

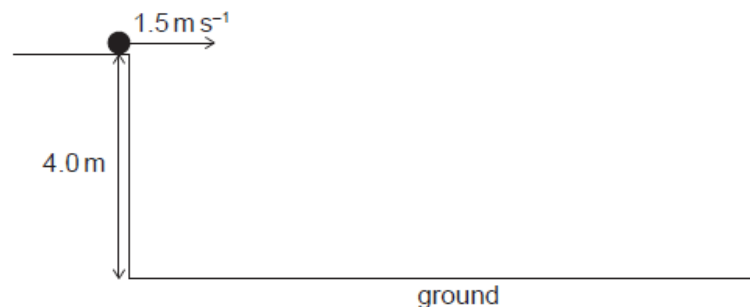
mechanics SL small packet [54 marks]

1. A block moving with initial speed v is brought to rest, after travelling a distance d , by a frictional force f . A second identical block moving with initial speed u is brought to rest in the same distance d by a frictional force $\frac{f}{2}$. What is u ? [1 mark]

- A. v
- B. $\frac{v}{\sqrt{2}}$
- C. $\frac{v}{2}$
- D. $\frac{v}{4}$

2. A stone is kicked horizontally at a speed of 1.5 m s^{-1} from the edge of a cliff on one of Jupiter's moons. It hits the ground 2.0 s later. The height of the cliff is 4.0 m . Air resistance is negligible. [1 mark]

What is the magnitude of the displacement of the stone?



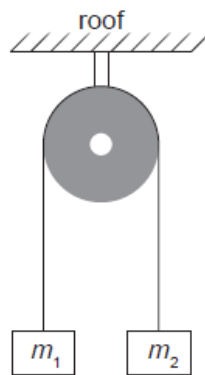
- A. 7.0 m
- B. 5.0 m
- C. 4.0 m
- D. 3.0 m

3. Which of the formulae represents Newton's second law?

[1 mark]

- A. $\frac{\text{mass}}{\text{volume}}$
- B. $\frac{\text{work}}{\text{displacement}}$
- C. $\frac{\text{change of momentum}}{\text{time}}$
- D. $\text{pressure} \times \text{area}$

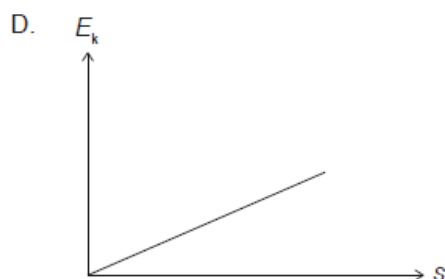
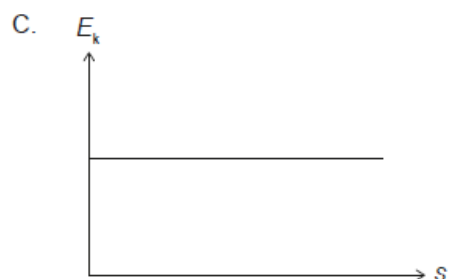
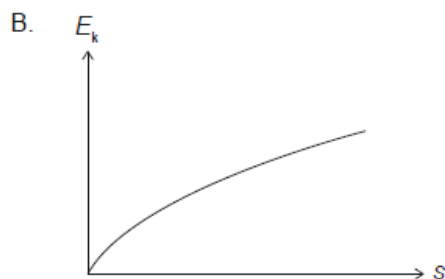
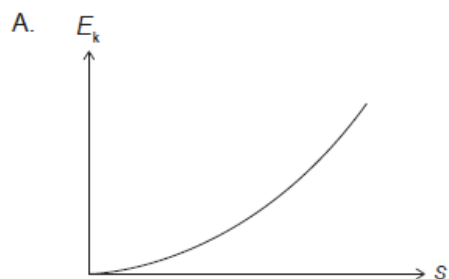
4. Two masses m_1 and m_2 are connected by a string over a frictionless pulley of negligible mass. The masses are released from rest. Air resistance is negligible. [1 mark]



Mass m_2 accelerates downwards at $\frac{g}{2}$. What is $\frac{m_1}{m_2}$?

- A. $\frac{1}{3}$
- B. $\frac{1}{2}$
- C. 2
- D. 3

5. A cart travels from rest along a horizontal surface with a constant acceleration. What is the variation of the kinetic energy E_k of the cart with its distance s travelled? Air resistance is negligible. [1 mark]



6. Two trolleys of equal mass travel in opposite directions as shown. [1 mark]

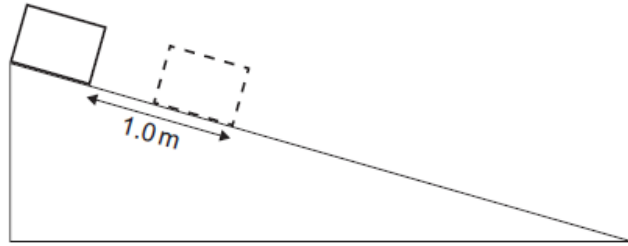


The trolleys collide head-on and stick together.

What is their velocity after the collision?

- A. 1 m s^{-1}
 B. 2 m s^{-1}
 C. 5 m s^{-1}
 D. 10 m s^{-1}
7. A car accelerates uniformly from rest to a velocity v during time t_1 . It then continues at constant velocity v from t_1 to time t_2 . [1 mark]
- What is the total distance covered by the car in t_2 ?
- A. $v t_2$
 B. $\frac{1}{2}v(t_2 - t_1) + v t_1$
 C. $\frac{1}{2}v(t_2 + t_1)$
 D. $\frac{1}{2}v t_1 + v(t_2 - t_1)$

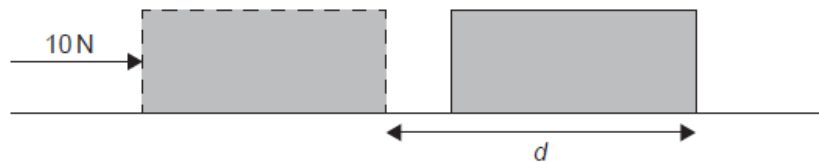
8. An object is sliding from rest down a frictionless inclined plane. The object [1 mark] slides 1.0 m during the first second.



What distance will the object slide during the next second?

- A. 1.0 m
- B. 2.0 m
- C. 3.0 m
- D. 4.9 m

9. An object of mass 2.0 kg rests on a rough surface. A person pushes the object in a straight line with a force of 10 N through a distance d . [1 mark]



The resultant force acting on the object throughout d is 6.0 N.

What is the value of the sliding coefficient of friction μ between the surface and the object and what is the acceleration a of the object?

	μ	a / ms^{-2}
A.	0.20	3.0
B.	0.20	5.0
C.	0.40	3.0
D.	0.40	5.0

10. A rocket has just been launched vertically from Earth. The image shows the free-body diagram of the rocket. F_1 represents a larger force than F_2 . [1 mark]



Which force pairs with F_1 and which force pairs with F_2 , according to Newton’s third law?

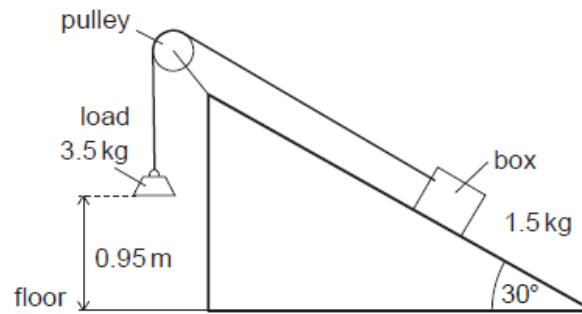
	Force pair with F_1	Force pair with F_2
A.	force of rocket on exhaust gases	force of exhaust gases on rocket
B.	force of rocket on exhaust gases	gravitational force of rocket on Earth
C.	gravitational force of Earth on rocket	force of exhaust gases on rocket
D.	gravitational force of Earth on rocket	gravitational force of rocket on Earth

11. An object is pushed from rest by a constant net force of 100 N. When the object has travelled 2.0 m the object has reached a velocity of 10 m s^{-1} . [1 mark]

What is the mass of the object?

- A. 2 kg
- B. 4 kg
- C. 40 kg
- D. 200 kg

A student uses a load to pull a box up a ramp inclined at 30° . A string of constant length and negligible mass connects the box to the load that falls vertically. The string passes over a pulley that runs on a frictionless axle. Friction acts between the base of the box and the ramp. Air resistance is negligible.



The load has a mass of 3.5 kg and is initially 0.95 m above the floor. The mass of the box is 1.5 kg.

The load is released and accelerates downwards.

- 12a. Outline **two** differences between the momentum of the box and the momentum of the load at the same instant. *[2 marks]*

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- 12b. The vertical acceleration of the load downwards is 2.4 m s^{-2} . *[2 marks]*

Calculate the tension in the string.

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12c. Show that the speed of the load when it hits the floor is about 2.1 m s^{-1} . *[2 marks]*

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12d. The radius of the pulley is 2.5 cm. Calculate the angular speed of rotation of the pulley as the load hits the floor. State your answer to an appropriate number of significant figures. *[2 marks]*

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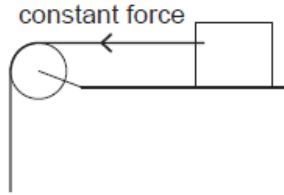
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- 12f. The student then makes the ramp horizontal and applies a constant horizontal force to the box. The force is just large enough to start the box moving. The force continues to be applied after the box begins to move. [3 marks]



Explain, with reference to the frictional force acting, why the box accelerates once it has started to move.

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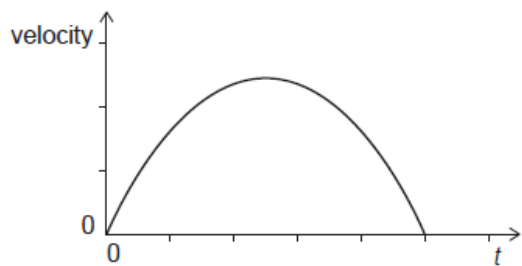
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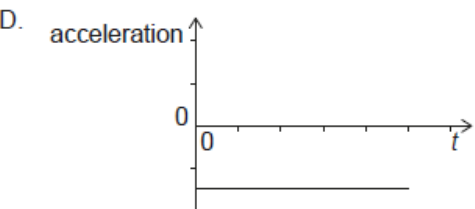
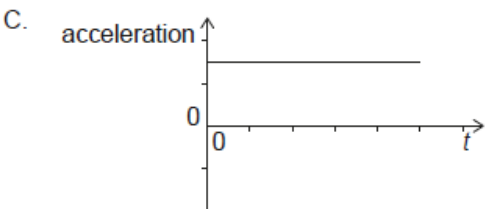
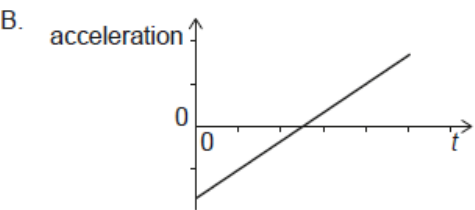
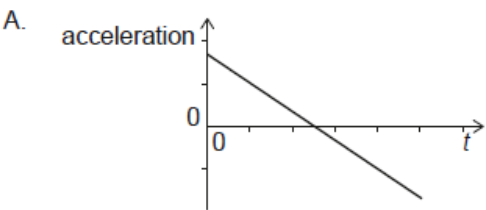
13. An electric motor of efficiency 0.75 is connected to a power supply with an emf of 20 V and negligible internal resistance. The power output of the motor is 120 W. What is the average current drawn from the power supply? [1 mark]

- A. 3.1 A
- B. 4.5 A
- C. 6.0 A
- D. 8.0 A

14. The graph shows the variation with time t of the velocity of an object. [1 mark]



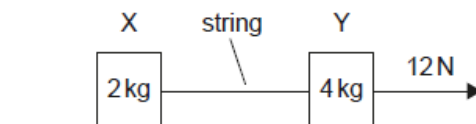
What is the variation with time t of the acceleration of the object?



15. A ball is thrown vertically downwards with an initial speed of 4.0 m s^{-1} . [1 mark]
The ball hits the ground with a speed of 16 m s^{-1} . Air resistance is negligible. What is the time of fall and what is the distance travelled by the ball?

	Time of fall/s	Distance/m
A.	1.0	10
B.	1.0	12
C.	1.2	10
D.	1.2	12

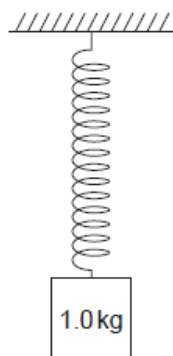
16. X and Y are two objects on a frictionless table connected by a string. The [1 mark]
mass of X is 2 kg and the mass of Y is 4 kg. The mass of the string is negligible. A constant horizontal force of 12 N acts on Y.



What are the acceleration of Y and the magnitude of the tension in the string?

	Acceleration of Y/ ms^{-2}	Tension in the string/N
A.	2	4
B.	2	6
C.	3	4
D.	3	6

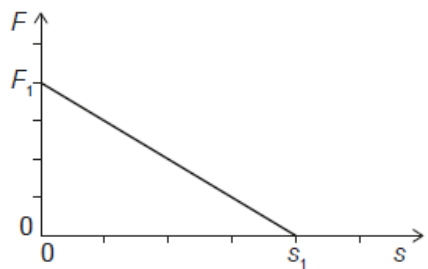
17. An object of mass 1.0 kg hangs at rest from a spring. The spring has a [1 mark]
negligible mass and the spring constant k is 20 N m^{-1}



What is the elastic potential energy stored in the spring?

- A. 1.0 J
- B. 2.5 J
- C. 5.0 J
- D. 10 J

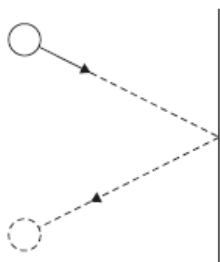
18. A net force F acts on an object of mass m that is initially at rest. The object moves in a straight line. The variation of F with the distance s is shown. [1 mark]



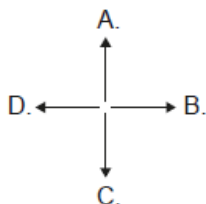
What is the speed of the object at the distance s_1 ?

- A. $\sqrt{\frac{F_1 s_1}{2m}}$
B. $\sqrt{\frac{F_1 s_1}{m}}$
C. $\sqrt{\frac{2F_1 s_1}{m}}$
D. $\sqrt{\frac{4F_1 s_1}{m}}$

19. A ball rolls on the floor towards a wall and rebounds with the same speed [1 mark] and at the same angle to the wall.



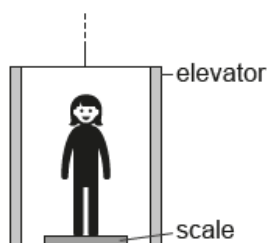
What is the direction of the impulse applied to the ball by the wall?



20. A large stone is dropped from a tall building. What is correct about the speed of the stone after 1 s? [1 mark]
- A. It is decreasing at increasing rate.
 - B. It is decreasing at decreasing rate.
 - C. It is increasing at increasing rate.
 - D. It is increasing at decreasing rate.

21. An electron has a linear momentum of $4.0 \times 10^{-25} \text{ kg m s}^{-1}$. What is the order of magnitude of the kinetic energy of the electron? [1 mark]
- A. 10^{-50} J
 - B. 10^{-34} J
 - C. 10^{-19} J
 - D. 10^6 J

22. A person with a weight of 600 N stands on a scale in an elevator. [1 mark]



What is the acceleration of the elevator when the scale reads 900 N?

- A. 5.0 m s^{-2} downwards
 - B. 1.5 m s^{-2} downwards
 - C. 1.5 m s^{-2} upwards
 - D. 5.0 m s^{-2} upwards
23. A projectile is launched upwards at an angle θ to the horizontal with an initial momentum p_0 and an initial energy E_0 . Air resistance is negligible. What are the momentum and total energy of the projectile at the highest point of the motion? [1 mark]

	Momentum	Energy
A.	$< p_0$	E_0
B.	p_0	E_0
C.	p_0	$< E_0$
D.	$< p_0$	$< E_0$

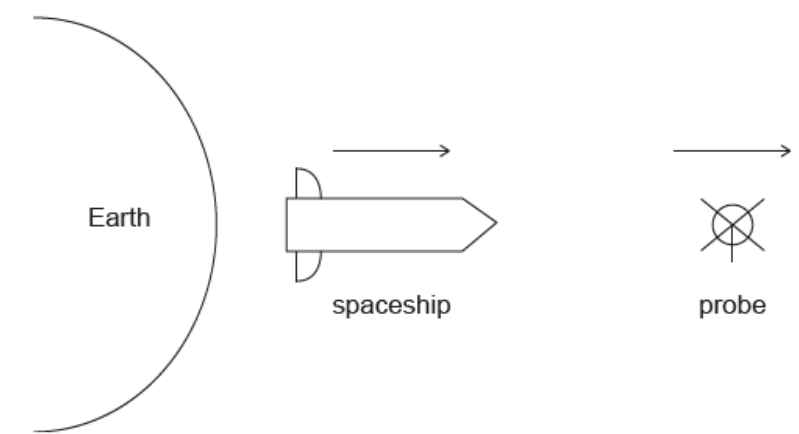
24. An object of mass $2m$ moving at velocity $3v$ collides with a stationary object of mass $4m$. The objects stick together after the collision. What is the final speed and the change in total kinetic energy immediately after the collision? [1 mark]

	Final speed	Change in total kinetic energy
A.	v	$3mv^2$
B.	v	$6mv^2$
C.	$2v$	$3mv^2$
D.	$2v$	$6mv^2$

25a. An object of mass 1 kg is thrown downwards from a height of 20 m . The initial speed of the object is 6 m s^{-1} . The object hits the ground at a speed of 20 m s^{-1} . Assume $g = 10\text{ m s}^{-2}$. What is the best estimate of the energy transferred from the object to the air as it falls? [1 mark]

A. 6 J
 B. 18 J
 C. 182 J
 D. 200 J

A spaceship is travelling at $0.80c$, away from Earth. It launches a probe away from Earth, at $0.50c$ relative to the spaceship. An observer on the probe measures the length of the probe to be 8.0 m .



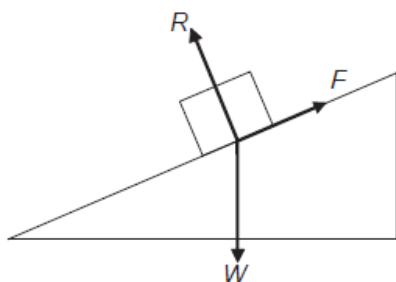
25b. Calculate the speed of the probe in terms of c , relative to Earth. [2 marks]

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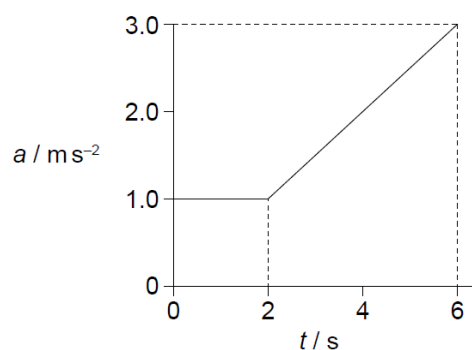
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26. Three forces act on a block which is sliding down a slope at constant speed. W is the weight, R is the reaction force at the surface of the block and F is the friction force acting on the block. [1 mark]



In this situation

- A. there must be an unbalanced force down the plane.
B. $W = R$.
C. $F = W$.
D. the resultant force on the block is zero.
27. The variation with time t of the acceleration a of an object is shown. [1 mark]

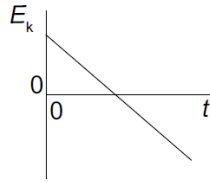


What is the change in velocity of the object from $t = 0$ to $t = 6 \text{ s}$?

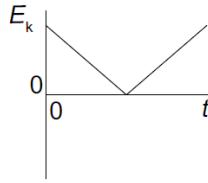
- A. 6 m s^{-1}
B. 8 m s^{-1}
C. 10 m s^{-1}
D. 14 m s^{-1}

28. A ball is thrown vertically upwards. Air resistance is negligible. What is the [1 mark] variation with time t of the kinetic energy E_k of the ball?

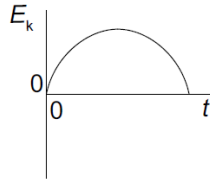
A.



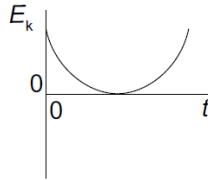
B.



C.



D.



29. The tension in a horizontal spring is directly proportional to the extension [1 mark] of the spring. The energy stored in the spring at extension x is E . What is the work done by the spring when its extension changes from x to $\frac{x}{4}$?

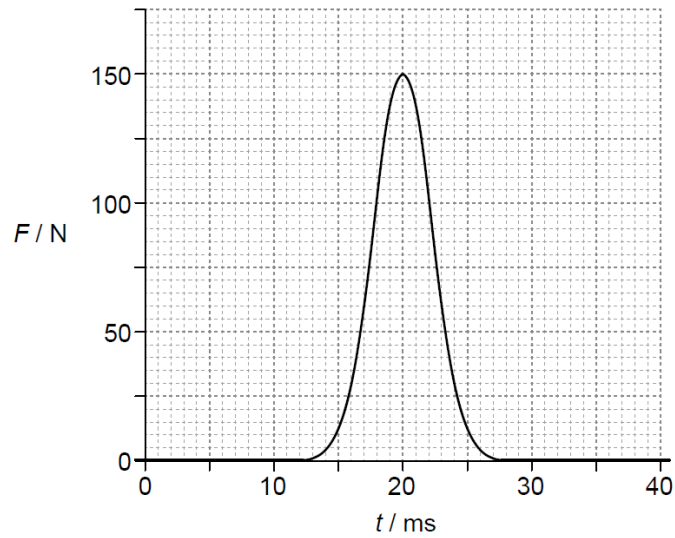
A. $\frac{E}{16}$

B. $\frac{E}{4}$

C. $\frac{3E}{4}$

D. $\frac{15E}{16}$

The graph shows the variation with time t of the horizontal force F exerted on a tennis ball by a racket.



The tennis ball was stationary at the instant when it was hit. The mass of the tennis ball is 5.8×10^{-2} kg. The area under the curve is 0.84 N s.

30a. Calculate the speed of the ball as it leaves the racket.

[2 marks]

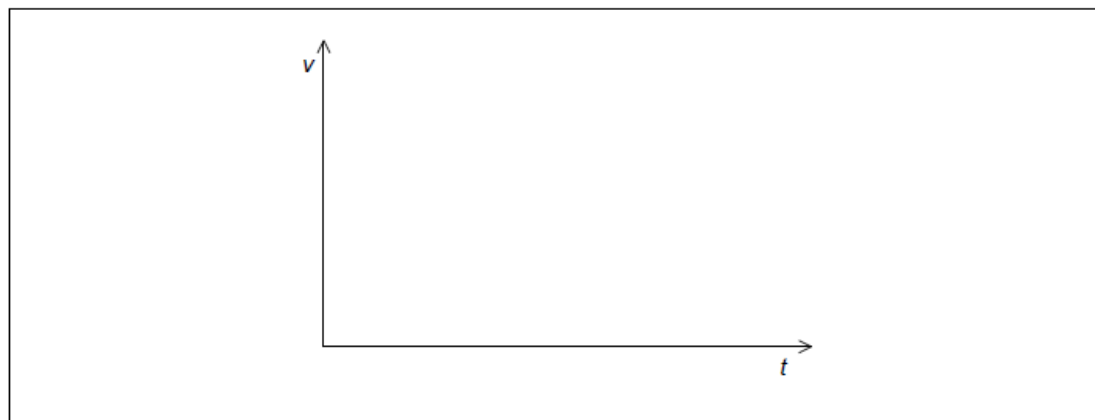
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30b. Show that the average force exerted on the ball by the racket is about 50 N. [2 marks]

30c. Determine, with reference to the work done by the average force, the horizontal distance travelled by the ball while it was in contact with the racket. [3 marks]

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30d. Draw a graph to show the variation with t of the horizontal speed v of the ball while it was in contact with the racket. Numbers are **not** required on the axes. [2 marks]



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