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

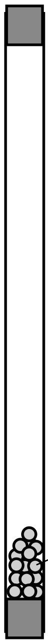

Fig. 3.1

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]

MARKING SCHEME:

(a)	**(i)**	(g.p.e. =) *mgh* **OR** $0.15 \times 10 \times 1.8$ 2.7 J ignore minus sign	C1 A1
	(ii)	(k.e. **OR** 2.7 =) $\frac{1}{2}mv^2$ **OR** $\frac{1}{2} \times 0.15v^2$ (v^2 =) 36 6.0 m / s	C1 C1 A1
(b)	**(i)**	<u>initial</u> temperature (of metal) **OR** <u>final</u> temperature (of metal) **OR** temperature change (of metal)	B1
	(ii)	thermal energy transferred to something specific e.g. air / tube / stopper / thermometer / surroundings / environment **OR** small spheres lost before / after weighing **OR** not all the spheres fall the same distance	B1
	(iii)	higher temperature increase **OR** calculate mean of (100) readings small measurements less accurate owtte	M1 A1

[Total: 9]

2 **(a)** Explain why

(i) metals are good conductors of electricity,

....

....

(ii) insulators do not conduct electricity.

....

....
[3]

(b) The battery of an electric car supplies a current of 96 A at 120 V to the motor which drives the car.

(i) State the useful energy change that takes place in the battery.

....[1]

(ii) Calculate the energy delivered to the motor in 10 minutes.

energy = ... [2]

(iii) The motor operates with an efficiency of 88 %.

Calculate the power output of the motor.

power = ... [2]

[Total: 8]

MARKING SCHEME:

(a)	mark **(i)** and **(ii)** together:	
	mention of free electrons	B1
	(current is) flow/movement of free electrons	B1
	insulators contain no free electrons / metals contain many free electrons	B1
(b) (i)	chemical (energy) to electrical (energy) (**IGNORE** heat)	B1
(ii)	(energy =) VIt **OR** $120 \times 96 \times 10$ (**OR** $\times 60$ **OR** $\times 10 \times 60$) **OR** $11\,520 \times 10$ (**OR** $\times 60$ **OR** $\times 10 \times 60$)	C1
	6.9×10^6 J	A1
(iii)	96×120 **OR** $1.2 / 1.15(2) \times 10^4$ **OR** 12 000 / 11 500 / 11 520	C1
	1.0×10^4 W	A1

[Total: 8]

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

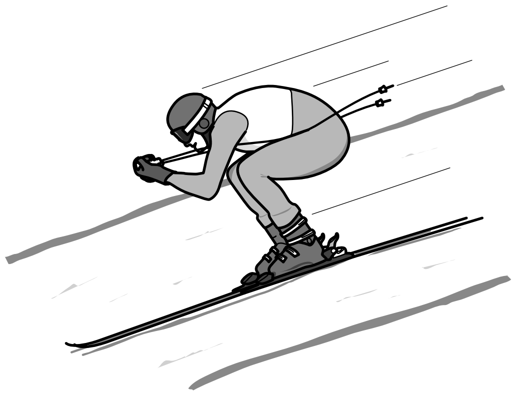

Fig. 3.1

(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]

MARKING SCHEME;

(a)	(g.p.e.=) mgh OR $75 \times 10 \times 880$ $= 6.6 \times 10^5$ J / Nm OR 660 kJ / kNm	C1 A1
(b) **(i)**	(work =) Fs / Fd OR 220×2800 $= 6.2 \times 10^5$ J / Nm OR 620 kJ / kNm	C1 A1
(ii)	answer to **(a)** – answer to **(b)(i)** e.g. (k.e.=) $6.6 \times 10^5 - 6.2 \times 10^5 = 4.0 \times 10^4$ J OR 44 kJ OR $6.6 \times 10^5 - 6.16 \times 10^5 = 4.0 \times 10^4$ J OR 44 kJ	C1 A1
(c)	(to go faster by) reduced air resistance / drag / resistive force OR to lower centre of mass OR increase stability / balance	 B1

[Total: 7]

4 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]

MARKING SCHEME;

(a)	**(i)**	gravitational (potential energy) to kinetic (energy)	B1
	(ii)	kinetic (energy) to elastic / strain (potential energy)	B1
	(iii)	elastic / strain (potential energy) to kinetic (energy)	B1

(b) mgh OR $0.15 \times 10 \times 2.0$ OR 3(.0 J) C1
$\frac{1}{2} mv^2$ OR $v^2 = 2gh$ C1
$v^2 = 2 \times 3.0 / 0.15$ OR 40 C1
6.3(24555) m / s A1

(c) heat / thermal / internal energy lost OR ball / surface gains heat / thermal / internal energy B1

[Total: 8]

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

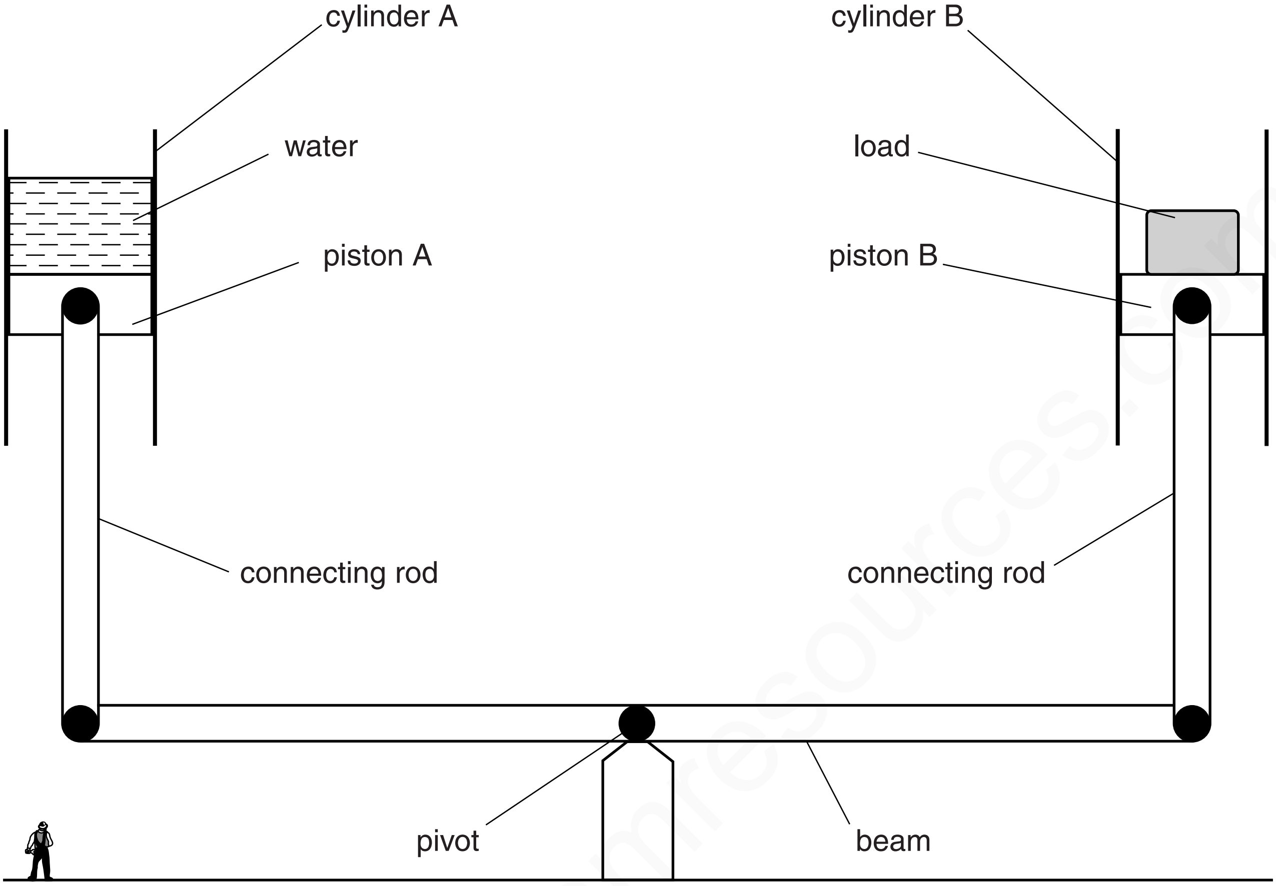

Fig. 3.1 (not to scale)

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]

MARKING SCHEME:

(a)	$W = mg$ in any form OR $(m =)\ W \div g$ OR $80\,000 \div 10$	C1
	8000 kg	A1
(b)	$\rho = m \div V$ in any form OR $(V =)\ m \div \rho$ OR $8000 \div 1000$	C1
	= 8.0 m^3 ecf **(a)**	A1
(c)	mgh OR weight $\times\ h$ OR $8000 \times 10 \times 4$	C1
	= 320 000 J OR 320 kJ ecf **(a)**	A1
(d)	(efficiency =) output (energy) ÷ input (energy) (× 100) OR 96 ÷ 320 (× 100)	C1
	= 0.30 OR 30% ecf **(c)**	A1

[Total: 8]

6 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]

MARKING SCHEME:

(a)		kinetic (energy)	B1
(b)	**(i)**	(work done =) $F \times x$ in any form: words, symbols, numbers	C1
		1.4×10^9 J	A1
	(ii)	work done = kinetic energy OR $\frac{1}{2}mv^2$ seen	C1
		($v^2 =$)$2WD \div m$ OR $2 \times 1.4\,(4) \times 10^9 \div 4.5 \times 10^5$ OR 6400	C1
		80 m / s ecf **(i)**	A1
	(iii)	(work done against) friction / (air) resistance / drag	B1
		ACCEPT energy converted to thermal energy	
(c)		perpendicular (to curved path) OR centripetal OR towards centre (of circle)	B1

[Total: 8]