Exercise 3 – Forces and Energy

Past paper Homework Questions

1. A person stands on bathroom scales in a lift. The scales show a reading greater than the person's weight.

The lift is moving

A upwards at constant velocity

B downwards at constant velocity

C downwards and accelerating

D downwards and decelerating

E upwards and decelerating.

2. A person stands on a weighing machine in a lift. When the lift is at rest, the reading on the machine is 700 N. The lift now descends and its speed increases at a constant rate. The reading on the machine

A is a constant value higher than 700 N

B is a constant value lower than 700 N

C continually increases from 700 N

D continually decreases from 700 N

E remains constant at 700 N.

3. The total mass of a motorcycle and rider is 250 kg. During braking, they are brought to rest from a speed of $16{\cdot}0\,m\,s^{-1}$ in a time of 10·0 s.

The maximum energy which could be converted to heat in the brakes is

A 2000 J

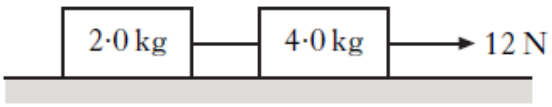
B 4000 J

C 32 000 J

D 40 000 J

E 64 000 J.

4. Two boxes on a frictionless horizontal surface are joined together by a string. A constant horizontal force of 12 N is applied as shown.



The tension in the string joining the two boxes is

A 2·0 N

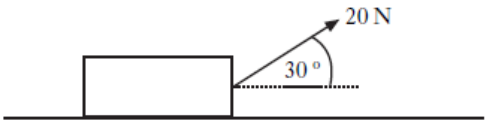
B 4·0 N

C 6·0 N

D 8·0 N

E 12 N.

5. A box of weight 120 N is placed on a smooth horizontal surface.
A force of 20 N is applied to the box as shown.



The box is pulled a distance of 50 m along the surface.

The work done in pulling the box is

A 500 J

B 866 J

C 1000 J

D 6000 J

E 6866 J.

6. A skydiver of total mass 85 kg is falling vertically.

At one point during the fall, the air resistance on the skydiver is 135 N.

The acceleration of the skydiver at this point is

A $0{\cdot}6\,m\,s^{-2}$

B $1{\cdot}6\,m\,s^{-2}$

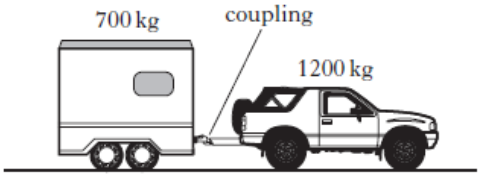
C $6{\cdot}2\,m\,s^{-2}$

D $8{\cdot}2\,m\,s^{-2}$

E $13{\cdot}8\,m\,s^{-2}$.

7. A car of mass 1200 kg pulls a horsebox of mass 700 kg along a straight, horizontal road.

They have an acceleration of $2{\cdot}0\,m\,s^{-2}$.



Assuming that the frictional forces are negligible, the tension in the coupling between the car and the horsebox is

A 500 N

B 700 N

C 1400 N

D 2400 N

E 3800 N.

8. A car of mass 1000 kg is travelling at a speed of $40\,m\,s^{-1}$ along a race track. The brakes are applied and the speed of the car decreases to $10\,m\,s^{-1}$.

How much kinetic energy is lost by the car?

A 15 kJ

B 50 kJ

C 450 kJ

D 750 kJ

E 800 kJ

9. A rocket of mass 200 kg accelerates vertically upwards from the surface of a planet at $2{\cdot}0\,m\,s^{-2}$.

The gravitational field strength on the planet is $4{\cdot}0\,N\,kg^{-1}$.

What is the size of the force being exerted by the rocket's engines?

A 400 N

B 800 N

C 1200 N

D 2000 N

E 2400 N

10. Two blocks are linked by a newton balance of negligible mass.

The blocks are placed on a level, frictionless surface. A force of 18·0 N is applied to the blocks as shown.

The reading on the newton balance is

A 7·2 N

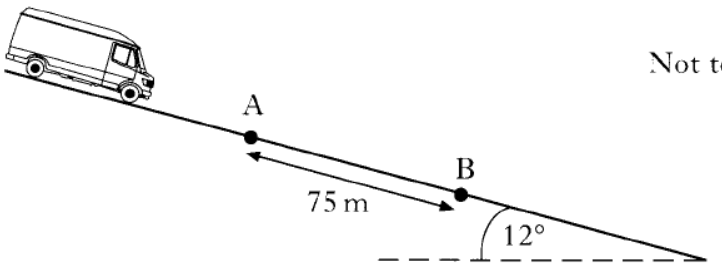
B 9·0 N

C 10·8 N

D 18·0 N

E 40·0 N.

11. A van of mass 2600 kg moves down a slope which is inclined at 12° to the horizontal as shown.



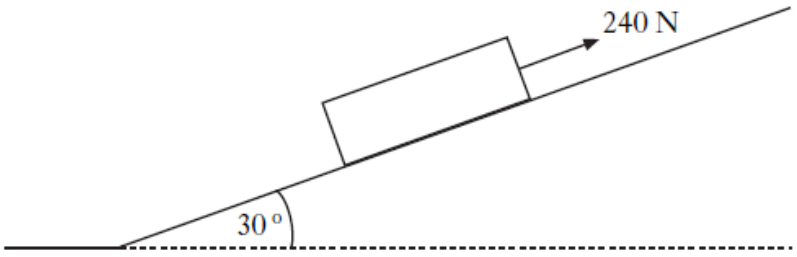
(*a*) Calculate the component of the van's weight parallel to the slope. **2**

(*b*) A constant frictional force of 1400 N acts on the van as it moves down the slope.

Calculate the acceleration of the van. **2**

(4)

12. A crate of mass 40·0 kg is pulled up a slope using a rope.
The slope is at an angle of 30° to the horizontal.



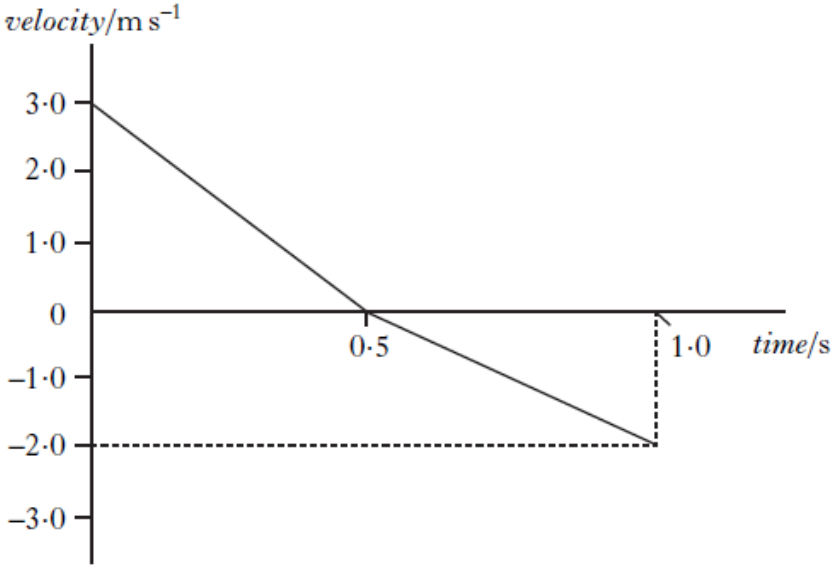
A force of 240 N is applied to the crate parallel to the slope.
The crate moves at a constant speed of 3·0 m s^{-1}.

(*a*) (i) Calculate the component of the weight of the crate acting parallel to the slope. **2**

(ii) Calculate the frictional force acting on the crate. **2**

(*b*) As the crate is moving up the slope, the rope snaps.

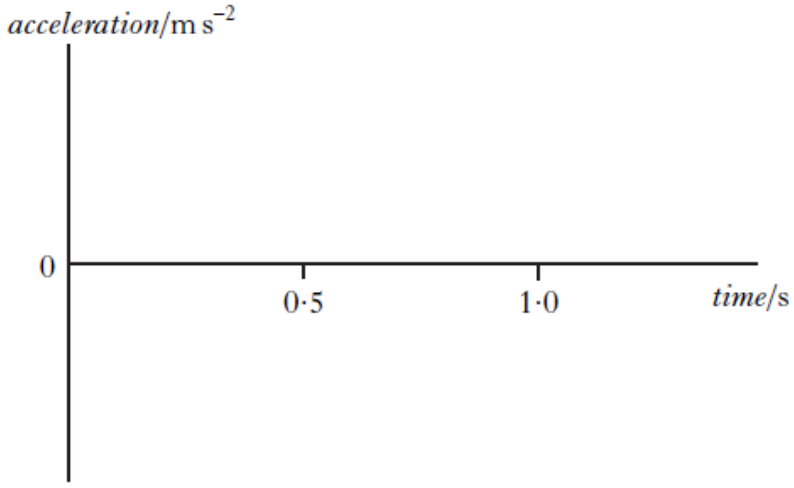
The graph shows how the velocity of the crate changes from the moment the rope snaps.



(i) Describe the motion of the crate during the first 0·5 s after the rope snaps. **1**

(ii) Copy the axes shown below and sketch the graph to show the acceleration of the crate between 0 and 1·0 s.

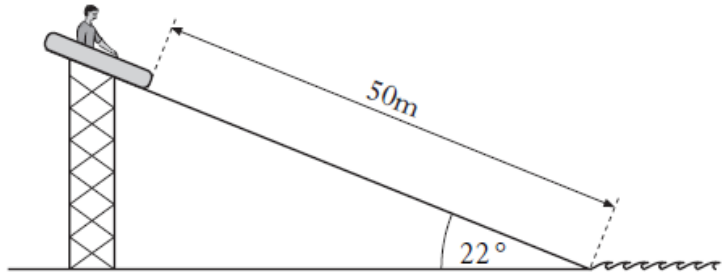
Appropriate numerical values are also required on the acceleration axis. **2**



(iii) Explain, in terms of the forces acting on the crate, why the magnitude of the acceleration changes at 0·5 s. **2**

(9)

13. A fairground ride consists of rafts which slide down a slope into water.



The slope is at an angle of 22 ° to the horizontal. Each raft has a mass of 8·0 kg. The length of the slope is 50 m.

A child of mass 52 kg sits in a raft at the top of the slope. The raft is released from rest. The child and raft slide together down the slope into the water. The force of friction between the raft and slope remains constant at 180 N.

(*a*) Calculate the component of weight, in newtons, of the child and raft down the slope. **1**

(*b*) Show by calculation that the acceleration of the child and raft down the slope is 0·67 m s^{-2}. **2**

(*c*) Calculate the speed of the child and raft at the bottom of the slope. **2**

(*d*) A second child of smaller mass is released from rest in an identical raft at the same starting point. The force of friction is the same as before.

How does the speed of this child and raft at the bottom of the slope compare with the answer to part (*c*)?

Justify your answer. **2**

(7)

30 marks