1 Fig. 7.1 shows the driving force acting on a car of mass 1200 kg travelling at a constant speed of 18 m/s.

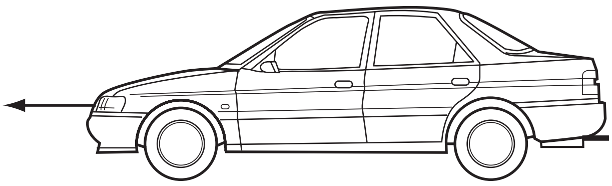


Fig. 7.1

(a) Calculate the amount of work done by the driving force in one minute.

Show your working.

.... [2]

(b) The car when travelling at 18 m/s is stopped using a braking force of 10 000 N.

(i) Calculate the deceleration of the car.

State the formula that you use and show your working.

formula used

working

.... [2]

(ii) Calculate the time needed for the car to stop.

State the formula that you use and show your working.

formula used

working

.... [2]

(c) Fig. 7.2 shows a car on a hydraulic lift in a garage. The total weight being lifted is 18 000 N. The lift uses four large pistons. Each large piston has an area of $0.03\,m^2$. The smaller piston **X** has an area of $0.01\,m^2$.

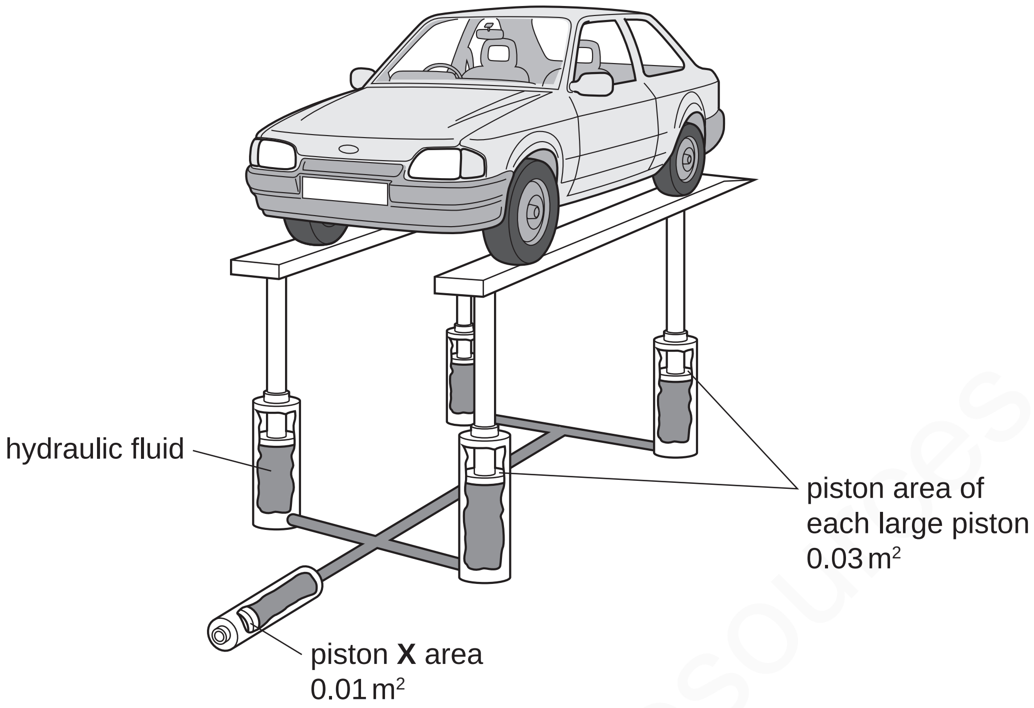


Fig. 7.2

(i) Calculate the total area of the four large pistons.

.... [1]

(ii) Use the formula

pressure = force / area

to calculate the pressure in the hydraulic fluid used in the lift.

Show your working.

.... [1]

(iii) This pressure is caused by piston **X**.

Calculate the minimum force which piston **X** must exert to lift the car.

Show your working.

.... [1]

MARKING SCHEME

(a) (distance covered in one minute =) 18 × 60 = 1080 m ;
(work = **F** × **d** =) 1000 × 1080 = 1 080 000 J ; ecf [2]

(b) **(i)** force = mass × acceleration / (acceleration =) force / mass ;
acceleration = 10 000 / 1200 = 8.3 m / s^2 ; [2]

(ii) acceleration = (change in) speed / time ;
time = 18/8.3 = 2.17 s ; ecf [or 2.2 s, A 2.16 s] [2]

(c) **(i)** 0.12 m^2 ; [1]

(ii) (pressure = force / area =) 18000 / 0.12 = 150 000 N / m^2 / Pa ; ecf [1]

(iii) (force =) 150 000 × 0.01 = 1 500 N ; ecf [1]

[Total: 9]

2 **(a)** An aircraft has a mass of 400 000 kg. It has four engines each capable of producing a maximum force of 300 000 N.

Calculate the maximum acceleration of the aircraft.

State the formula that you use and show your working.

formula used

working

.... [3]

MARKING SCHEME

(a) force = mass × acceleration ;
acceleration = 1 200 000 / 400 000 ;
= 3 m / s^2 ; [3]

3 **(a)** Fig. 4.1 shows a car travelling from left to right.

Two horizontal forces affect its motion. These are the forward driving force and air resistance.

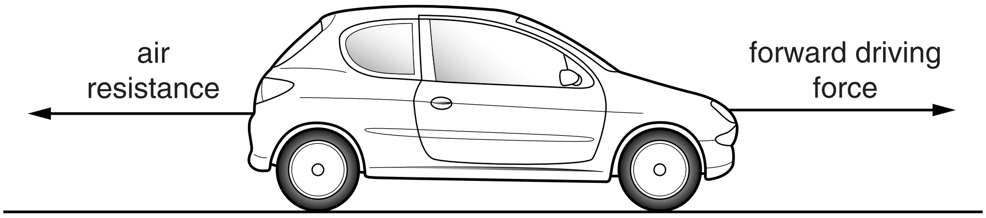


Fig. 4.1

(i) The car is accelerating.

Tick one of the boxes to show which of the following statements is correct.

The driving force is greater than the air resistance. ☐

The driving force is equal to the air resistance. ☐

The driving force is less than the air resistance. ☐

Explain your answer.

....

....[1]

(ii) The car accelerates from 16 m/s to 30 m/s in 4 seconds.

The mass of the car is 1200 kg.

Calculate the force required to produce this acceleration.

State the formula that you use and show your working.

formula used

working

force = ... N [3]

MARKING SCHEME

(a) **(i)** *(positive acceleration: driving force is greater than air resistance* ***OR*** *negative acceleration: driving force is less than air resistance)*
there is a resultant / net force / sum of forces is not zero ; [1]

(ii) (force =) mass × acceleration ;
acceleration = 3.5 (m/s^2) ;
= 1200 × (3.5) = 4200 (N) ; [3]

4 **(a)** Fig. 12.1 shows two forces acting on a swimmer as he swims in a swimming pool.

Fig. 12.1

(i) State the size **and** direction of the resultant force.

size ....

direction ....
[2]

(ii) State how the speed of the swimmer is changing.

Explain your answer.

....

....

.... [2]

(b) The swimmer starts a race when he hears the starting sound from a loudspeaker.

(i) The sound waves travel through the air.

Fig. 12.2 represents a sound wave travelling through the air.

The sound wave travels by a series of compressions **(C)** and rarefactions **(R)**.

Fig. 12.2

Use Fig. 12.2 to describe **one** difference between a region of compression and a region of rarefaction.

....

....

.... [1]

(ii) Water waves are transverse waves. Sound waves are longitudinal waves.

Describe the difference between a transverse wave and a longitudinal wave.

You may draw a labelled diagram if it helps your answer.

....

....

....

.... [2]

(c) There are submerged lamps in the pool. Fig. 12.3 shows two light rays from one of these lamps.

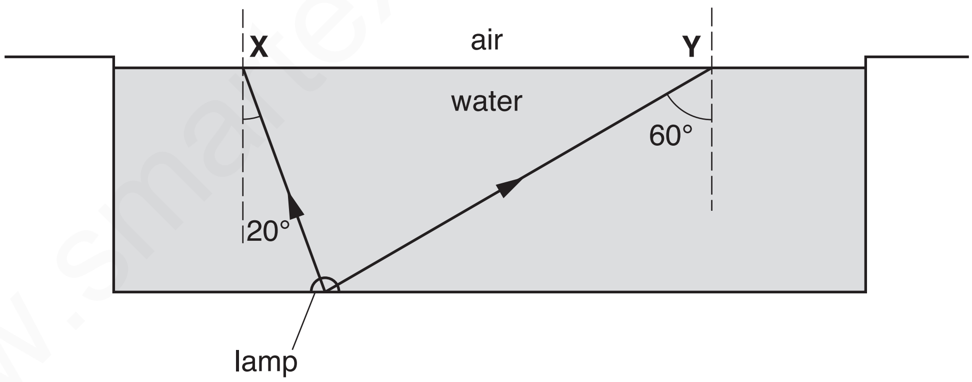


Fig. 12.3

The critical angle for the boundary between water and air is 48°.

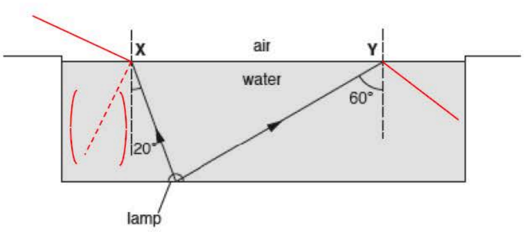
On Fig. 12.3, complete the paths of the two rays after they reach the surface at **X** and **Y**. Explain your answer.

....

....

.... [3]

MARKING SCHEME

(a)(i)	20 N ; forwards / to the right ;	2
(a)(ii)	the swimmers speed increases/ acceleration ; resultant force/ unbalanced force, to right / in direction of movement, /driving force > frictional force ;	2
(b)(i)	compressions are regions where the particles in air are close together / rarefactions are regions where the particles in air are spread out ; compressions are regions with air at high pressure / rarefactions are regions with air at low pressure ;	max 1
(b)(ii)	transverse waves oscillate at right angles to direction of wave/energy transfer ; longitudinal waves oscillate parallel to direction of wave/energy transfer ;	2
(c)	at Y reflection only is shown ; at X refraction (and reflection) is shown ; total internal reflection occurs when angle of incidence exceeds critical angle / angle of incidence = angle of reflection / refraction away from normal when ray travels from denser to less dense medium ; 	3

5 **(a)** A cyclist accelerates along a straight road from a speed of 4 m/s to maximum speed.

The combined mass of the cyclist and bicycle is 80 kg.

Fig. 12.1 is the speed-time graph for the bicycle and cyclist.

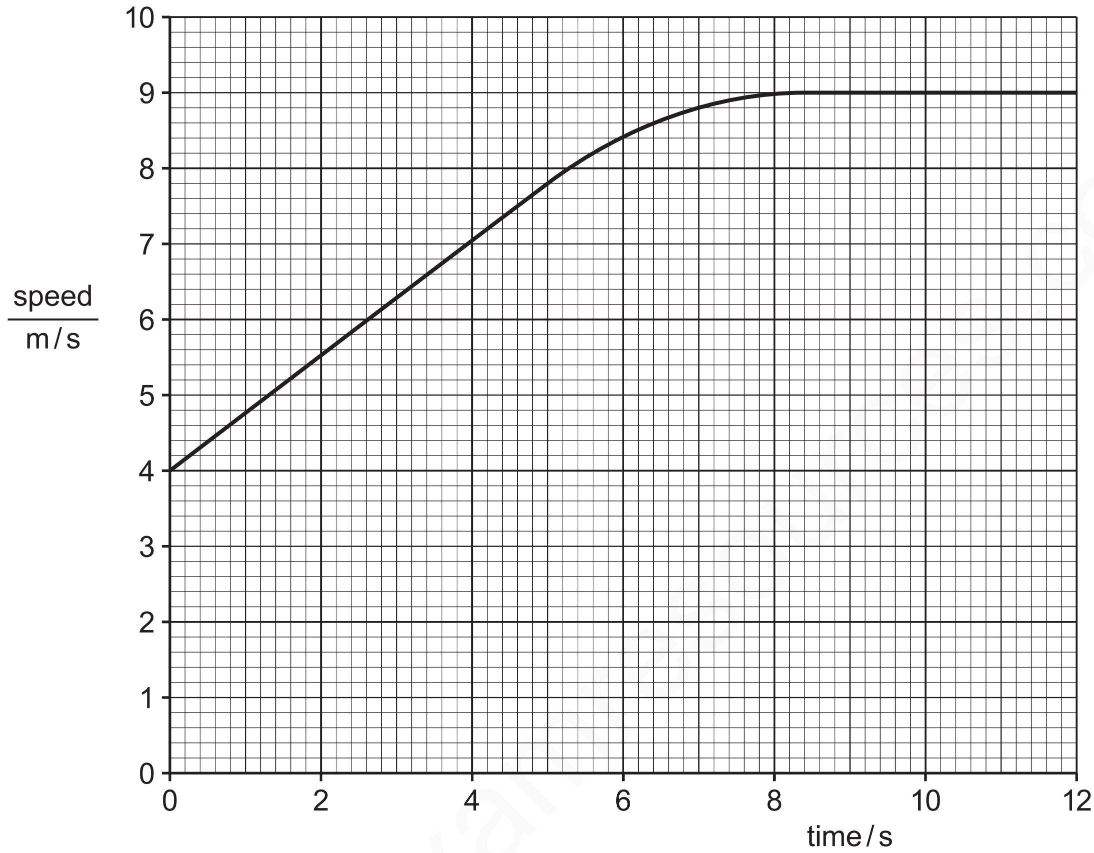


Fig. 12.1

(i) Use Fig. 12.1 to calculate the acceleration at 2 s.

Show your working.

acceleration = ... m/s^2 [2]

(ii) Calculate the resultant force acting on the cyclist and bicycle during this acceleration.

force = ... N [2]

(iii) Calculate the maximum kinetic energy of the cyclist and bicycle during the 12 second period in Fig. 12.1.

kinetic energy = ... J [3]

(b) Fig. 12.2 shows a section through a plastic reflector on the bicycle. A ray of light from a car is incident on the flat surface of the reflector.

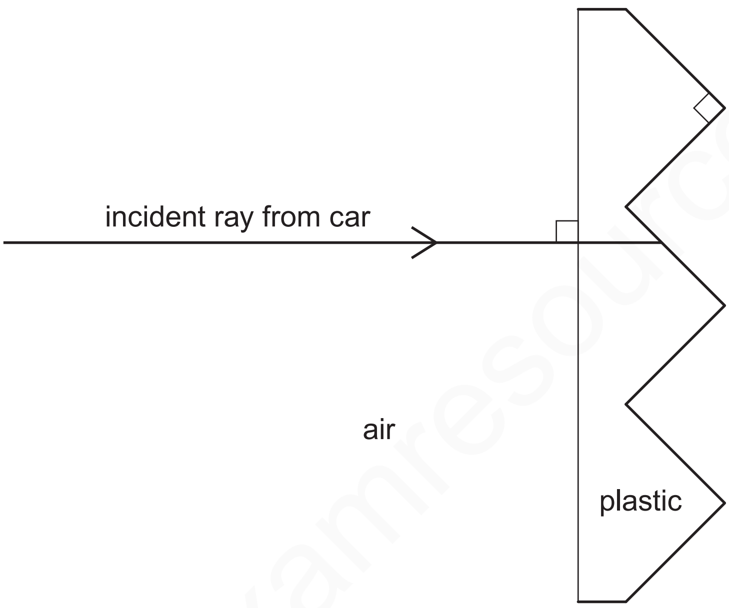


Fig. 12.2

The incident ray is totally internally reflected.

Continue the incident ray on Fig. 12.2 to show the path of the ray of light until it leaves the reflector. [2]

(c) Fig. 12.3 shows a metal nut on the bicycle wheel.

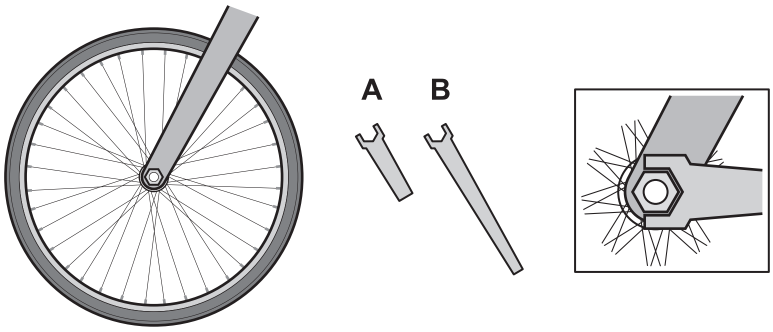


Fig. 12.3

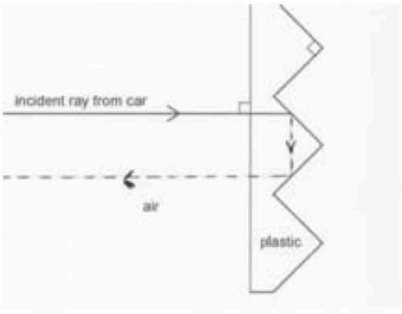
The nut must be turned by either spanner **A** or spanner **B**.

State why spanner **B** will turn the nut more easily than spanner **A**.

.... [1]

[Total: 10]

MARKING SCHEME

(a)(i)	change of speed or correct substitution (e.g. 1.55/2); 0.775 (m/s^2);	2
(a)(ii)	F = ma or 80 × 0.775; 62 (N);	2
(a)(iii)	max speed = 9 m/s; KE = ½mv^2 or ½ × 80 × 9 × 9; 3240 (J);	3
(b)	 reflection only shown at first reflection; after second reflection ray emerges parallel to incident ray;	2
12(c)	spanner **B** is longer / gives a bigger, moment / turning force ;	1