	Possible candidate responses
		Detailed knowledge of principles with logical connections made in one section and statement from the other section	Friction and tension are equal and opposite there is no resultant /no acceleration
			The weight (of the block) and the(normal) reaction are equal and opposite

Q4.

Question Number:	Answer	Mark
(i)	C gravitational **The only correct answer is C** *A is not correct as the moon does not touch the Earth* *B is not correct as the Earth does not carry a charge* *D is not correct as the Earth has a magnetic field but it does not extend far enough to have any effect on the moon*	**(1)** AO 2 1

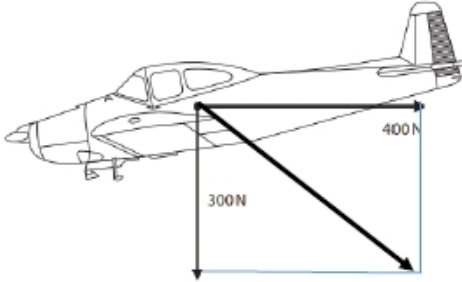| Question Number:	Answer	Mark
(ii)	C energy **The only correct answer is C** *A is not correct as velocity is a vector quantity* *B is not correct as momentum is a vector quantity* *D is not correct as acceleration is a vector quantity*	**(1)** AO 1 1

Q5.

Question number	Answer	Mark
	B A, C and D are incorrect because they all show a resultant force which would cause the trolley to accelerate	**(1)**

Q6.

Question number	Answer	Mark
	C It has direction and size Option C is the only correct combination for a vector quantity	**(1)** **AO1**

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 x 10 x 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 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)	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**