Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

AS and A level Further Mathematics
Further Mechanics 1

Practice Paper
Work, energy and power (part 1)

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

Instructions

- Use black ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer all the questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 10 questions in this question paper. The total mark for this paper is 80.
- The marks for each question are shown in brackets – use this as a guide as to how much time to spend on each question.
- Calculators must not be used for questions marked with a * sign.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

1. A van of mass 900 kg is moving down a straight road that is inclined at an angle θ to the horizontal, where $\sin\ \theta = \frac{1}{30}$. The resistance to motion of the van has constant magnitude 570 N. The engine of the van is working at a constant rate of 12.5 kW.

At the instant when the van is moving down the road at 5 m s^{-1}, the acceleration of the van is a m s^{-2}.

Find the value of a.

(Total 5 marks)

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2. A van of mass 600 kg is moving up a straight road inclined at an angle θ to the horizontal, where $\sin\ \theta = \frac{1}{16}$. The resistance to motion of the van from non-gravitational forces has constant magnitude R newtons. When the van is moving at a constant speed of 20 m s^{-1}, the van's engine is working at a constant rate of 25 kW.

(*a*) Find the value of R.

(4)

The power developed by the van's engine is now increased to 30 kW. The resistance to motion from non-gravitational forces is unchanged. At the instant when the van is moving up the road at 20 m s^{-1}, the acceleration of the van is a m s^{-2}.

(*b*) Find the value of a.

(4)

(Total 8 marks)

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3. A caravan of mass 600 kg is towed by a car of mass 900 kg along a straight horizontal road. The towbar joining the car to the caravan is modelled as a light rod parallel to the road. The total resistance to motion of the car is modelled as having magnitude 300 N. The total resistance to motion of the caravan is modelled as having magnitude 150 N. At a given instant the car and the caravan are moving with speed 20 m s^{-1} and acceleration 0.2 m s^{-2}.

(*a*) Find the power being developed by the car's engine at this instant.

(5)

(*b*) Find the tension in the towbar at this instant.

(2)

(Total 7 marks)

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4. A car of mass 1000 kg moves with constant speed V m s^{-1} up a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{30}$. The engine of the car is working at a rate of 12 kW. The resistance to motion from non-gravitational forces has magnitude 500 N.

Find the value of V.

(Total 5 marks)

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5. A truck of mass 900 kg is towing a trailer of mass 150 kg up an inclined straight road with constant speed 15 m s^{-1}. The trailer is attached to the truck by a light inextensible towbar which is parallel to the road. The road is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{9}$. The resistance to motion of the truck from non-gravitational forces has constant magnitude 200 N and the resistance to motion of the trailer from non-gravitational forces has constant magnitude 50 N.

(*a*) Find the rate at which the engine of the truck is working.

(5)

When the truck and trailer are moving up the road at 15 m s^{-1} the towbar breaks, and the trailer is no longer attached to the truck. The rate at which the engine of the truck is working is unchanged. The resistance to motion of the truck from non-gravitational forces and the resistance to motion of the trailer from non-gravitational forces are still forces of constant magnitudes 200 N and 50 N respectively.

(*b*) Find the acceleration of the truck at the instant after the towbar breaks.

(3)

(*c*) Use the work-energy principle to find out how much further up the road the trailer travels before coming to instantaneous rest.

(4)

(Total 12 marks)

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6. A car of mass 800 kg is moving on a straight road which is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{20}$. The resistance to the motion of the car from non-gravitational forces is modelled as a constant force of magnitude R newtons. When the car is moving up the road at a constant speed of 12.5 m s^{-1}, the engine of the car is working at a constant rate of $3P$ watts. When the car is moving down the road at a constant speed of 12.5 m s^{-1}, the engine of the car is working at a constant rate of P watts.

(*a*) Find

(i) the value of P,

(ii) the value of R.

(6)

When the car is moving up the road at 12.5 m s^{-1} the engine is switched off and the car comes to rest, without braking, in a distance d metres. The resistance to the motion of the car from non-gravitational forces is still modelled as a constant force of magnitude R newtons.

(*b*) Use the work-energy principle to find the value of d.

(4)

(Total 10 marks)

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7. A particle P of mass 3 kg moves from point A to point B up a line of greatest slope of a fixed rough plane. The plane is inclined at 20° to the horizontal. The coefficient of friction between P and the plane is 0.4.

Given that $AB = 15$ m and that the speed of P at A is 20 m s^{-1}, find

(*a*) the work done against friction as P moves from A to B,

(3)

(*b*) the speed of P at B.

(4)

(Total 7 marks)

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8. A ball of mass 0.2 kg is projected vertically upwards from a point O with speed 20 m s^{-1}. The non-gravitational resistance acting on the ball is modelled as a force of constant magnitude 1.24 N and the ball is modelled as a particle. Find, using the work-energy principle, the speed of the ball when it first reaches the point which is 8 m vertically above O.

(Total 6 marks)

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9. A truck of mass 1800 kg is towing a trailer of mass 800 kg up a straight road which is inclined to the horizontal at an angle α, where $\sin \alpha = \frac{1}{20}$. The truck is connected to the trailer by a light inextensible rope which is parallel to the direction of motion of the truck. The resistances to motion of the truck and the trailer from non-gravitational forces are modelled as constant forces of magnitudes 300 N and 200 N respectively. The truck is moving at constant speed v m s^{-1} and the engine of the truck is working at a rate of 40 kW.

(*a*) Find the value of v.

(5)

As the truck is moving up the road the rope breaks.

(*b*) Find the acceleration of the truck immediately after the rope breaks.

(4)

(Total 9 marks)

10.

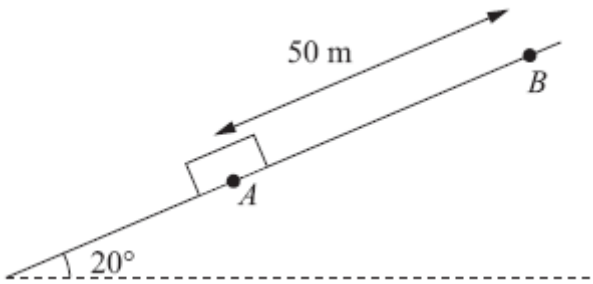

Figure 1

A box of mass 30 kg is held at rest at point A on a rough inclined plane. The plane is inclined at 20° to the horizontal. Point B is 50 m from A up a line of greatest slope of the plane, as shown in Figure 1. The box is dragged from A to B by a force acting parallel to AB and then held at rest at B. The coefficient of friction between the box and the plane is $\frac{1}{4}$. Friction is the only non-gravitational resistive force acting on the box. Modelling the box as a particle,

(*a*) find the work done in dragging the box from A to B.

(6)

The box is released from rest at the point B and slides down the slope. Using the work-energy principle, or otherwise,

(*b*) find the speed of the box as it reaches A.

(5)

(Total 11 marks)

TOTAL FOR PAPER: 80 MARKS