Pearson Edexcel

Additional Assessment Materials Summer 2021

Pearson Edexcel GCSE in Physics (1PH0) Higher

Resource Set Topic B – Test 2: Energy and Forces doing work, Forces, and their effects

Questions

(Public release version)

Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

3 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)

$$= \frac{1}{2} \times 68 \times 12^2$$

$$= 4896 \approx 4900$$

kinetic energy = 4900 J

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

(2)

The kinetic energy of the bicycle converts to thermal energy at the brakes.

(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)

$$W = F \times d$$

$$1600 = F \times 28$$

$$F = \frac{1600}{28} = 57.14 \approx 57$$

average force = 57 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 5 shows the displays for two different sessions by the same athlete.

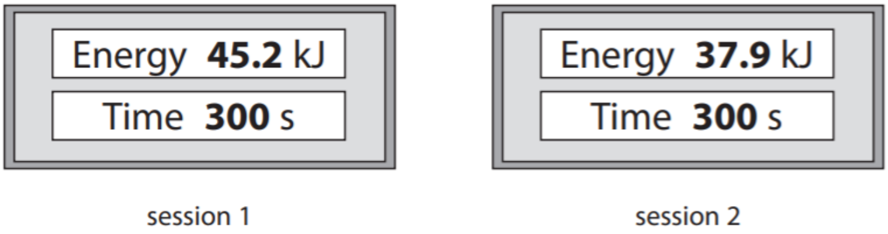

Figure 5

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

(2)

More work is done in session 1 compared to session 2 for the same time.

The larger amount of power is produced in session 1 compared to session 2.

6 (a) Figure 10 shows an arrangement of gears.

Each gear turns around a fixed axle.

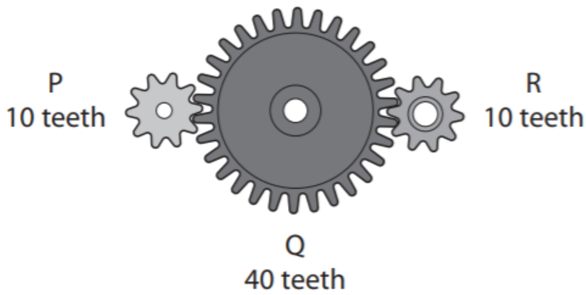

Figure 10

Gear P is turned through one complete revolution per second.

(i) Which of the following describes the motion of gear R?

(1)

		speed (revolutions per second)	direction of rotation
☐	**A**	4	same as P
☒	**B**	1	same as P
☐	**C**	4	opposite to P
☐	**D**	1	opposite to P

(ii) Figure 11 shows the same arrangement with gear R replaced by a rack.

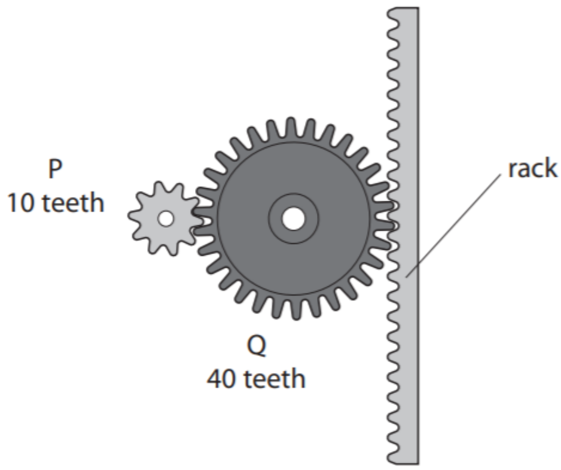

Figure 11

The rack can move up or down when the gears turn.

The teeth on the rack are 2 mm apart.

Calculate how far the rack moves when P turns through to one complete revolution.

(2)

distance = pitch × no. of teeth moved

distance = 20 mm

(b) Figure 12 shows three toy animals hanging from a rod.

The rod hangs from the ceiling by a string tied to the centre of the rod.

The system is in equilibrium.

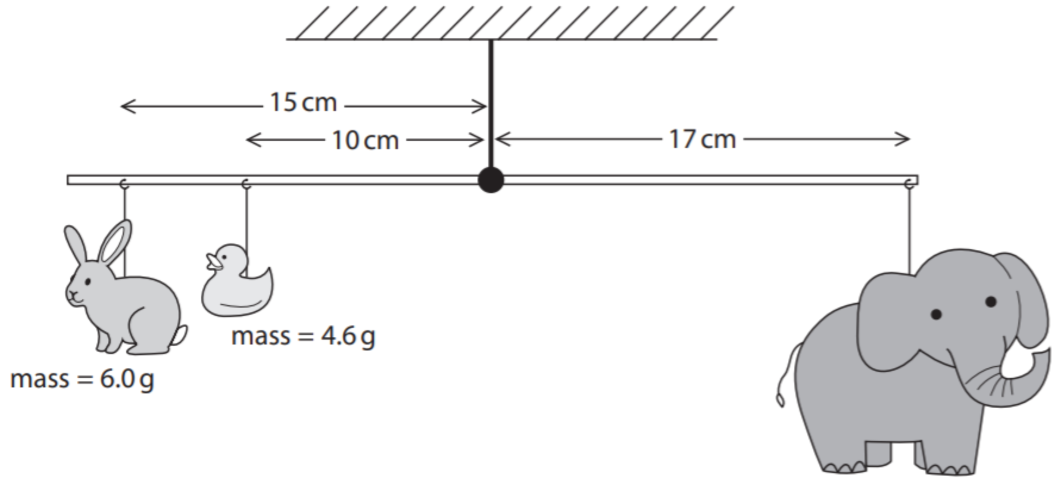

Figure 12

Use the principle of moments to calculate the mass of the toy elephant.

(4)

Clockwise moment = Anti-clockwise moment

$x \times 17 = 10 \times 4.6 + 15 \times 6$

$x = \frac{46 + 90}{17} = \frac{136}{17}$

mass = 8 g

(c) Figure 13 shows a diagram of a device for lifting heavy loads.

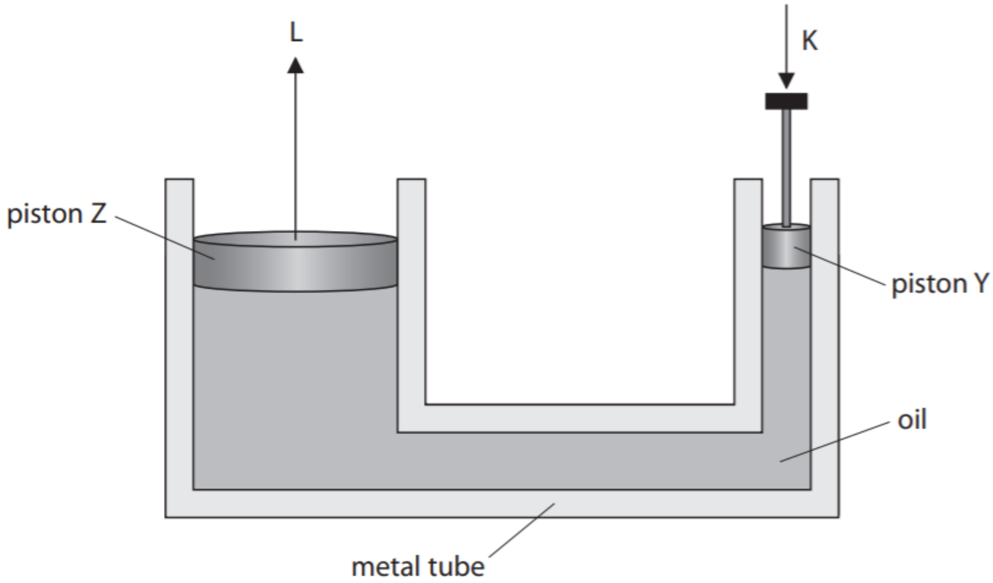

Figure 13

The metal tube is filled with oil.

The piston Y is pushed down with a force K.

This produces a force L on piston Z.

The pressure exerted on the oil by piston Y is the same as the pressure exerted by the oil on piston Z.

Explain the difference between the size of force K and the size of force L.

(3)

The force L is larger as when the area of Y is less, a larger pressure is created even for a small force. Using P= F/A , when the pressure is high, the force gets larger at the higher area piston Z

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

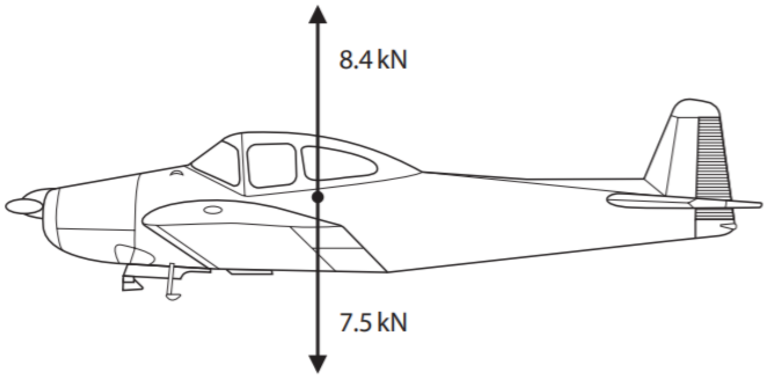

Figure 14

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

(2)

8.4 − 7.5

= 0.9

size = 0.9 kN, direction is upwards

(ii) The aeroplane is descending.

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

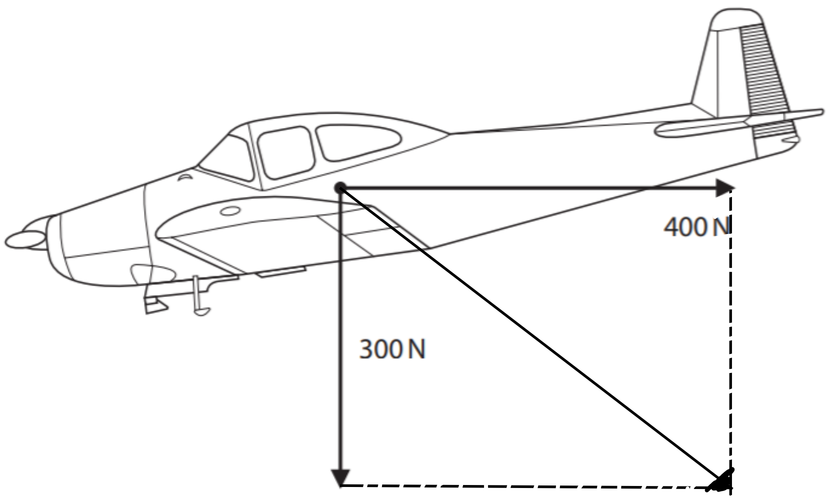

Figure 15

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)

GPE = mgh

= 750 × 10 × 1300

= 750000 ≈ 9800000

energy = 9800000 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)

eficency = useful energy output / total power in ut.

.70 = $\frac{x}{6500}$

x = 0.70 × 6500

= 4550

P = energy / time

power = 76 kW

P = $\frac{4550}{60}$ = 75.8 ≈ 76

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

(2)

The useful energy output is smaller than the total energy input as some energy is converted to heat and lost to the surrounding.

2 (a) Which of these is the equation for work done?

(1)

- ☐ **A** work done = force ÷ distance moved in direction of force
- ☒ **B** work done = force × distance moved in direction of force
- ☐ **C** work done = force ÷ distance moved at right angles to direction of force
- ☐ **D** work done = force × distance moved at right angles to direction of force

(b) 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)

$= 0.046 \times 10 \times 2.05$

$= 0.943$

≈ 0.94

change in gravitational potential energy = 0.94 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)

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0.046 \times (3.5)^2$

$= .2817 \approx 0.28$

kinetic energy of the ball = 0.28 J

(iii) The ball bounces several times.

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

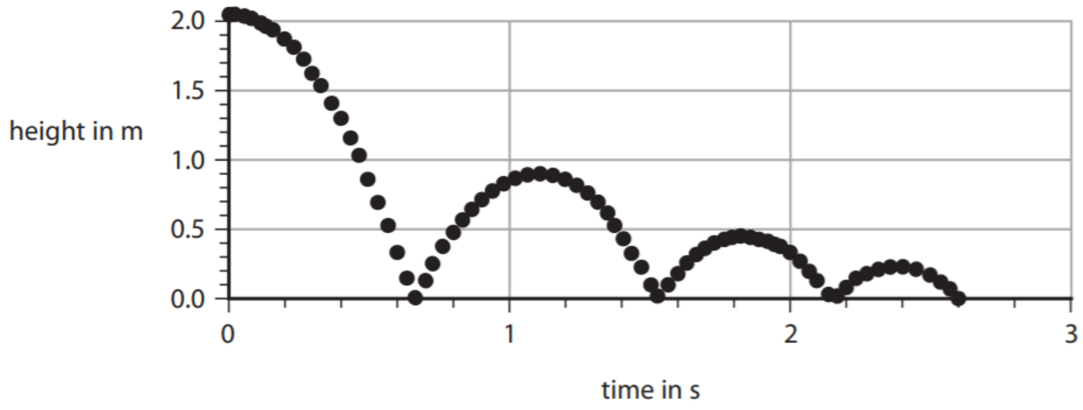

Figure 4

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

(1)

height after first bounce = 0.8 m

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

(2)

Some of the energy of the ball has been lost as heat and sound to the surrounding.

4 (a) Figure 6 shows four forces, P, Q, R and S, acting on a rod.

The rod can rotate around an axle.

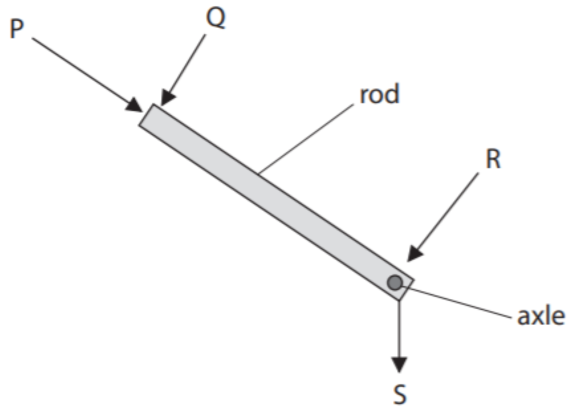

Figure 6

Which force will make the rod rotate about the axle?

(1)

☐ **A** P

☒ **B** Q

☐ **C** R

☐ **D** S

(b) Figure 7 shows a person trying to lift a large rock using a metal bar.

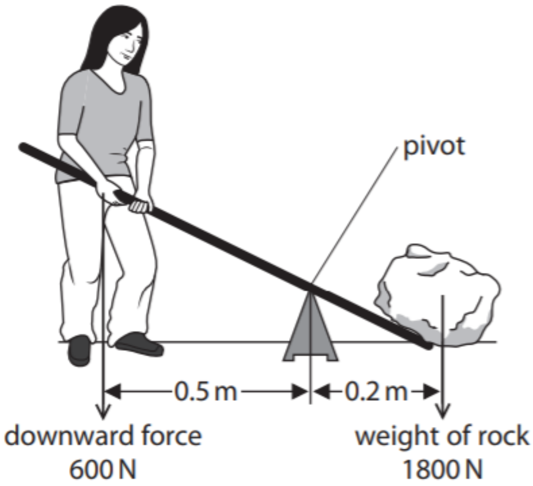

Figure 7

The rock weighs 1800 N.

The person can only produce a downwards force of 600 N.

The person cannot lift the rock.

(i) Explain, using calculations, why the person cannot lift the rock.

(3)

↗ Momentum = 1800 × 0.2 = 360 Nm

↖ Momentum (max) = 600 × 0.5 = 300 Nm

The rock produces a moment of 360Nm clockwise. In order for the person to lift the rock she has to produce a moment of 360Nm or more counter clockwise. However, the person can only produce a moment of 300Nm which is not sufficient to lift the rock.

(ii) Explain **one** change to the arrangement that will make it possible for this person to lift the rock.

(2)

Increase the distance between the person and the pivot keeping the distance between the rock and the pivot the same which increases the moment anticlockwise.

(c) 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)

$$2 \times 48 = 12 \times x$$

$$x = \frac{2 \times 48}{12}$$

8 turns each second

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

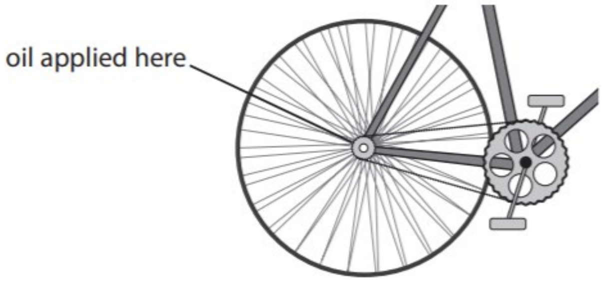

Figure 9

Explain how the oil improves the efficiency of the bicycle.

(3)

Applying oil reduces the friction and less thermal energy is lost to the surrounding. Hence, less energy input is required to produce the same output in the wheel. As efficiency is the ratio of useful energy output by the bicycle and the total energy input by the rider, the overall efficiency is improved.

1 (a) Figure 1 shows some forces acting on a seesaw.

The forces shown have the same magnitude but act in different directions.

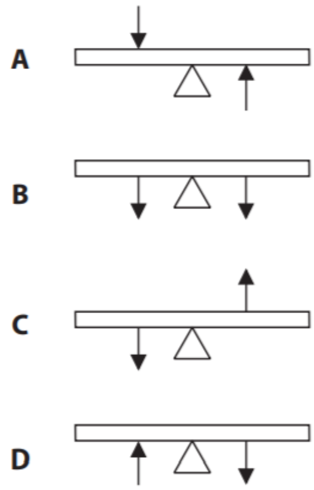

Figure 1

In which of these could the forces acting on a seesaw be in equilibrium?

(1)

- ☐ A
- ☒ B
- ☐ C
- ☐ D

(b) Figure 2 shows an open door.

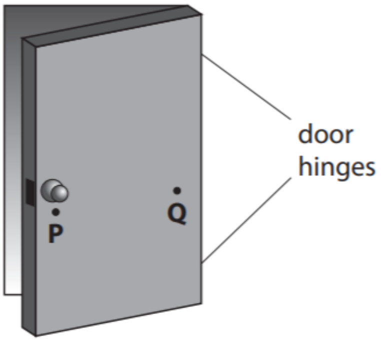

Figure 2

Explain why it is easier to close the door by pushing at point **P** rather than pushing at point **Q**.

(2)

A larger moment is created at P from the definition moment = force x d and since P has a larger distance from the hinge. Hence a lower force is required at P to achieve the required moment to close the door compared to q.

(c) Figure 3 is a diagram of the forces acting on a swing.

The swing is not moving.

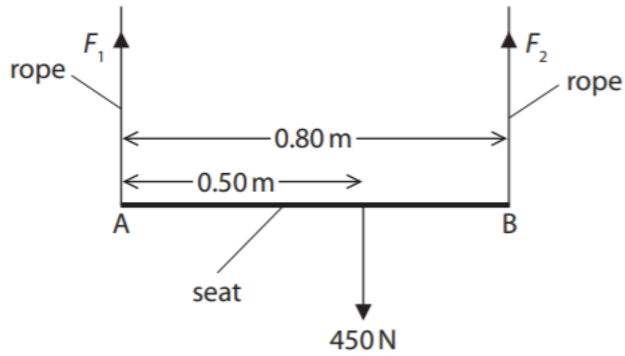

Figure 3

The seat of the swing, AB, is 0.80 m long.

A person of weight 450 N sits on the seat.

The person's weight acts at a distance of 0.50 m from A as shown in Figure 3.

Ignore the weight of the seat.

The upward forces exerted by the ropes on the seat are F_1 and F_2.

Calculate the force F_2 by taking moments about A.

(3)

$\Sigma M_A (\circlearrowright +) = 0$

$450 \times 0.5 - F_2 \times 0.8 = 0$

$F_2 = \frac{450 \times 0.5}{0.8} = 281.25 \approx 281$

force F_2 = 281 N

3 (a) Figure 7 shows a drone.

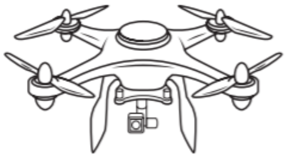

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Figure 7

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

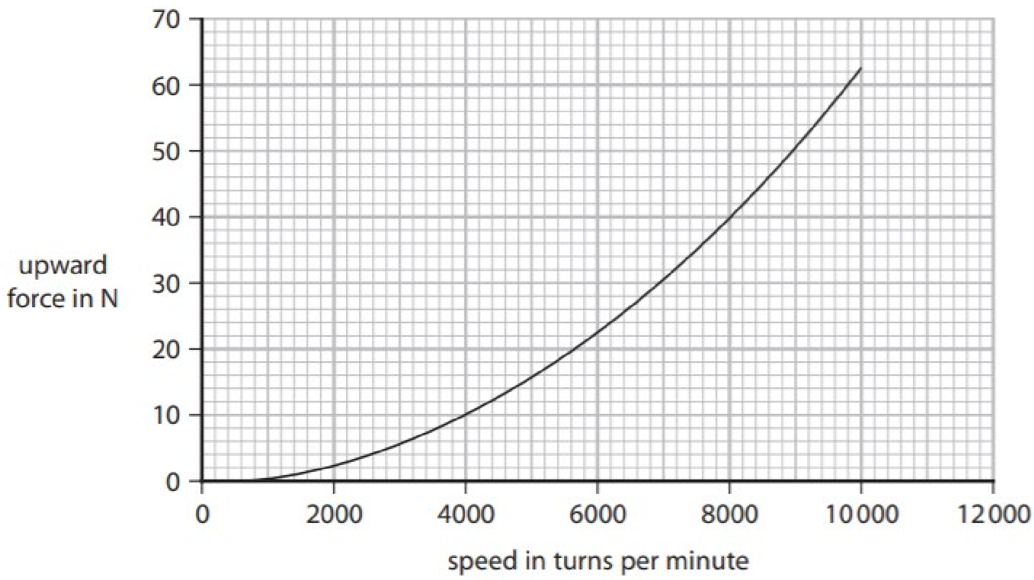


Figure 8

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

(2)

As the speed of the blades increases, the upward force increases. The force however, begins to come into effect after a minimum speed of 1000 turns per minute. The force also has an increasing gradient with the speed.

(b) A different 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 N/kg.

(2)

$\Delta GPE = mgh$

$= 4.5 \times 10 \times 20$

$= 900$

change in gravitational potential energy = 900 J

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

(1)

useful work done = 900 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)

$P = \frac{wd}{t} = \frac{900}{4}$

useful power developed = 225 W

9 (a) 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)

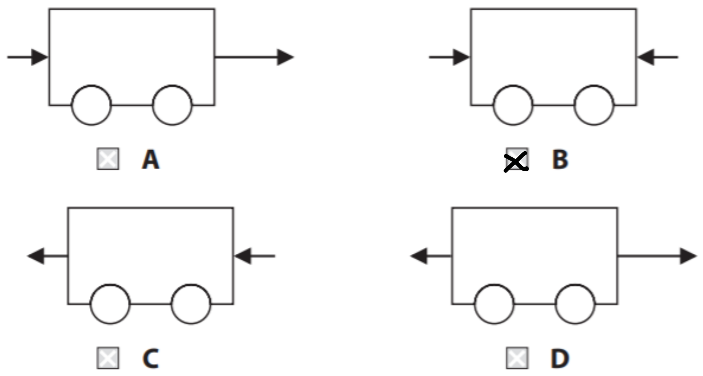


Figure 22

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

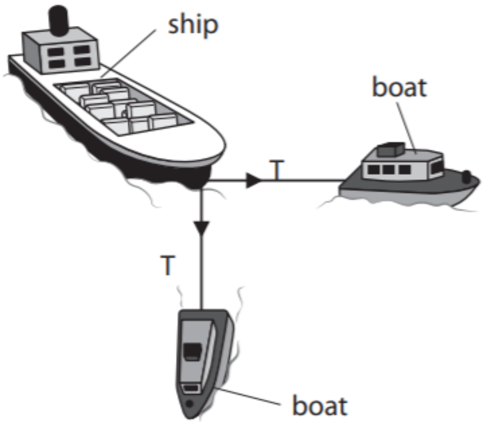


Figure 23

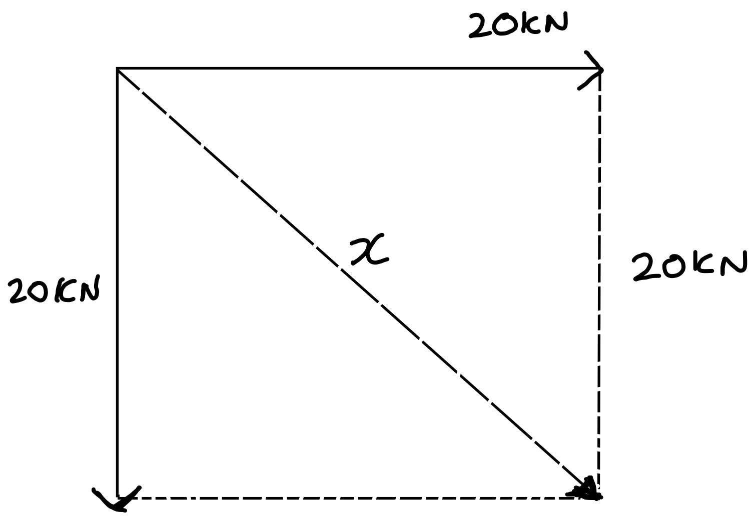
The ship is connected to the boats with ropes.

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)



$x^2 = 20^2 + 20^2$

$x = \sqrt{800}$

$= 28.28$

≈ 28.3

magnitude of resultant force on the ship = 28.3 kN *(c) 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.

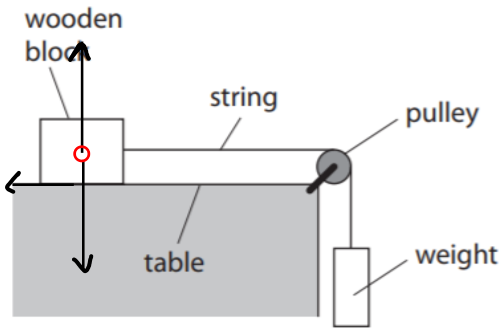


Figure 24

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)

There is a normal contact force upwards from the table acting on the block that is equal in size and acts in the opposite direction. These two forces produces zero resultant force and hence no vertical motion is observed. There is a tension force towards the right acting from the string due to the gravitational attraction of the of the weight. However, there is a frictional force acting toward left between the surface of the block and the table. The two forces are equal in magnitude and acts in the opposite direction. From Newton's first law, the block can be explained to be in constant speed..

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