1.7 Energy, work and power

01. 0625_m23_qp_42 Q: 2

Fig. 2.1 shows a ship loaded with containers.

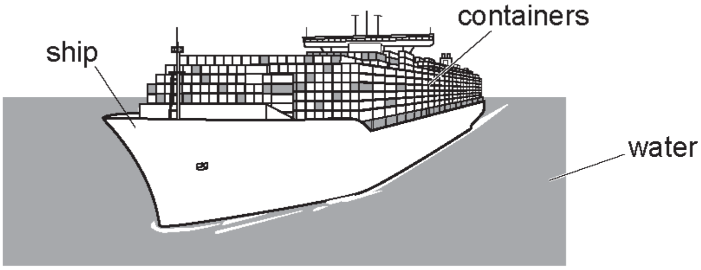


Fig. 2.1

(a) The ship is made of steel.

The density of steel is 7800 kg / m^3 and the density of water is 1000 kg / m^3.

Explain why the ship floats in the water.

....

....

.... [2]

(b) The containers with the greatest mass are loaded near the bottom of the ship.

State and explain the effect on the stability of the ship of loading the containers in this way.

....

....

.... [2]

(c) A crane lifts a container 48 m vertically upwards. The mass of the container is 30 000 kg.

Calculate the energy transferred to the gravitational potential energy stored in the container.

energy = ... [2]

02. 0625_m23_qp_42 Q: 3

(a) State the principle of conservation of energy.

....

....

.... [2]

(b) A wind turbine has a maximum output power of 1.8 MW. The turbine operates at maximum power for 4.0 h.

(i) Define the unit kW h.

....

....

.... [1]

(ii) Calculate the energy produced by the wind turbine operating at maximum power for 4.0 h. Give your answer in kW h.

energy = ... kW h [2]

(c) Radiation from the Sun is the main source of energy for most of our energy resources.

State **two** energy resources that are **not** due to radiation from the Sun.

....

.... [2]

03. 0625_s23_qp_42 Q: 1

(a) Fig. 1.1 shows a helicopter which is stationary at a height of 1500 m above the ground.

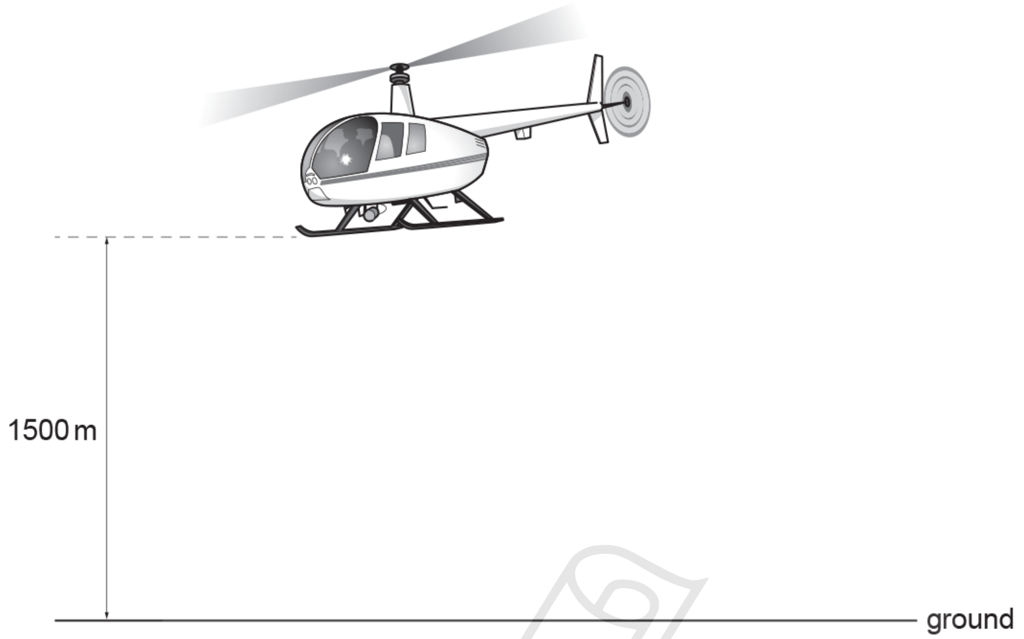


Fig. 1.1 (not to scale)

(i) State the **two** conditions necessary for the helicopter to remain in equilibrium.

condition 1 ....

....

condition 2 ....

....

[2]

(ii) The mass of the helicopter is 3200 kg.

Calculate the change in the gravitational potential energy of the helicopter as it rises from the ground to 1500 m.

change in gravitational potential energy = ... [2]

(b) Fig. 1.2 shows a vertical speed–time graph for a parachutist who jumps from a stationary hot-air balloon.

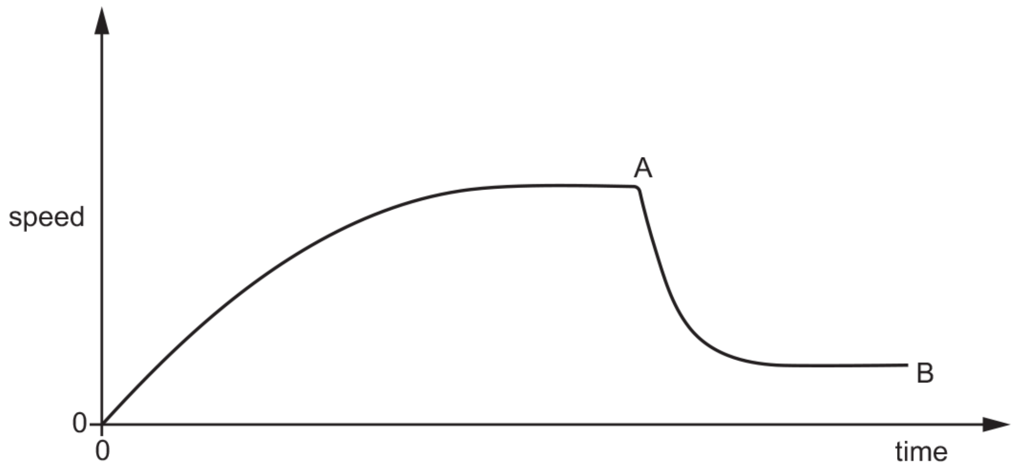


Fig. 1.2

The parachutist jumps from the balloon at time = 0 and reaches the ground at B. The point A indicates when the parachute opens.

(i) On Fig. 1.2, label a point on the graph where the acceleration is:

- zero with '1'
- negative with '2'
- decreasing with '3'. [3]

(ii) Explain, in terms of forces, the changes in motion which occur from when the parachutist leaves the hot-air balloon until point A.

....

....

....

....

....

....

....

.... [4]

04. 0625_s23_qp_42 Q: 2

A student catches a cricket ball. The speed of the ball immediately before it is caught is 18 m/s. The mass of the cricket ball is 160 g.

(a) Calculate the kinetic energy stored in the cricket ball immediately before it is caught.

kinetic energy = ... [3]

(b) It takes 0.12 s to catch the ball and bring it to rest.

Calculate the average force exerted on the ball.

average force = ... [2]

(c) As the student catches the ball, she moves her hands backwards.

Explain the effect of this action on the student's hands.

....

.... [1]

05. 0625_w23_qp_41 Q: 1

A girl holds a rubber ball out of a window of a tall building. The mass of the ball is 0.20 kg. The ball is at rest 10 m above a concrete path.

(a) Calculate the gravitational potential energy of the ball relative to the concrete path.

gravitational potential energy = ... [2]

(b) The girl releases the ball and it falls towards the path. The ball strikes the path and bounces vertically upwards.

Fig. 1.1 shows the ball falling towards the path.

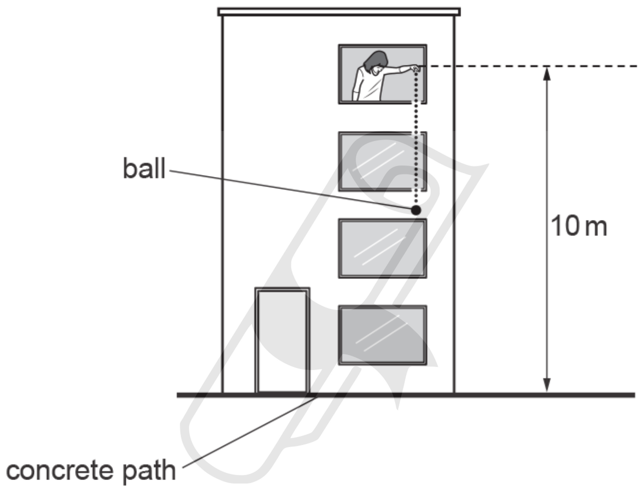


Fig. 1.1

The speed of the ball immediately **before** it strikes the path is 14 m / s.

The speed of the ball immediately **after** it strikes the path is 12 m / s.

(i) Calculate the kinetic energy of the ball immediately **after** it strikes the concrete path.

kinetic energy = ... [2]

(ii) Show that the change in momentum of the ball when it bounces off the path is 5.2 kg m / s.

[3]

(iii) The ball is in contact with the path for 0.25 s.

Calculate the average resultant force on the ball when it is in contact with the path.

force = ... [2]

---

06. 0625_w23_qp_41 Q: 5

Many methods of generating electrical power involve the use of water.

(a) Describe **one** method of generating electrical power from energy stored in water.

....

....

....

....

.... [3]

(b) For the method you chose in **(a)**, state **one** advantage and **one** disadvantage of generating electricity this way.

advantage ....

....

disadvantage ....

....
[2]

(c) State **two** methods of generating electrical power for which the main source of energy is **not** the Sun.

1 ....

2 ....
[2]

---

07. 0625_w23_qp_42 Q: 1

A car accelerates uniformly in a straight line from rest at time t = 0. At t = 3.2 s, the speed of the car is 13.0 m/s.

(a) **(i)** Calculate the acceleration of the car.

acceleration = ... [2]

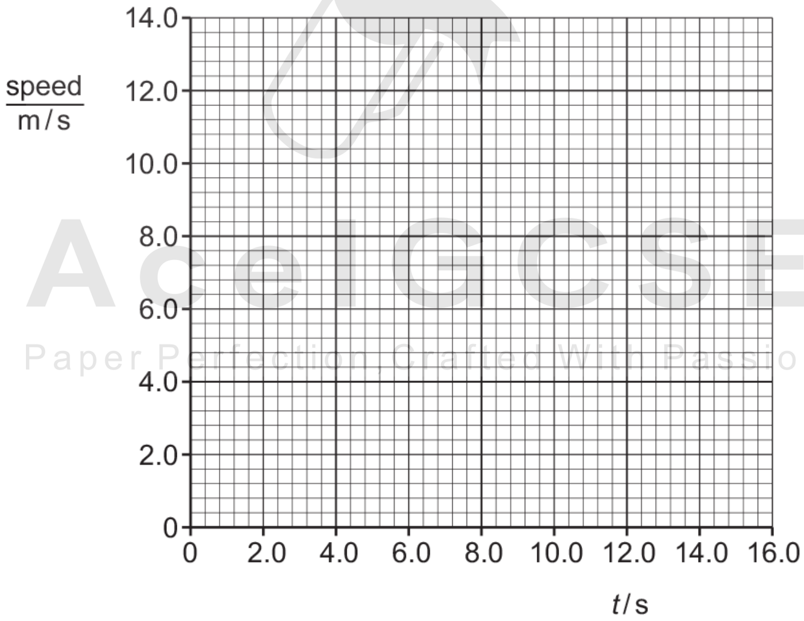
(ii) Explain in words what is meant by the term acceleration.

....

.... [1]

(b) The car travels at 13.0 m/s from t = 3.2 s to t = 12.0 s.

(i) Plot the speed–time graph for the car from t = 0 to t = 12.0 s.



[2]

(ii) Determine the distance travelled by the car between t = 0 and t = 3.2 s.

distance = ... [2]

(c) The car decelerates from 13.0 m/s to 0 m/s at a constant deceleration. The mass of the car is 1350 kg. The car travels 13 m in 2.0 s as it decelerates.

Show that the work done by the car as it decelerates is approximately 1.1×10^5 J.

[4]

(d) On another day, the car in **(c)** travels a longer distance while it decelerates from 13.0 m/s to 0 m/s. The deceleration is constant.

Suggest and explain what causes the stopping distance to increase.

suggestion ....

....

explanation ....

....
[2]

08. 0625_w23_qp_43 Q: 3

Fig. 3.1 shows a boy throwing a ball at an object in a fairground.

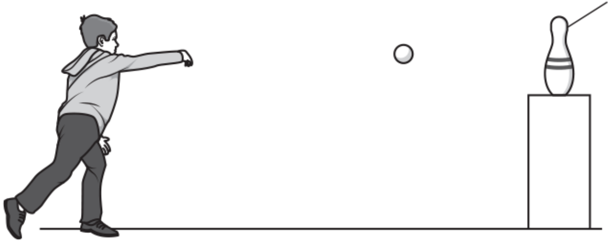


Fig. 3.1

The ball has a mass of 190 g and travels horizontally with a constant speed of 6.9 m/s.

(a) Calculate the momentum of the ball.

momentum = ... [2]

(b) After hitting the object, the ball bounces back along the same straight path with a speed of 1.5 m/s. The object has a mass of 1.8 kg.

Calculate the speed of the object after it is hit by the ball.

speed = ... [3]

(c) The kinetic energy of the ball is 4.5 J before the collision and 0.2 J after the collision.

Calculate the change in total kinetic energy of the ball and object during the collision.

change in total kinetic energy = ... [3]

09. 0625_m22_qp_42 Q: 2

Fig. 2.1 shows a spring balance used to measure the weight of a baby. The spring inside the balance extends when a mass is suspended from it. The dial shows the extension of spring as a value of mass in kg.

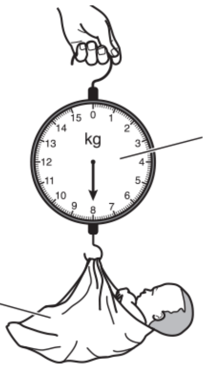


Fig. 2.1

The spring obeys Hooke's law up to a weight of 175 N.

(a) **(i)** State Hooke's law.

....

.... [1]

(ii) State the relationship between the mass of the baby and the force exerted on the spring due to the baby.

....

.... [1]

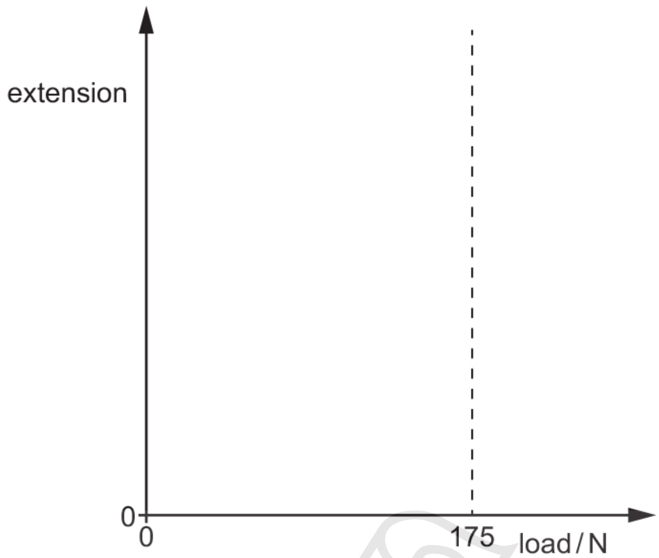
(iii) The reading on the spring balance is 8.0 kg.

Determine the force exerted on the spring due to the baby.

force = ... [1]

(b) The limit of proportionality for the spring is at a force of 175 N.

Sketch the extension–load graph for the spring. The sketch must continue beyond a force of 175 N.



[2]

(c) The baby is carried from the ground floor to the bedroom. The vertical height of the bedroom above the ground floor is 3.5 m.

Calculate the change in gravitational potential energy of the baby when it is carried from the ground floor to the bedroom.

change in gravitational potential energy = ... [2]

10. 0625_s22_qp_42 Q: 1

Fig. 1.1 shows an electrically powered bicycle.

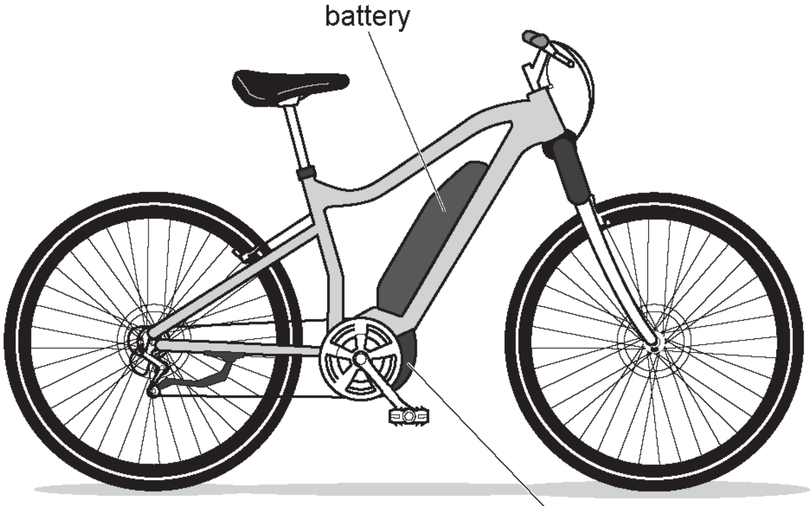


Fig. 1.1

When fully charged, the battery can deliver a power of 600 W for 60 min.

(a) **(i)** Calculate the energy, in joules, stored in the battery when fully charged.

energy = ... J [3]

(ii) State the form of energy stored by the battery.

.... [1]

(b) The bicycle has a motor with an electrical input power of 250 W.

Calculate the time for which the battery can power the bicycle.

time = ... [2]

(c) Consider this bicycle compared to a small motorcycle.

State **two** environmental benefits of the electrically powered bicycle.

1. ....

2. ....

[2]

11. 0625_s22_qp_42 Q: 3

(a) Fig. 3.1 shows water in a river moving parallel to the river bank at 4.0 m/s and a canoe travelling in the river.

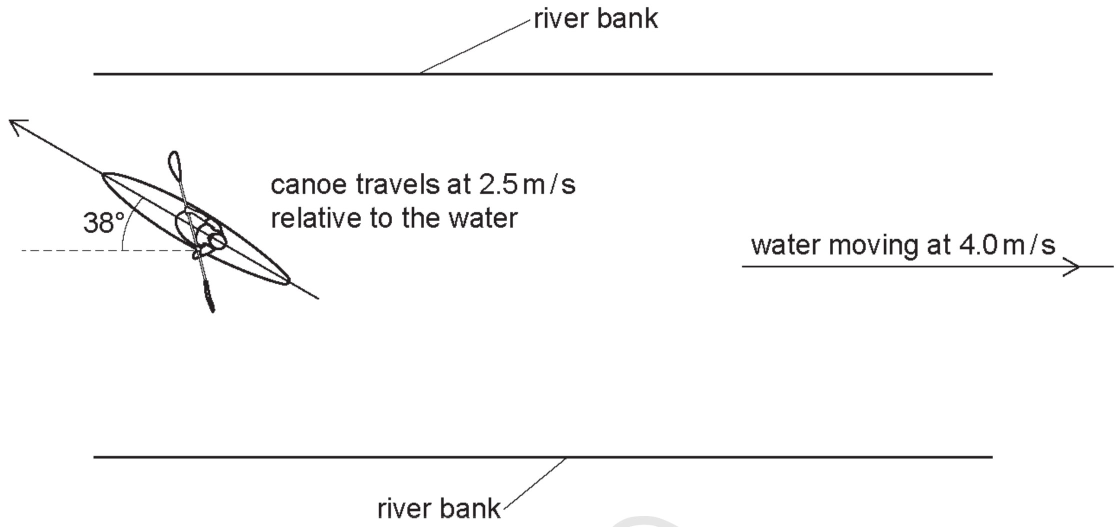


Fig. 3.1

The canoe travels at 2.5 m/s relative to the water and heads at an angle of 38° to the river bank.

Draw a scale diagram to determine the canoe's resultant velocity and state the scale you used.

scale ....

magnitude of resultant velocity ....

direction of resultant velocity (angle from the river bank) ....

[4]

(b) The mass of the canoeist is 65 kg.

Calculate her kinetic energy when travelling on still water at 2.5 m / s.

energy = ... [2]

12. 0625_s22_qp_43 Q: 2

Water is held behind a dam in a hydroelectric power scheme.

(a) State the main form of energy stored in the water behind the dam.

.... [1]

(b) The water is released from the dam and falls a vertical height of 410 m at a rate of 480 kg / s.

(i) Calculate the rate at which energy is transferred by the falling water.

rate of energy transfer = ... [3]

(ii) The power scheme supplies a current of 270 A at a voltage of 6000 V.

Calculate the efficiency of the power scheme.

efficiency = ... % [3]

(c) Hydroelectric energy is a renewable form of energy.

(i) State **one** disadvantage of hydroelectric power schemes.

.... [1]

(ii) State **one** other renewable source of energy.

.... [1]

13. 0625_w22_qp_41 Q: 1

Two blocks, A and B, are joined by a thin thread that passes over a frictionless pulley. Block A is at rest on a rough horizontal surface and block B is held at rest, just below the pulley.

Fig. 1.1 shows the thread hanging loose.

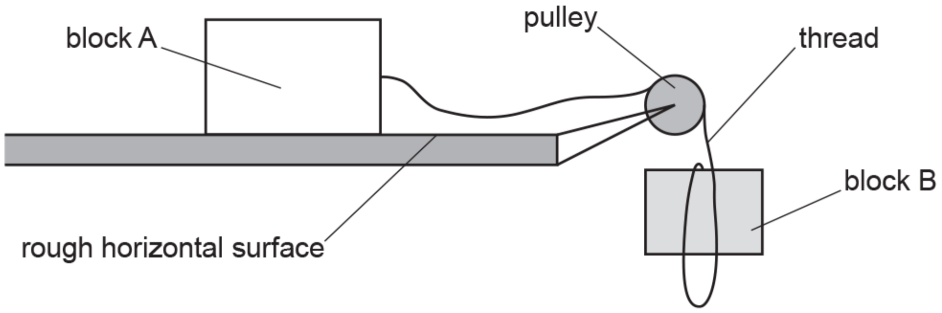


Fig. 1.1 (not to scale)

Block B is released and it falls vertically. The thread remains loose until block B has fallen a distance of 0.45 m.

The mass of block B is 0.50 kg.

(a) Calculate the change in the gravitational potential energy (g.p.e.) of block B as it falls through 0.45 m.

change in g.p.e. .... [2]

(b) The mass of block A is 2.0 kg.

When the thread tightens, it pulls on block A which moves to the right at a speed of 0.60 m/s.

(i) Calculate the impulse exerted on block A as it accelerates from rest to 0.60 m/s.

impulse = ... [3]

(ii) Both of the blocks now move at a constant speed of 0.60 m/s until block B hits the ground and the thread becomes loose.

Explain the energy change that takes place in block A after block B stops moving.

....

....

....

.... [3]

14. 0625_w22_qp_42 Q: 3

(a) Tidal power derives most of its energy from the Moon and part of its energy from the Sun.

(i) State **one** other source of power which derives its energy from the Sun.

.... [1]

(ii) State **one** source of power which does **not** derive its energy from the Sun.

.... [1]

(b) Fig. 3.1 shows a small water turbine driven by a tidal flow of water to generate electrical power.

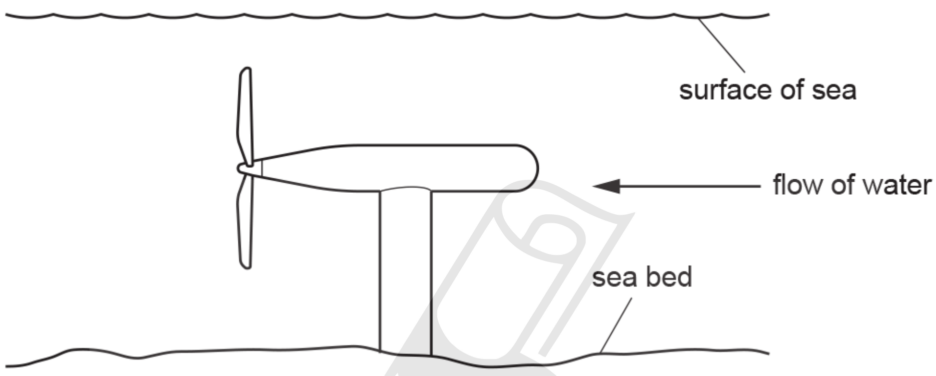


Fig. 3.1

(i) Explain whether this method of generation of electrical power is renewable.

....

....

.... [2]

(ii) The mass of water passing through the turbine each second is 6.0×10^3 kg. The speed of the water is 2.0 m/s. 40% of the kinetic energy of the water is converted to electrical energy.

Calculate the electrical power generated.

power = ... [4]

15. 0625_w22_qp_43 Q: 2

Fig. 2.1 shows a tennis ball approaching a tennis racket.

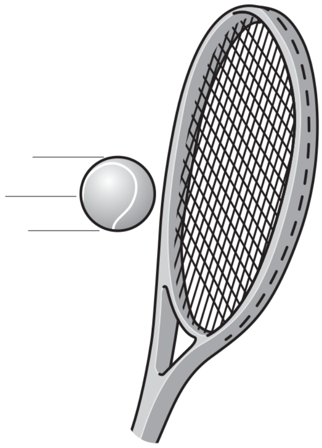


Fig. 2.1

The tennis ball hits the racket at a speed of 52 m/s. The average force on the ball during the time that it is in contact with the racket is 350 N. The speed of the ball after it leaves the racket is 26 m/s in the opposite direction to the initial speed of the ball. The mass of the ball is 58 g.

(a) **(i)** Calculate the change in momentum of the ball while it is in contact with the racket.

change in momentum = ... [3]

(ii) State an equation which defines impulse in terms of force and time.

.... [1]

(iii) Calculate the time that the racket is in contact with the ball.

time = ... [2]

(b) Calculate the difference between the values of the kinetic energy of the ball before and after the impact with the racket.

difference in kinetic energy = ... [3]

16. 0625_w22_qp_43 Q: 3

Fig. 3.1 shows the cross-section of a barrage built across a tidal bay. The barrage is part of a tidal power station.

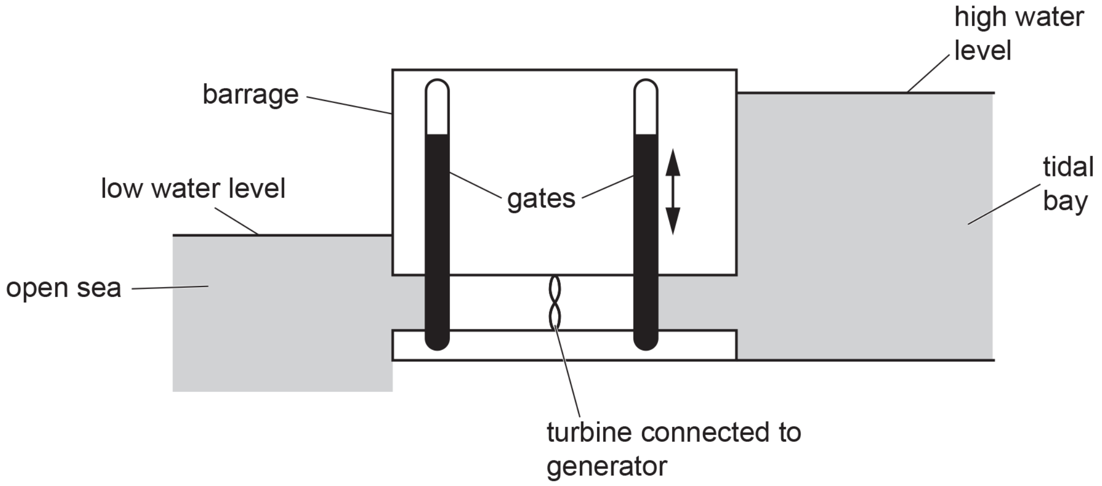


Fig. 3.1

The gates are raised to be open when the tide comes in. The gates are lowered to close when it is high tide. Fig. 3.1 shows the water levels in the open sea and the tidal bay when it is low tide. The gates are raised and water flows through the turbine.

(a) Complete the sentences to describe the energy transfers which take place when the gates are opened.

Use words from the list.

tidal bay **kinetic** **gates** **gravitational potential**

open sea **turbines** **water**

.... energy of the .... in the

.... is transferred to .... energy in the

rotating .... This energy is used in the generator to produce

electrical power. [3]

(b) State **one** advantage and **one** disadvantage of tidal power as an energy resource.

advantage ....

disadvantage ....
[2]

(c) State the **main** source of energy for tidal energy.

.... [1]

17. 0625_s21_qp_41 Q: 2

Fig. 2.1 shows a wooden trolley of mass 1.2 kg at rest on the rough surface of a bench.

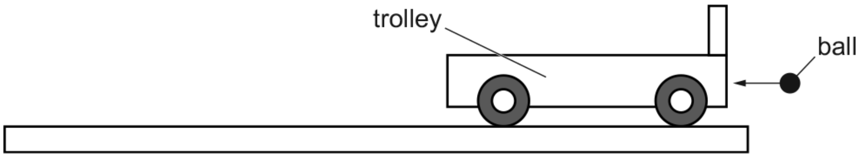


Fig. 2.1

A ball of mass 0.52 g travels horizontally towards the trolley. The ball embeds itself in the wood of the trolley. The trolley moves with an initial speed of 0.065 m / s.

(a) Calculate:

(i) the impulse exerted on the trolley

impulse = ... [2]

(ii) the speed of the ball as it hits the trolley.

speed = ... [2]

(b) As the trolley moves across the rough surface, it slows down and stops.

Explain, in terms of the work done, the energy change that takes place as the trolley slows down.

....

....

....

.... [3]

[Total: 7]

18. 0625_s21_qp_42 Q: 3

Fig. 3.1 shows water flowing at very slow speed over a cliff edge.

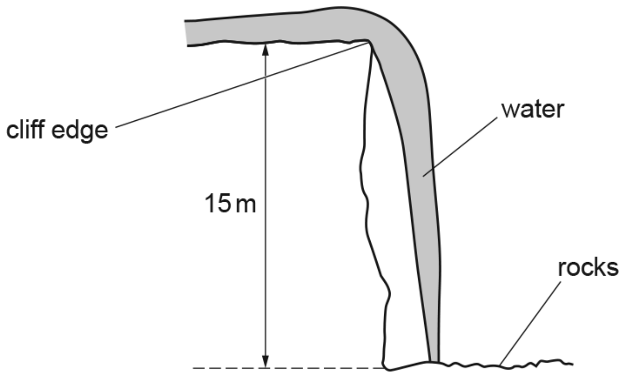


Fig. 3.1

The water falls 15 m onto the rocks below.

(a) Show that the velocity of the water when it strikes the rocks is 17 m / s.

[4]

(b) 30 kg of water flows over the cliff edge every second.

Calculate the force exerted by the rocks on the falling water. Ignore any splashing.

force = ... [3]

[Total: 7]

19. 0625_s21_qp_43 Q: 1

Fig. 1.1 shows a load suspended from a spring.

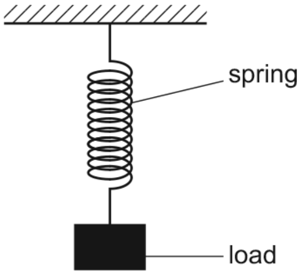


Fig. 1.1

The value of the spring constant k of the spring is 0.20 N / cm. The spring reaches its limit of proportionality when the load is 15 N.

(a) Calculate the extension of the spring when the load is 3.0 N.

extension = ... [2]

(b) Explain what is meant by the term *limit of proportionality* of the spring.

....

....

.... [2]

(c) On Fig. 1.2, sketch an extension–load graph for a spring. Label the limit of proportionality with the letter L on your graph.

Fig. 1.2

[2]

(d) The load is pulled down a small distance below its equilibrium position to position A, as shown in Fig. 1.3. The load then moves up and down between position A and position B in Fig. 1.3.

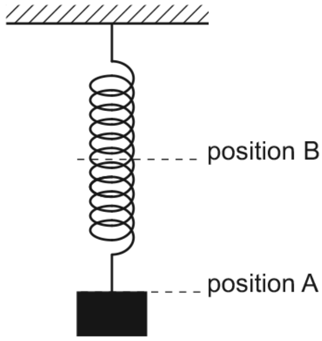


Fig. 1.3

Describe the energy transfers which occur as the load moves:

from position A to the equilibrium position

....

....

from the equilibrium position to position B.

....

....
[3]

[Total: 9]

20. 0625_s21_qp_43 Q: 3

A car travels at constant speed v on a horizontal, straight road. The driver sees an obstacle on the road ahead.

(a) The distance travelled in the time between the driver seeing the obstruction and applying the brakes is the thinking distance.

Explain why the thinking distance is directly proportional to v.

....

.... [1]

(b) When the brakes are applied, the car decelerates uniformly to rest. The frictional force applied by the brakes is constant. The distance travelled between first applying the brakes and the car stopping is the braking distance.

Explain why the braking distance is proportional to v^2.

....

....

....

.... [3]

(c) The car is travelling at 22 m/s.

(i) The thinking distance is 15 m.

Calculate the time taken to travel the thinking distance.

time = ... [2]

(ii) The car has a mass of 1400 kg. The time taken for the car to stop after the brakes are applied is 2.1 s.

Calculate the force required to stop the car in this time.

force = ... [2]

[Total: 8]

21. 0625_w21_qp_41 Q: 4

A train of mass 1.8×10^5 kg is at rest in a station. At time t = 0, the train begins to accelerate along a straight, horizontal track and reaches a speed of 20 m/s at t = 15 s. The train continues at a speed of 20 m/s for 10 s.

At t = 25 s, the driver applies the brakes and the resistive force on the train causes it to decelerate uniformly to rest in a further 24 s.

Fig. 4.1 is an incomplete distance–time graph for this journey.

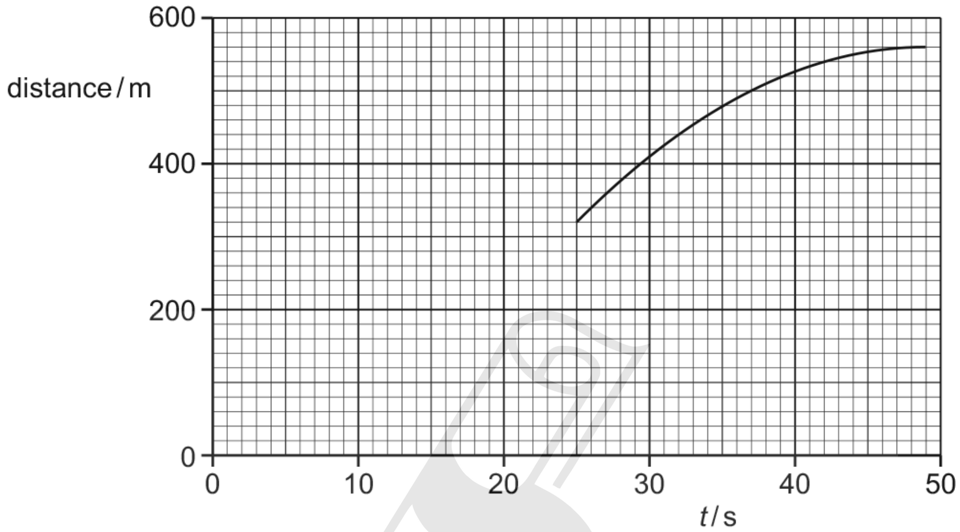


Fig. 4.1

(a) Complete Fig. 4.1 by drawing:

(i) a line to represent the motion of the train between t = 15 s and t = 25 s [1]

(ii) a curve to represent the motion of the train between t = 0 and t = 15 s. [1]

(b) Calculate the kinetic energy of the train between t = 15 s and t = 25 s.

kinetic energy = ... [3]

(c) While the train decelerates to rest, it does work against the resistive force and its kinetic energy decreases.

(i) Define *work done*.

....

.... [2]

(ii) Using Fig. 4.1, determine the distance moved by the train while it decelerates.

distance moved = ... [1]

(iii) Calculate the resultant force acting on the train while it decelerates.

resultant force = ... [2]

---

22. 0625_w21_qp_42 Q: 4

(a) A power station uses wind energy to generate electricity.

State and explain whether this method of generating electricity is renewable.

statement ....

explanation ....

....

....
[2]

(b) State **two** energy resources that do **not** have the Sun as their source.

1 ....

2 ....
[2]

(c) For each energy resource, state the form of energy stored in:

fossil fuels ....

water behind hydroelectric dams. ....
[2]

---

23. 0625_w21_qp_43 Q: 2

Fig. 2.1 shows a simplified version of a 'gravity lamp'. This apparatus is used to light a light-emitting diode (LED) without mains electricity.

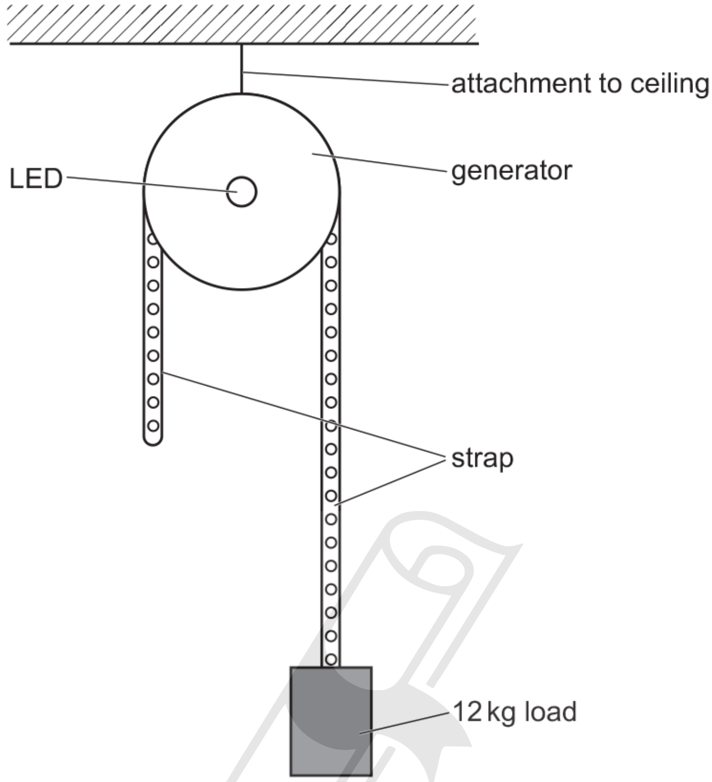


Fig. 2.1

The load of 12 kg is raised to a height of 1.7 m above the ground. The load is connected to a pulley system. The time taken for the load to fall to the ground is 1200 seconds. The load falls at constant speed. The generator is connected to an LED.

(a) Calculate the rate of transfer of gravitational potential energy as the load falls to the ground.

rate of transfer of gravitational potential energy = ... [4]

(b) The light output of the LED is 0.10 W.
Calculate the efficiency of the 'gravity lamp'.

efficiency = ... [2]

(c) Suggest a social or environmental advantage of using a 'gravity lamp'.

....

.... [1]

24. 0625_m20_qp_42 Q: 3

Fig. 3.1 shows a model of a wind turbine used to demonstrate the use of wind energy to generate electricity. The wind is blowing towards the model, as shown.

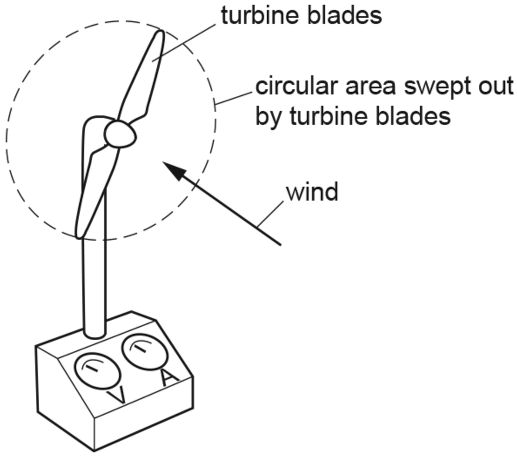


Fig. 3.1

(a) The mass of air passing through the circular area swept out by the turbine blades each second is 7.5 kg. The kinetic energy of the air that passes through this circular area each second is 240 J.

(i) Calculate the speed of the air.

speed = ... [3]

(ii) The kinetic energy of the air drives a generator. State the input power of the air passing through the turbine blades.

input power = ... [1]

(b) The output current of the generator is 2.0A. The output potential difference (p.d.) of the generator is 11V.

(i) Calculate the output power of the generator.

output power = ... [2]

(ii) Calculate the efficiency of the wind turbine.

efficiency = ... % [2]

(c) The density of air is 1.3 kg/m^3.
Calculate the volume of air passing through the circular area swept out by the turbine blades each second.

volume = ... [2]

[Total: 10]

25. 0625_s20_qp_41 Q: 1

An aeroplane of mass 2.5×10^5 kg lands with a speed of 62 m/s, on a horizontal runway at time t = 0. The aeroplane decelerates uniformly as it travels along the runway in a straight line until it reaches a speed of 6.0 m/s at t = 35 s.

(a) Calculate:

(i) the deceleration of the aeroplane in the 35 s after it lands

deceleration = ... [2]

(ii) the resultant force acting on the aeroplane as it decelerates

force = ... [2]

(iii) the momentum of the aeroplane when its speed is 6.0 m/s.

momentum = ... [2]

(b) At t = 35 s, the aeroplane stops decelerating and moves along the runway at a constant speed of 6.0 m/s for a further 15 s.

On Fig. 1.1, sketch the shape of the graph for the distance travelled by the aeroplane along the runway between t = 0 and t = 50 s. You are **not** required to calculate distance values.

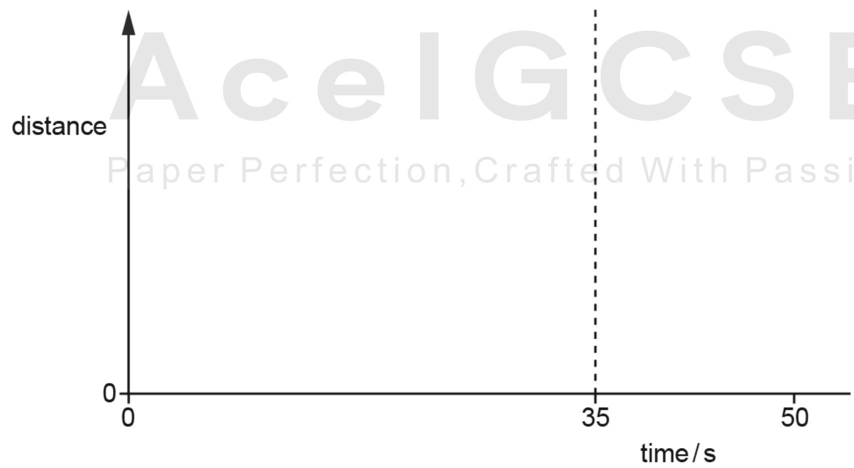


Fig. 1.1

[3]

(c) As the aeroplane decelerates, its kinetic energy decreases.

Suggest what happens to this energy.

....

.... [1]

[Total: 10]

---

26. 0625_s20_qp_41 Q: 2

Fig. 2.1 is the extension–load graph for a light spring S.

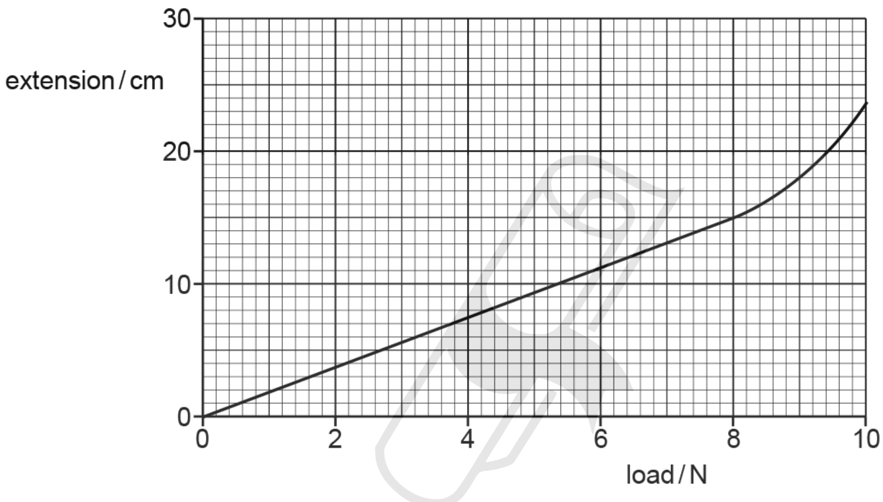


Fig. 2.1

(a) State the range of loads for which S obeys Hooke's law.

from .... to .... [1]

(b) Using information from Fig. 2.1, determine the spring constant *k* of spring S.

k = ... [2]

(c) A second spring, identical to spring S, is attached to spring S. The two springs are attached to a rod, as shown in Fig. 2.2. A load of 4.0 N is suspended from the bottom of spring S. The arrangement is in equilibrium.

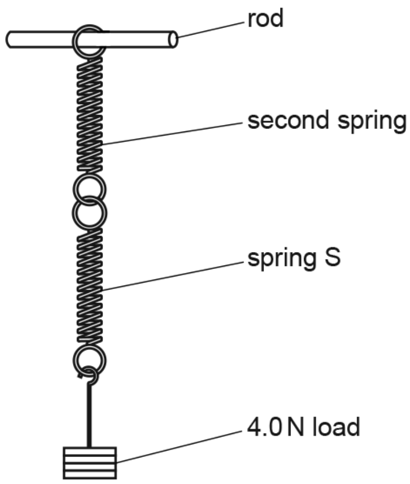


Fig. 2.2

(i) State the name of the form of energy stored in the two springs when they are stretched.

.... [1]

(ii) Determine the extension of the arrangement in Fig. 2.2.

extension = ... cm [1]

(iii) The load is carefully increased to 6.0 N in total.

Calculate the distance moved by the load to the new equilibrium position as the load increases from 4.0 N to 6.0 N.

distance moved = ... [1]

[Total: 6]

27. 0625_w20_qp_41 Q: 2

A vertical tube contains a liquid. A metal ball is held at rest by a thread just below the surface of the liquid, as shown in Fig. 2.1.

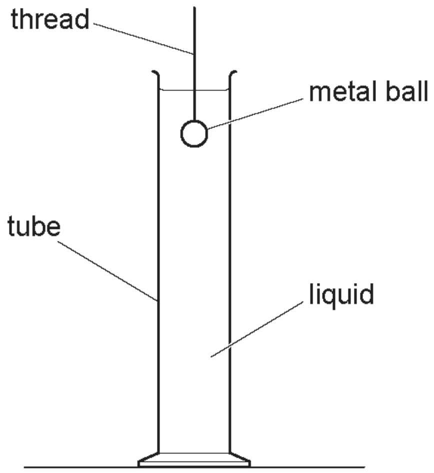


Fig. 2.1 (not to scale)

The diameter of the tube is much greater than the diameter of the ball. The ball is released and it accelerates downwards uniformly for a short period of time.

(a) Describe what happens to the velocity of the ball in the short period of time as it accelerates downwards uniformly.

....

.... [2]

(b) The ball reaches terminal velocity.

Describe and explain the motion of the ball from when it is released until it reaches terminal velocity.

....

....

....

.... [3]

(c) The metal ball has a mass of 2.1 g. It falls a distance of 0.80 m between being released and reaching the bottom of the tube.

(i) Calculate the gravitational potential energy transferred from the ball as it falls.

gravitational potential energy transferred = ... [2]

(ii) When the ball reaches the bottom of the tube, it has a speed of 1.2 m/s. Calculate the kinetic energy of the ball at the bottom of the tube.

kinetic energy = ... [3]

(iii) Explain why the value calculated in **(c)(i)** is different from that calculated in **(c)(ii)**.

....

.... [1]

---

28. 0625_w20_qp_42 Q: 3

The kinetic energy of air passing through a wind turbine every minute is 720 000 J. The electrical output of the turbine is 9.0 A at a potential difference (p.d.) of 240 V.

Calculate the efficiency (%) of the wind turbine.

efficiency = ... % [5]

---

29. 0625_w20_qp_43 Q: 2

Fig. 2.1 shows a cliff edge with water below it.

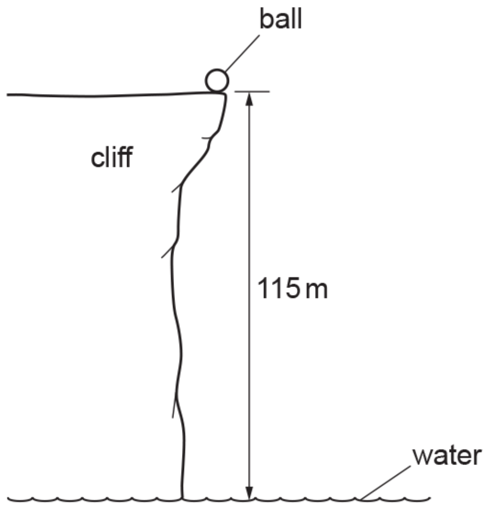


Fig. 2.1

A ball falls over the edge of the cliff. The mass of the ball is 160 g. The height of the cliff is 115 m.

(a) Calculate the vertical speed of the ball as it hits the water. Air resistance can be ignored.

speed = ... [3]

(b) Calculate the vertical momentum of the ball as it hits the water.

momentum = ... [2]

30. 0625_m19_qp_42 Q: 2

(a) State **one** advantage and one disadvantage of using a wind turbine as a source of electrical energy.

advantage ....

disadvantage ....
[2]

(b) Fig. 2.1 shows a wind turbine.

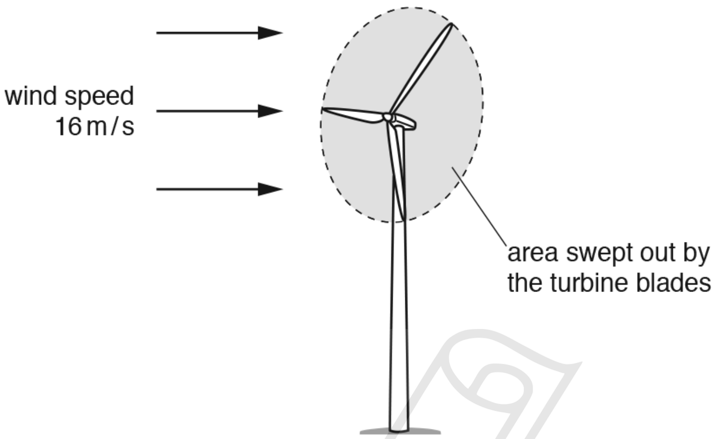


Fig. 2.1

(i) The wind blows at a speed of 16 m/s towards the turbine blades. In one second, a volume of 24 000 m^3 of air passes through the circular area swept out by the blades. The density of air is 1.3 kg/m^3.

Calculate:

1. the mass of air that passes through the circular area swept out by the blades in 1.0 s

mass = ... [2]

2. the kinetic energy of the mass of air that passes through the area swept out by the blades.

kinetic energy = ... [2]

(ii) Suggest why some of the kinetic energy of the air that passes through the circular area swept out by the blades is **not** converted into electrical energy.

....

.... [1]

[Total: 7]

31. 0625_s19_qp_42 Q: 3

Fig. 3.1 shows solar cells used to generate electrical energy.

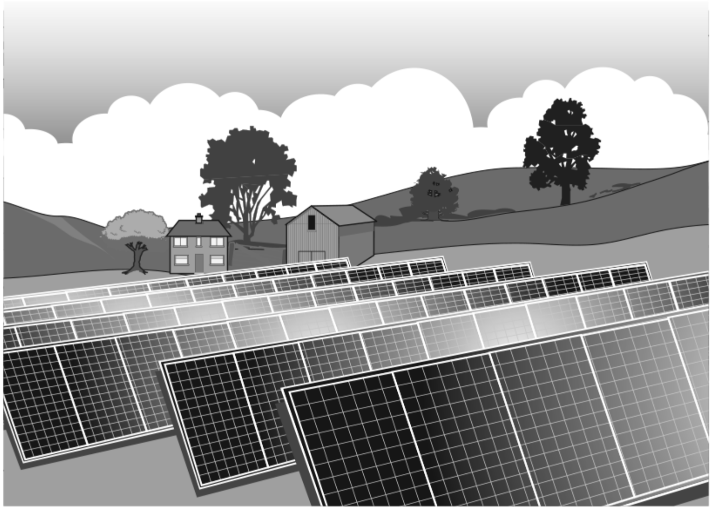


Fig. 3.1

(a) State the main form of energy transferred from the Sun to the solar cells for the generation of electrical energy.

.... [1]

(b) Consider the generation of electrical energy by a large number of solar cells, as shown in Fig. 3.1.

(i) State **one** environmental advantage and **one** environmental disadvantage.

advantage ....

....

disadvantage ....

....
[2]

(ii) State and explain whether this source of electrical energy is renewable.

....

.... [1]

(c) Each group of solar cells is arranged in a rectangle 1.2 m × 2.8 m. The solar cells are situated in a region where 260 W of solar energy is received per square metre of the cells. The electrical output of each group of solar cells is a current of 2.5 A with a potential difference of 86 V.

Calculate the efficiency of the solar cells.

efficiency = ... % [4]

[Total: 8]

---

32. 0625_s19_qp_43 Q: 2

Fig. 2.1 is the top view of a small ship of mass 1.2×10^6 kg. The ship is moving slowly sideways at 0.040 m/s as it comes in to dock.

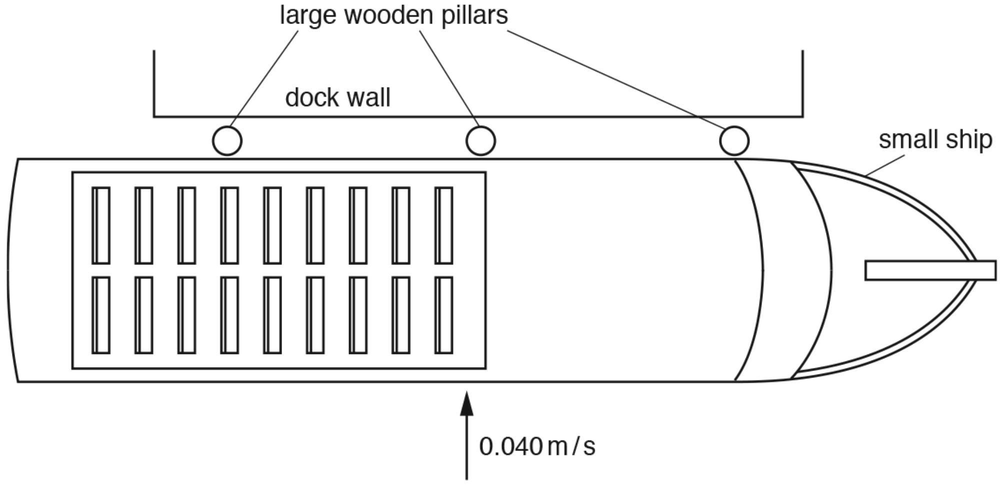


Fig. 2.1

The ship hits the wooden pillars which move towards the dock wall.

(a) Calculate the kinetic energy of the ship before it hits the pillars.

kinetic energy = ... [2]

(b) The ship is in contact with the pillars for 0.30 s as it comes to rest.

Calculate the average force exerted on the side of the ship.

force = ... [4]

(c) Assume that the kinetic energy calculated in **(a)** is used to do work moving the pillars.

Calculate the distance moved by the pillars.

distance = ... [2]

(d) Dock walls sometimes have the pillars replaced with rubber car tyres.

Explain how this reduces the possibility of damage when a boat docks.

....

....

.... [1]

[Total: 9]

33. 0625_w19_qp_41 Q: 2

(a) State **two** properties of an object that may be changed by the action of forces.

1. ....

2. .... [2]

(b) A chest expander is a piece of equipment used by athletes in a gym. Fig. 2.1 shows a chest expander that consists of five identical springs connected in parallel between two handles.

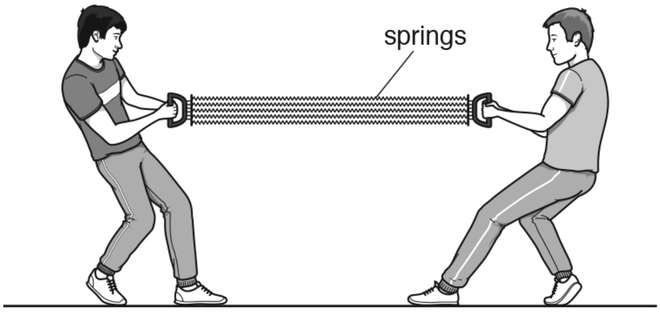


Fig. 2.1

Each spring has an unstretched length of 0.63 m.

Two athletes are stretching the chest expander by pulling on the two handles in opposite directions.

(i) The springs obey Hooke's law.

Explain what is meant by this statement.

....

....

.... [2]

(ii) Each athlete pulls the handle towards himself with a force of 1300 N.

1. State the tension in each spring.

tension = ... [1]

2. The chest expander stretches and each spring is now 0.94 m long.

Calculate the spring constant k of each spring.

k = ... [2]

(iii) State the energy changes taking place as the two athletes use their muscles to stretch the chest expander.

....

....

.... [2]

[Total: 9]

34. 0625_w19_qp_43 Q: 3

(a) Fig. 3.1 shows a waterfall.

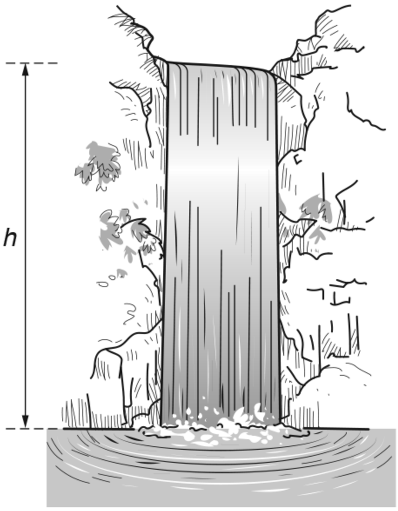


Fig. 3.1

(i) Describe the main energy transfer which is taking place as the water falls.

.... [2]

(ii) The speed of the water as it hits the bottom is 21 m/s.

Calculate the height *h* of the waterfall.

height = ... [3]

(iii) State and explain any assumption you made in **(ii)**.

.... [1]

(b) The Sun is the source of energy for most energy resources used to produce electricity.

State **two** energy resources that have another source for their energy.

1. ....

2. ....
[2]

[Total: 8]

35. 0625_m18_qp_42 Q: 2

(a) A force is used to move an object from the Earth's surface to a greater height.

Explain why the gravitational potential energy (g.p.e.) of the object increases.

....

.... [1]

(b) Fig. 2.1 shows a train moving up towards the top of a mountain.

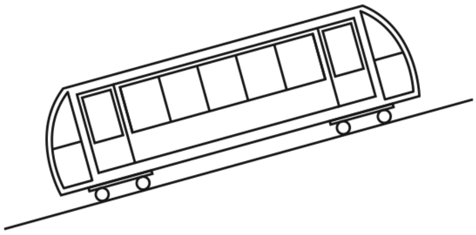


Fig. 2.1

The train transports 80 passengers, each of average mass 65 kg, through a vertical height of 1600 m.

Calculate the increase in the total gravitational potential energy (g.p.e.) of the passengers.

increase in g.p.e. = ... [2]

(c) The engine of the train has a power of 1500 kW. The time taken to reach the top of the mountain is 30 minutes.

Calculate the efficiency of the engine in raising the 80 passengers 1600 m to the top of the mountain.

efficiency = ... [4]

[Total: 7]

36. 0625_s18_qp_41 Q: 2

Fig. 2.1 shows a fork-lift truck lifting a box.

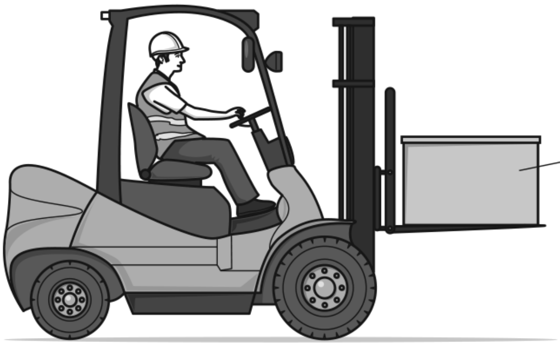


Fig. 2.1

The electric motor that drives the lifting mechanism is powered by batteries.

(a) State the form of the energy stored in the batteries.

.... [1]

(b) The lifting mechanism raises a box of mass 32 kg through a vertical distance of 2.5 m in 5.4 s.

(i) Calculate the gravitational potential energy gained by the box.

gravitational potential energy = ... [2]

(ii) The efficiency of the lifting mechanism is 0.65 (65%).

Calculate the input power to the lifting mechanism.

input power = ... [3]

(c) The batteries are recharged from a mains voltage supply that is generated in an oil-fired power station.

By comparison with a wind farm, state one advantage and one disadvantage of running a power station using oil.

advantage ....

....

disadvantage ....

.... [2]

[Total: 8]

37. 0625_s18_qp_42 Q: 3

Fig. 3.1 shows an aircraft on the deck of an aircraft carrier.

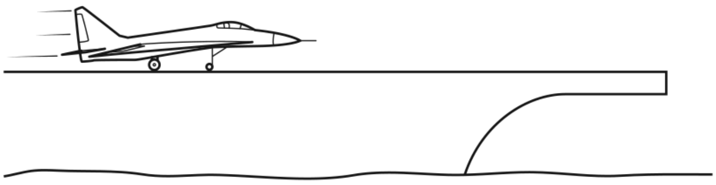


Fig. 3.1

The aircraft accelerates from rest along the deck. At take-off, the aircraft has a speed of 75 m/s. The mass of the aircraft is 9500 kg.

(a) Calculate the kinetic energy of the aircraft at take-off.

kinetic energy = ...[3]

(b) On an aircraft carrier, a catapult provides an accelerating force on the aircraft. The catapult provides a constant force for a distance of 150 m along the deck.

Calculate the resultant force on the aircraft as it accelerates. Assume that all of the kinetic energy at take-off is from the work done on the aircraft by the catapult.

force = ...[2]

[Total: 5]

38. 0625_s18_qp_43 Q: 2

A rifle fires a bullet of mass 0.020 kg vertically upwards through the air. As it leaves the rifle, the speed of the bullet is 350 m/s.

(a) Calculate

(i) the kinetic energy of the bullet as it leaves the rifle,

kinetic energy = ...[3]

(ii) the maximum possible height that the bullet can reach.

maximum height = ...[2]

(b) The actual height reached by the bullet is less than the value calculated in **(a)(ii)**.

(i) Explain, in terms of the forces acting on the bullet, why this is so.

....

....

....[2]

(ii) As the bullet rises through the air, its kinetic energy decreases.

State what happens to this energy.

....

....

....[2]

[Total: 9]

39. 0625_w18_qp_41 Q: 3

(a) State what is meant by *the principle of conservation of energy*.

....

....[1]

(b) Fig. 3.1 shows a girl throwing a heavy ball.

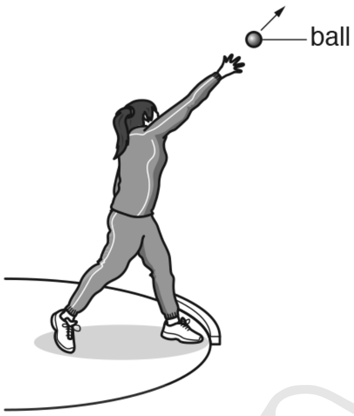


Fig. 3.1

(i) State the energy changes that take place from when the girl begins to exert a force on the ball until the ball hits the ground and stops moving.

....

....

....

....

....[2]

(ii) The mass of the ball is 4.0 kg. The girl exerts a force on the ball for 0.60 s. The speed of the ball increases from 0 m/s to 12 m/s before it leaves the girl's hand.

Calculate:

1. the momentum of the ball on leaving the girl's hand

momentum = ...[2]

2. the average resultant force exerted on the ball.

average resultant force = ...[2]

[Total: 7]

40. 0625_w18_qp_42 Q: 3

(a) The velocity of an object of mass *m* increases from *u* to *v*.

State, in terms of *m*, *u* and *v*, the change of momentum of the object.

....[1]

(b) In a game of tennis, a player hits a stationary ball with his racquet.

(i) The racquet is in contact with the ball for 6.0 ms. The average force on the ball during this time is 400 N.

Calculate the impulse on the tennis ball.

impulse = ...[2]

(ii) The mass of the ball is 0.056 kg.

Calculate the speed with which the ball leaves the racquet.

speed = ...[2]

(iii) State the energy transfer that takes place:

1. as the ball changes shape during the contact between the racquet and the ball

....

....

2. as the ball leaves the racquet.

....

....
[2]

[Total: 7]

41. 0625_w18_qp_43 Q: 2

(a) Complete Fig. 2.1 by writing in the right-hand column the name of the quantity given by the product in the left-hand column.

product	quantity
mass × acceleration	
force × time	

[2]

Fig. 2.1

(b) Fig. 2.2 shows a man hitting a ball with a golf club.

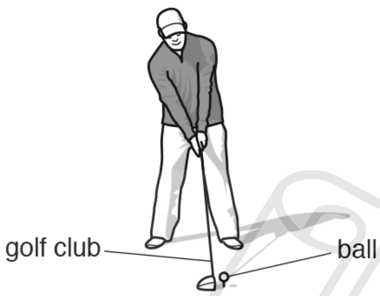


Fig. 2.2

The ball has a mass of 0.046 kg. The golf club is in contact with the ball for 5.0×10^{-4} s and the ball leaves the golf club at a speed of 65 m/s.

(i) Calculate:

1. the momentum of the ball as it leaves the golf club

momentum = ...[2]

2. the average resultant force acting on the ball while it is in contact with the golf club.

average force = ...[2]

(ii) While the golf club is in contact with the ball, the ball becomes compressed and changes shape.

State the type of energy stored in the ball during its contact with the golf club.

....[1]

[Total: 7]

42. 0625_m17_qp_42 Q: 2

(a) Explain why momentum is a vector quantity.

....[1]

(b) The crumple zone at the front of a car is designed to collapse during a collision.

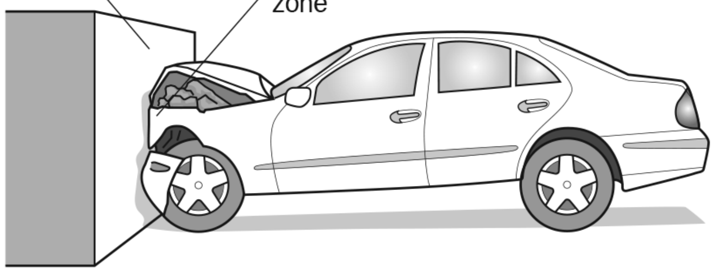


Fig. 2.1

In a laboratory test, a car of mass 1200 kg is driven into a concrete wall, as shown in Fig. 2.1.

A video recording of the test shows that the car is brought to rest in 0.36 s when it collides with the wall. The speed of the car before the collision is 7.5 m/s.

Calculate

(i) the change of momentum of the car,

change of momentum = ...[2]

(ii) the average force acting on the car.

average force = ...[2]

(c) A different car has a mass of 1500 kg. It collides with the same wall and all of the energy transferred during the collision is absorbed by the crumple zone.

(i) The energy absorbed by the crumple zone is 4.3×10^5 J. Show that the speed of the car before the collision is 24 m/s.

[2]

(ii) Suggest what would happen to the car if it is travelling faster than 24 m/s when it hits the wall.

....

....[1]

[Total: 8]

43. 0625_s17_qp_41 Q: 2

A footballer kicks a ball vertically upwards. Initially, the ball is stationary.

(a) His boot is in contact with the ball for 0.050 s. The average resultant force on the ball during this time is 180 N. The ball leaves his foot at 20 m/s.

Calculate

(i) the impulse of the force acting on the ball,

impulse = ...[2]

(ii) the mass of the ball,

mass = ...[2]

(iii) the height to which the ball rises. Ignore air resistance.

height = ...[3]

(b) While the boot is in contact with the ball, the ball is no longer spherical.

State the word used to describe the energy stored in the ball.

....[1]

[Total: 8]

44. 0625_s17_qp_42 Q: 3

(a) Underline the pair of quantities which must be multiplied together to calculate *impulse*.

force and mass	force and velocity	mass and time
time and velocity	weight and velocity	force and time

[1]

(b) Fig. 3.1 shows a collision between two blocks A and B on a smooth, horizontal surface.

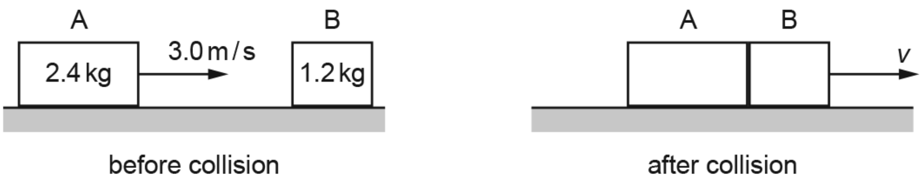


Fig. 3.1

Before the collision, block A, of mass 2.4 kg, is moving at 3.0 m/s. Block B, of mass 1.2 kg, is at rest.

After the collision, blocks A and B stick together and move with velocity v.

(i) Calculate

1. the momentum of block A before the collision,

momentum = ... [2]

2. the velocity v,

velocity = ... [2]

3. the impulse experienced by block B during the collision.

impulse = ... [2]

(ii) Suggest why the total kinetic energy of blocks A and B after the collision is less than the kinetic energy of block A before the collision.

....

.... [1]

[Total: 8]

45. 0625_s17_qp_43 Q: 2

(a) State the word equation that defines *momentum*.

....[1]

(b) A metal block A, travelling in a straight line at 4.0 m/s on a smooth surface, collides with a second metal block B which is at rest. Fig. 2.1 shows the two metal blocks A and B before and after the collision.

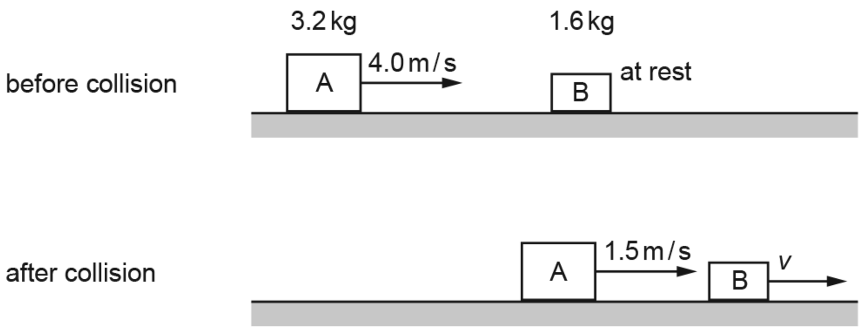


Fig. 2.1

The mass of A is 3.2 kg. The mass of B is 1.6 kg.
After the collision, the velocity of A is 1.5 m/s.

Calculate

(i) the momentum of A before the collision,

momentum = ...[2]

(ii) the velocity v of B after the collision.

v = ...[3]

(c) In the collision that occurred in **(b)**, block A and block B are in contact for 0.050 s.

Calculate the average force that is exerted on B during the collision.

average force = ...[2]

(d) After the collision in **(b)**, the total kinetic energy of the two blocks is less than the kinetic energy of block A before the collision.

Suggest **one** reason for this.

....

....[1]

[Total: 9]

46. 0625_w17_qp_42 Q: 3

(a) State the name of a fuel that is burnt to produce large amounts of electrical energy.

Describe a process by which electrical energy is obtained from the chemical energy stored in this fuel.

Name of fuel: ....

Description of process: ....

....

....

....

....[4]

(b) Explain why the Sun is the source of the energy stored in the fuel in **(a)**.

....

....

....

....[2]

(c) Explain whether the process in **(a)** is renewable.

....

....

....

....[2]

[Total: 8]

47. 0625_w17_qp_43 Q: 3

Fig. 3.1 shows solar cells that use radiation from the Sun to generate electricity.

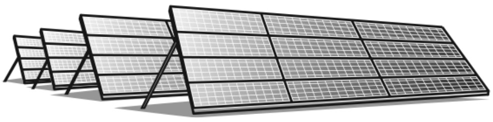


Fig. 3.1

(a) **(i)** State the name of the process which releases energy in the Sun.

....[1]

(ii) A reaction takes place in the Sun as energy is released.

Describe what happens in this reaction.

....

....

....[2]

(b) Apart from solar cells, there are other energy resources used on Earth for which the radiation from the Sun is the source.

State the name of **one** of these energy resources and explain whether it is renewable.

....

....

....[2]

(c) State **two** advantages and **two** disadvantages of using solar cells to generate electricity.

advantage 1 ....

....

advantage 2 ....

....

disadvantage 1 ....

....

disadvantage 2 ....

....

[4]

[Total: 9]