1 **(a)** **(i)** On Fig. 3.1, draw a graph of extension against load for a spring which obeys Hooke's law. [1]

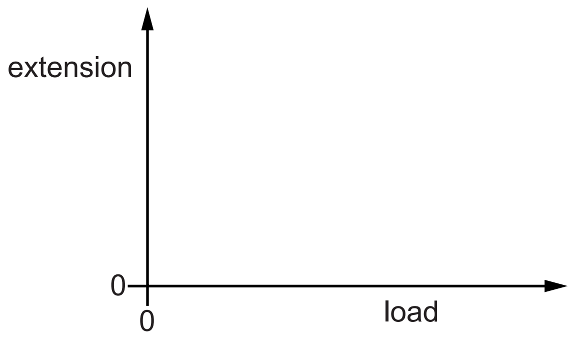

Fig. 3.1

(ii) State the word used to describe the energy stored in a spring that has been stretched or compressed.

....[1]

(b) Fig. 3.2 shows a model train, travelling at speed *v*, approaching a buffer.

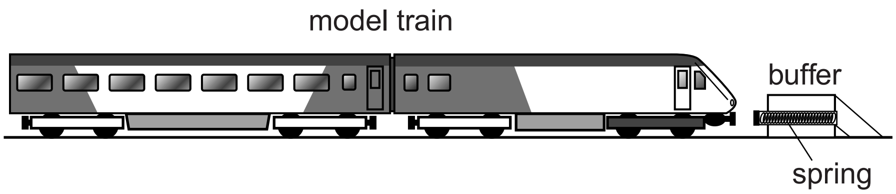

Fig. 3.2

The train, of mass 2.5 kg, is stopped by compressing a spring in the buffer. After the train has stopped, the energy stored in the spring is 0.48 J.

Calculate the initial speed *v* of the train.

v = ...[4]

[Total: 6]

2 Fig. 2.1 shows a conveyor belt transporting a package to a raised platform. The belt is driven by a motor.

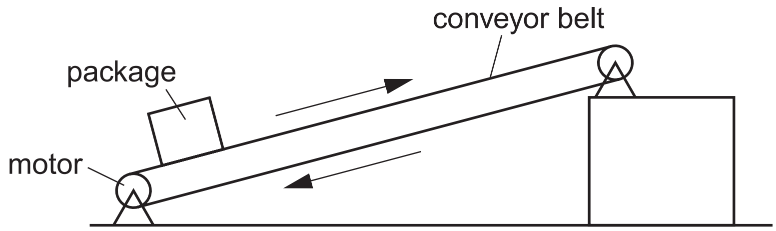

Fig. 2.1

(a) The mass of the package is 36 kg.

Calculate the increase in the gravitational potential energy (g.p.e.) of the package when it is raised through a vertical height of 2.4 m.

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

(b) The package is raised through the vertical height of 2.4 m in 4.4 s.

Calculate the power needed to raise the package.

power = ... [2]

(c) The electrical power supplied to the motor is much greater than the answer to **(b)**.

Explain how the principle of conservation of energy applies to this system.

....

....

.... [2]

(d) Assume that the power available to raise packages is constant. A package of mass greater than 36 kg is raised through the same height.

Suggest and explain the effect of this increase in mass on the operation of the conveyer belt.

....

....

....

....

.... [3]

[Total: 9]

3 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.

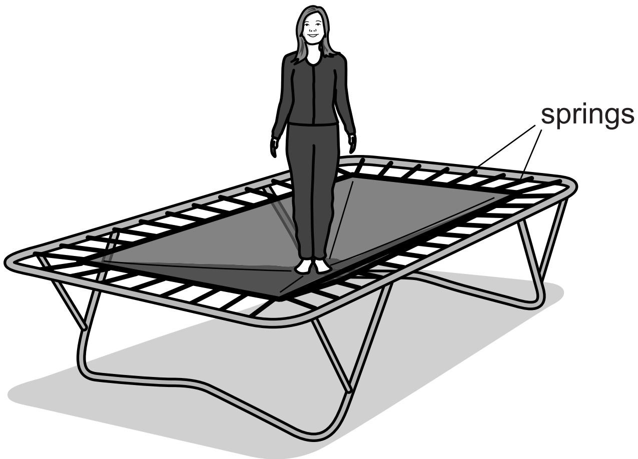

Fig. 3.1

(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]

(c) The trampoline springs are tested. An extension-load graph is plotted for one spring. Fig. 3.2 is the graph.

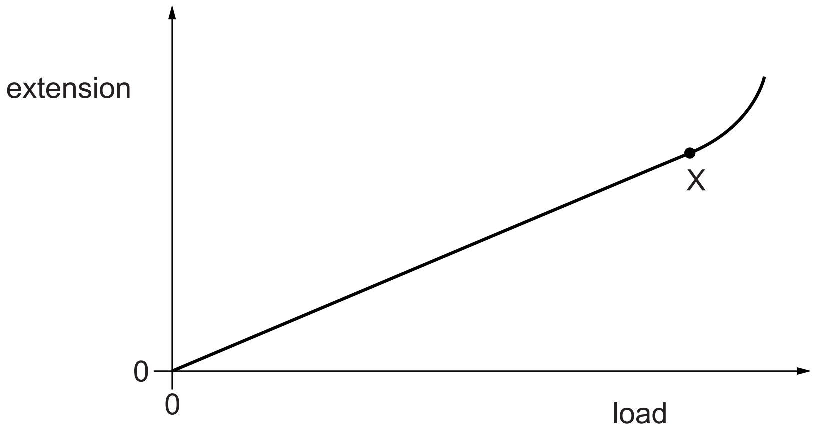

Fig. 3.2

(i) State the name of the point X.

....[1]

(ii) State the name of the law that the spring obeys between the origin of the graph and point X.

....[1]

[Total: 9]

4 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]

5 **(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]

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

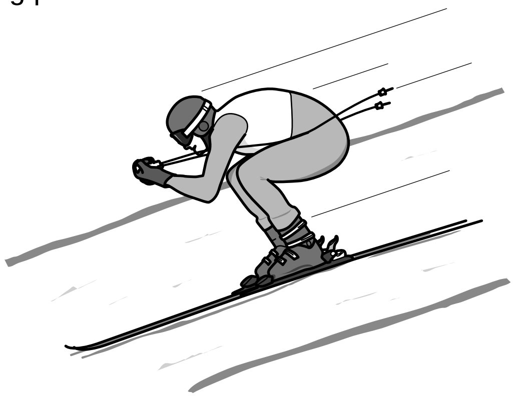

Fig. 3.1

(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]