Topical Practice

IGCSE PHYSICS

Paper 4

Chapters 5 – 7

EDITION • Volum • STUDENT

CONTENTS

Chapter 5: Energy, Work, and Power

1 Fig. 3.1 shows a water turbine that is generating electricity in a small tidal energy scheme.

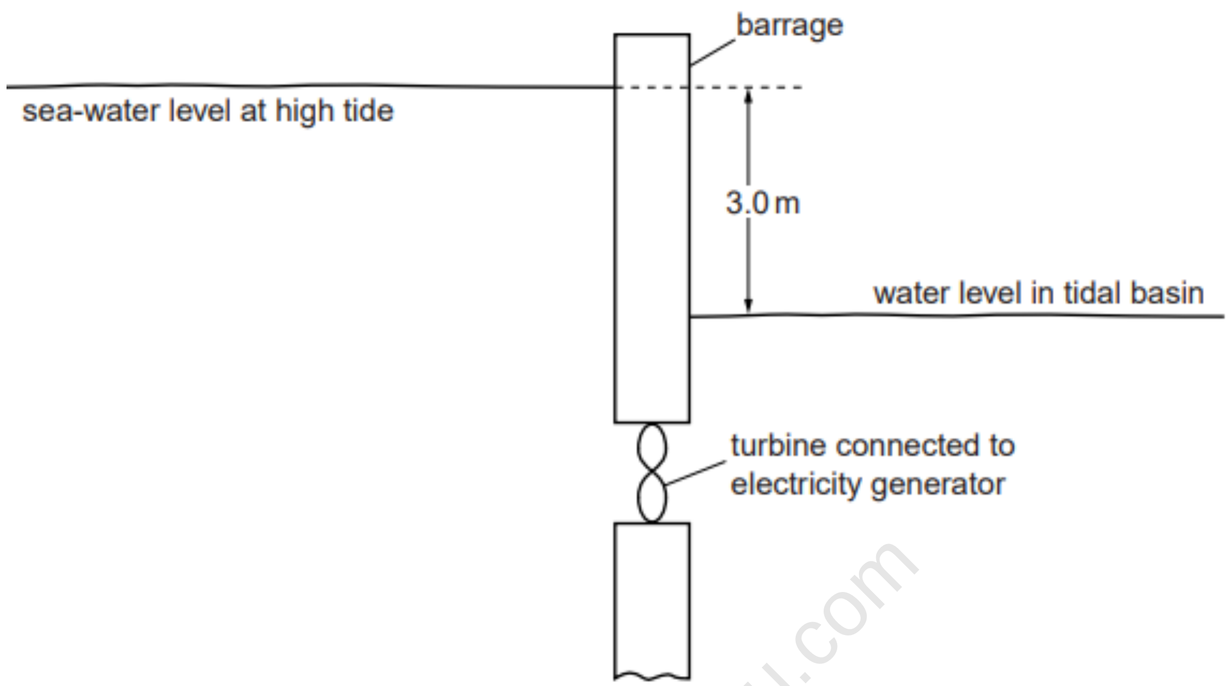

Fig. 3.1

At high tide, $1.0\,m^3$ of sea-water of density $1030\,kg/m^3$ flows through the turbine every second.

(a) Calculate the loss of gravitational potential energy when $1.0\,m^3$ of sea-water falls through a vertical distance of 3.0 m.

loss of gravitational potential energy = ... [3]

(b) Assume that your answer to **(a)** is the energy lost per second by the sea-water passing through the turbine at high tide. The generator delivers a current of 26 A at 400 V.

Calculate the efficiency of the scheme.

efficiency = ... % [3]

(c) At low tide, the sea-water level is lower than the water level in the tidal basin.

(i) State the direction of the flow of water through the turbine at low tide.

....

(ii) Suggest an essential feature of the turbine and generator for electricity to be generated at low tide.

....

....

....
[2]

[Total: 8]

2 (a) State an example of the conversion of chemical energy to another form of energy.

example ....

energy conversion .... [1]

(b) The electrical output of a solar panel powers a pump. The pump operates a water fountain. The output of the solar panel is 17 V and the current supplied to the pump is 0.27 A.

(i) Calculate the electrical power generated by the solar panel.

power = ... [2]

(ii) The pump converts electrical energy to kinetic energy of water with an efficiency of 35%.

Calculate the kinetic energy of the water delivered by the pump in 1 second.

kinetic energy = ... [2]

(iii) The pump propels 0.00014 m^3 of water per second. This water rises vertically as a jet. The density of water is 1000 kg/m^3.

Calculate

1. the mass of water propelled by the pump in 1 second,

mass = ... [2]

2. the maximum height of the jet of water.

maximum height = ... [2]

[Total: 9]

3 Fig. 4.1 represents part of the hydraulic braking system of a car.

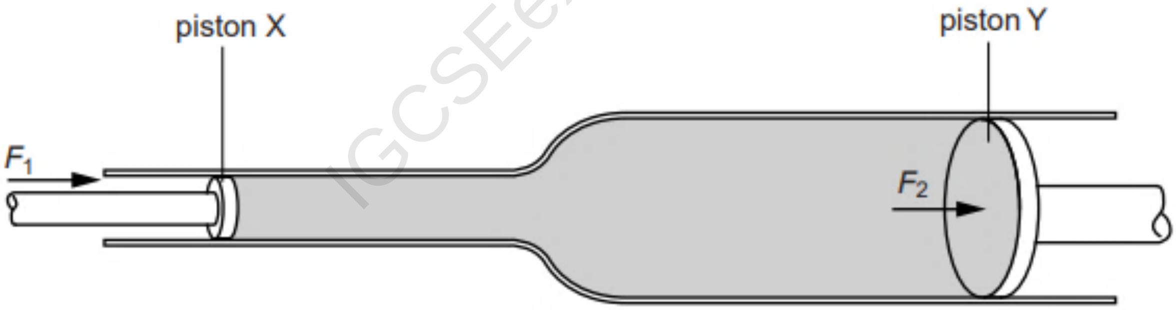

Fig. 4.1

The force F_1 of the driver's foot on the brake pedal moves piston X. The space between pistons X and Y is filled with oil which cannot be compressed. The force F_2 exerted by the oil moves piston Y. This force is applied to the brake mechanism in the wheels of the car.

(c) Piston Y moves a smaller distance than piston X. Explain why.

....

....

.... [2]

4 Fig. 3.1 shows an aeroplane of mass 3.4×10^5 kg accelerating uniformly from rest along a runway.

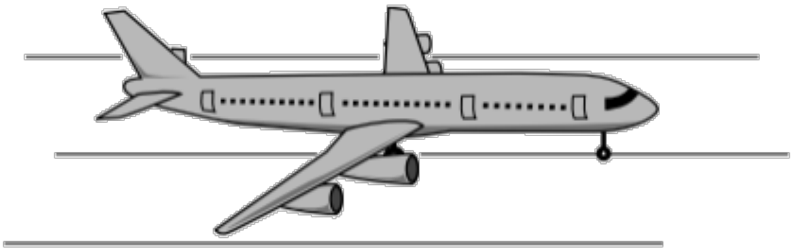

Fig. 3.1

After 26 s it reaches a speed of 65 m/s.

(a) Calculate

(i) the acceleration of the aeroplane,

acceleration = ... [2]

(ii) the resultant force on the aeroplane.

force = ... [2]

(b) Just after taking off, the aeroplane continues to accelerate as it gains height.

(i) State **two** forms of energy that increase during this time.

1. ....

2. .... [2]

(ii) State **one** form of energy that decreases during this time.

.... [1]

(iii) State why the total energy of the aeroplane decreases during this time.

....

.... [1]

(c) When the aeroplane reaches its maximum height, it starts to follow a curved path at a constant speed.

State the direction of the resultant force on the aeroplane.

.... [1]

[Total: 9]

5 Solar panels are positioned on the roof of the house shown in Fig. 6.1. They use thermal energy from the Sun to provide hot water in an environmentally friendly way.

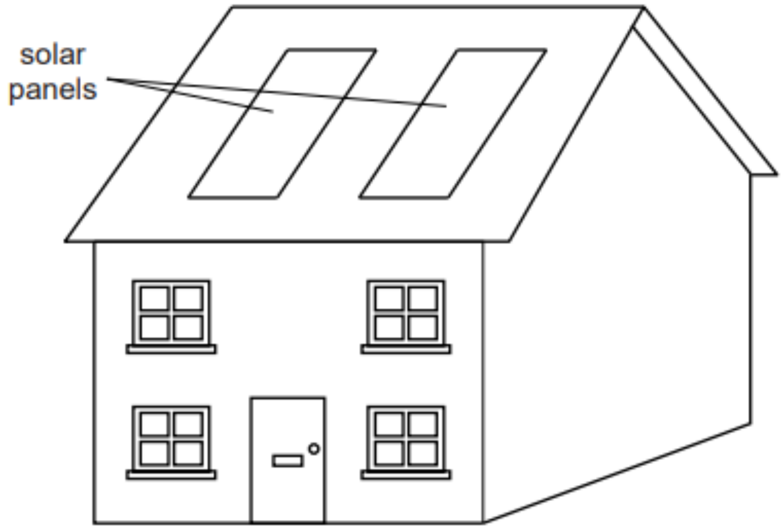

Fig. 6.1

Cold water flows to the panels at 15 °C. During the day, the panels supply 3.8 kg of hot water at 65 °C every hour.

(a) Calculate the average energy that the solar panels deliver to the water in one hour. Specific heat capacity of water = 4200 J / (kg °C).

energy = ... [3]

(b) The solar power incident on the roof during this heating period is 170 W / m^2. The solar panels have a total area of 8.0 m^2.

Calculate the solar energy incident on the panels in one hour.

solar energy = ... [2]

(c) Calculate the efficiency of the solar panels, stating the equation you use.

efficiency = ... [2]

(d) Explain why solar energy is called *renewable* energy.

....

.... [1]

(e) State one disadvantage of using solar energy.

....

.... [1]

[Total: 9]

6 (a) State what is meant by the *centre of mass* of a body.

....

....

.... [1]

(b) Fig. 4.1 shows an athlete successfully performing a high jump.

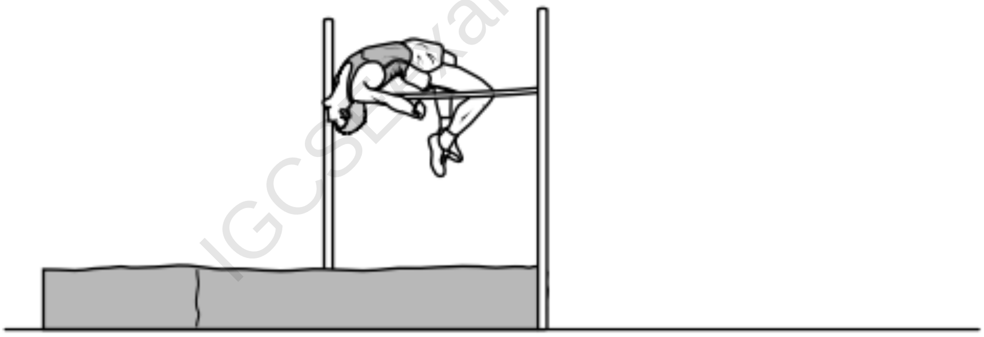

Fig. 4.1

The height of the bar above the ground is 2.0 m. The maximum increase in gravitational potential energy (g.p.e.) of the athlete during the jump is calculated using the expression g.p.e. = *mgh*.

Explain why the value of *h* used in the calculation is much less than 2.0 m.

....

....

.... [1]

(c) Fig. 4.2 shows, in order, five stages of an athlete successfully performing a pole-vault.

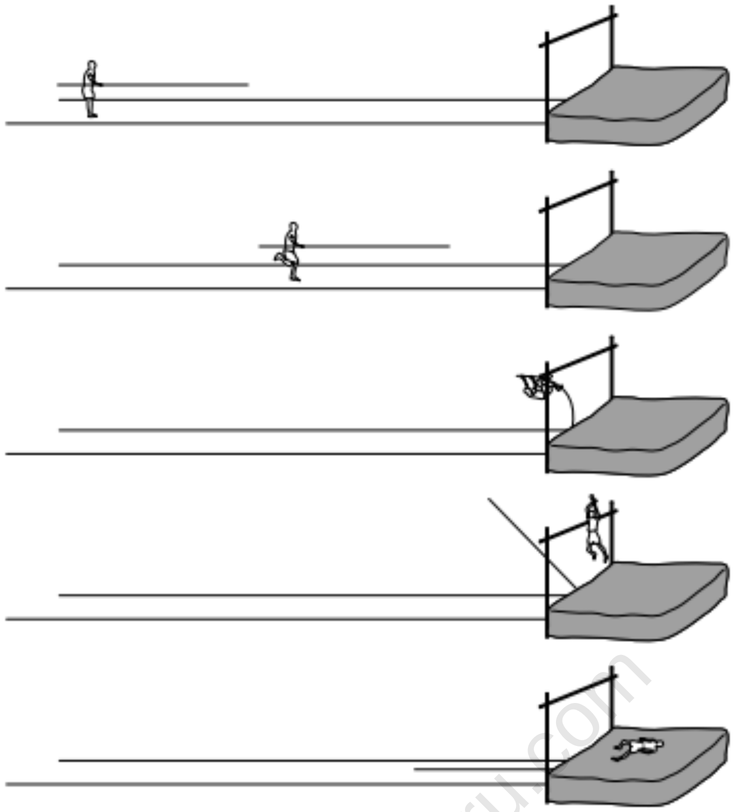

Fig. 4.2

Describe the energy changes which take place during the performance of the pole-vault, from the original stationary position of the pole-vaulter before the run-up, to the final stationary position after the vault.

....

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 8]

7 Water is stored in a reservoir at an average vertical height of 350 m above the turbines of a hydroelectric power station.

During a 7.0 hour period, $1.8 \times 10^6\,m^3$ of water flows down from the reservoir to the turbines.

(a) The density of water is $1000\,kg/m^3$.

For this 7.0 hour period, calculate

(i) the mass of water that flows from the reservoir to the turbines,

mass = ... [2]

(ii) the gravitational potential energy transformed as the water flows to the turbines,

energy = ... [2]

(iii) the maximum possible average output power.

power = ... [2]

(b) A hydroelectric power station generates electricity from a renewable energy source.

(i) Explain what is meant, in this context, by *renewable*.

....

.... [1]

(ii) State two other renewable energy sources.

1. ....

2. ....

[2]

[Total: 9]

8 Fig. 3.1 shows the descent of a sky-diver from a stationary balloon.

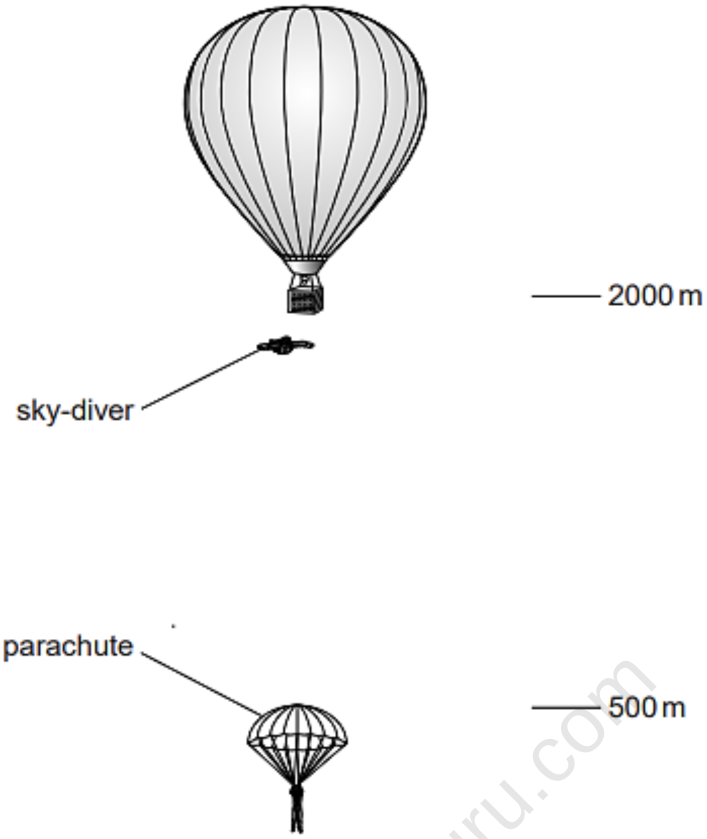

Fig. 3.1 (not to scale)

The sky-diver steps from the balloon at a height of 2000 m and accelerates downwards.

His speed is 52 m/s at a height of 500 m.

He then opens his parachute. From 400 m to ground level, he falls at constant speed.

(a) The total mass of the sky-diver and his equipment is 92 kg.

(i) Calculate, for the sky-diver,

1. the loss of gravitational potential energy in the fall from 2000 m to 500 m,

loss of gravitational potential energy = ... [2]

2. the kinetic energy at the height of 500 m.

kinetic energy = ... [2]

(ii) The kinetic energy at 500 m is not equal to the loss of gravitational potential energy. Explain why there is a difference in the values.

....

....

.... [1]

(b) State

(i) what happens to the air resistance acting on the sky-diver during the fall from 2000 m to 500 m,

.... [1]

(ii) the value of the air resistance during the fall from 400 m to ground.

air resistance = ... [1]

[Total: 7]

9 Fig. 3.1 shows a fork-lift truck lifting a crate on to a high shelf in a warehouse.

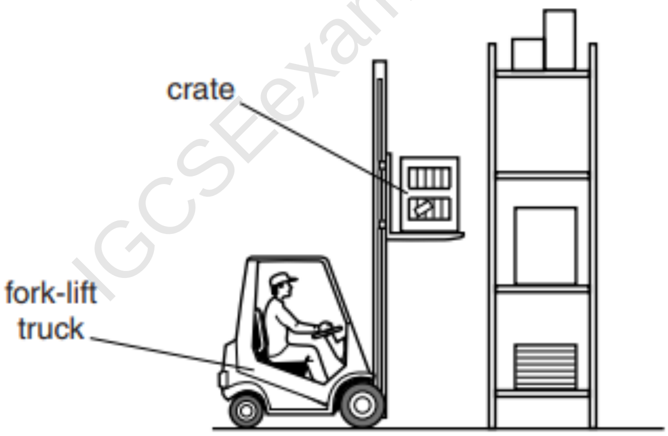

Fig. 3.1

The fork-lift truck lifts a crate of weight 640 N through a vertical distance of 3.5 m in 4.0 s.

(a) Calculate the useful work done in lifting the crate.

work done = ... [2]

(b) A motor drives a mechanism to lift the crate. The current in the motor is 25 A. The motor is connected to a 75 V battery.

Calculate

(i) the energy supplied to the motor in 4.0 s,

energy = ... [2]

(ii) the overall efficiency of the fork-lift truck in lifting the crate.

efficiency = ... [2]

(c) Not all of the energy supplied is used usefully in lifting the crate.

Suggest two mechanisms by which energy is wasted.

1. ....

2. .... [2]

[Total: 8]

10 A child's toy launches a model parachutist of mass 0.40 kg vertically upwards. The model parachutist reaches a maximum height of 8.5 m.

(a) Calculate

(i) the gravitational potential energy gained by the model parachutist,

energy = ... [2]

(ii) the minimum possible speed with which the model parachutist was launched.

speed = ... [3]

(b) In practice, the launch speed must be greater than the value calculated in **(a)(ii)**.

Explain why.

....

....

.... [2]

(c) As the model parachutist returns to the ground, it loses gravitational potential energy.

Explain what happens to this energy as the model parachutist falls through the air at constant speed.

....

.... [1]

[Total: 8]

11 The Sun is a large sphere of high temperature gas. An extremely large quantity of energy radiates from the Sun into space every second.

(a) A process releases energy inside the Sun and its temperature stays high.

State the name of this process.

.... [1]

(b) The train now travels with a constant speed of 24 m/s along a straight, horizontal track. The total force opposing the motion due to friction and air resistance is 7.2×10^4 N.

(i) By considering the work done by the train's engine in 1.0 s, calculate its output power.

power = ... [2]

(ii) The train begins to travel up a slope.

Explain why the power of the train's engine must be increased to maintain the speed of 24 m/s.

....

....

....

....

.... [3]

[Total: 9]

12 (a) State the energy changes that take place when

(i) a cyclist rides down a hill without pedalling,

....

....

(ii) a cyclist pedals up a hill at a constant speed.

....

....

[3]

(b) A car of mass 940 kg is travelling at 16 m/s.

(i) Calculate the kinetic energy of the car.

kinetic energy = ... [2]

13 When a salmon swims up a river to breed, it often has to jump up waterfalls. Fig. 3.1 shows a salmon jumping above the surface of the water. On this occasion the salmon falls back down into the river.

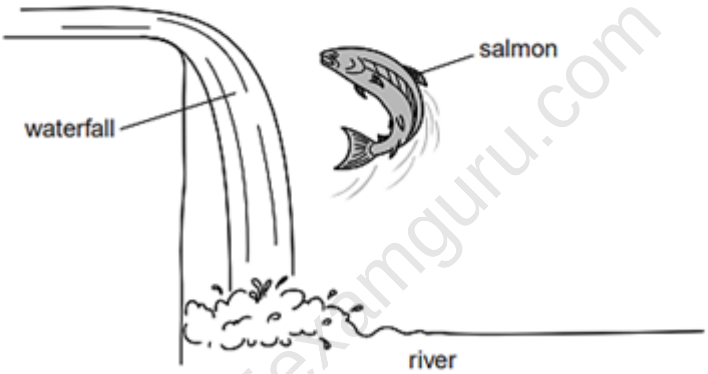

Fig. 3.1

The salmon has a mass of 2.0 kg.

(a) The salmon leaves the water vertically with a kinetic energy of 16.2 J.

(i) Calculate the speed of the salmon as it leaves the water.

speed = ... [2]

(ii) Calculate the maximum height gained by the salmon. Ignore air resistance.

gain in height = ... [3]

(iii) After the salmon has re-entered the river, it has lost nearly all its original kinetic energy.

State what has happened to the lost energy.

....

....

....

.... [2]

(b) Another salmon, of much greater mass, leaves the water vertically with the same speed.

State and explain how the height of this salmon's jump compares to the height reached by the first salmon.

....

....

.... [2]

[Total: 9]

14 (a) On a day with no wind, a fountain in Switzerland propels 30 000 kg of water per minute to a height of 140 m.

Calculate the power used in raising the water.

power = ... [4]

(b) The efficiency of the pump which operates the fountain is 70%.

Calculate the power supplied to the pump.

power = ... [3]

(c) On another day, a horizontal wind is blowing. The water does not rise vertically.

Explain why the water still rises to a height of 140 m.

....

.... [1]

[Total: 8]

15 Fig. 3.1 shows a long, plastic tube, sealed at both ends. The tube contains 0.15 kg of small metal spheres.

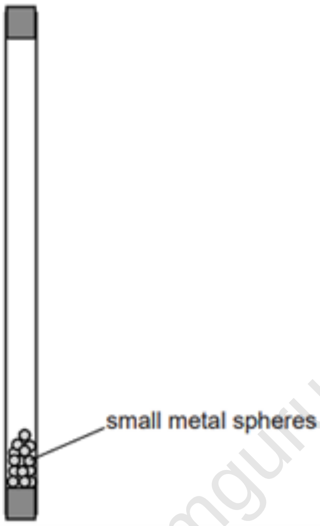

Fig. 3.1

A physics teacher turns the tube upside down very quickly and the small metal spheres then fall through 1.8 m and hit the bottom of the tube.

(a) Calculate

(i) the decrease in gravitational potential energy as the spheres fall 1.8 m,

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

(ii) the speed of the spheres as they hit the bottom of the tube.

speed = ... [3]

(b) The gravitational potential energy of the spheres is eventually transformed to thermal energy in the metal spheres. The physics teacher explains that this procedure can be used to determine the specific heat capacity of the metal.

(i) State one other measurement that must be made in order for the specific heat capacity of the metal to be determined.

....

....[1]

(ii) Suggest a source of inaccuracy in determining the specific heat capacity using this experiment.

....

....[1]

(iii) The teacher turns the tube upside down and lets the spheres fall to the bottom 100 times within a short period of time.

Explain why turning the tube upside down 100 times, instead of just once, produces a more accurate value of the specific heat capacity.

....

....

....[2]

[Total: 9]

16 Fig. 4.1 shows a small wind-turbine used to generate electricity.

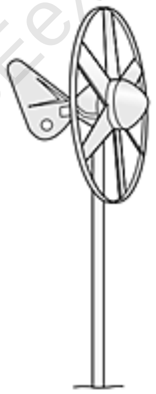

Fig. 4.1

The wind-turbine drives an electric generator.

The wind blows with a velocity of 7.0 m/s at right angles to the plane of the turbine. The mass of air passing per second through the turbine is 6.7 kg.

(a) **(i)** Calculate the kinetic energy of the air blown through the turbine per second.

kinetic energy = ... [2]

(ii) Only 8% of this energy is converted to electrical energy.

Calculate the power output of the electric generator.

power output = ... [2]

(b) The volume of air passing through the turbine each second is 5.6 m^3 (flow rate is 5.6 m^3/s).

Calculate the density of the air.

density of air = ... [2]

(c) The turbine turns a generator.

Describe the essential action within the generator that produces electricity.

....

....

.... [2]

[Total: 8]

17 A diver climbs some steps on to a fixed platform above the surface of the water in a swimming-pool.

He dives into the pool. Fig. 2.1 shows the diver about to enter the water.

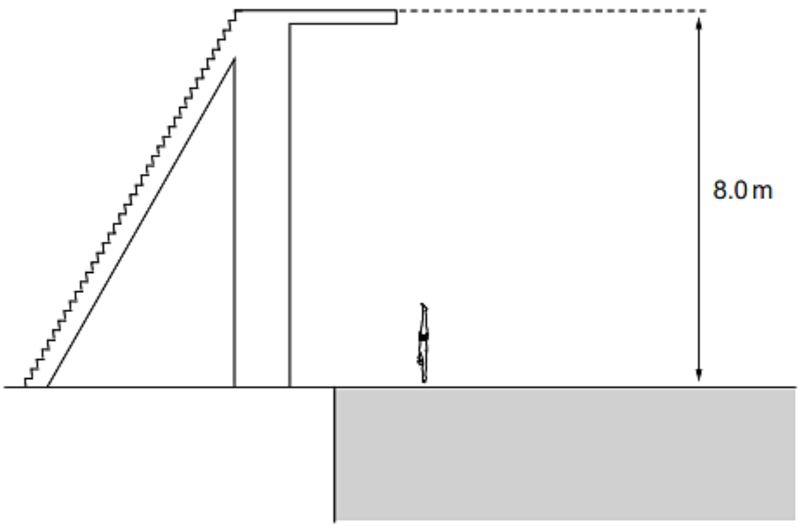

Fig. 2.1

The mass of the diver is 65 kg. The platform is 8.0 m above the surface of the water.

(a) Calculate

(i) the increase in the gravitational potential energy of the diver when he climbs up to the platform.

increase in gravitational potential energy = ...[1]

(ii) the speed with which the diver hits the surface of the water. Ignore any effects of air resistance.

speed = ...[4]

(b) In another dive from the same platform, the diver performs a somersault during the descent. He straightens, and again enters the water as shown in Fig. 2.1.

Discuss whether the speed of entry into the water is greater than, less than or equal to the speed calculated in **(a)(ii)**. Ignore any effects of air resistance.

....

....

....

....[3]

[Total: 8]

18 An electric train is initially at rest at a railway station. The motor causes a constant force of 360 000 N to act on the train and the train begins to move.

(a) State the form of energy gained by the train as it begins to move.

....[1]

(b) The train travels a distance of 4.0 km along a straight, horizontal track.

(i) Calculate the work done on the train during this part of the journey.

work done = ...[2]

(ii) The mass of the train is 450 000 kg.

Calculate the maximum possible speed of the train at the end of the first 4.0 km of the journey.

maximum possible speed = ... [3]

(iii) In practice, the speed of the train is much less than the value calculated in **(ii)**.

Suggest **one** reason why this is the case.

....

.... [1]

(c) After travelling 4.0 km, the train reaches its maximum speed. It continues at this constant speed on the next section of the track where the track follows a curve which is part of a circle.

State the direction of the resultant force on the train as it follows the curved path.

.... [1]

[Total: 8]

19 (a) The boxes on the left contain the names of some sources of energy. The boxes on the right contain properties of some sources of energy.

Draw **two** straight lines **from each box** on the left to the two boxes on the right which describe that source of energy.

	renewable
solar energy	not renewable
natural gas	polluting
	not polluting

[2]

(b) Coal-fired power stations are polluting.

State an advantage of using coal as a source of energy.

....

....[1]

(c) A coal-fired power station generates electricity at night when it is not needed.

Some of this energy is stored by pumping water up to a mountain lake. When there is high demand for electricity, the water is allowed to flow back through turbines to generate electricity.

On one occasion, 2.05×10^8 kg of water is pumped up through a vertical height of 500 m.

(i) Calculate the weight of the water.

weight = ...[1]

(ii) Calculate the gravitational potential energy gained by the water.

energy gained = ...[2]

(iii) The electrical energy used to pump the water up to the mountain lake is 1.2×10^{12} J. Only 6.2×10^{11} J of electrical energy is generated when the water is released.

Calculate the efficiency of this energy storage scheme.

efficiency = ...[2]

[Total: 8]

20 An athlete of mass 64 kg is bouncing up and down on a trampoline.

At one moment, the athlete is stationary on the stretched surface of the trampoline. Fig. 3.1 shows the athlete at this moment.

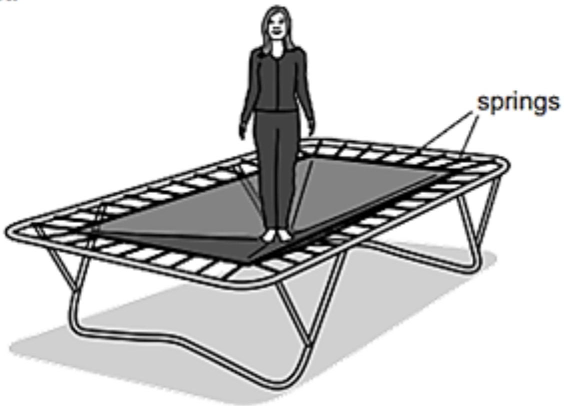

Fig. 3.1

(a) State the form of energy stored due to the stretching of the surface of the trampoline.

....[1]

(b) The stretched surface of the trampoline begins to contract. The athlete is pushed vertically upwards and she accelerates. At time *t*, when her upwards velocity is 6.0 m/s, she loses contact with the surface.

(i) Calculate her kinetic energy at time *t*.

kinetic energy = ...[2]

(ii) Calculate the maximum possible distance she can travel upwards after time *t*.

maximum distance = ...[3]

(iii) In practice, she travels upwards through a slightly smaller distance than the distance calculated in **(ii)**.

Suggest why this is so.

....

....[1]

21 Fig. 3.1 shows an early water-powered device used to raise a heavy load. The heavy load rests on piston B.

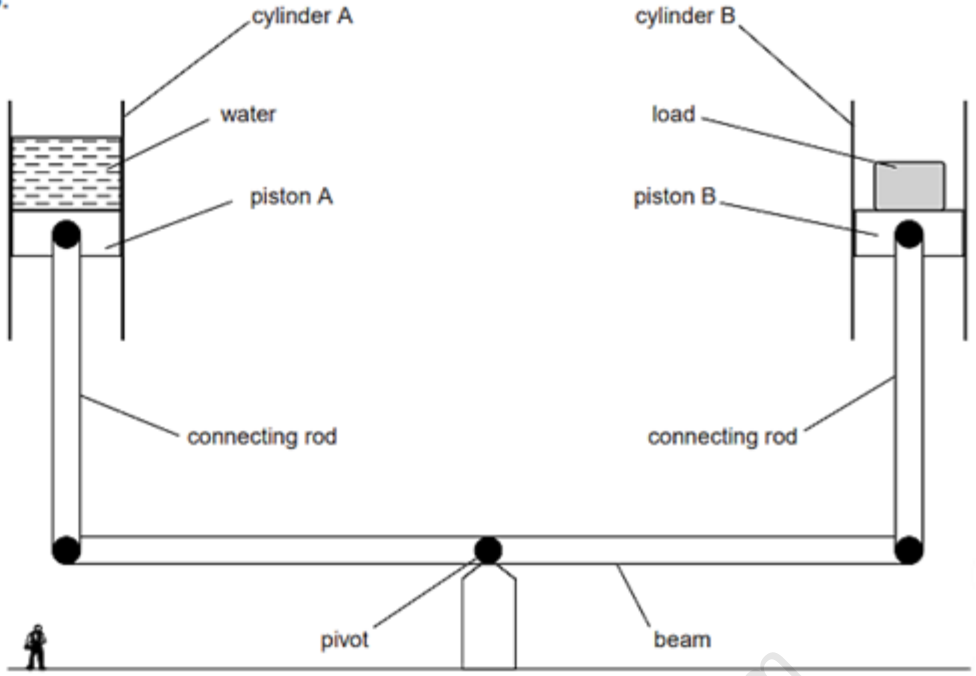

Fig. 3.1 (not to scale)

Initially, a large weight of water in cylinder A pushes piston A down. This causes the left-hand end of the beam to move down and the right-hand end of the beam to move up. Piston B rises, lifting the heavy load.

(a) The weight of water in cylinder A is 80 kN.

Calculate the mass of water in cylinder A.

mass = ... [2]

(b) The density of water is 1000 kg / m^3.

Calculate the volume of water in cylinder A.

volume = ... [2]

(c) Piston A moves down a distance of 4.0 m.

Calculate the gravitational potential energy lost by the water.

loss of gravitational potential energy = ... [2]

(d) The heavy load lifted by piston B gains 96 kJ of gravitational potential energy.

Calculate the efficiency of the device.

efficiency = ... [2]

[Total: 8]

22 A soft rubber ball of mass 0.15 kg is dropped, in a vacuum, from a height of 2.0 m on to a hard surface. The ball then bounces.

(a) State the main energy changes taking place when

(i) the ball is falling,

....

(ii) the ball hits the surface and is changing shape,

....

(iii) the ball is regaining its shape and is rising from the surface.

....
[3]

(b) Calculate the speed with which the ball hits the surface.

speed = ... [4]

(c) After rebounding from the surface, the ball rises to a height of 1.9 m.

Suggest why the height to which the ball rises is less than the height from which the ball falls.

....

....[1]

[Total: 8]

23 (a) (i) Define *power*.

....[1]

(ii) In the following list, tick the **two** boxes next to the two quantities needed to calculate the work done on an object.

☐ mass of the object

☐ force acting on the object

☐ speed of the object

☐ acceleration of the object

☐ distance moved by the object [1]

(b) A lift (elevator) in a high building transports 12 passengers, each of mass 65 kg, through a vertical height of 150 m in a time of 64 s.

(i) Calculate the power needed to transport the passengers through this height.

power = ...[4]

(ii) The lift (elevator) is driven by an electric motor.

State a reason, other than friction, why the power supplied by the motor is greater than the power needed to transport the passengers.

....

....[1]

[Total: 7]

24 Fig. 3.1 shows a skier taking part in a downhill race.

Fig. 3.1

(a) The mass of the skier, including his equipment, is 75 kg. In the ski race, the total vertical change in height is 880 m.

Calculate the decrease in the gravitational potential energy (g.p.e.) of the skier.

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

(b) The skier starts from rest. The total distance travelled by the skier during the descent is 2800 m. The average resistive force on the skier is 220 N.

Calculate

(i) the work done against the resistive force,

work done = ...[2]

(ii) the kinetic energy of the skier as he crosses the finishing line at the end of the race.

kinetic energy = ...[2]

(c) Suggest why the skier bends his body as shown in Fig. 3.1.

....[1]

[Total: 7]

Chapter 6: Pressure

1 Fig. 4.1 represents part of the hydraulic braking system of a car.

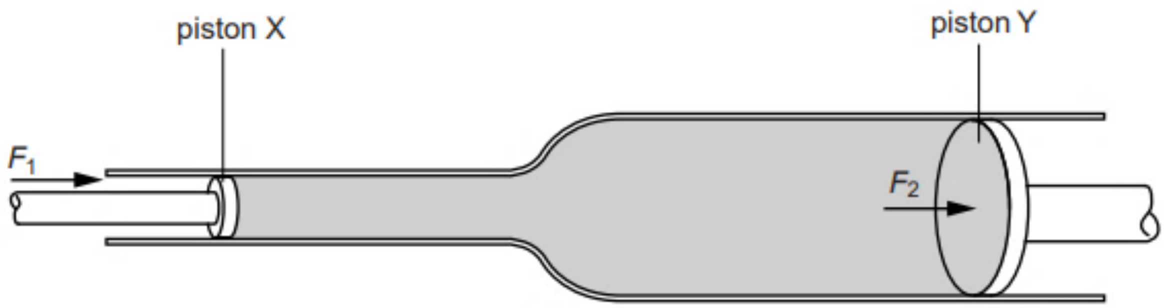

Fig. 4.1

The force F_1 of the driver's foot on the brake pedal moves piston X. The space between pistons X and Y is filled with oil which cannot be compressed. The force F_2 exerted by the oil moves piston Y. This force is applied to the brake mechanism in the wheels of the car.

The area of cross-section of piston X is 4.8 cm^2.

(a) The force F_1 is 90 N. Calculate the pressure exerted on the oil by piston X.

pressure = ... [2]

(b) The pressure on piston Y is the same as the pressure applied by piston X. Explain why the force F_2 is greater than the force F_1.

....

.... [1]

(c) Piston Y moves a smaller distance than piston X. Explain why.

....

....

.... [2]

(d) Suggest why the braking system does not work properly if the oil contains bubbles of air.

....

....

.... [2]

[Total: 7]

2 A diver is at a depth of 25 m beneath the surface of a lake. He carries a cylinder of high-pressure air on his back.

(b) The density of the water in the lake is 1000 kg / m^3 and the atmospheric pressure at the surface is 1.0×10^5 Pa.

Calculate the total pressure 25 m beneath the surface of the lake.

total pressure = ... [3]

[Total: 7]

3 **(a)** Fig. 4.1 shows some gas contained in a cylinder by a heavy piston. The piston can move up and down in the cylinder with negligible friction.

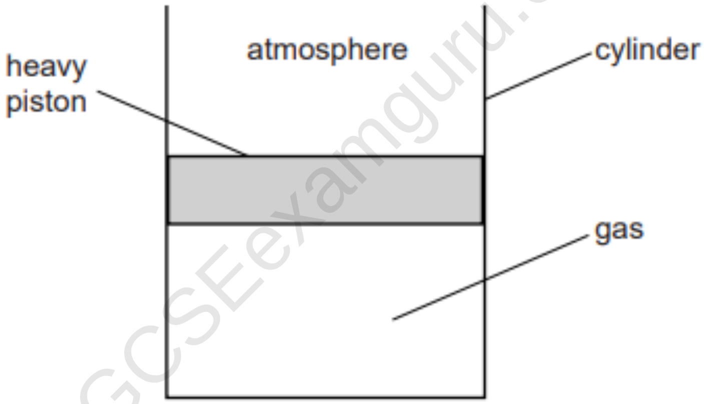

Fig. 4.1

There is a small increase in the pressure of the atmosphere above the piston.

(i) On Fig. 4.1, draw a possible new position for the lower face of the piston. [1]

(ii) Explain, in terms of the molecules of the gas and the molecules of the atmosphere, your answer to **(a)(i)**.

....

....

....

....

....

.... [3]

(b) The pressure of the atmosphere above the piston returns to its original value, and the piston returns to its original position, as shown in Fig. 4.2.

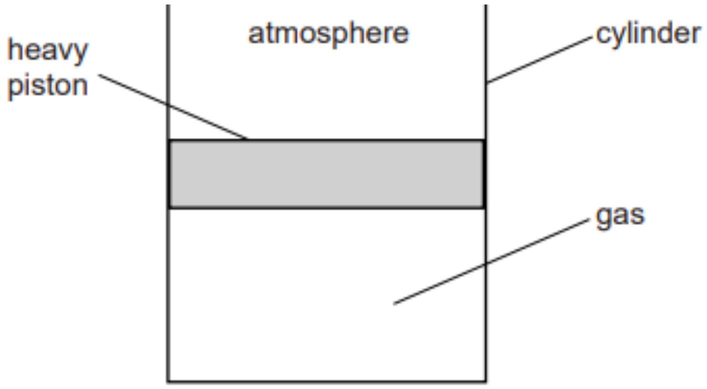

Fig. 4.2

The gas, piston and cylinder are now heated to a much higher temperature.

(i) On Fig. 4.2, draw a possible new position for the lower face of the piston. [1]

(ii) Explain, in terms of the molecules of the gas and the molecules of the atmosphere, your answer to **(b)(i)**.

....

....

....

....

.... [2]

[Total: 7]

4 A large crane has a mass of 8500 kg. Fig. 4.1 shows the crane on a muddy building-site.

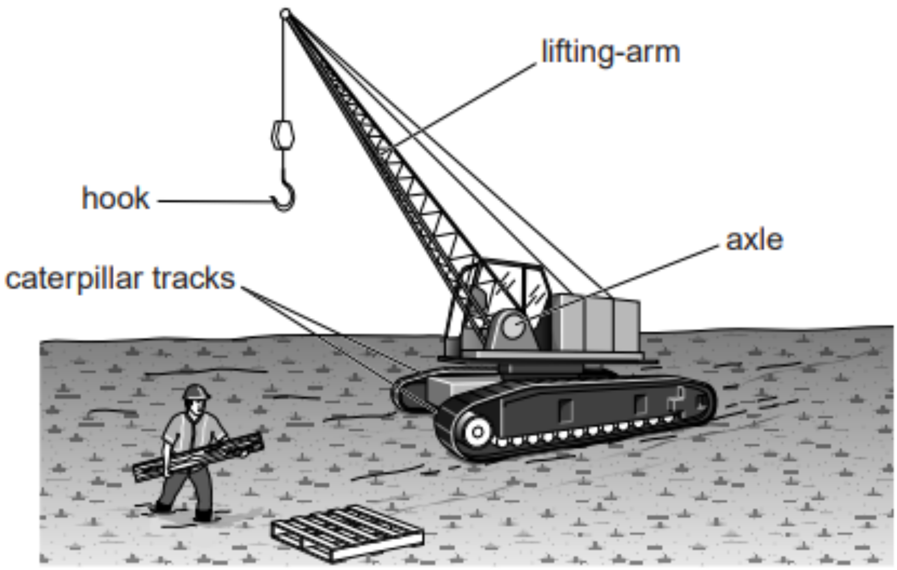

Fig. 4.1

(a) Calculate the weight of the crane.

weight = ... [1]

(b) The crane rests on two caterpillar tracks each of which has a contact area with the ground of $3.4\,m^2$.

(i) Calculate the pressure that the crane exerts on the ground.

pressure = ... [2]

(ii) As the crane driver walks towards the crane, he starts to sink into the mud. He lays a wide plank of wood on the mud and he walks along the plank.

Explain why he does not sink into the mud when he walks along the plank.

....

....

.... [2]

5 Fig. 1.1 shows a side view of a large tank in a marine visitor attraction.

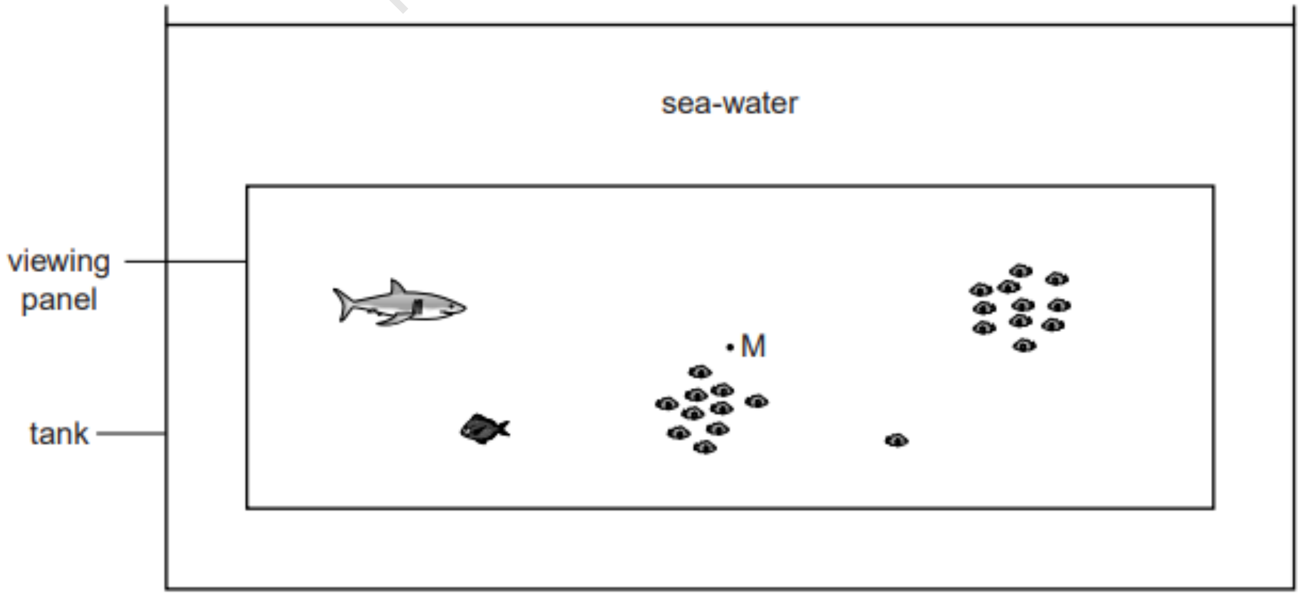

Fig. 1.1 (not to scale)

The tank is 51 m long and 20 m wide. The sea-water in the tank is 11 m deep and has a density of 1030 kg / m^3.

(a) Calculate the mass of water in the tank.

mass = ... [3]

(b) The pressure at point M, halfway down the large viewing panel, is 60 kPa more than atmospheric pressure.

Calculate the depth of M below the surface of the water.

depth = ... [2]

(c) The viewing panel is 32.8 m wide and 8.3 m high.

Calculate the outward force of the water on the panel. Assume that the pressure at M is the average pressure on the whole panel.

force = ... [2]

[Total: 7]

6 **(a)** **(i)** Define *pressure*.

....[1]

(b) Fig. 6.1 shows a flask connected to a pump and also to a manometer containing mercury.

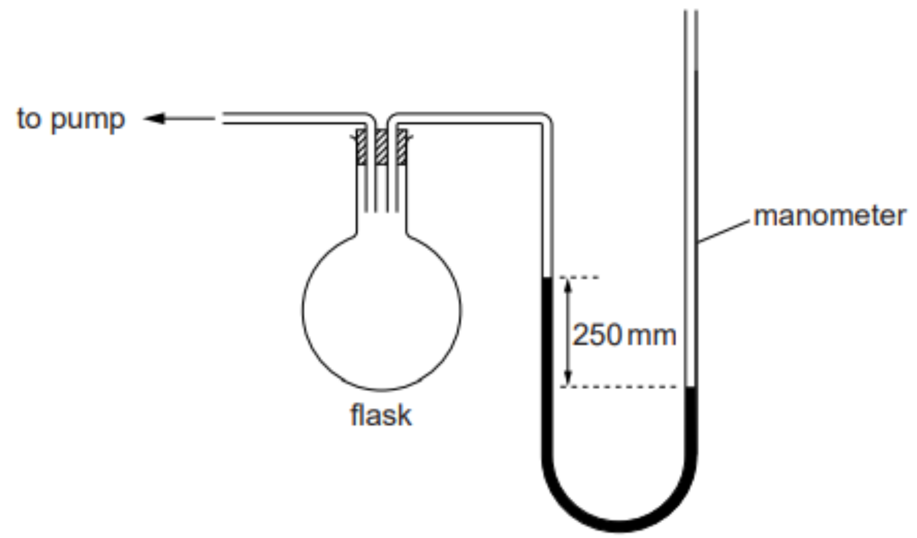

Fig. 6.1

The right-hand tube of the manometer is open to the atmosphere.

The pump has been operated so that the mercury levels differ, as shown, by 250 mm. The density of mercury is 13 600 kg/m^3.

(i) Calculate the pressure, in Pa, due to the 250 mm column of mercury.

pressure = ... [2]

(ii) The pressure of the atmosphere is 1.02×10^5 Pa.

Calculate the pressure of the air in the flask.

pressure = ... [1]

[Total: 7]

7 **(a)** A water tank has a rectangular base of dimensions 1.5 m by 1.2 m and contains 1440 kg of water.

Calculate

(i) the weight of the water,

weight = ... [1]

(ii) the pressure exerted by the water on the base of the tank.

pressure = ... [2]

(b) Fig. 5.1 shows two water tanks **P** and **Q** of different shape. Both tanks are circular when viewed from above. The tanks each contain the same volume of water. The depth of water in both tanks is 1.4 m.

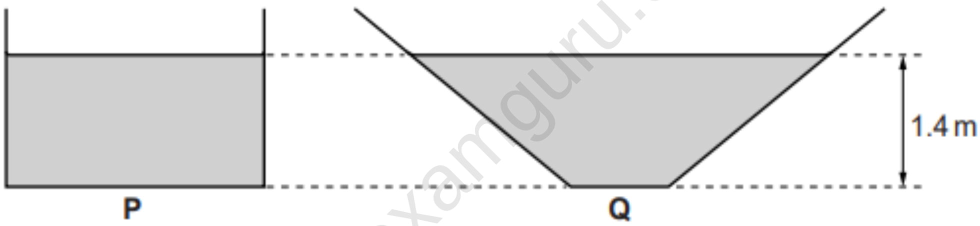

Fig. 5.1

(i) The density of water is 1000 kg / m^3. The pressures exerted by the water on the base of the two tanks are equal.

Calculate this pressure.

pressure = ... [2]

(ii) Equal small volumes of water are removed from each tank.

State which tank, **P** or **Q**, now has the greater water pressure on its base. Explain your answer.

....

....

.... [2]

[Total: 7]

8 Fig. 2.1 shows a uniform, rectangular slab of concrete ABCD standing upright on the ground. The slab has height 0.60 m, width 0.30 m and mass 18 kg. A force of 40 N acts horizontally to the left at B.

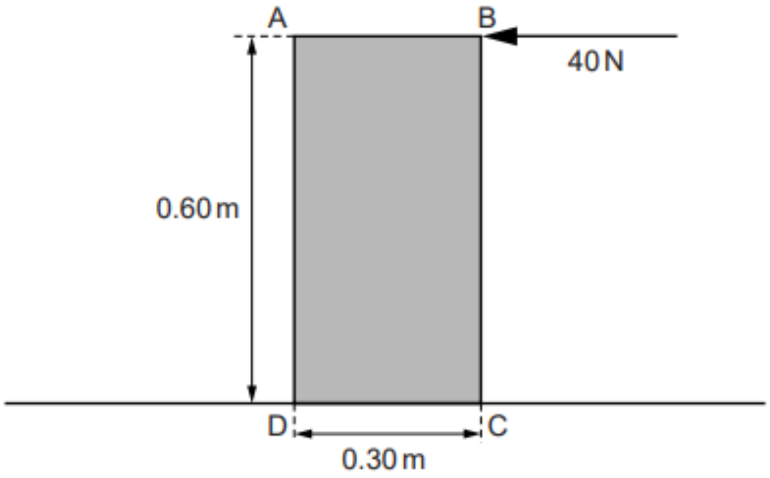

Fig. 2.1

(a) **(i)** Calculate the weight *W* of the concrete slab.

W = ... [1]

(ii) The thickness of the slab is 0.040 m.

Calculate the pressure exerted by the slab on the ground.

pressure = ... [2]

(b) **(i)** On Fig. 2.1, draw and label an arrow to show the weight *W* of the slab acting at its centre of mass. [1]

9 **(a)** Fig. 3.1 shows an oil can containing only air at atmospheric pressure.

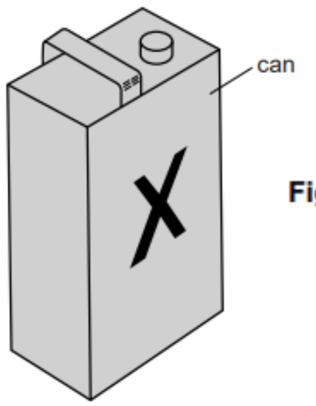

Fig. 3.1

Atmospheric pressure is 1.0×10^5 Pa.

The pressure of the air in the can is reduced by means of a pump. The can collapses when the pressure of the air in the can falls to 6000 Pa.

(i) Explain why the can collapses.

....

....[1]

(ii) The surface area of face X of the can is $0.12\,m^2$.

Calculate the resultant force on face X when the can collapses.

force = ...[3]

(b) Mercury is poured into a U-shaped glass tube. Water is then poured into one of the limbs of the tube. Oil is poured into the other limb until the surfaces of the mercury are at the same level in both limbs.

Fig. 3.2 shows the result.

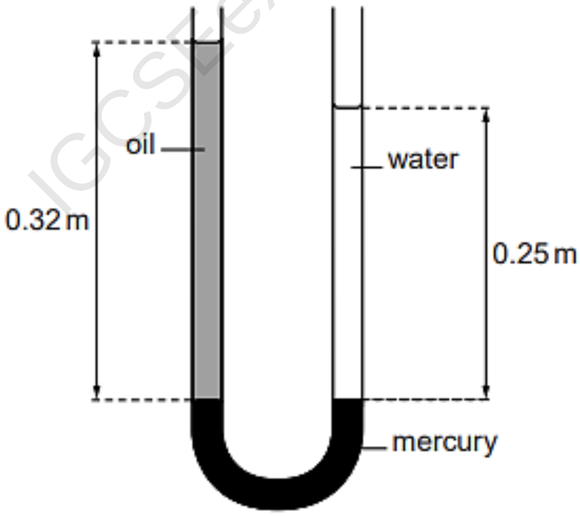

Fig. 3.2

(i) State a condition that must be true in order for the mercury surfaces to be at the same level in both limbs of the tube.

....[1]

(ii) The height of the water column is 0.25 m. The height of the oil column is 0.32 m. The density of water is 1000 kg/m^3.

Calculate

1. the pressure exerted by the water on the surface of the mercury,

pressure = ...[2]

2. the density of the oil.

density = ...[2]

[Total: 9]

Chapter 7: Kinetic Molecular Model of Matter

1 (a) Two students hang out identical T-shirts to dry at the same time in the same neighbourhood. The only difference between the drying conditions is that one T-shirt is sheltered from any wind and the other is in a strong breeze, as shown in Fig. 6.1.

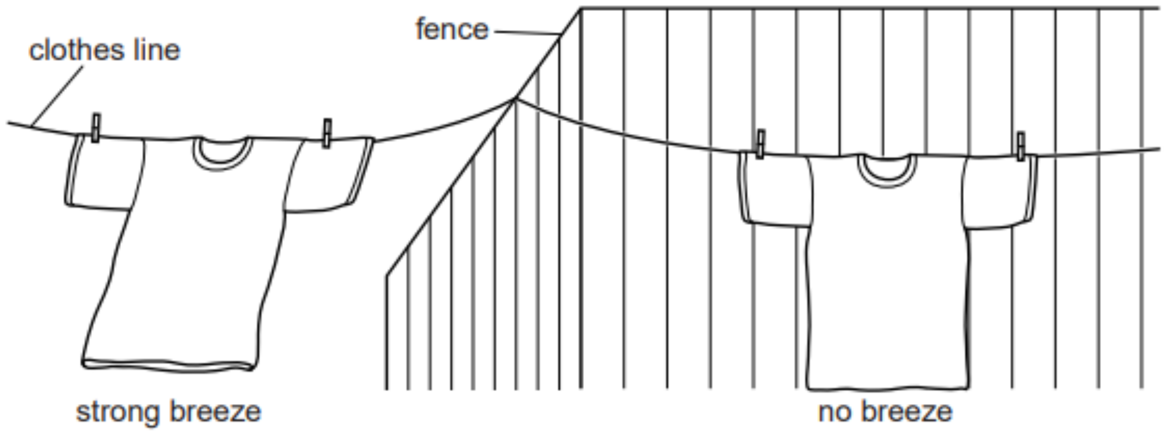

Fig. 6.1

State and explain, in terms of water molecules, the difference between the drying times of the T-shirts.

....

....

....

....

.... [2]

(b) Fig. 6.2 shows another occasion when a student hangs out two identical T-shirts to dry next to each other on a line. One T-shirt is folded double as shown in Fig. 6.2.

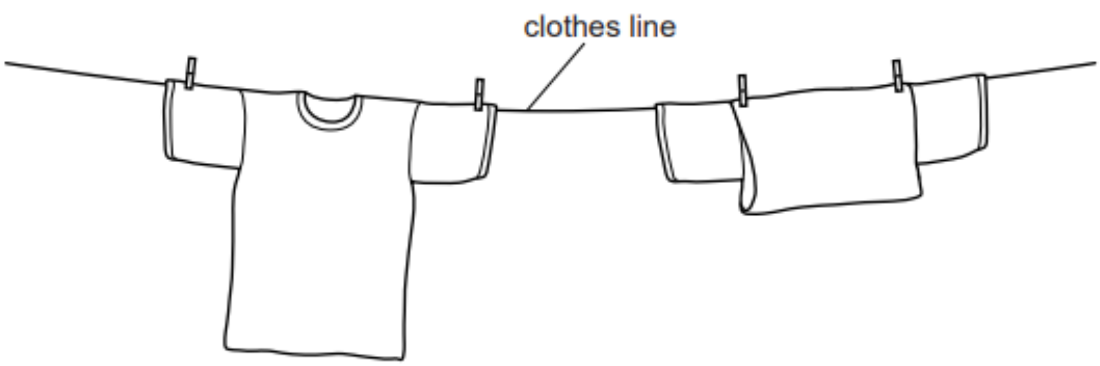

Fig. 6.2

State and explain, in terms of water molecules, the difference between the drying times of the T-shirts.

....

....

....

....

.... [2]

(c) A runner in a hot country feels cooler if she pours water over her hair to keep it wet, even when the water is at the same temperature as the air around her.

Explain, in terms of a change of state of water, why she feels cooler.

....

....

....

.... [2]

[Total: 6]

2 **(c)** Explain, in terms of their molecules, why the density of the oil is greater than that of air.

....

.... [1]

3 A diver is at a depth of 25 m beneath the surface of a lake. He carries a cylinder of high-pressure air on his back.

(a) **(i)** Explain how the air molecules exert a pressure on the inside surface of the cylinder.

....

....

....

.... [3]

(ii) The diver gradually uses up the air in the cylinder. Explain why the pressure falls.

....

....

.... [1]

4 (a) Explain

(i) how gas molecules exert a force on a solid surface,

....

....

.... [1]

(ii) the increase in pressure of a gas when its volume is decreased at constant temperature.

....

....

....

.... [3]

(b) A cylinder of volume $5.0 \times 10^3\,cm^3$ contains air at a pressure of 8.0×10^5 Pa.

A leak develops so that air gradually escapes from the cylinder until the air in the cylinder is at atmospheric pressure. The pressure of the atmosphere is 1.0×10^5 Pa.

Calculate the volume of the escaped air, now at atmospheric pressure. Assume that the temperature stays constant.

volume = ...cm^3 [4]

[Total: 8]

5 (a) Explain why a liquid cools when evaporation takes place from its surface.

....

....

.... [2]

6 **(a)** **(i)** State two ways in which the molecular structure of a gas differs from the molecular structure of a liquid.

1. ....

2. ....
[2]

(ii) Compressibility is the ease with which a substance can be compressed.

State and explain, in terms of the forces between the molecules, how the compressibility of a gas differs from that of a liquid.

....

....

.... [2]

(b) Fig. 6.1 shows a weather balloon being inflated by helium from a cylinder.

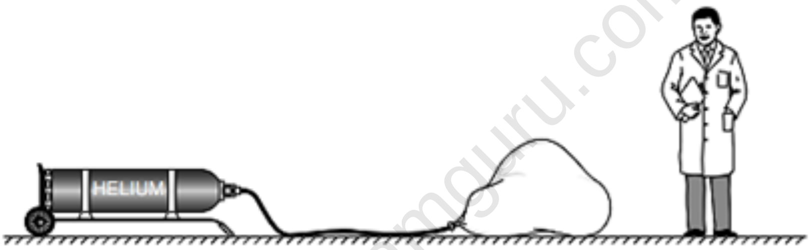

Fig. 6.1

(i) The helium that inflates the balloon had a volume of $0.035\,m^3$ at a pressure of 2.6×10^6 Pa, inside the cylinder.

The pressure of the helium in the balloon is 1.0×10^5 Pa and its temperature is the same as it was when in the cylinder.

Calculate the volume occupied by the helium in the balloon.

volume = ... [3]

(ii) As the balloon rises up through the atmosphere, the temperature of the helium decreases.

State the effect of this temperature change on the helium molecules.

....

.... [1]

[Total: 8]

7 **(a)** On a hot day, sweat forms on the surface of a person's body and the sweat evaporates.

Explain, in terms of the behaviour of molecules,

(i) the process of evaporation,

....

....

....

(ii) how this process helps the body to cool down.

....

....

....

....

....

....

[3]

8 **(a)** **(i)** Define *pressure*.

....[1]

(ii) A closed box contains a gas.

Explain, in terms of molecules, how the gas exerts a pressure on the walls of the box.

....

....

....

....

....[3]

9 Fig. 4.1 shows a small, closed, transparent chamber containing smoke.

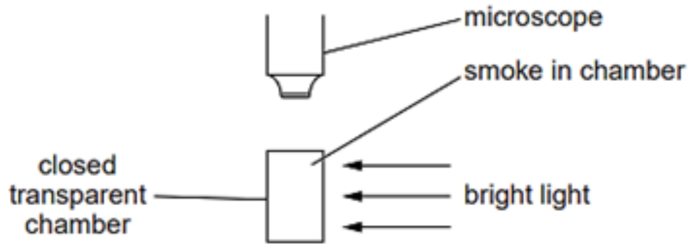

Fig. 4.1

The chamber is brightly lit and observed through a microscope. The smoke particles are seen as very small, bright dots.

(a) Describe the movement of the dots.

....

....

....

....[2]

(b) Explain, in terms of molecules, how this movement is caused.

....

....

....

....[2]

(c) Describe what is seen as the smoke particles move towards and away from the observer.

....

....

....

....[1]

[Total: 5]

10 (a) Complete the following statements by writing appropriate words in the spaces.

The pressure of a gas in a sealed container is caused by the collisions of

.... with the container wall.

An increase in the temperature of the gas increases the pressure because the

.... of the .... increases.

The force on the wall due to the gas is the pressure multiplied by the ....

of the wall. [2]

(b) A mountaineer takes a plastic bottle containing some water to the top of a mountain. He removes the cap from the bottle, drinks all the water and then replaces the cap, as shown in Fig. 6.1.

On returning to the base of the mountain, he finds that the bottle has collapsed to a much smaller volume, as shown in Fig. 6.2.

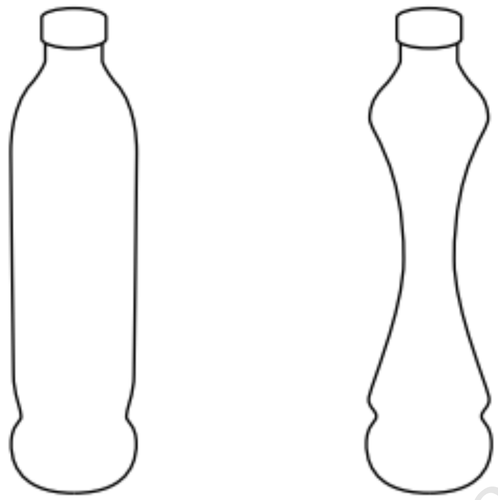

Fig. 6.1 **Fig. 6.2**

(i) Explain why the bottle collapsed.

....

....

....

.... [2]

(ii) At the top of the mountain the atmospheric pressure was 4.8×10^4 Pa and the volume of the bottle was 250 cm^3.

Calculate the volume of the bottle at the base of the mountain where the pressure of the air inside the bottle is 9.2×10^4 Pa. Assume no change of temperature.

volume = ... [3]

[Total: 7]

11 A teacher shows a class examples of three states of matter. These are a solid metal block resting on the bench, a liquid in a glass beaker and a gas in a clear balloon in the laboratory.

Fig. 4.1a represents the arrangement of molecules in the solid.

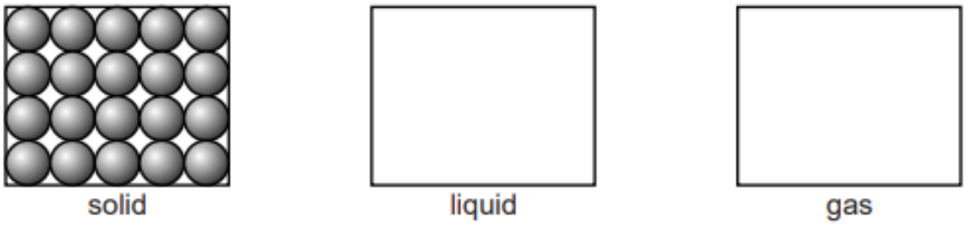

Fig. 4.1a **Fig. 4.1b** **Fig. 4.1c**

(a) **(i)** Complete Fig. 4.1b, to show the arrangement of molecules in the liquid.

(ii) Complete Fig. 4.1c, to show the arrangement of molecules in the gas.

[3]

(b) **(i)** In the list below, draw a ring around the state of matter that is the easiest to compress.

the solid **the liquid** **the gas**

[1]

(ii) In terms of its molecules, explain why this state of matter is the easiest to compress.

....

....

.... [2]

[Total: 6]

12 **(b)** The rate at which the mass of **evaporating** water decreases depends on other factors.

(i) State two of these factors.

1. ....

2. ....

[2]

(ii) State two other ways in which evaporation is different from boiling.

1. ....

2. ....

[2]

[Total: 6]

13 (a) Puddles of water form on a path after rainfall on a windy day.

In terms of molecules, state and explain how the rate of evaporation of the puddles is affected by

(i) a reduction of wind speed,

....

....

....

.... [2]

(ii) an increase of water temperature.

....

....

....

.... [2]

(b) Fig. 5.1 shows two puddles.

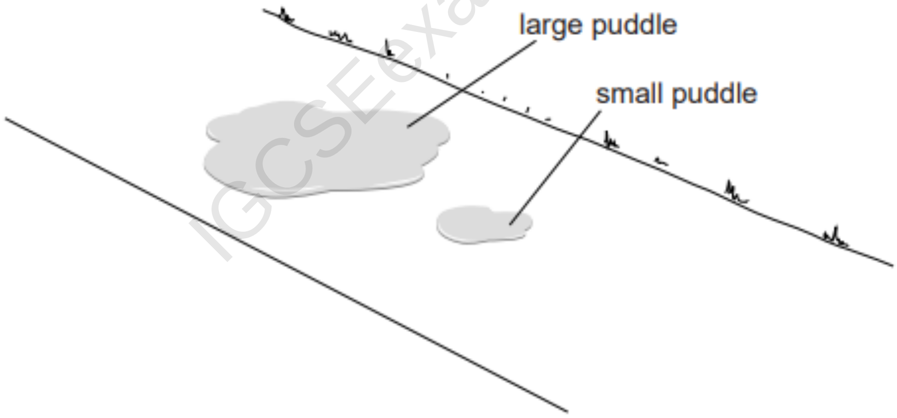

Fig. 5.1

State and explain how the rate of evaporation from the large puddle compares to that from the small puddle under the same conditions.

....

....

....

.... [2]

14 Fig. 6.1 shows a quantity of gas in a cylinder fitted with a piston P.

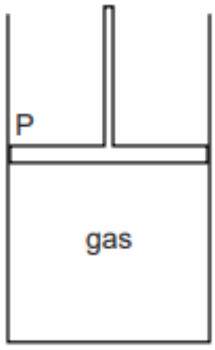

Fig. 6.1

(a) Describe the motion of the molecules of the gas.

....

....

....

....

.... [3]

(b) The piston is now slowly pushed down to decrease the volume of the gas. The temperature of the gas does not change.

(i) State and explain, in terms of molecules, what happens to the pressure of the gas.

....

....

.... [2]

(ii) Before pushing the piston down, the pressure of the gas was 1.0×10^5 Pa. Pushing the piston down reduces the volume of the gas from 500 cm^3 to 240 cm^3.

Calculate the final pressure of the gas.

pressure = ... [2]

[Total: 7]

15 (a) The following are three statements about boiling.

- A liquid boils at a fixed temperature.
- During boiling, vapour can form at any point within the liquid.
- Without a supply of thermal energy, boiling stops.

Complete the following equivalent statements about evaporation.

- A liquid evaporates at ....

  ....
- During evaporation ....

  ....
- Without a supply of thermal energy, evaporation ....

[3]

16 (a) Fig. 4.1 shows a syringe containing 100 cm^3 of air at atmospheric pressure. Atmospheric pressure is 1.0×10^5 Pa.

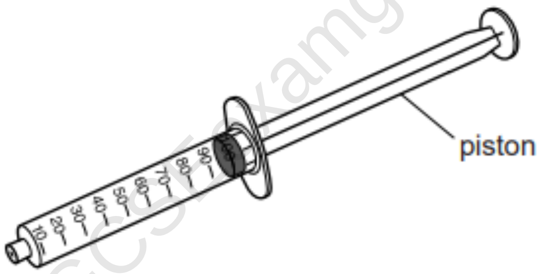

Fig. 4.1

The open end of the syringe is sealed and the piston is pushed inwards until the air occupies a volume of 40 cm^3. The temperature of the air remains constant.

Calculate the new pressure of the air in the syringe.

air pressure = ... [2]

(b) A syringe is used to transfer smokey air from above a flame to a small glass container.

Extremely small solid smoke particles are suspended in the air in the container.

The container is brightly illuminated from the side and viewed through a microscope.

(i) The movement of the suspended smoke particles is called Brownian motion. Describe this Brownian motion.

....

....

....[2]

(ii) Explain what causes the motion of the smoke particles.

....

....

....[2]

(c) In the space below, sketch a diagram to represent the molecular structure of a solid. Show the molecules as small circles of equal sizes.

[2]

[Total: 8]

17 (a) In the box below, sketch a diagram to represent the molecular structure of a liquid. Show the molecules as small circles of equal size.

[2]

(b) A teacher in a school laboratory pours liquid ethanol from a bottle into a glass dish. The glass dish rests on an electronic balance. Although the temperature of the laboratory is below the boiling point of ethanol, the mass of ethanol in the dish quickly decreases as ethanol evaporates.

(i) State the effect of this evaporation on the temperature of the remaining ethanol.

.... [1]

(ii) Explain, in terms of the ethanol molecules, why this is happening.

....

.... [1]

(iii) The specific latent heat of vaporisation of ethanol is 850 J/g.

Calculate the thermal energy required to evaporate 3.4 g of ethanol.

thermal energy = ... [2]

(iv) Suggest **two** ways in which the rate of evaporation of ethanol from the dish can be reduced.

1. ....

2. ....

[2]

[Total: 8]

18 A small cylinder of compressed helium gas is used to inflate balloons for a celebration.

(a) **(i)** In the box below, sketch a diagram to represent the arrangement of helium molecules in a balloon.

[2]

(ii) State and explain how the size of the attractive forces acting between the molecules of a gas compares with the size of the attractive forces between the molecules of a solid.

....

....

....[2]

(b) The helium in the cylinder has a volume of $6.0 \times 10^{-3}\,m^3$ ($0.0060\,m^3$) and is at a pressure of $2.75 \times 10^6\,Pa$.

(i) The pressure of helium in each balloon is $1.1 \times 10^5\,Pa$. The volume of helium in an inflated balloon is 3.0×10^{-3} ($0.0030\,m^3$). The temperature of the helium does not change.

Calculate the number of balloons that were inflated.

number of balloons = ...[3]

(ii) Later, the temperature increases and some of the balloons burst.

Suggest and explain why this happens.

....

....

....[2]

[Total: 9]

19 Fig. 2.1 shows a cylinder containing gas compressed by the movement of a piston.

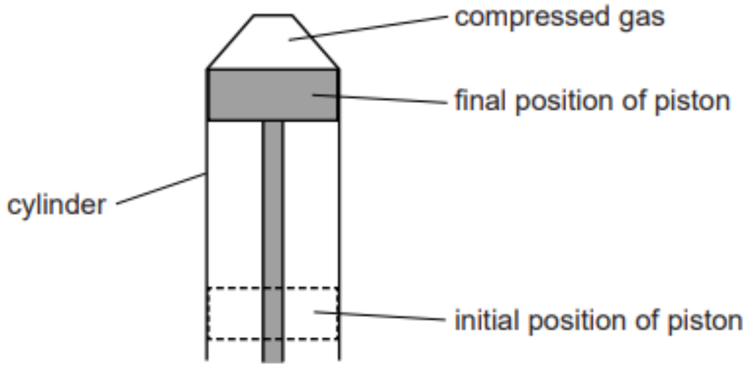

Fig. 2.1

Initially the volume of the gas was 470 cm^3. The piston moves up and compresses the gas to a volume of 60 cm^3. The whole arrangement is left for some time until the gas cools to its original temperature. The pressure of the gas is now 800 kPa.

(a) Calculate the initial pressure of the gas.

pressure = ...[3]

(b) Explain, in terms of molecules, the effect on the pressure of the gas if it was not given time to cool to its original temperature.

....

....

....

....[3]

(c) The area of the piston is $5.5 \times 10^{-3} m^2$ ($0.0055 m^2$).

Calculate the force exerted by the gas on the piston when the pressure is 800 kPa.

force = ...[2]

[Total: 8]

20 (a) (i) State two ways in which the molecular structure of a liquid is different from the molecular structure of a solid.

1. ....

....

2. ....

....

[2]

(ii) Explain, in terms of energy, the process which takes place as a solid at its melting point changes into a liquid at the same temperature.

....

....

.... [1]

21 **(a)** In the space below, draw a simple labelled diagram of the apparatus used to demonstrate Brownian motion.

[2]

(b) State what is observed.

....

....

....[2]

(c) Explain what is observed in terms of molecules.

....

....

....

....[2]

[Total: 6]

22 **(a)** Smoke particles are introduced into a glass box containing air. Light shines into the box so that, when observed through a microscope, the smoke particles can be seen as bright points of light.

Describe the motion of the smoke particles and account for this motion in terms of the air molecules.

....

....

....

....

....

....[4]

(b) Fig. 5.1 shows a quantity of gas in a cylinder sealed by a piston that is free to move.

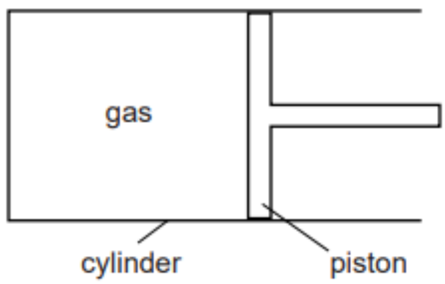

Fig. 5.1

(i) The temperature of the gas is increased.

State what happens, if anything,

1. to the piston,

....

2. to the pressure of the gas.

....
[2]

(ii) The piston is now fixed in place and the temperature of the gas is increased further.

Explain, in terms of the behaviour of molecules, what happens to the pressure of the gas.

....

....

....[2]

[Total: 8]