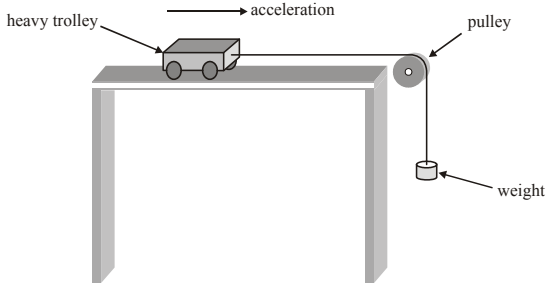
NEWTON'S LAWS REVIEW PROBLEMS

1. This question is about an experiment designed to investigate Newton's second law.

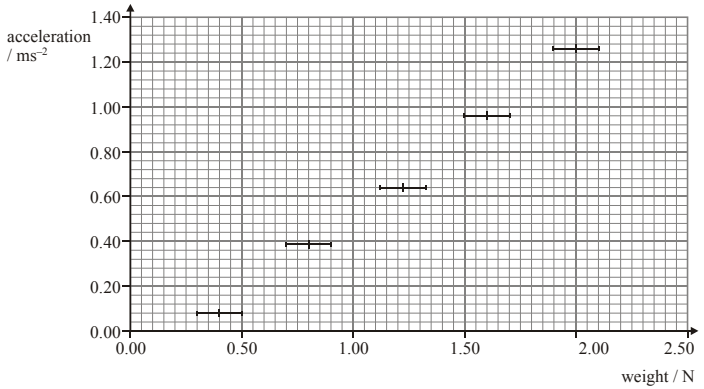
In order to investigate Newton's second law, David arranged for a heavy trolley to be accelerated by small weights, as shown below. The acceleration of the trolley was recorded electronically. David recorded the acceleration for different weights up to a maximum of 3.0 N. He plotted a graph of his results.



(a) Describe the graph that would be expected if two quantities are proportional to one another.

(2)

(b) David's data are shown below, with uncertainty limits included for the value of the weights. Draw the best-fit line for these data.



(2)

(c) Use the graph to

(i) explain what is meant by a *systematic* error.

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(2)

(ii) estimate the value of the frictional force that is acting on the trolley.

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(1)

(iii) estimate the mass of the trolley.

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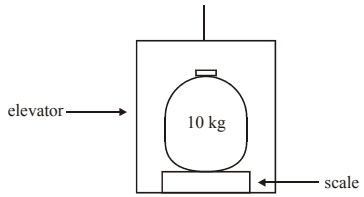
(2)

(Total 9 marks)

2. An elevator (lift) is used to either raise or lower sacks of potatoes. In the diagram, a sack of potatoes of mass 10 kg is resting on a scale that is resting on the floor of an accelerating elevator. The scale reads 12 kg.



The best estimate for the acceleration of the elevator is

A. 2.0 m s^{-2} downwards.

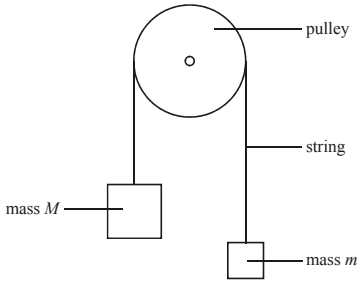
B. 2.0 m s^{-2} upwards.

C. 1.2 m s^{-2} downwards.

D. 1.2 m s^{-2} upwards.

(1)

3. A light inextensible string has a mass attached to each end and passes over a frictionless pulley as shown.



The masses are of magnitudes M and m, where $m < M$. The acceleration of free fall is g. The downward acceleration of the mass M is

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

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

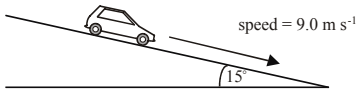
C. $\frac{(M+m)g}{(M-m)}$.

D. $\frac{Mg}{(M+m)}$.

(1)

4. This question is about the breaking distance of a car and specific heat capacity.

(a) A car of mass 960 kg is free-wheeling down an incline at a constant speed of 9.0 m s^{-1}.



The slope makes an angle of 15° with the horizontal.

(i) Deduce that the average resistive force acting on the car is 2.4×10^{3}N.

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(2)

(ii) Calculate the kinetic energy of the car.

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(1)

(b) The driver now applies the brakes and the car comes to rest in 15 m. Use your answer to (a)(ii) to calculate the average braking force exerted on the car in coming to rest.

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(2)

(c) The same braking force is applied to each rear wheel of the car. The effective mass of each brake is 5.2 kg with a specific heat capacity of 900 J kg^{-1} K^{-1}. Estimate the rise in temperature of a brake as the car comes to rest. State **one** assumption that you make in your estimation.

estimate:

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assumption:

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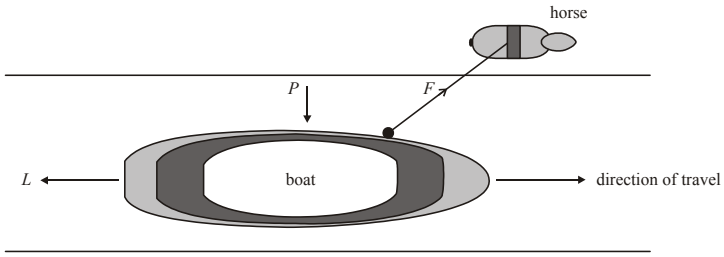
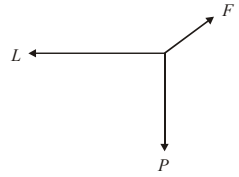
(4)
(Total 9 marks)

5. A horse pulls a boat along a canal at constant speed in a straight-line as shown below.

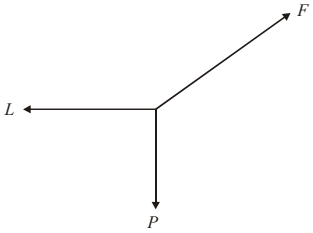


The horse exerts a constant force *F* on the boat. The water exerts a constant drag force *L* and a constant force *P* on the boat. The directions of *F*, *L* and *P* are as shown. Which **one** of the following best represents a free-body diagram for the boat?

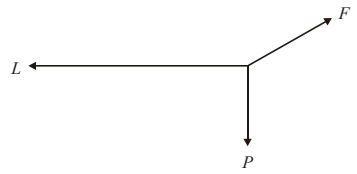
A.



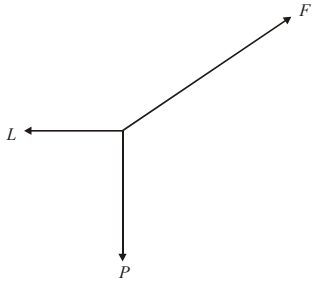
B.



C.



D.



(1)

6. Two blocks having different masses slide down a frictionless slope.

Which of the following correctly compares the accelerating force acting on each block and also the accelerations of the blocks down the slope?

	Accelerating force	Acceleration
A.	Equal	Equal
B.	Equal	Different
C.	Different	Equal
D.	Different	Different

(1)

7. If the resultant external force acting on a particle is zero, the particle

A. must have constant speed.

B. must be at rest.

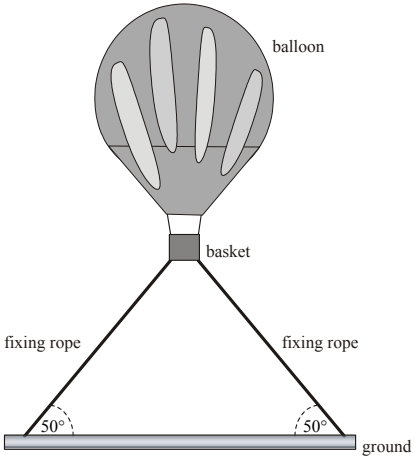
C. must have constant velocity.

D. must have zero momentum.

(1)

8. This question is about a balloon used to carry scientific equipment.

The diagram below represents a balloon just before take-off. The balloon's basket is attached to the ground by two fixing ropes.



There is a force F vertically upwards of 2.15×10^3 N on the balloon. The total mass of the balloon and its basket is 1.95×10^2 kg.

(a) State the magnitude of the resultant force on the balloon when it is attached to the ground.

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(1)

(b) Calculate the tension in **either** of the fixing ropes.

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(3)

(c) The fixing ropes are released and the balloon accelerates upwards. Calculate the magnitude of this initial acceleration.

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(2)

(d) The balloon reaches a terminal speed 10 seconds after take-off. The upward force F remains constant. Describe how the magnitude of air friction on the balloon varies during the first 10 seconds of its flight.

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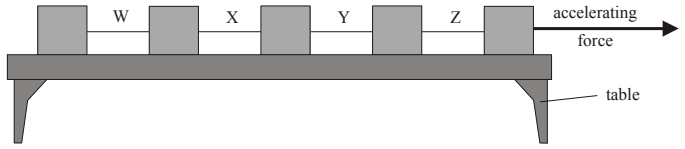
(2)
(Total 8 marks)

9. The diagram below shows five wooden blocks joined by inelastic strings. A constant force accelerates the blocks to the right on a frictionless horizontal table.



In which string is the tension the greatest?

A. W

B. X

C. Y

D. Z

(1)

10. Which of the following quantities **must** be zero for a particle in equilibrium?

A. Kinetic energy

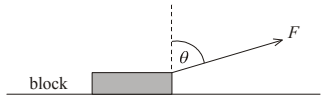
B. Acceleration

C. Velocity

D. Momentum

(1)

11. A block of mass m is pulled along a horizontal, frictionless surface by a force of magnitude F. The force makes an angle θ with the vertical.



The magnitude of the acceleration of the block in the horizontal direction produced by the force F is

A. $\frac{F}{m}$.

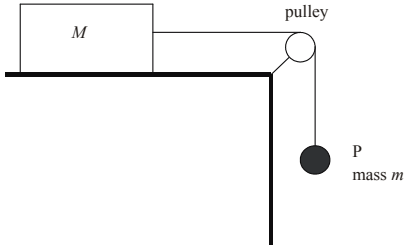
B. $\frac{F\sin\theta}{m}$.

C. $\frac{F\cos\theta}{m}$.

D. $\frac{F\tan\theta}{m}$.

(1)

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.

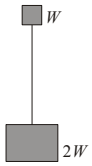
B. $\frac{m}{M}g$.

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

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

(1)

13. A body of weight $2W$ hangs vertically from a string attached to a body of weight W. Weight W is released and both bodies fall vertically.



Air resistance may be neglected. What is the tension in the string during the fall?

A. Zero

B. W

C. $2W$

D. $3W$

(1)