Newton-Momentum Problems

M13

3. Which of the following is always true for an object moving in a straight line at constant speed?

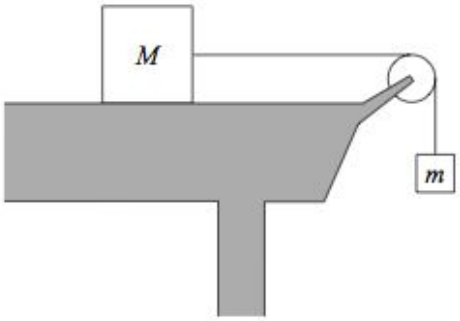
A. No forces act on the object.

B. No resultant force acts on the object.

C. The momentum of the object is zero.

D. No work is being done on the object.

4. An object of mass m is connected via a frictionless pulley to an object of mass M, where $M > m$. M rests on a horizontal frictionless surface.



What is the acceleration of the system?

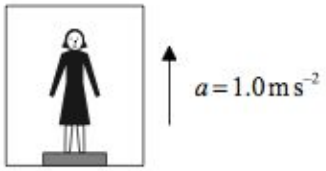
A. $\frac{mg}{(M+m)}$

B. $\frac{(M+m)g}{m}$

C. $\frac{gm}{M}$

D. Zero

6. A person of weight 600 N is standing on a weighing scale in a lift (elevator). The lift is accelerating upwards at $1.0\,\text{m s}^{-2}$. Which of the following is the reading on the scale?



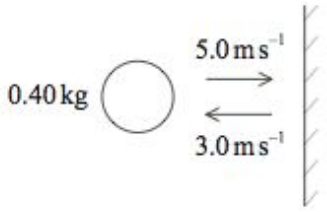
A. 0 N

B. 540 N

C. 600 N

D. 660 N

5. A ball of mass 0.40 kg travels horizontally and strikes a vertical wall with a speed of $5.0\,\text{m s}^{-1}$. It rebounds horizontally with a speed of $3.0\,\text{m s}^{-1}$. The ball is in contact with the wall for a time of 0.20 s.



What is the average magnitude of the force exerted by the ball on the wall?

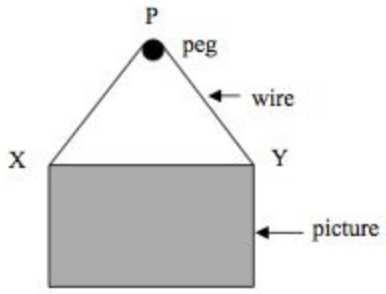
A. 0.16 N

B. 0.64 N

C. 4 N

D. 16 N

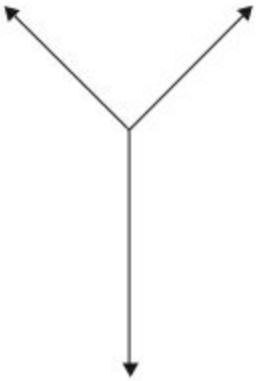
7. A picture is supported vertically by a wire that is looped over a horizontal light peg P. There is no friction between the wire and the peg.



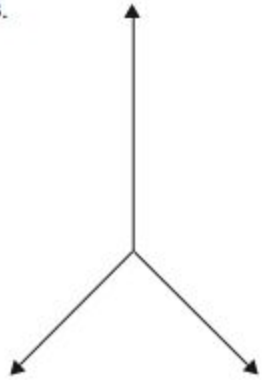
The mass of the picture is uniformly distributed and PX = PY.

Which of the following best represents the free body diagram of the forces acting on the peg?

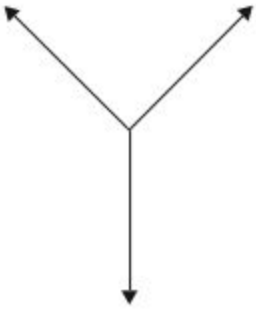
A.



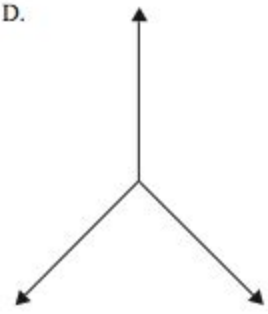
B.



C.



D.



9. A net force of magnitude F acts on a body for a time Δt producing an impulse of magnitude Y. Which of the following is the magnitude of the rate of change of momentum of the body?

A. F

B. $F\Delta t$

C. Y

D. $Y\Delta t$

15. A block is at rest on a horizontal surface. The magnitude of the minimum force to start the block moving is F_M. The magnitude of the force required to keep the block moving at constant speed is F_C.

Which of the following statements is true?

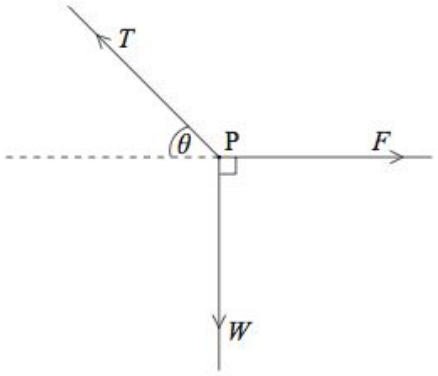
A. F_M will always equal F_C provided the speed of the block is not too great.

B. F_M will always be equal to F_C no matter what the speed of the block.

C. F_M will always be greater than F_C.

D. F_M will always be less than F_C.

2. Three forces F, T and W act at a point P as shown below.



Which of the following gives the condition for point P to be in equilibrium?

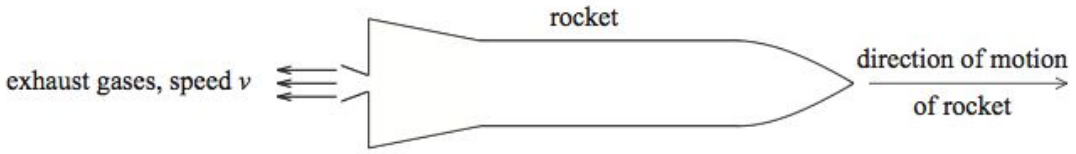
A. $W = F\tan\theta$

B. $W = F\cos\theta$

C. $F = W\tan\theta$

D. $F = W\cos\theta$

6. A rocket is moving through space. The rocket engine ejects a mass m of exhaust gases in time t. The speed of the exhaust gases, relative to the rocket, is v as shown below.



Which of the following expressions is the magnitude of the force exerted on the rocket by the exhaust gases?

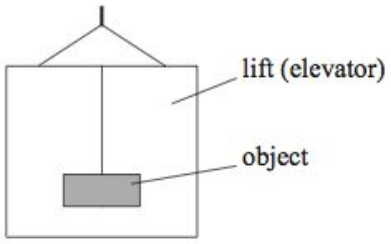
A. mv

B. mv^2

C. mvt

D. $\frac{mv}{t}$

7. An object is suspended from the roof of a lift (elevator) as shown below.

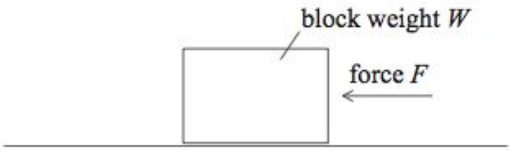


When the lift is moving upwards at **constant speed**, the weight of the object is W and its mass is M.

Which of the following correctly gives the mass and the weight of the object as the lift is **accelerating upwards**?

	Mass	Weight
A.	M	W
B.	M	greater than W
C.	greater than M	W
D.	greater than M	greater than W

16. A block of weight W rests on a horizontal surface as shown below.



A horizontal force F acts on the block and is slowly increased from zero until the block begins to move. The coefficient of static friction is μ_S and of dynamic friction is μ_D.

Which of the following is the magnitude of the maximum frictional force between the block and the surface?

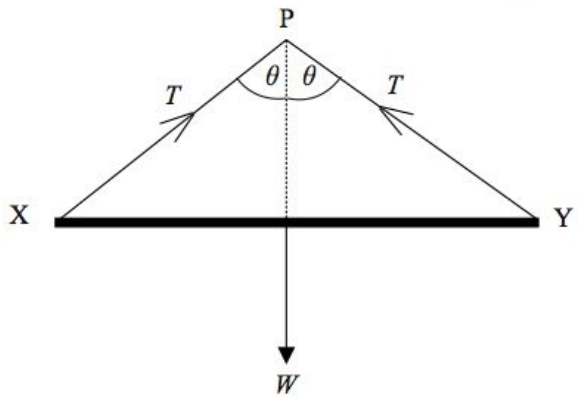
A. $(\mu_S - \mu_D)W$

B. $\mu_S W$

C. $\mu_D W$

D. $(\mu_S + \mu_D)W$

4. A uniform metal bar XY of weight W is hung from a horizontal support at point P by two wires of negligible mass.



Each wire makes an angle θ with the vertical.

Which of the following is equal to the tension T in one of the wires?

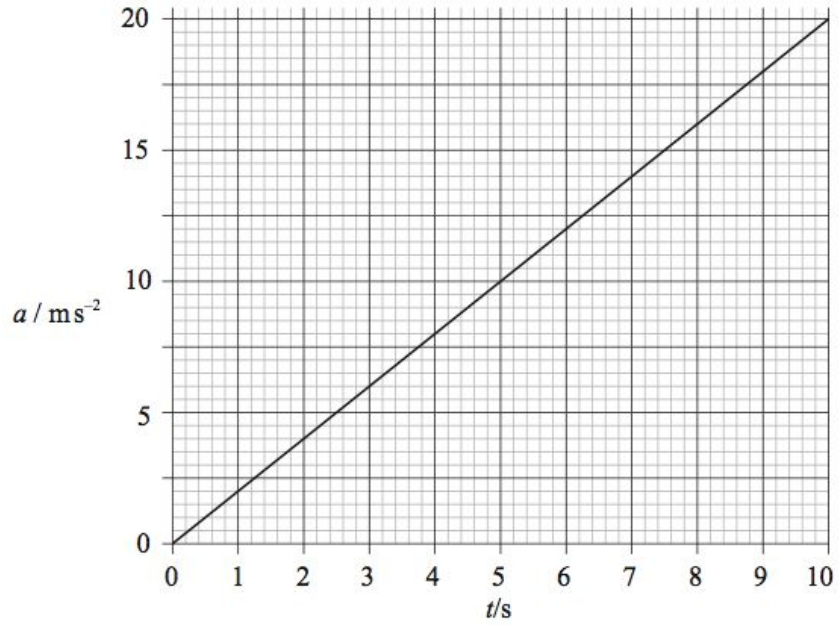
A. $\dfrac{W}{\cos\theta}$

B. $\dfrac{W}{2\cos\theta}$

C. $\dfrac{W}{\sin\theta}$

D. $\dfrac{W}{2\sin\theta}$

5. The graph shows the variation with time t of the acceleration a of an object.



The object is at rest at time $t = 0$.

Which of the following is the velocity of the object at time $t = 6.0$ s?

A. $0.50\ \text{m s}^{-1}$.

B. $2.0\ \text{m s}^{-1}$.

C. $36\ \text{m s}^{-1}$.

D. $72\ \text{m s}^{-1}$.

10. The net force acting on a body is zero. Which of the following quantities must also have zero magnitude for this body?

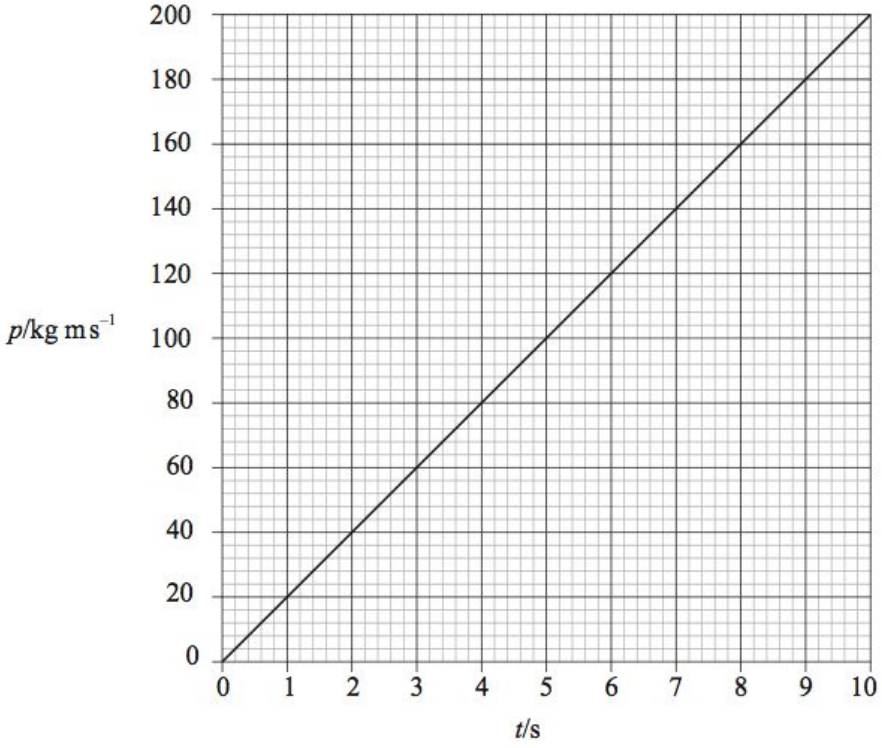
A. Momentum

B. Velocity

C. Speed

D. Acceleration

11. A constant force of magnitude F acts on a body. The graph shows the variation with time t of the momentum p of the body.



The magnitude of the force F is

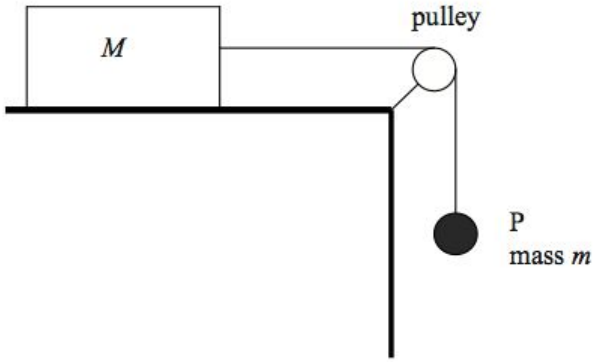
A. 1000 N.

B. 200 N.

C. 20 N.

D. 0.05 N.

12. A block on a frictionless horizontal table is attached by a light, inextensible string to an object P of mass m that hangs vertically as shown below.



The pulley has zero friction and the acceleration of free fall is g. The acceleration of the block and object P is

A. g.

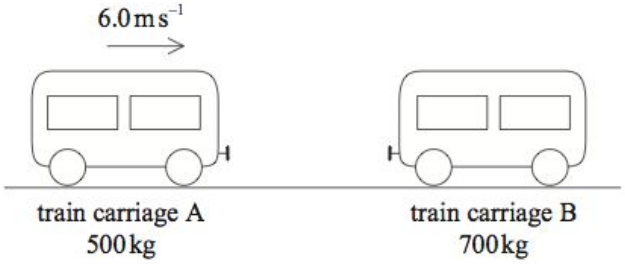
B. $\frac{m}{M}g$.

C. $\frac{m}{m+M}g$.

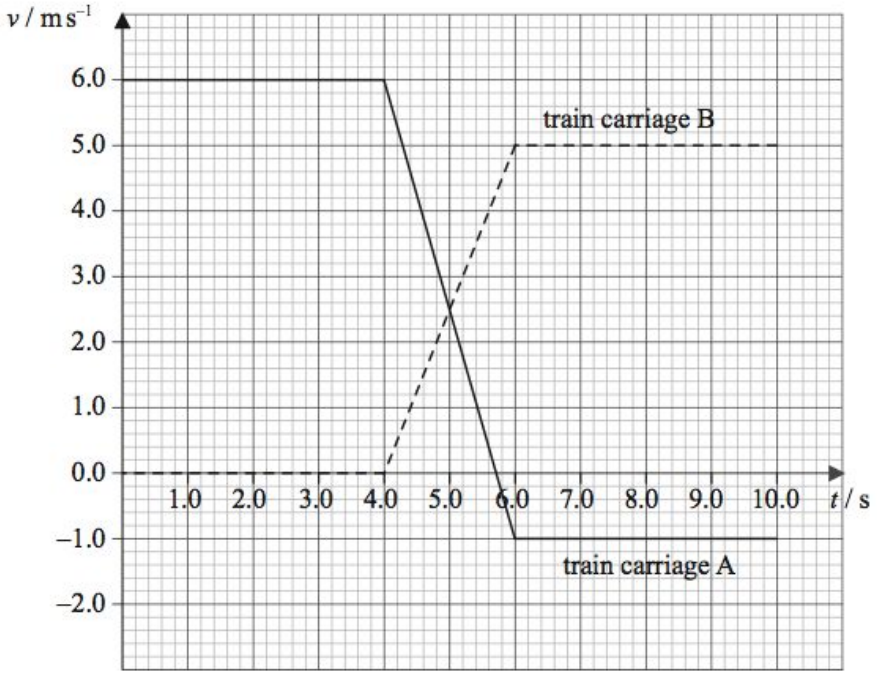
D. $\frac{m+M}{m}g$.

A2. This question is about energy and momentum.

A train carriage A of mass 500 kg is moving horizontally at $6.0\,m\,s^{-1}$. It collides with another train carriage B of mass 700 kg that is initially at rest, as shown in the diagram below.



The graph below shows the variation with time t of the velocities of the two train carriages before, during and after the collision.



(a) Use the graph to deduce that

(i) the total momentum of the system is conserved in the collision. *[2]*

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(b) Calculate the magnitude of the average force experienced by train carriage B. *[3]*

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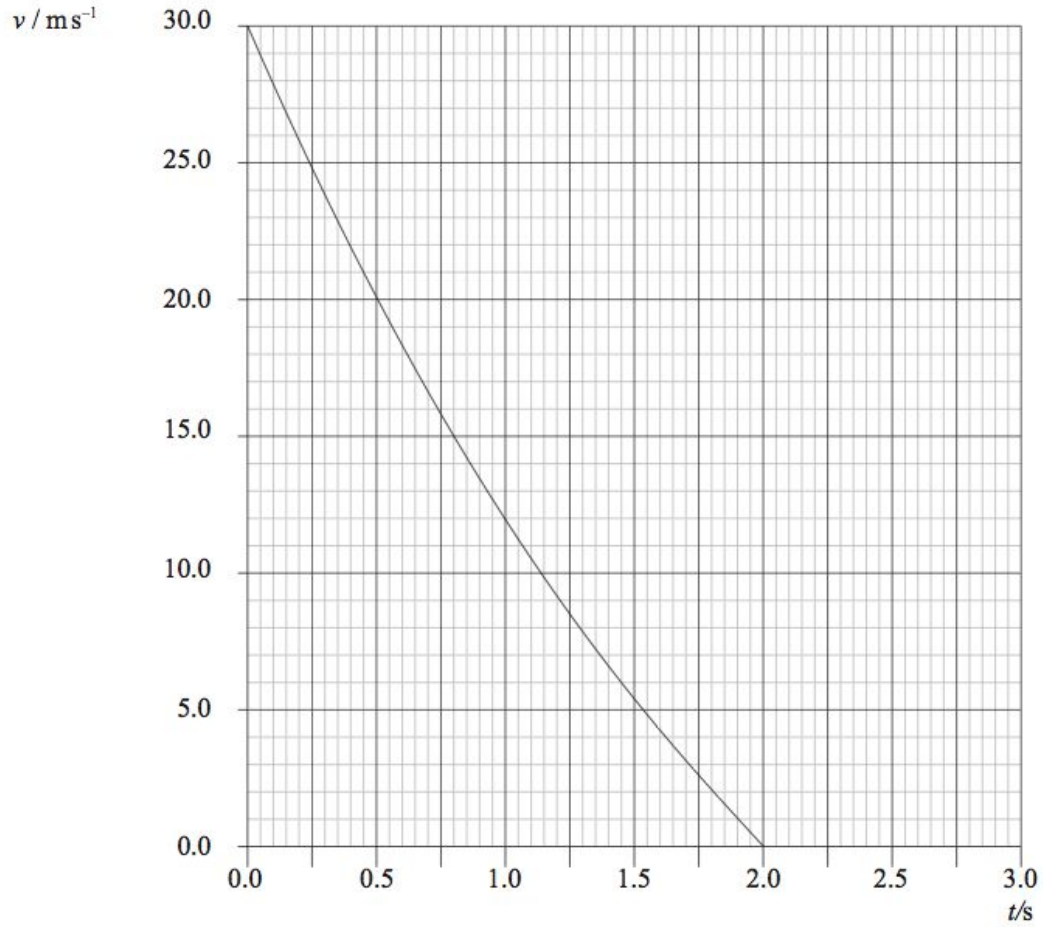
B1. This question is in **two** parts. **Part 1** is about the motion of a ball in the presence of air resistance. **Part 2** is about the emission of electrons from a surface.

Part 1 Motion of a ball

A ball of mass 0.25 kg is projected vertically upwards from the ground with an initial velocity of $30\,m\,s^{-1}$. The acceleration of free fall is $10\,m\,s^{-2}$, but air resistance **cannot** be neglected.

The graph below shows the variation with time t of the velocity v of this ball for the upward part of the motion.



(a) State what the area under the graph represents. *[1]*

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(b) Estimate the maximum height reached by the ball. *[1]*

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(c) Determine, for the ball at $t = 1.0\,\text{s}$,

(i) the acceleration. *[3]*

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(ii) the magnitude of the force of air resistance. *[2]*

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(d) Use the graph to explain, without any further calculations, that the force of air resistance is decreasing in magnitude as the ball moves upward. *[2]*

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B1. This question is about Newton's laws of motion, the dynamics of a model helicopter and the engine that powers it.

(a) Explain how Newton's third law leads to the concept of conservation of momentum in the collision between two objects in an isolated system. *[4]*

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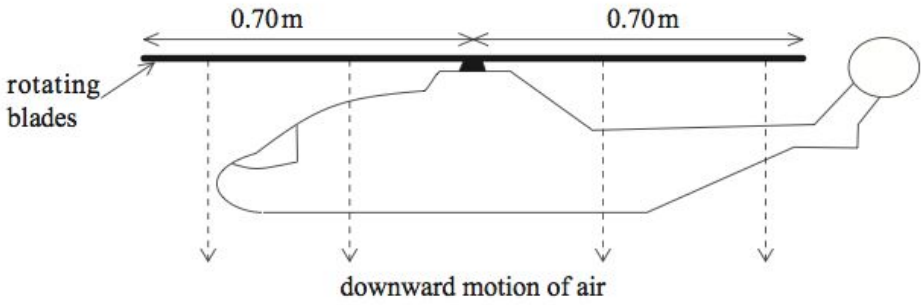
(b) The diagram illustrates a model helicopter that is hovering in a stationary position.



The rotating blades of the helicopter force a column of air to move downwards. Explain how this may enable the helicopter to remain stationary. *[3]*

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(c) The length of each blade of the helicopter in (b) is 0.70 m. Deduce that the area that the blades sweep out as they rotate is 1.5 m^2. (Area of a circle = πr^2) *[1]*

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(d) For the hovering helicopter in (b), it is assumed that all the air beneath the blades is pushed vertically downwards with the same speed of $4.0\,m\,s^{-1}$. No other air is disturbed.

The density of the air is $1.2\,kg\,m^{-3}$.

Calculate, for the air moved downwards by the rotating blades,

(i) the mass per second. *[2]*

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(ii) the rate of change of momentum. *[1]*

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(e) State the magnitude of the force that the air beneath the blades exerts on the blades. *[1]*

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(f) Calculate the mass of the helicopter and its load. *[2]*

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