1 **(a)** Energy from the Sun evaporates water from the sea. Some of this water eventually drives a hydroelectric power station. Give an account of the processes and energy changes involved.

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....

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....

....

....[4]

(b) In a hydroelectric power station, 200 000 kg of water per second fall through a vertical distance of 120 m. The water passes through turbines to generate electricity, and leaves the turbines with a speed of 14 m / s.

(i) Calculate the gravitational potential energy lost by the water in 1 second. Use $g = 10\,\text{m/s}^2$.

potential energy lost = ...[2]

(ii) Calculate the kinetic energy of the water leaving the turbines in 1 second.

kinetic energy = ...[2]

[Total: 8]

2 Fig. 1.1 shows a simple pendulum being used by a student to investigate the energy changes at various points in the pendulum's swing.

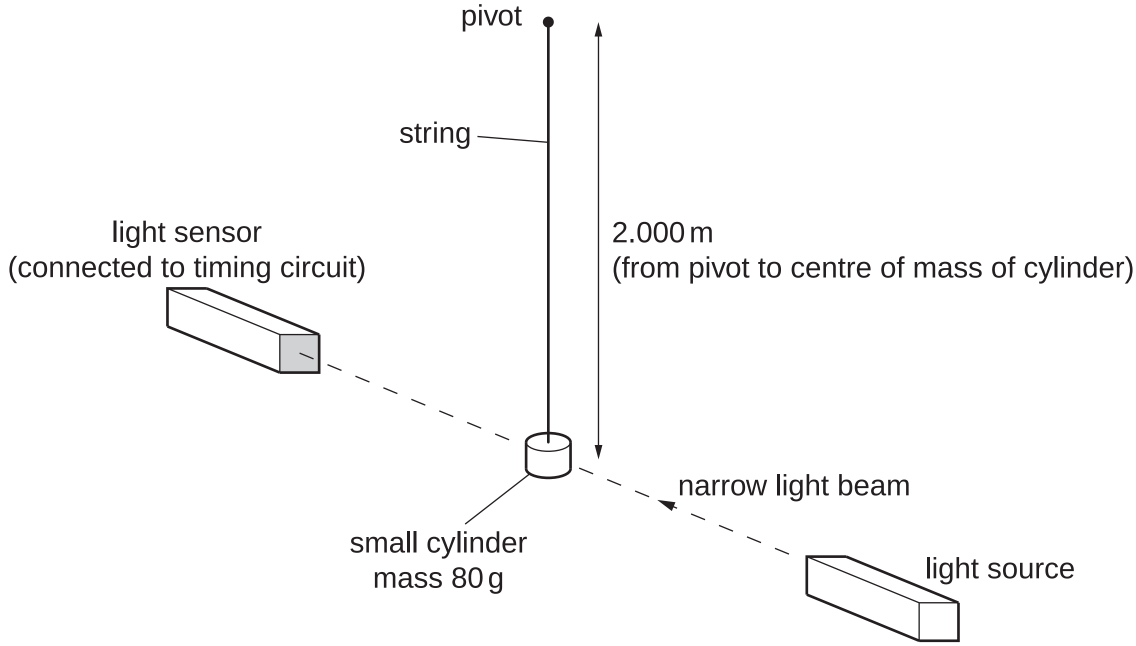

Fig. 1.1

(a) When the string is displaced by a small angle from the vertical, the height of the cylinder changes so that its centre of mass is now 1.932 m below the pivot. Determine the gravitational potential energy gained by the cylinder. Use g = 10 m / s^2.

gravitational potential energy gained = ... [3]

(b) The cylinder is released from the displaced position in **(a)**. Calculate the expected speed of the cylinder when the string is vertical.

expected speed = ... [2]

(c) As the string passes through the vertical, the narrow beam of light is interrupted by the cylinder for 22 ms. The cylinder has a diameter of 2.5 cm.

(i) Calculate the actual speed of the cylinder.

actual speed = ...

(ii) Suggest how the difference between the actual and expected speeds could occur.

....

....

....

....

[3]

[Total: 8]

3 The racing car shown in Fig. 2.1 uses a Kinetic Energy Recovery System (KERS). This system stores within the car some of the kinetic energy lost when the car slows down for a corner. The driver can later release the stored energy when maximum power is required.

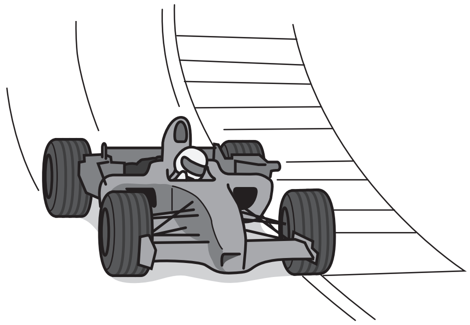

Fig. 2.1

(a) The car approaches a corner and decelerates from 82 m / s to 61 m / s in 0.90 s. Calculate the deceleration.

deceleration = ... [2]

(b) **(i)** The energy lost during the braking in **(a)** is 8.4×10^5 J. 40% of this lost energy is directed to the KERS system. Determine the amount of energy stored.

energy stored = ...

(ii) The driver later uses all of this stored energy to give 60 kW of useful extra power for 3.0 s. Calculate the energy released.

energy released = ...

(iii) Calculate the efficiency of the KERS system.

efficiency = ...
[4]

(c) Suggest a possible device to store energy when a moving vehicle slows down. For this device, state the change that occurs as more energy is stored.

device ....

change ....

....

.... [2]

[Total: 8]

4 Two workmen are employed on a building project, as shown in Fig. 5.1.

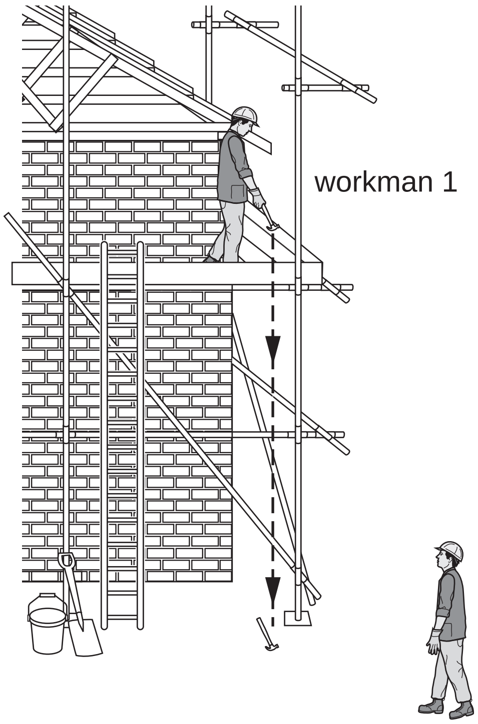

Fig. 5.1

(a) Workman 1 drops a hammer, which falls to the ground. The hammer has a mass of 2.0 kg, and is dropped from a height of 4.8 m above the ground.

(i) Calculate the change in gravitational potential energy of the hammer when it is dropped.

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

(ii) Describe the energy changes from the time the hammer leaves the hand of workman 1 until it is at rest on the ground.

....

....

....

....[2]

(b) Workman 2 picks up the hammer and takes it back up the ladder to workman 1.

He climbs the first 3.0 m in 5.0 s. His total weight, including the hammer, is 520 N.

(i) Calculate the useful power which his legs are producing.

power = ...[2]

(ii) In fact his body is only 12% efficient when climbing the ladder.

Calculate the rate at which energy stored in his body is being used.

rate = ...[1]

[Total: 7]

5 A car of mass 900 kg is travelling at a steady speed of 30 m/s against a resistive force of 2000 N, as illustrated in Fig. 2.1.

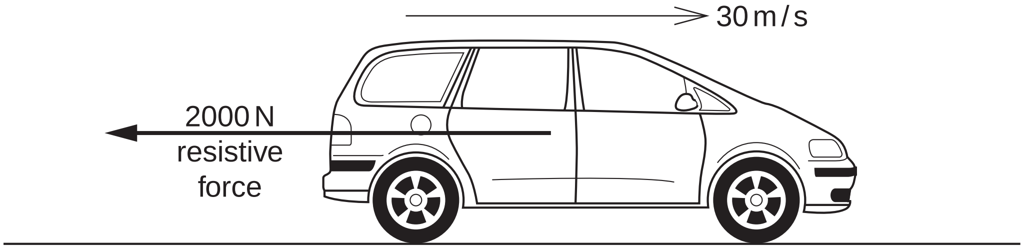

Fig. 2.1

(a) Calculate the kinetic energy of the car.

kinetic energy = ... [2]

(b) Calculate the energy used in 1.0 s against the resistive force.

energy = ... [2]

(c) What is the minimum power that the car engine has to deliver to the wheels?

minimum power = ... [1]

(d) What form of energy is in the fuel, used by the engine to drive the car?

.... [1]

(e) State why the energy in the fuel is converted at a greater rate than you have calculated in **(c)**.

....

.... [1]

[Total: 7]