1. The manufacturer of a family car gave the following information.

Mass of car 950 kg.

The car will accelerate from 0 to 33 m/s in 11 seconds.

(a) Calculate the acceleration of the car during the 11 seconds

.....

.....

Answer .....

(2)

(b) Calculate the force needed to produce this acceleration.

.....

.....

.....

(3)

(c) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

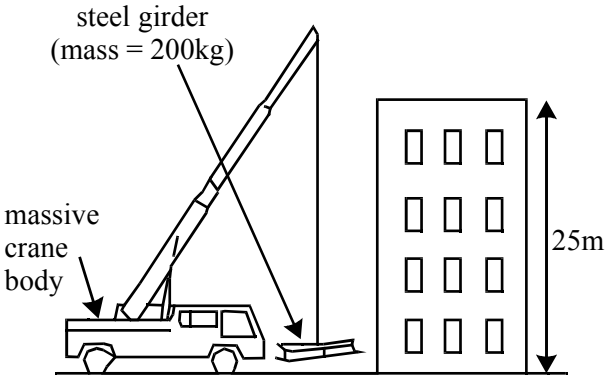
.....

.....

.....

(3)
(Total 8 marks)

2. A crane is used to lift a steel girder to the top of a high building.



When it is lifted by the crane:

- the girder accelerates from rest to a speed of 0.6 m/s in the first 3 seconds;
- it then rises at a steady speed.

(a) Calculate the **acceleration** of the girder.

(Show your working.)

.....

.....

.....

.....

(3)

(b) (i) What is the **weight** of the steel girder?

Answer ..... N

(1)

(ii) Calculate the **power** of the crane motor as it lifts the girder at a steady speed of 0.6 m/s.

(*Show your working. You can ignore the weight of the cable and hook which is small compared to the weight of the girder.*)

.....

.....

.....

Answer ..... W

(2)

(c) A new motor is fitted to the crane. This motor accelerates the girder at 0.3 m/s^2.

Calculate the **force** which the crane applies to the girder to produce this acceleration.

(Show your working.)

.....

.....

.....

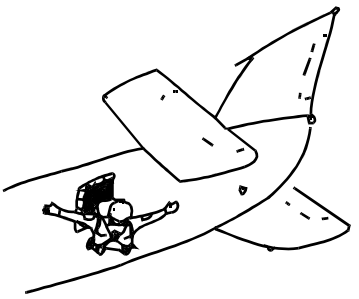
Answer ..... N

(3)
(Total 9 marks)

3. A sky-diver steps out of an aeroplane.

After 10 seconds she is falling at a steady speed of 50m/s.

She then opens her parachute.



After another 5 seconds she is once again falling at a steady speed.

This speed is now only 10m/s.

(a) Calculate the sky-diver's average acceleration during the time from when she opens her parachute until she reaches her slower steady speed. (Show your working.)

.....

.....

.....

(3)

(b) Explain, as fully as you can:

(i) why the sky-diver eventually reaches a steady speed (with or without her parachute).

.....

.....

.....

.....

(3)

(ii) why the sky-diver's steady speed is lower when her parachute is open.

.....

(1)

(c) The sky-diver and her equipment have a total mass of 75kg. Calculate the gravitational force acting on this mass. (Show your working.)

.....

.....

Answer ..... N

(1)
(Total 8 marks)

4. (a) The amount of damage caused when a car collides with a wall depends on the amount of energy transferred.

If the speed of a car **doubles**, the amount of energy transferred in a collision increases **four** times.

Explain, as fully as you can, why this is so.

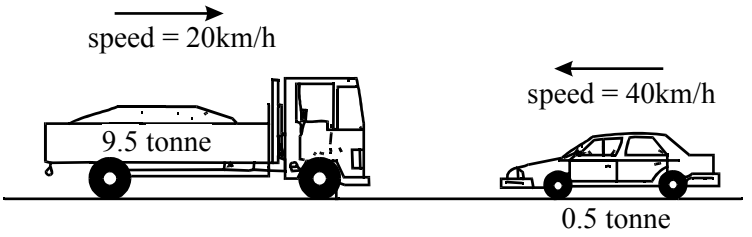
.....

.....

.....

(3)

(b) The diagram shows a car and a lorry about to collide.



When they collide, the two vehicles become tightly locked together.

(i) Calculate the speed of the vehicles immediately after the collision.

(Show your working. There is no need to change to standard units.)

.....

.....

.....

.....

.....

Answer ..... km/h

(6)

(ii) The collision between the car and the lorry is inelastic.

Explain, in terms of energy, what this means.

.....

(1)
(Total 10 marks)

5. A cyclist accelerates from a set of traffic lights.

The driving force of the back tyre on the ground is 250 N.

(a) How much work is done by this force when the cyclist travels 5 metres?
(Show your working.)

.....

.....

.....

Answer ..... joules (J)

(2)

(b) What happens to the energy transferred by this force?

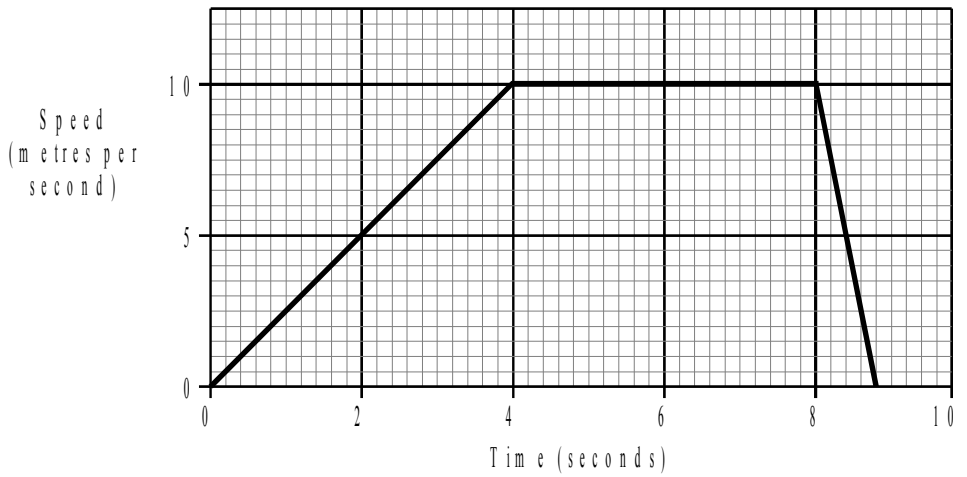
.....

.....

.....

(2)
(Total 4 marks)

6. The graph shows the speed of a runner during an indoor 60 metres race.



(a) Calculate the acceleration of the runner during the first four seconds.
(Show your working.)

.....

.....

.....

(3)

(b) How far does the runner travel during the first four seconds?
(Show your working.)

.....

.....

.....

(3)

(c) At the finish, a thick wall of rubber foam slows the runner down at a rate of 25 m/s^2.
The runner has a mass of 75kg.
Calculate the average force of the rubber foam on the runner.
(Show your working.)

.....

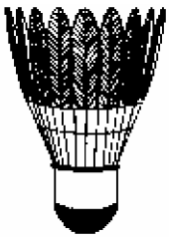
.....

.....

Answer ..... newtons (N)

(2)
(Total 8 marks)

7. The diagram shows a shuttlecock that is used for playing badminton.



The shuttlecock weighs very little.
When you drop it from a height of a few metres, it accelerates at first but soon reaches a steady speed.

Explain, as fully as you can:

(a) why the shuttlecock accelerates at first,

.....

.....

.....

(2)

(b) why the shuttlecock reaches a steady speed.

.....

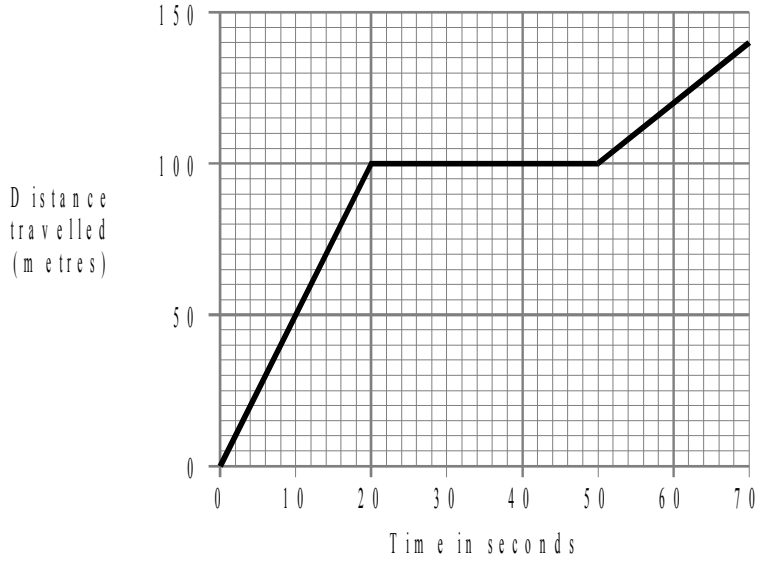
.....

.....

.....

(3)
(Total 5 marks)

8. A child goes out to visit a friend.
The graph shows the child's journey.



(a) Calculate the child's average speed for the whole journey.
[Show your working and give the units in your answer.]

.....

.....

(3)

(b) How many times faster is the child travelling in part A of the graph than in part C? [You should show how you obtained your answer.]

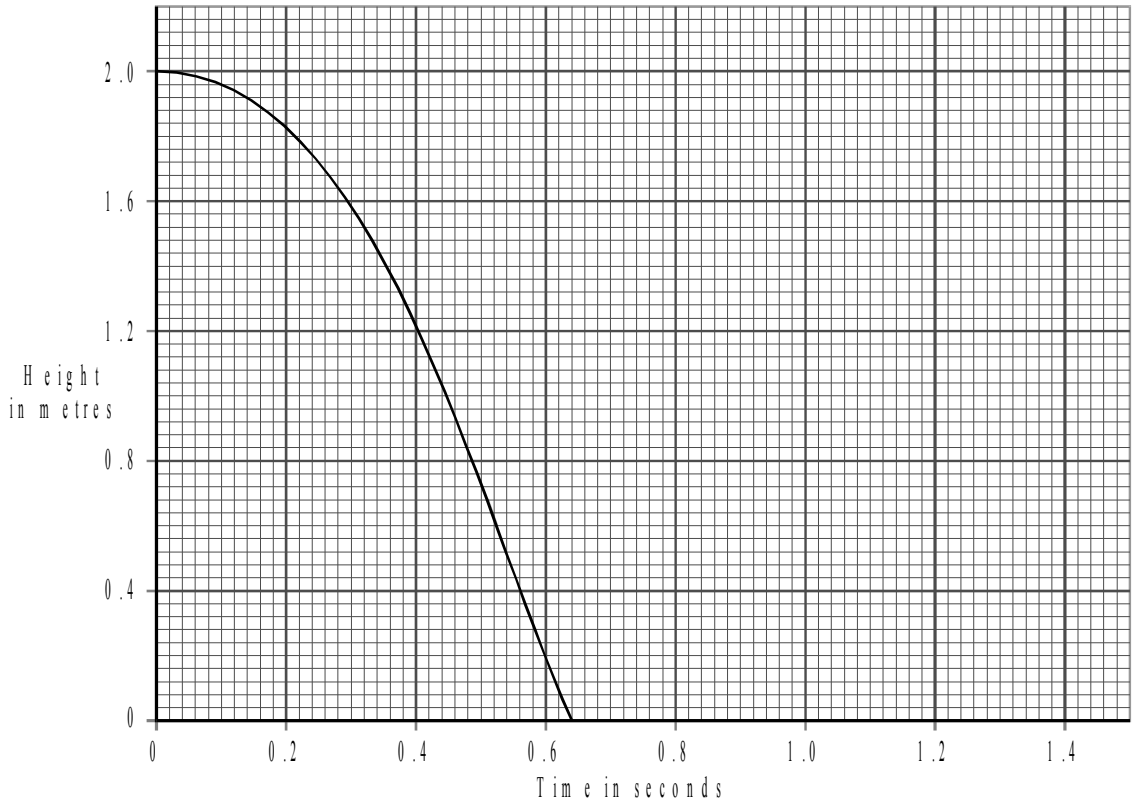
.....

.....

.....

(2)
(Total 5 marks)

9. A bouncy ball is dropped vertically from a height of 2.00 m onto the floor. The graph shows the height of the ball above the floor at different times during its fall until it hits the floor after 0.64 s.



(a) What is the average speed of the ball over the first 0.64 s? Show clearly how you work out your answer.

.....

.....

Average speed = ... m/s

(1)

(b) After it hits the floor the ball bounces back to a height of 1.25 m. It reaches this height 1. 16 s after it was dropped. Plot this point on the grid above and sketch a graph to show the height of the ball above the floor between 0. 64 s and 1.16 s.

(3)

(c) (i) The ball bounces on the floor 0.64 s after being dropped. How long after being dropped will it be before it bounces a second time?

.....

.....

(1)

(ii) What distance will the ball travel between its first and second bounce?

.....

.....

(1)

(d) The ball was held stationary before being dropped. On the graph and your sketch mark **two** other points $\mathbf{X_1}$ and $\mathbf{X_2}$, where the ball is stationary, and in each case explain why the ball is not moving.

$\mathbf{X_1}$ .....

.....

$\mathbf{X_2}$ .....

.....

(2)
(Total 8 marks)

10. Mira and Susan are rock climbing. They are using a nylon climbing rope. Mira has fastened herself to the rock face and to one end of the rope. The other end of the rope is fastened to Susan. This means that, if Susan falls, the rope will hold her. Susan weighs 540 N.

(a) (i) Use the words *distance*, *force* and *work* to write an equation which shows the relationship between them

.....

(1)

(ii) What vertical distance up the rock face does Susan climb when she does 2000 J of work against gravity? Show your working and give your answer to the nearest 0.1 m.

.....

.....

Distance = ... metres

(2)

(iii) How much gravitational energy will Susan gain when she does 2000 J of work against gravity?

.....

(1)

(b) The climbers dislodge a 3 kg stone which falls down the rock face.

What is the speed of the stone when its kinetic energy is 600 J?

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

Show clearly how you get to your answer and give the unit.

.....

.....

.....

Speed = ...

(3)

(c) The climbing rope is made of nylon. Nylon is very strong. Another advantage is that it stretches. This means that, if Susan falls, it transfers some of her kinetic energy to elastic (or strain) energy at the end of the fall.

Explain, in terms of *force* and *deceleration*, what would happen if Susan fell and the climbing rope did **not** transfer any of her kinetic energy to elastic energy.

.....

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.....

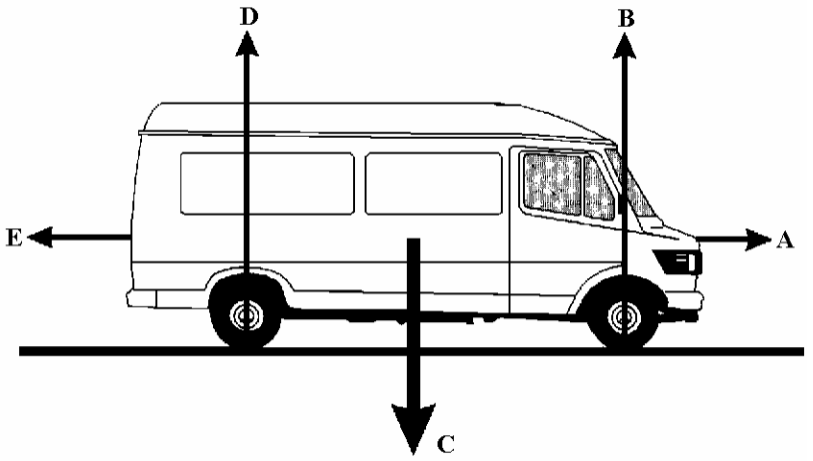
.....

.....

.....

(3)
(Total 10 marks)

11. Five forces, **A, B, C, D** and **E** act on the van.



(a) Complete the following sentences by choosing the correct forces from **A** to **E**.

Force ..... is the forward force from the engine.

Force ..... is the force resisting the van's motion.

(1)

(b) The size of forces **A** and **E** can change.
Complete the table to show how big force **A** is compared to force **E** for each motion of the van.
Do this by placing a tick in the correct box.
The first one has been done for you.

Motion of van	**Force A smaller than force E**	**Force A equal to force E**	**Force A bigger than force E**

Not moving		✓	
Speeding up			
Constant speed			
Slowing down			

(3)

(c) When is force **E** zero?

.....

(1)

(d) The van has a fault and leaks one drop of oil every second.
The diagram below shows the oil drops left on the road as the van moves from **W** to **Z**.

Describe the motion of the van as it moves from:

W to **X** .....

.....

X to Y .....

.....

Y to **Z** .....

.....

(3)

(e) The driver and passengers wear seatbelts.
Seatbelts reduce the risk of injury if the van stops suddenly.

backwards **downwards** **force** **forwards** **mass** **weight**

Complete the following sentences, using words from the list above, to explain why the risk of injury is reduced if the van stops suddenly.

A large ..... is needed to stop the van suddenly.

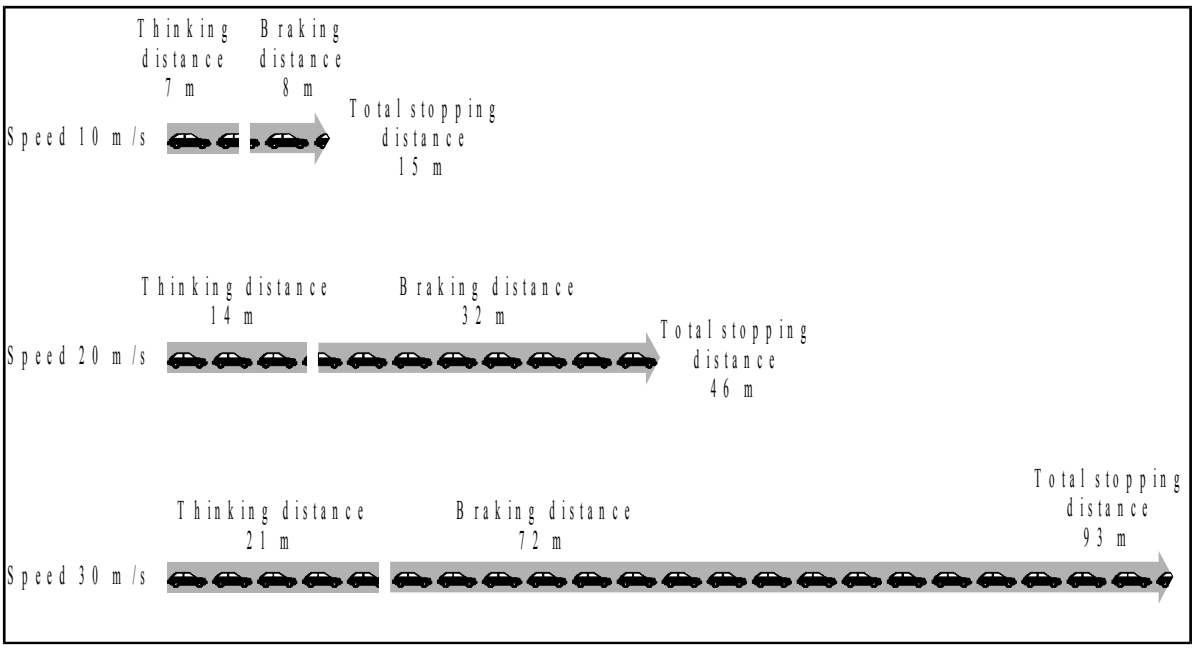
The driver and passengers would continue to move ..... .

The seatbelts supply a ..... force to keep the driver and passengers

in their seats.

(3)
(Total 11 marks)

12. The diagram below shows the thinking distances, braking distances and total stopping distances at different speeds.



(a) Look at the total stopping distances at each speed.

Complete the sentence by choosing the correct words from the box.

distance	force	mass	time

The total stopping distance depends on the distance the car travels during the driver's reaction ..... and under the braking ..... .

(2)

(b) Give **three** other factors that could cause the total stopping distance of a car to be greater. Do **not** give the factors in **Figure 1.**

1 .....

.....

2 .....

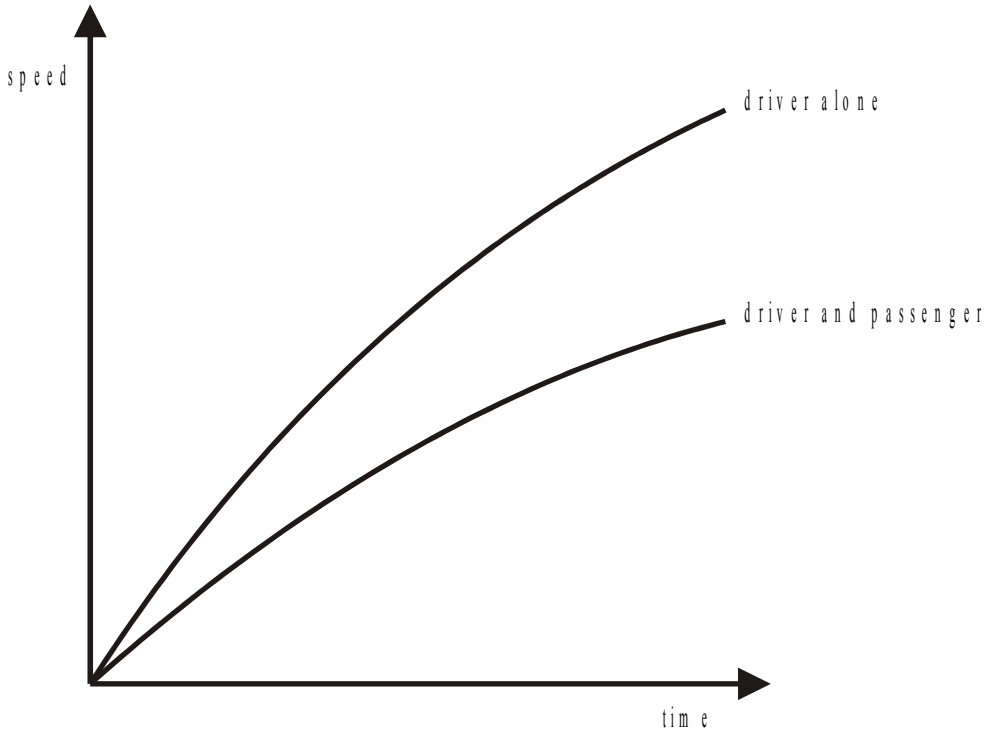
.....

3 .....

.....

(3)
(Total 5 marks)

13. (a) When a car is driven efficiently the engine gives a constant forward pull on the car as the car accelerates to its maximum speed. During this time frictional forces and air resistance oppose the forward motion of the car. The sketch graphs below show how the car's speed increases when only the driver is in the car, and when the driver has a passenger in the car.



(i) How does the acceleration of the car change with time?

.....

.....

(1)

(ii) What conclusion can be made about the resultant (net) forward force on the car as its speed increases?

.....

.....

(1)

(ii) On the graph, draw a line to show how you would expect the car's speed to vary if it carried three passengers.

(1)

(b) The manufacturer of a family car gave the following information.

Mass of car 950g

The car will accelerate from 0 to 33 m/s in 11 seconds.

(i) Calculate the acceleration of the car during the 11 seconds.

.....

.....

.....

Answer .....

(2)

(ii) Calculate the force needed to produce this acceleration.

.....

.....

.....

Answer ..... N

(2)

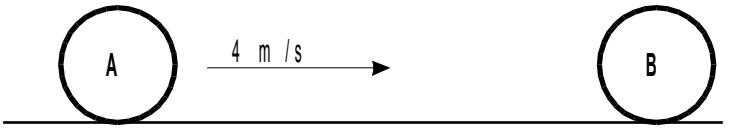
(iii) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

.....

.....

(2)
(Total 9 marks)

14. The diagram below shows two balls on the bowling green. Ball A is moving with a velocity of 4 m/s, and is about to collide with ball B which is stationary. Both balls have a mass of 1.5 kg.



After the collision both balls move to the right but the velocity of A is now 1 m/s.

(a) (i) Calculate the momentum of ball A just before the collision.

.....

Answer ..... kg m/s

(1)

(ii) What is the total momentum of balls A and B after the collision?

.....

.....

Answer ..... kg m/s

(1)

(iii) Calculate the momentum of ball A just after the collision.

.....

Answer ..... kg m/s

(1)

(iv) Calculate the momentum of ball B just after the collision.

.....

Answer ..... kg m/s

(1)

(v) Calculate the velocity of ball B just after the collision.

.....

Answer ..... m/s

(1)

(b) Calculate the loss of kinetic energy in the collision.

.....

.....

.....

.....

.....

Answer ..... J

(3)
(Total 8 marks)

15. (a) How can the momentum of an object be calculated?

.....

.....

(2)

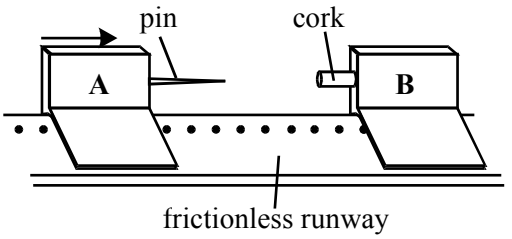
(b) In a collision momentum is always conserved. What does this mean?

.....

.....

(2)

(c) Two trolleys are placed on a frictionless runway as shown in the diagram below. Trolley A has a protruding pin, and trolley B is fitted with a piece of soft cork so that the trolleys will stick together after colliding.



Trolley A has a mass of 2 kg, and trolley B has a mass of 1 kg. Trolley B is stationary. Trolley A strikes trolley B at a speed of 6 m/s. Both trolleys then move to the right together.

(i) Calculate the speed at which trolleys A and B jointly move after the collision.

.....

.....

.....

.....

(4)

(ii) Calculate the change in kinetic energy which occurs during the collision.

.....

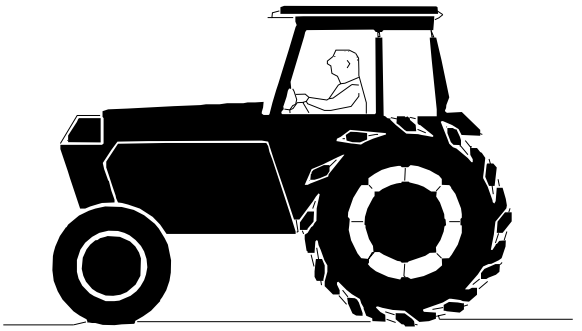
.....

.....

.....

(4)
(Total 12 marks)

16. (a) The diagram below shows a moving tractor. The forward force from the engine exactly balances the resisting forces on the tractor.



(i) Describe the motion of the tractor.

.....

(ii) The tractor comes to a drier part of the field where the resisting forces are less. If the forward force from the engine is unchanged how, if at all, will the motion of the tractor be affected?

.....

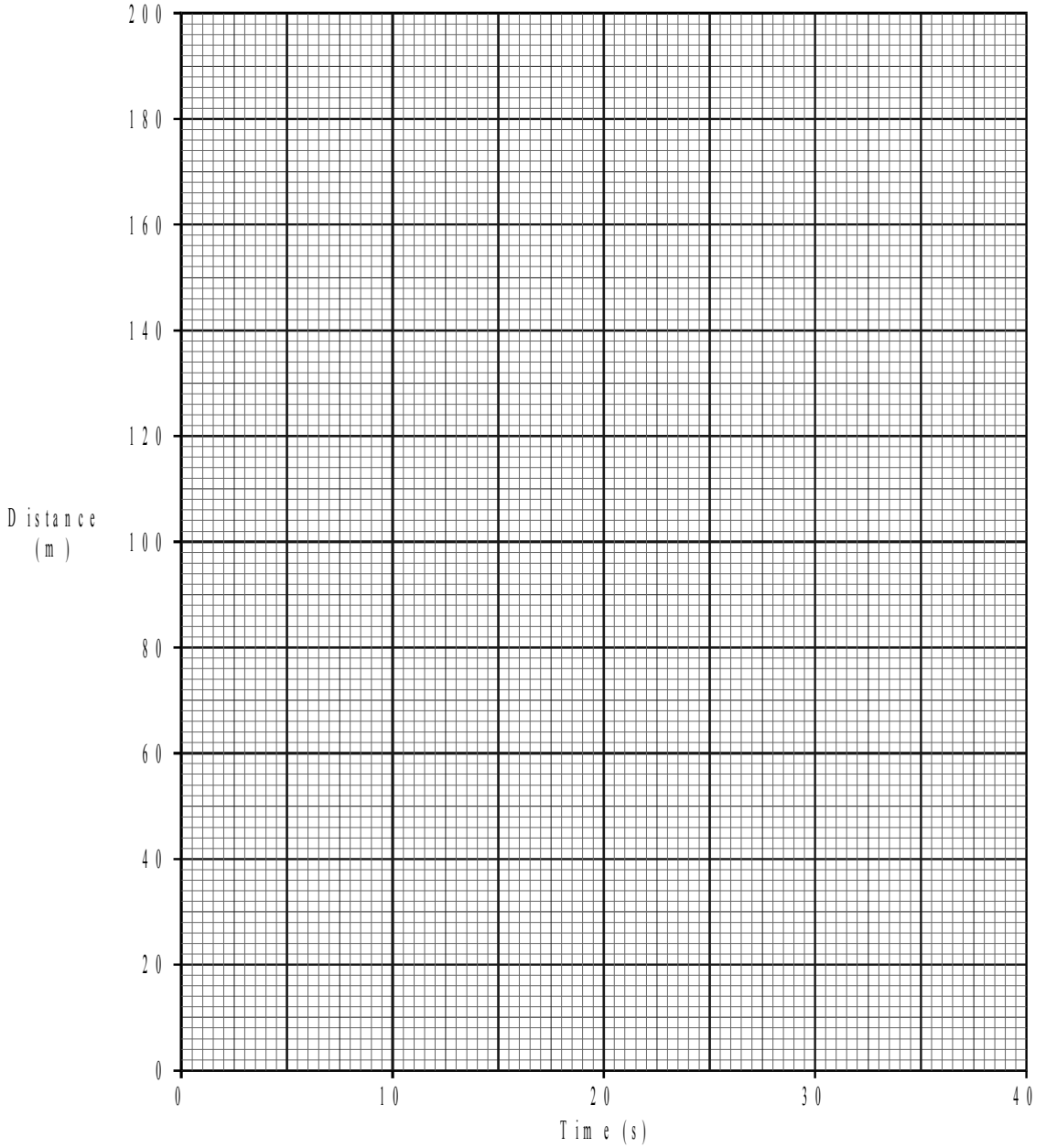
.....

(3)

(b) Two pupils are given the task of finding out how fast a tractor moves across a field. As the tractor starts a straight run across the field the pupils time how long it takes to pass a series of posts which are forty metres apart. The results obtained are shown in the table below.

Distance travelled (m)	0	40	80	120	160	200
Time taken (s)	0	8	16	24	32	40

(i) Draw a graph of distance travelled against time taken using the axes on the graph below. Label your graph line A.



(2)

(ii) Calculate the speed of the tractor.

.....

.....

(3)

(c) In another, wetter field there is more resistance to the movement of the tractor. It now travels at 4 m/s.

(i) Calculate the time needed to travel 200m.

.....

.....

.....

(ii) On the graph in part (b) draw a line to represent the motion of the tractor across the second field. Label this line B.

(4)

(d) On a road the tractor accelerates from rest up to a speed of 6 m/s in 15 seconds.

Calculate the acceleration of the tractor.

.....

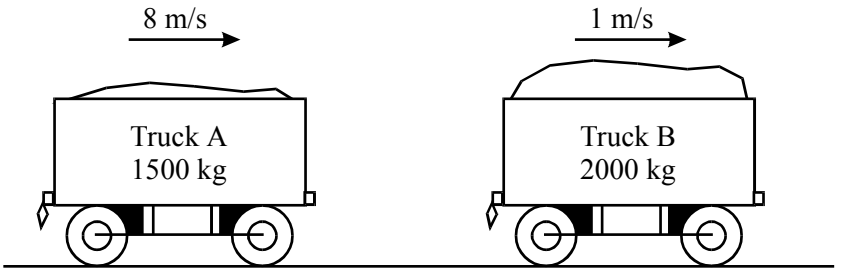
.....

.....

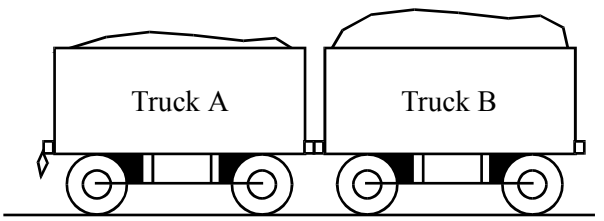
.....Acceleration = ...m/s²

(3)
(Total 15 marks)

17. The drawing below shows two railway trucks A and B, moving in the same direction. Truck **A**, of mass 1500 kg, is initially moving at a speed of 8 m/s. Truck **B**, of mass 2000 kg, is initially moving at a speed of 1 m/s.



Truck A catches up and collides with truck B. The two trucks become coupled together as shown in the diagram.



(a) Calculate:

(i) the initial momentum of truck A.

.....

..... momentum ..... kg m/s

(ii) the initial momentum of truck B.

.....

..... momentum ..... kg m/s

(iii) the total momentum of the trucks before the collision.

.....

..... total momentum ..... kg m/s

(6)

(b) Calculate the speed of the coupled trucks after the collision.

.....

.....

.....

.....

(5)

(c) (i) How is the total kinetic energy of the trucks changed as a result of the collision? A calculated answer is not needed for full marks.

.....

(ii) State an energy transfer which accounts for part of the change in the total kinetic energy of the trucks during the collision.

.....

(iii) What would have been the effect on the change of total kinetic energy of the trucks if the collision had been more elastic?

.....

(3)
(Total 14 marks)

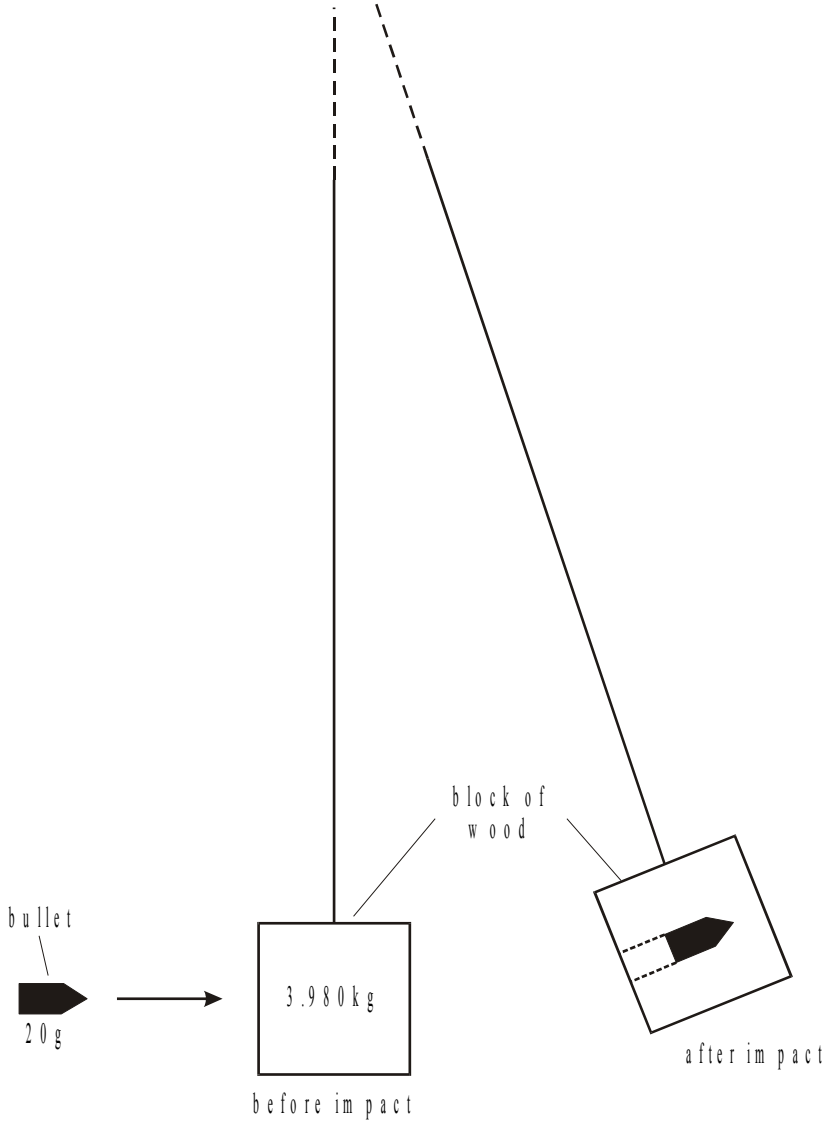
18. (a) When an object is moving it is said to have momentum.
Define momentum.

.....

.....

(1)

(b) The diagram below shows one way of measuring the velocity of a bullet.



A bullet is fired into a block of wood suspended by a long thread.
The bullet stops in the wooden block.
The impact of the bullet makes the block swing.
The velocity of the wooden block can be calculated from the distance it swings.

In one such experiment the block of wood and bullet had a velocity of 2 m/s **immediately after** impact. The mass of the bullet was 20g and the mass of the wooden block 3.980 kg.

(i) Calculate the combined mass of the block of wood and bullet.

..... Mass .....

(1)

(ii) Calculate the momentum of the block of wood and bullet **immediately after** impact.

.....

.....

.....

.....

…..... Momentum .....

(3)

(iii) State the momentum of the bullet **immediately before** impact.

.....

(1)

(iv) Calculate the velocity of the bullet **before** impact.

.....

.....

.....

……..... Velocity ..... m/s

(3)

(v) Calculate the kinetic energy of the block of wood and bullet **immediately after** impact.

.....

.....

.....

……..... Kinetic energy ..... J

(3)

(vi) The kinetic energy of the bullet before the impact was 1600 joules. This is much greater than the kinetic energy of the bullet and block just after the impact. What has happened to the rest of the energy?

.....

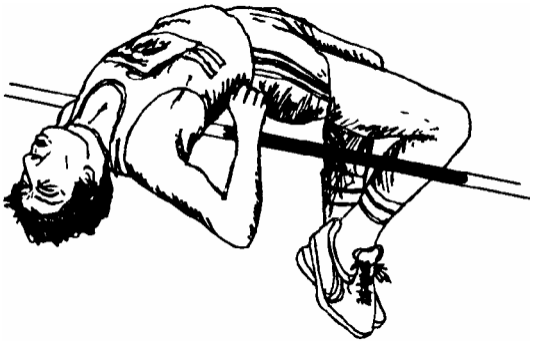
.....

.....

.....

(1)
(Total 13 marks)

19. The diagram shows a high jumper.



In order to jump over the bar, the high jumper must raise his mass by 1.25m.
The high jumper has a mass of 65kg. The gravitational field strength is 10N/kg.

(a) The high jumper just clears the bar.

Use the following equations to calculate the gain in his gravitational potential energy.

weight	=	mass	x	gravitational field strength
(newton, N)		(kilogram, kg)		(newton/kilogram, N/kg)

change in gravitational potential energy	=	weight	x	change in vertical height
(joule, J)		(newton, N)		(metre, m)

.....

.....

.....

.....

.....

.....

Gain in gravitational potential energy ..... J

(4)

(b) Use the following equation to calculate the minimum speed the high jumper must reach for take-off in order to jump over the bar.

$$\text{kinetic energy (joule, J)} = \frac{1}{2} \times \text{mass (kilogram, kg)} \times [\text{speed}]^2 \; [(\text{metre/second})^2, (\text{m/s})^2]$$

.....

.....

.....

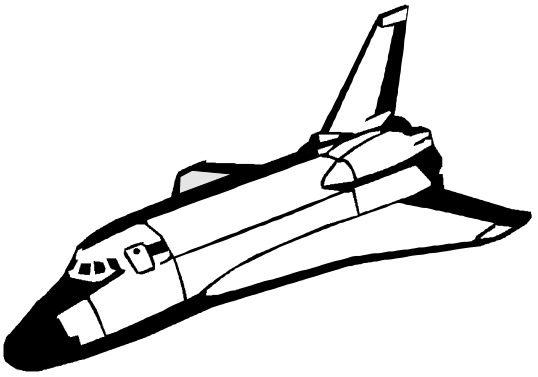
.....

.....

Speed ..... m/s

(3)
(Total 7 marks)

20. 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.

$$\text{kinetic energy} = \tfrac{1}{2}\, mv^2$$

.....

.....

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.

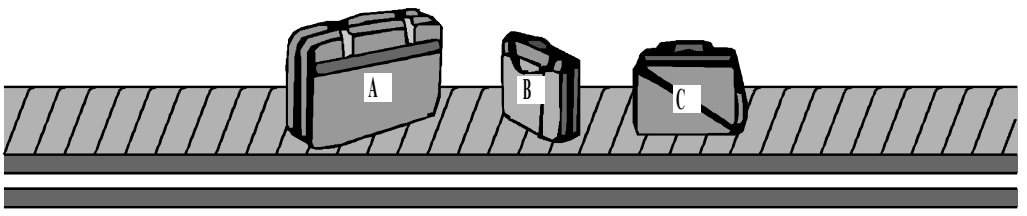
.....

.....

Force = ... newtons

(1)
(Total 9 marks)

21. The picture shows luggage which has been loaded onto a conveyor belt.



Each piece of luggage has a different mass.

Mass of **A** = 22 kg mass of **B** = l2 kg mass of **C** = 15 kg

(a) (i) What is the momentum of the luggage before the conveyor belt starts to move?

.....

Give a reason for your answer.

.....

.....

(2)

(ii) When the conveyor belt is switched on the luggage moves with a constant speed. Which piece of luggage **A**, **B** or **C** has the most momentum?

.....

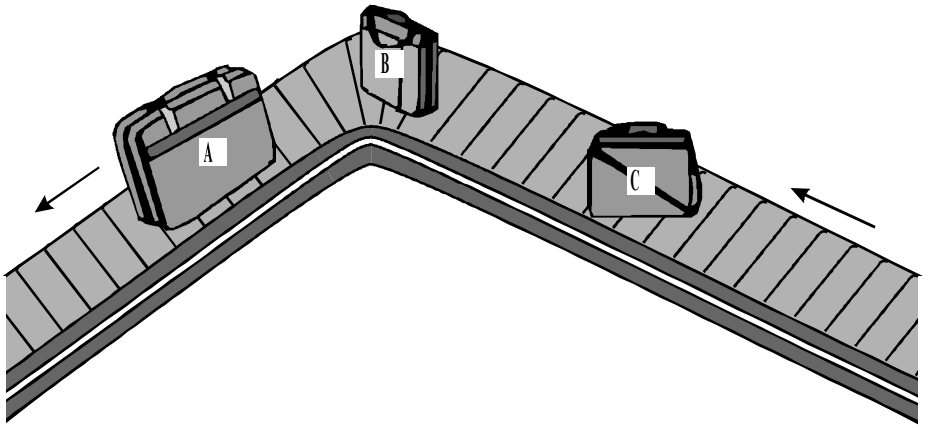
Give a reason for your answer.

.....

.....

(2)

(iii) At one point the conveyor belt turns left. The luggage on the belt continues to move at a constant speed.



Does the momentum of the luggage change as it turns left with the conveyor belt?

.....

Give a reason for your answer.

.....

.....

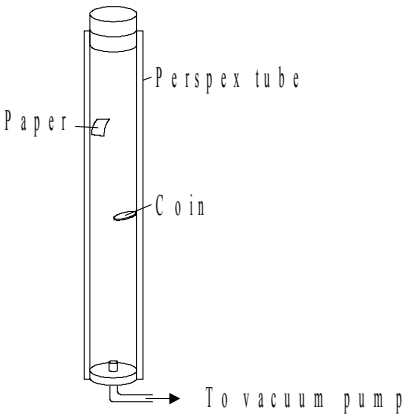
(2)

(b) Draw a circle around the unit which can be used to measure momentum.

J/s kg m/s Nm

(1)
(Total 7 marks)

22. The apparatus shown is used to compare the motion of a coin with the motion of a piece of paper as they both fall.



(a) When the tube is filled with air the coin falls faster than the piece of paper. Why?

.....

.....

(1)

(b) The air in the tube is removed by the vacuum pump. The tube is turned upside down. State **two** ways in which the motion of the coin and piece of paper will change compared to when there was air in the tube.

1 .....

.....

.....

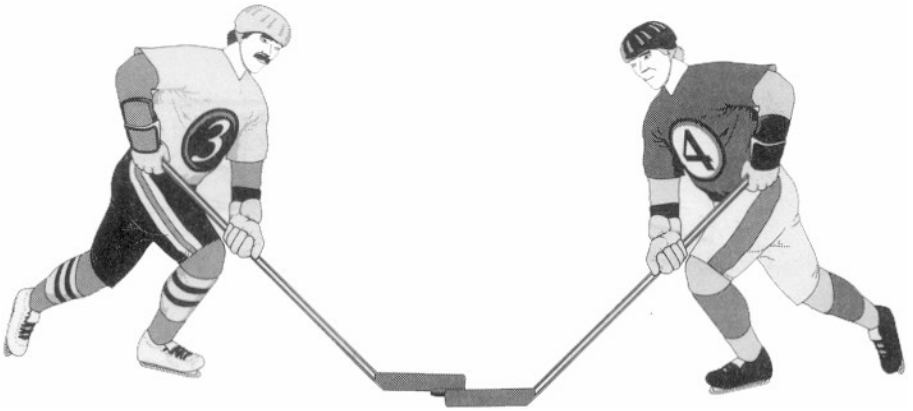
2 .....

.....

.....

(2)
(Total 3 marks)

23. (a) The picture shows two ice hockey players skating towards the puck. The players, travelling in opposite directions, collide, fall over and stop.



Player **3**

mass = 75 kg
speed = 4 m/s

Player **4**

(i) Use the following equation and the data given in the box to calculate the momentum of player number **3** before the collision. Show clearly how you work out your answer and give the unit.

momentum = mass × velocity

.....

.....

Momentum of player **3** = ...

(3)

(ii) What is the momentum of player **4** just before the collision?

.....

(1)

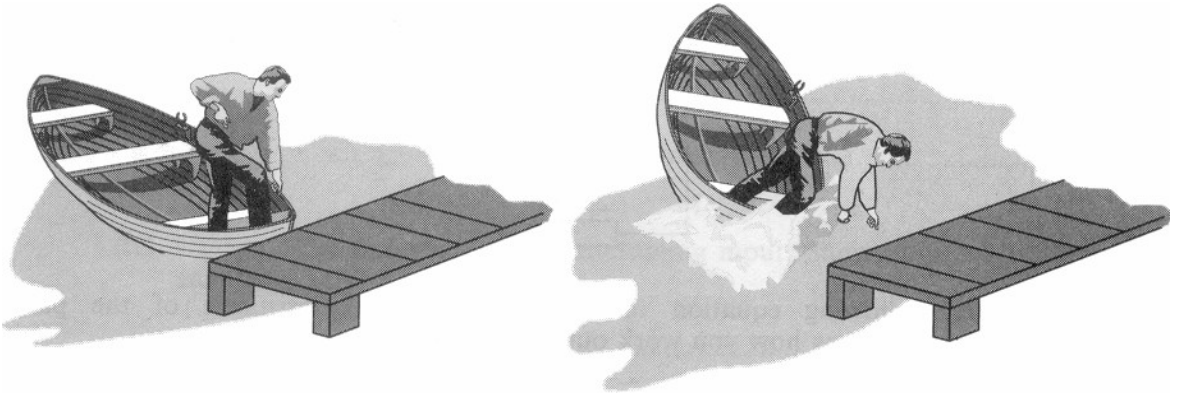
(iii) The collision between the two players is **not** *elastic*. What is meant by an *elastic* collision?

.....

.....

(1)

(b) The pictures show what happened when someone tried to jump from a stationary rowing boat to a jetty.



Use the idea of momentum to explain why this happened.

.....

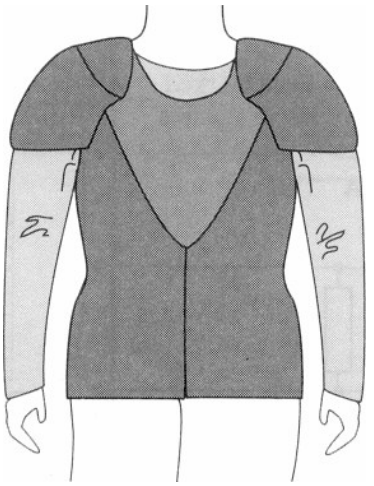
.....

.....

.....

(2)

(c) The diagram shows one type of padded body protector which may be worn by a horse rider.



If the rider falls off the horse, the body protector reduces the chance of the rider being injured. Use the idea of momentum to explain why.

.....

.....

.....

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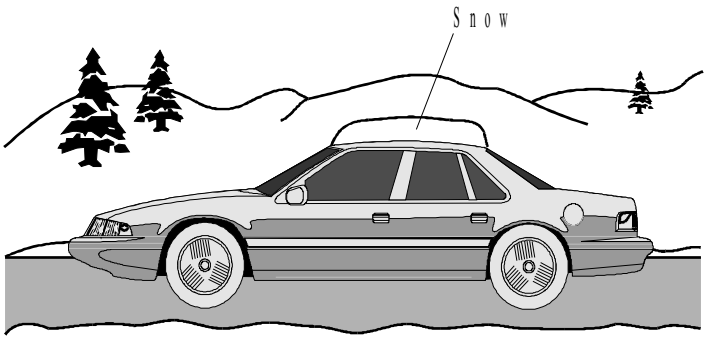
.....

(3)
(Total 10 marks)

24. (a) The diagram shows a car being driven at 14 rn/s. The driver has forgotten to clear a thick layer of snow from the roof.



Mass of car	= 750 kg
Mass of driver	= 80 kg
Mass of snow	= 35 kg

Which of the following has the smallest momentum? Draw a circle around your answer.

the car the driver the snow

Give a reason for your answer.

.....

.....

(2)

(b) Seeing an obstacle in the road, the driver applies the car brakes. The car slows down in a straight line.

(i) Does the momentum of the car increase, decrease or stay the same?

.....

Give a reason for your answer.

.....

(2)

(ii) As the car slows down the snow starts to slide. In which direction will the snow start to slide, backwards, forwards or sideways?

.....

Give a reason for your choice of direction.

.....

(2)

(c) Draw a circle around the unit which can be used to measure momentum.

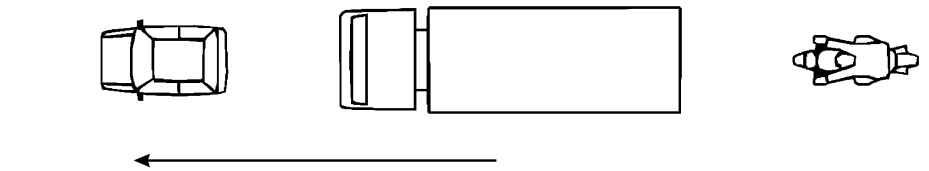
Nm J/s Ns

(1)
(Total 7 marks)

25. The lorry, the car and the motor cycle are travelling along a straight road in the direction shown.

All three vehicles are travelling at the **same** speed.

overhead view



(a) Which word is used to describe the speed of an object in a particular direction?

.....

(1)

(b) Which of the three vehicles will have the greatest momentum?

.....

Explain your answer

.....

.....

.....

.....

....

(4)

(c) Complete the sentences.

(i) When a vehicle has a steady speed the frictional forces ..... the driving force.

(ii) Momentum has both ..... and direction.

(2)
(Total 7 marks)

26. (a) The picture shows a golfer about to strike a stationary golf ball of mass 0.045 kg.

What is the momentum of the golf ball before it is struck.

(1)

(b) When the golf club strikes the ball it is in contact for 0.001s and exerts a force of 3600 N on the ball.

(i) Write dow the equation that links change in momentum, force and time.

.....

(1)

(ii) Calculate the velocity at which the ball leaves the club. Show clearly how you work out your final answer.

.....

.....

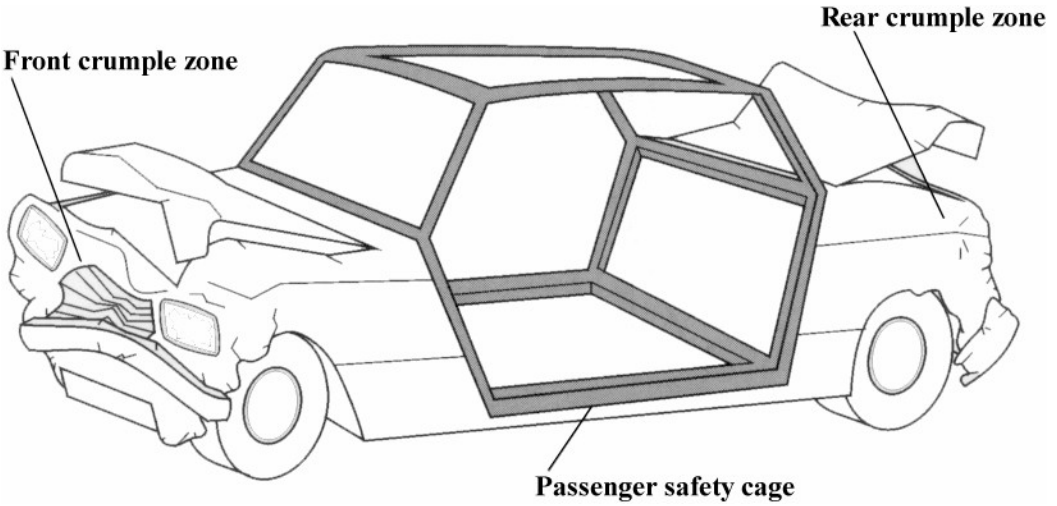
.....

Velocity of ball = ...m/s

(3)

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

(c) A modern car with a rigid passenger safety cage has zones at the front and rear which are designed to crumple in a crash.



Use the idea of momentum to explain why 'crumple zones' should reduce passenger injury in a car crash.

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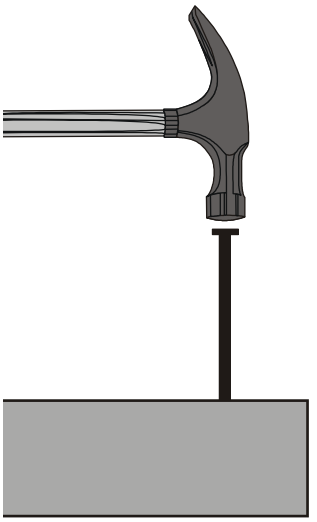
(3)
(Total 8 marks)

27. (a) The diagram shows a hammer which is just about to drive a nail into a block of wood.



The mass of the hammer is 0.75 kg and its velocity, just before it hits the nail, is 15.0 m/s downward. After hitting the nail, the hammer remains in contact with it for 0.1 s. After this time both the hammer and the nail have stopped moving.

(i) Write down the equation, in words, which you need to use to calculate momentum.

.....

(1)

(ii) What is the momentum of the hammer just before it hits the nail?

Show how you work out your answer and give the units and direction.

.....

.....

.....

Momentum = ...

(3)

(iii) What is the change in momentum of the hammer during the time it is in contact with the nail?

.....

(1)

(iv) Write down an equation which connects *change in momentum*, *force* and *time*.

.....

(1)

(v) Calculate the force applied by the hammer to the nail.

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

.....

.....

.....

Force = ...

(3)

(b) A magazine article states that:

"Wearing a seat belt can save your life in a car crash."

Use your understanding of momentum to explain how this is correct.

.....

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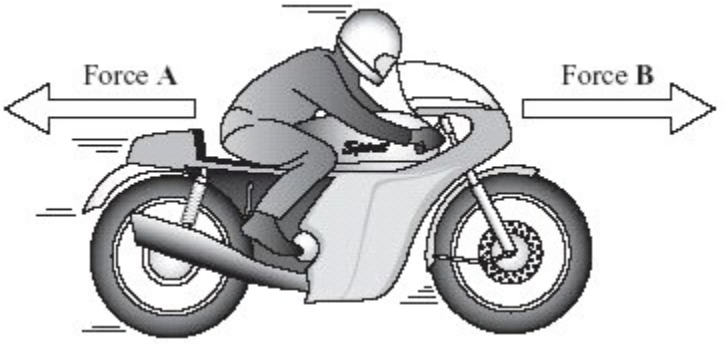
(4)
(Total 13 marks)

28. (a) The diagram shows the horizontal forces that act on a **moving** motorbike.



(i) Describe the movement of the motorbike when force **A** equals force **B**.

.....

.....

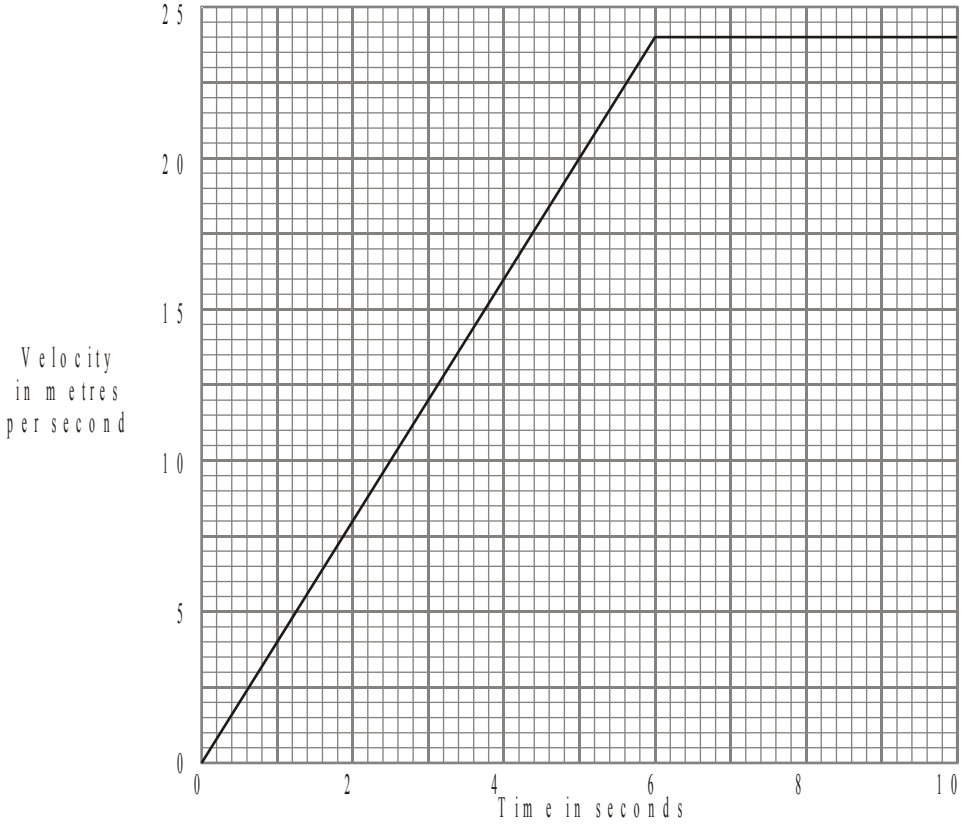
(2)

(ii) What happens to the speed of the motorbike if force **B** becomes smaller than force **A**?

.....

(1)

(b) The graph shows how the velocity of a motorbike changes when it is travelling along a straight road.



(i) What was the change in velocity of the motorbike in the first 5 seconds?

.....

(1)

(ii) Write down the equation which links acceleration, change in velocity and time taken.

.....

(1)

(iii) Calculate the acceleration of the motorbike during the first 5 seconds. Show clearly how you work out your answer and give the unit.

.....

.....

Acceleration = ...

(3)

(c) A car is travelling on an icy road.

Describe and explain what might happen to the car when the brakes are applied.

.....

.....

.....

.....

(2)

(d) Name **three** factors, other than weather conditions, which would increase the overall stopping distance of a vehicle.

1 .....

.....

2 .....

.....

3 .....

.....

(3)
(Total 13 marks)

29. (a) When two objects collide, and no other forces act, then *conservation of momentum* applies.

(i) What does the term conservation of momentum mean?

.....

.....

.....

(2)

(ii) Apart from collisions and similar events, give another type of event in which *conservation of momentum* applies.

.....

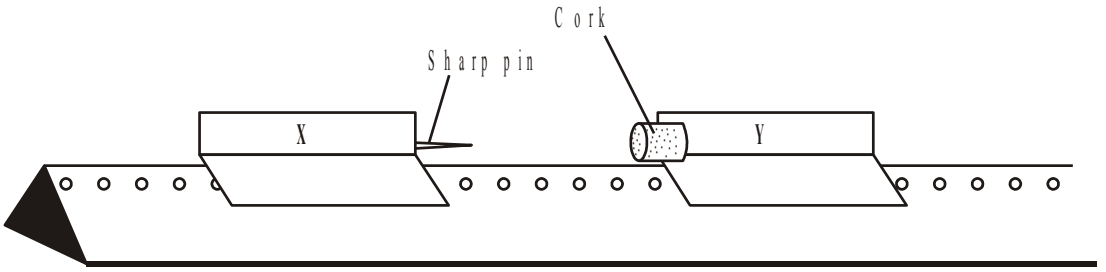
(1)

(iii) Write, in words, the equation which you need to use to calculate momentum.

.....

(1)

(iv) The diagram shows a straight and horizontal runway and two trolleys, **X** and **Y**, which can move on the runway.



X has a mass of 0.2 kg and its velocity is 1.2 m/s to the right. **Y** has a mass of 0.1 kg and is stationary. When **X** collides with **Y** they stick together.

Calculate the velocity of the trolleys after the collision.

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

.....

.....

.....

.....

Velocity of the trolleys = ...

(5)

(v) What assumption did you make in order to calculate your answer to part (a)(iv)?

.....

.....

(1)

(b) Just before it hits a target, a bullet has a momentum of 5 kg m/s. It takes 0.00125 s for the target to stop the bullet.

Calculate the force, in newtons, needed to do this.

Write, in words, the equation that you will need to use and show clearly how you work out your answer.

Force = ... newtons

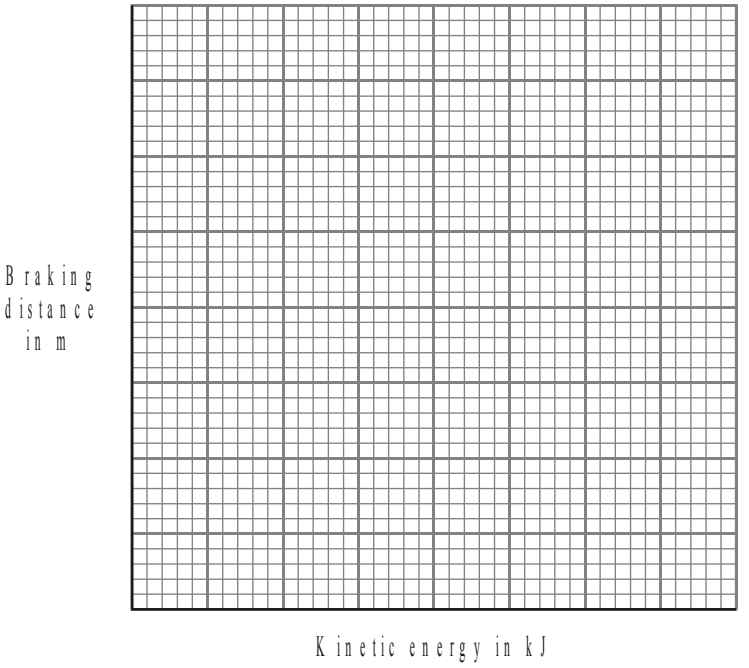
(3)
(Total 13 marks)

30. The table shows the braking distances for a car at different speeds and kinetic energy. The braking distance is how far the car travels once the brakes have been applied.

Braking distance in m	**Speed of car in m/s**	**Kinetic energy of car in kJ**
7	10	40
16	15	90
30	20	160
46	25	250
65	30	360

(a) A student suggests, "the braking distance is directly proportional to the kinetic energy".

(i) Draw a graph to test this suggestion.



(3)

(ii) Does the graph show that the student's suggestion was correct or incorrect? Give a reason for your answer.

.....

.....

(1)

(iii) State **one** factor, apart from speed, which would increase the car's braking distance.

.....

(1)

(b) In an experiment at an accident research laboratory, a car moving at 14 m/s is made to collide with a brick wall. On impact the dummy inside the car moves forward. Its head hits the dashboard and stops.

(i) Write down the equation that links mass, momentum and velocity.

.....

(1)

(ii) Calculate the momentum of the dummy's head just before impact. Take the mass of the head to be 8 kg. Show clearly how you get your answer.

.....

.....

momentum of dummy's head =..... kg m/s

(1)

(iii) Write down the equation that links change in momentum, force and time.

.....

(1)

(iv) The impact between the head and dashboard lasts 0.008 s.

Calculate the impact force between the head and dashboard. Show clearly how you get your answer.

.....

.....

impact force = ... N

(1)

(c) Most new cars are fitted with a driver's airbag. These are like large cushions, designed to inflate when the car is in a severe collision. In a test, an airbag deflates slowly when hit by the dummy's head.

Use the idea of momentum to explain why an airbag should reduce the risk of a serious head injury.

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(3)
(Total 12 marks)