Q1. When two objects interact, they exert forces on each other.

(a) Which statement about the forces is correct?

Tick (✓) **one** box.

	Tick (✓)
The forces are equal in size and act in the same direction.	
The forces are unequal in size and act in the same direction.	
The forces are equal in size and act in opposite directions.	
The forces are unequal in size and act in opposite directions.	

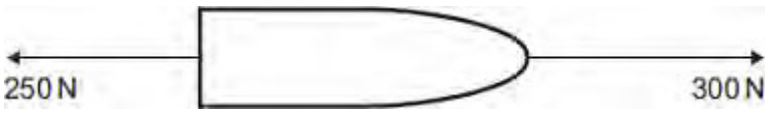
(1)

(b) A fisherman pulls a boat towards land.

The forces acting on the boat are shown in **Diagram 1**.

The fisherman exerts a force of 300 N on the boat.
The sea exerts a resistive force of 250 N on the boat.

Diagram 1



(i) Describe the motion of the boat.

.....

.....

.....

.....

(2)

(ii) When the boat reaches land, the resistive force increases to 300 N.
The fisherman continues to exert a force of 300 N.

Describe the motion of the boat.

Tick (✓) **one** box.

Accelerating to the right	☐
Constant velocity to the right	☐
Stationary	☐

(1)

(iii) Explain your answer to part **(b)(ii)**.

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(2)

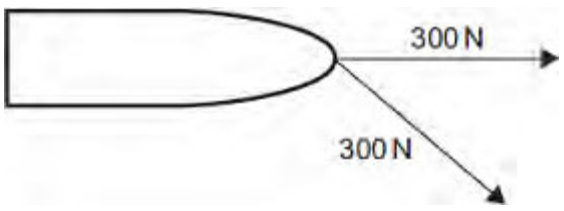
(iv) Another fisherman comes to help pull the boat. Each fisherman pulls with a force of 300 N, as shown in **Diagram 2**.

Diagram 2 is drawn to scale.

Add to **Diagram 2** to show the single force that has the same effect as the two 300 N forces.

Determine the value of this resultant force.

Diagram 2

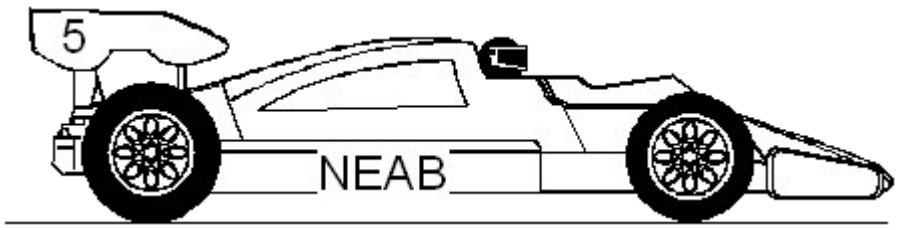


Resultant force = ... N

(4)

(Total 10 marks)

Q2. A racing driver is driving his car along a **straight** and **level** road as shown in the diagram below.



(a) The driver pushes the accelerator pedal as far down as possible. The car does not accelerate above a certain maximum speed. Explain the reasons for this in terms of the forces acting on the car.

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(4)

(b) The racing car has a mass of 1250 kg. When the brake pedal is pushed down a constant braking force of 10 000 N is exerted on the car.

(i) Calculate the acceleration of the car.

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.....

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.....

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(ii) Calculate the kinetic energy of the car when it is travelling at a speed of 48 m/s.

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(iii) When the brakes are applied with a constant force of 10 000 N the car travels a distance of 144 m before it stops. Calculate the work done in stopping the car.

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(12)
(Total 16 marks)

Q3. A rollercoaster car stops above a vertical drop. Suddenly it falls under gravity.



The drop is 60 metres high and at the bottom of the drop the car travels at 125 km/h. The acceleration experienced by the people in the car is 10 m/s^2. The mass of the car and its
passengers is 1210 kg.

Calculate the force exerted on the car and its passengers. Show your working.

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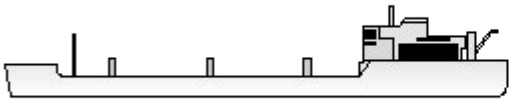
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Force = ... N

(Total 3 marks)

Q4. The table contains typical data for an oil tanker.



Mass	56 000 000 kg
Cruising speed	12 m/s
Deceleration force	392 000 N
Stopping distance	10 000 m

(i) Write down the equation which links acceleration, force and mass.

.....

(1)

(ii) Calculate the deceleration of the oil tanker. Show clearly how you work out your answer.

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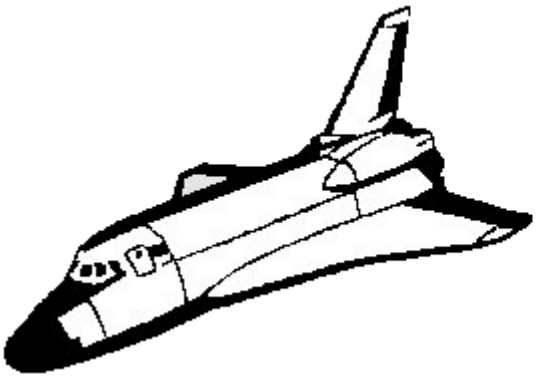
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Deceleration = ... m/s^2

(2)

(Total 3 marks)

Q5. The diagram shows an orbiter, the reusable part of a space shuttle. The data refers to a typical flight.



Orbiter data	
Mass	78 000 kg
Orbital speed	7.5 km/s
Orbital altitude	200 km
Landing speed	100 m/s
Flight time	7 days

(a) (i) What name is given to the force which keeps the orbiter in orbit around the Earth?

.....

(1)

(ii) Use the following equation to calculate the kinetic energy, in joules, of the orbiter while it is in orbit.

kinetic energy = ½ mv^2

.....

.....

Kinetic energy = ... joules

(2)

(iii) What happens to most of this kinetic energy as the orbiter re-enters the Earth's atmosphere?

.....

.....

(1)

(b) After touchdown the orbiter decelerates uniformly coming to a halt in 50 s.

(i) Give the equation that links acceleration, time and velocity.

.....

(1)

(ii) Calculate the deceleration of the orbiter. Show clearly how you work out your answer and give the unit.

.....

.....

Deceleration = ...

(2)

(c) (i) Give the equation that links acceleration, force and mass.

.....

(1)

(ii) Calculate, in newtons, the force needed to bring the orbiter to a halt. Show clearly how you work out your answer.

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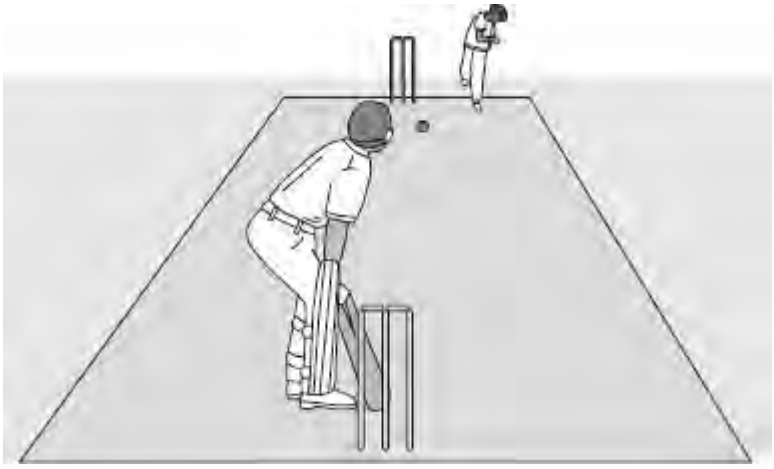
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Force = ... newtons

(1)

(Total 9 marks)

Q6. The picture shows players in a cricket match.



(a) A fast bowler bowls the ball at 35 m/s. The ball has a mass of 0.16 kg.

Use the equation in the box to calculate the kinetic energy of the cricket ball as it leaves the bowler's hand.

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$$

Show clearly how you work out your answer.

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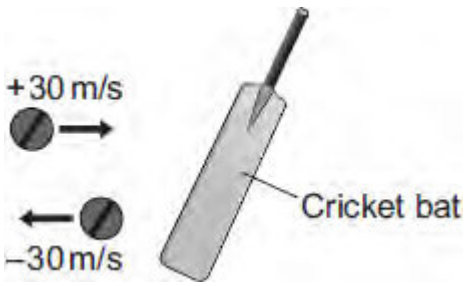
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Kinetic energy = ... J

(2)

(b) When the ball reaches the batsman it is travelling at 30 m/s. The batsman strikes the ball which moves off at 30 m/s in the opposite direction.



(i) Use the equation in the box to calculate the change in momentum of the ball.

momentum = mass × velocity

Show clearly how you work out your answer.

.....

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Change in momentum = ... kg m/s

(2)

(ii) The ball is in contact with the bat for 0.001 s.

Use the equation in the box to calculate the force exerted by the bat on the ball.

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken for the change}}$$

Show clearly how you work out your answer.

.....

.....

Force = ... N

(1)

(c) A fielder, as he catches a cricket ball, pulls his hands backwards.

Explain why this action reduces the force on his hands.

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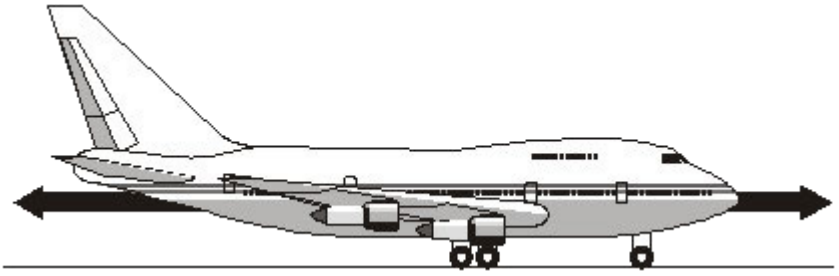
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(2)

(Total 7 marks)

Q7. (a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The *resultant force* on the aircraft is zero.



(i) What is meant by the term *resultant force*?

.....

.....

(1)

(ii) Describe the movement of the aircraft when the resultant force is zero.

.....

.....

(1)

(b) The aircraft has a take-off mass of 320 000 kg. Each of the 4 engines can produce a maximum force of 240 kN.

Calculate the maximum acceleration of the aircraft.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Acceleration = ...

(3)

(c) As the aircraft moves along the runway to take off, its acceleration decreases even though the force from the engines is constant.

Explain why.

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(2)
(Total 7 marks)