1 **(a)** State the SI base units of force.

.....[1]

(b) Two wires each of length l are placed parallel to each other a distance x apart, as shown in Fig. 1.1.

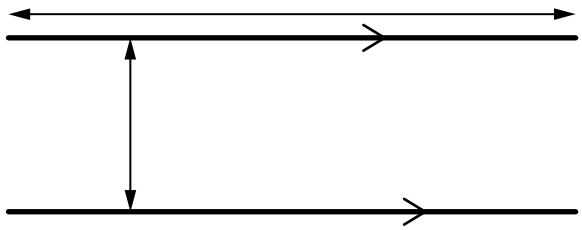

Fig. 1.1

Each wire carries a current I. The currents give rise to a force F on each wire given by

$$F = \frac{KI^2l}{x}$$

where K is a constant.

(i) Determine the SI base units of K.

units of K ..... [2]

(ii) On Fig. 1.2, sketch the variation with x of F. The quantities I and l remain constant.

Fig. 1.2 [2]

(iii) The current I in both of the wires is varied.

On Fig. 1.3, sketch the variation with I of F. The quantities x and l remain constant.

Fig. 1.3 [1]

2 **(a)** A student walks from A to B along the path shown in Fig. 2.1.

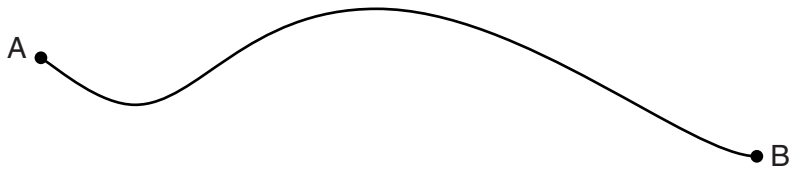

Fig. 2.1

The student takes time *t* to walk from A to B.

(i) State the quantity, apart from *t*, that must be measured in order to determine the average value of

1. speed,

.....

.....[1]

2. velocity.

.....

.....[1]

(ii) Define *acceleration*.

.....[1]

(b) A girl falls vertically onto a trampoline, as shown in Fig. 2.2.

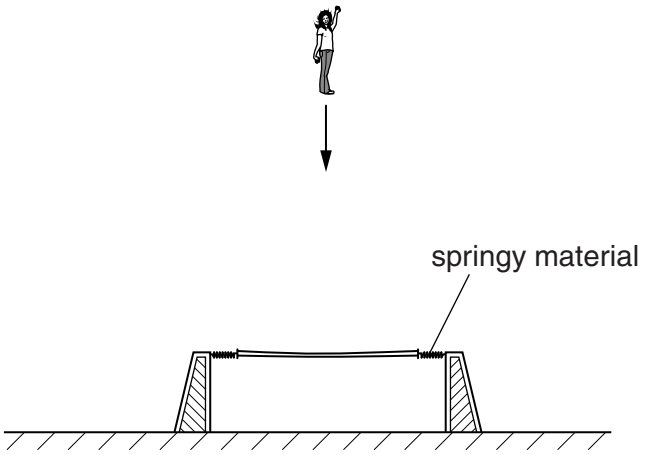

Fig. 2.2

The trampoline consists of a central section supported by springy material. At time $t = 0$ the girl starts to fall. The girl hits the trampoline and rebounds vertically. The variation with time t of velocity v of the girl is illustrated in Fig. 2.3.

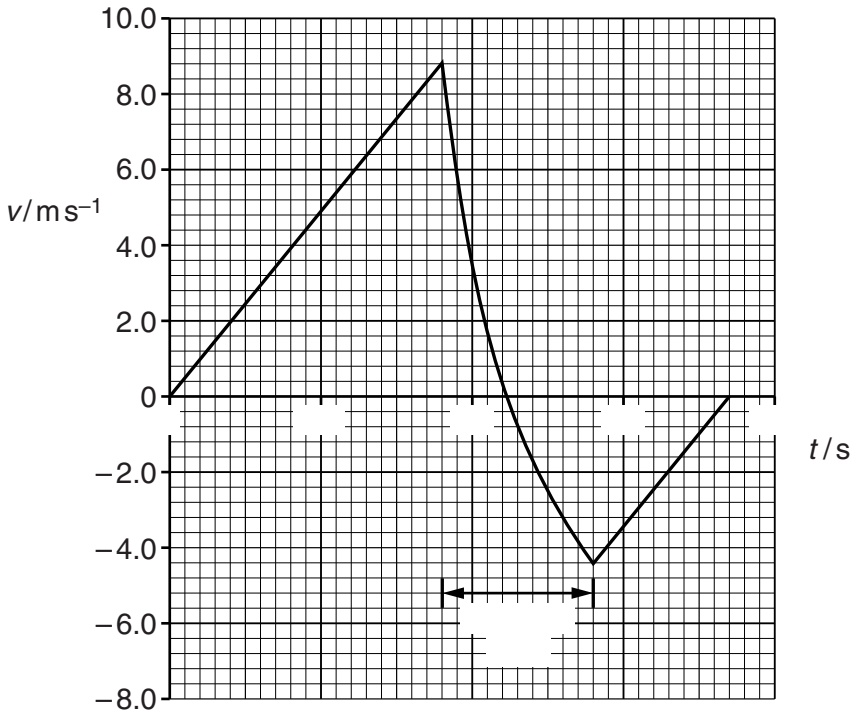

Fig. 2.3

the motion of the girl, calculate

(i) the distance fallen between time $t = 0$ and when she hits the trampoline,

distance = ... m [2]

(ii) the average acceleration during the rebound.

acceleration = ... $m\,s^{-2}$ [2]

(c) (i) Fig. 2.3 to compare, without calculation, the accelerations of the girl before and after the rebound. Explain your answer.

.....

.....

.....[2]

(ii) Fig. 2.3 to compare, without calculation, the potential energy of the girl at $t = 0$ and $t = 1.85\,s$. Explain your answer.

.....

.....

.....[2]

3 **(a)** **(i)** State the principle of conservation of momentum.

.....

.....

.....[2]

(ii) State the difference between an elastic and an inelastic collision.

.....[1]

(b) An object A of mass 4.2 kg and horizontal velocity 3.6 m s^{-1} moves towards object B as shown in Fig. 3.1.

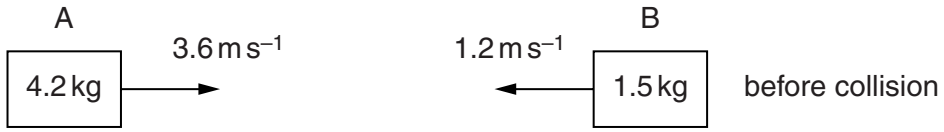

Fig. 3.1

Object B of mass 1.5 kg is moving with a horizontal velocity of 1.2 m s^{-1} towards object A.

The objects collide and then both move to the right, as shown in Fig. 3.2.

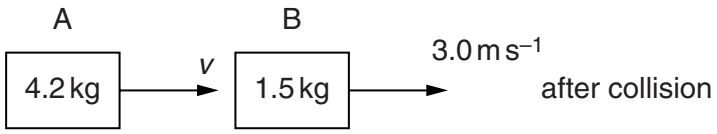

Fig. 3.2

Object A has velocity *v* and object B has velocity 3.0 m s^{-1}.

(i) Calculate the velocity *v* of object A after the collision.

velocity = ... m s^{-1} [3]

(ii) Determine whether the collision is elastic or inelastic.

[3]

4 **(a)** Define

(i) stress,

.....[1]

(ii) strain.

.....[1]

(b) The Young modulus of the metal of a wire is 0.17 TPa. The cross-sectional area of the wire is 0.18 mm^2.

The wire is extended by a force *F*. This causes the length of the wire to be increased by 0.095 %.

Calculate

(i) the stress,

stress = ... Pa [4]

(ii) the force *F*.

F = ... N [2]

5 **(a)** Explain the principle of superposition.

.....

.....

.....[2]

(b) Sound waves travel from a source S to a point X along two paths SX and SPX, as shown in Fig. 5.1.

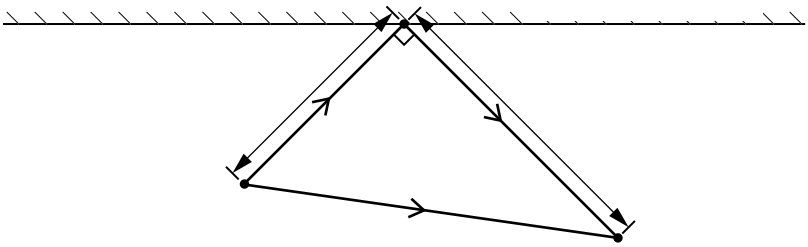

Fig. 5.1

(i) State the phase difference between these waves at X for this to be the position of

1. a minimum,

phase difference = ... unit .....[1]

2. a maximum.

phase difference = ... unit .....[1]

(ii) The frequency of the sound from S is 400 Hz and the speed of sound is 320 m s^{-1}. Calculate the wavelength of the sound waves.

wavelength = ... m [2]

(iii) The distance SP is 3.0 m and the distance PX is 4.0 m. The angle SPX is 90°. Suggest whether a maximum or a minimum is detected at point X. Explain your answer.

.....

.....[2]

6 **(a)** Define *potential difference* (p.d.).

.....[1]

(b) A battery of electromotive force 20 V and zero internal resistance is connected in series with two resistors R_1 and R_2, as shown in Fig. 6.1.

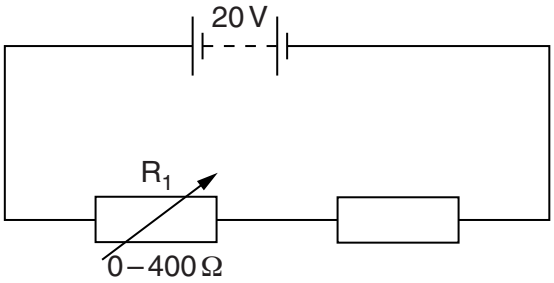

Fig. 6.1

The resistance of R_2 is 600 Ω. The resistance of R_1 is varied from 0 to 400 Ω.

Calculate

(i) the maximum p.d. across R_2,

maximum p.d. = ... V [1]

(ii) the minimum p.d. across R_2.

minimum p.d. = ... V [2]

7 **(a)** Two isotopes of uranium are uranium-235 ($^{235}_{92}U$) and uranium-238 ($^{238}_{92}U$).

(i) Describe in detail an atom of uranium-235.

.....

.....

.....

.....

.....[4]

(ii) With reference to the two forms of uranium, explain the term *isotopes*.

.....

.....

.....[2]

(b) When a uranium-235 nucleus absorbs a neutron, the following reaction may occur:

$$^{235}_{92}U + {}^{W}_{X}n \rightarrow {}^{148}_{57}La + {}^{Z}_{Y}Q + 3{}^{W}_{X}n$$

(i) Determine the values of Y and Z.

$Y =$ .....

$Z =$ .....

[2]

(ii) Explain why the sum of the masses of the uranium nucleus and of the neutron does not equal the total mass of the products of the reaction.

.....

.....

..... [2]