CLASSIFIED
International Examinations Papers
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Mechanics

TOPIC- Energy, Work & Power

Work Done

Energy, Work & Power-WORK DONE

1 A block B of mass 2.7 kg is pulled at constant speed along a straight line on a rough horizontal floor. The pulling force has magnitude 25 N and acts at an angle of θ above the horizontal. The normal component of the contact force acting on B has magnitude 20 N. J-15-41-1

(i) Show that $\sin\theta = 0.28$. [2]

(ii) Find the work done by the pulling force in moving the block a distance of 5 m. [2]

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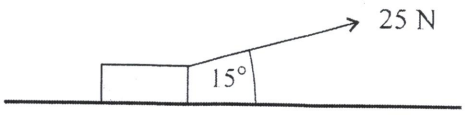
2 A block is being pulled along a horizontal floor by a rope inclined at 20° to the horizontal. The tension in the rope is 851 N and the block moves at a constant speed of 2.5 m s^{-1}.

(i) Show that the work done on the block in 12 s is approximately 24 kJ. [3]

(ii) Hence find the power being applied to the block, giving your answer to the nearest kW. [1]

3



A crate of mass 3 kg is pulled at constant speed along a horizontal floor. The pulling force has magnitude 25 N and acts at an angle of 15° to the horizontal, as shown in the diagram. Find

(i) the work done by the pulling force in moving the crate a distance of 2 m, [2]

(ii) the normal component of the contact force on the crate. [3]

4 A load of mass 160 kg is lifted vertically by a crane, with constant acceleration. The load starts from rest at the point O. After 7 s, it passes through the point A with speed $0.5\,\text{m s}^{-1}$. By considering energy, find the work done by the crane in moving the load from O to A. [6]

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5 A lorry of mass 15 000 kg climbs from the bottom to the top of a straight hill, of length 1440 m, at a constant speed of 15 m s^{-1}. The top of the hill is 16 m above the level of the bottom of the hill. The resistance to motion is constant and equal to 1800 N.

41-N-13

(i) Find the work done by the driving force. [4]

On reaching the top of the hill the lorry continues on a straight horizontal road and passes through a point P with speed 24 m s^{-1}. The resistance to motion is constant and is now equal to 1600 N. The work done by the lorry's engine from the top of the hill to the point P is 5030 kJ.

(ii) Find the distance from the top of the hill to the point P. [3]

6 A car of mass 1250 kg travels from the bottom to the top of a straight hill which has length 400 m and is inclined to the horizontal at an angle of α, where $\sin \alpha = 0.125$. The resistance to the car's motion is 800 N. Find the work done by the car's engine in each of the following cases.

42-J-12-fc/

(i) The car's speed is constant. [4]

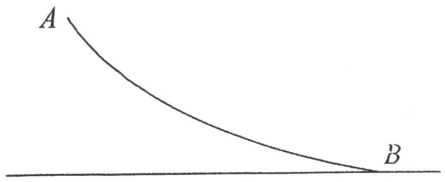
(ii) The car's initial speed is $6\,\text{m s}^{-1}$, the car's driving force is 3 times greater at the top of the hill than it is at the bottom, and the car's power output is 5 times greater at the top of the hill than it is at the bottom. [5]

7 A car of mass 120$\cap$ kg travels along a horizontal straight road. The power provided by the car's engine is constant and equal to 20 kW. The resistance to the car's motion is constant and equal to 500 N. The car passes through the points A and B with speeds 10 m s^{-1} and 25 m s^{-1} respectively. The car takes 30.5 s to travel from A to B.

(i) Find the acceleration of the car at A. [4]

(ii) By considering work and energy, find the distance AB. [8]

08

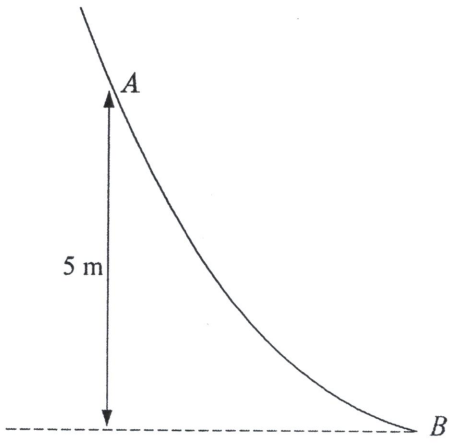


The diagram shows a vertical cross-section of a surface. A and B are two points on the cross-section. A particle of mass 0.15 kg is released from rest at A.

(i) Assuming that the particle reaches B with a speed of $8\,\text{m s}^{-1}$ and that there are no resistances to motion, find the height of A above B. [3]

(ii) Assuming instead that the particle reaches B with a speed of $6\,\text{m s}^{-1}$ and that the height of A above B is 4 m, find the work done against the resistances to motion. [3]

09



The diagram shows the vertical cross-section of a surface. A and B are two points on the cross-section, and A is 5 m higher than B. A particle of mass 0.35 kg passes through A with speed 7 m s^{-1}, moving on the surface towards B.

N-7

(i) Assuming that there is no resistance to motion, find the speed with which the particle reaches B. [3]

(ii) Assuming instead that there is a resistance to motion, and that the particle reaches B with speed 11 m s^{-1}, find the work done against this resistance as the particle moves from A to B. [3]

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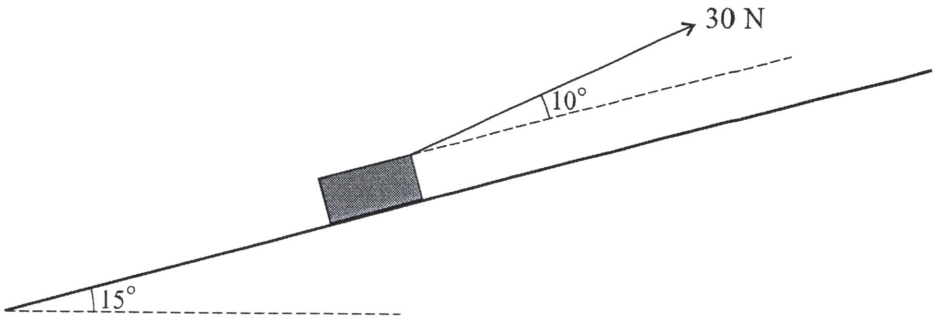


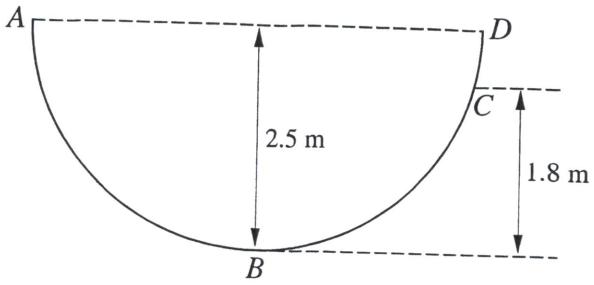
A box of mass 8 kg is pulled, at constant speed, up a straight path which is inclined at an angle of 15° to the horizontal. The pulling force is constant, of magnitude 30 N, and acts upwards at an angle of 10° from the path (see diagram). The box passes through the points A and B, where $AB = 20$ m and B is above the level of A. For the motion from A to B, find

(i) the work done by the pulling force, [2]

(ii) the gain in potential energy of the box, [2]

(iii) the work done against the resistance to motion of the box. [1]

11



$ABCD$ is a semi-circular cross-section, in a vertical plane, of the inner surface of half a hollow cylinder of radius 2.5 m which is fixed with its axis horizontal. AD is horizontal, B is the lowest point of the cross-section and C is at a height of 1.8 m above the level of B (see diagram). A particle P of mass 0.8 kg is released from rest at A and comes to instantaneous rest at C. 43-N-12

(i) Find the work done on P by the resistance to motion while P travels from A to C. [2]

The work done on P by the resistance to motion while P travels from A to B is 0.6 times the work done while P travels from A to C.

(ii) Find the speed of P when it passes through B. [3]

12 A and B are two points 50 metres apart on a straight path inclined at an angle θ to the horizontal, where $\sin\theta = 0.05$, with A above the level of B. A block of mass 16 kg is pulled down the path from A to B. The block starts from rest at A and reaches B with a speed of $10\,\text{m s}^{-1}$. The work done by the pulling force acting on the block is 1150 J.

42-J-13

(i) Find the work done against the resistance to motion. [3]

The block is now pulled up the path from B to A. The work done by the pulling force and the work done against the resistance to motion are the same as in the case of the downward motion.

(ii) Show that the speed of the block when it reaches A is the same as its speed when it started at B. [2]

13 A train of mass 200 000 kg moves on a horizontal straight track. It passes through a point A with speed 28 m s^{-1} and later it passes through a point B. The power of the train's engine at B is 1.2 times the power of the train's engine at A. The driving force of the train's engine at B is 0.96 times the driving force of the train's engine at A.

N-14-42-3

(i) Show that the speed of the train at B is 35 m s^{-1}. [2]

(ii) For the motion from A to B, find the work done by the train's engine given that the work done against the resistance to the train's motion is 2.3×10^6 J. [3]

14 A girl on a sledge starts, with a speed of $5\,\text{m s}^{-1}$, at the top of a slope of length 100 m which is at an angle of 20° to the horizontal. The sledge slides directly down the slope. 42-N-16

(i) Given that there is no resistance to the sledge's motion, find the speed of the sledge at the bottom of the slope. [3]

(ii) It is given instead that the sledge experiences a resistance to motion such that the total work done against the resistance is 8500 J, and the speed of the sledge at the bottom of the slope is $21\,\text{m s}^{-1}$. Find the total mass of the girl and the sledge. [3]

15 A lorry of mass 16 000 kg moves on a straight hill inclined at angle $\alpha°$ to the horizontal. The length of the hill is 500 m.

43-J-12

(i) While the lorry moves from the bottom to the top of the hill at constant speed, the resisting force acting on the lorry is 800 N and the work done by the driving force is 2800 kJ. Find the value of α. [4]

(ii) On the return journey the speed of the lorry is $20\,\text{m s}^{-1}$ at the top of the hill. While the lorry travels down the hill, the work done by the driving force is 2400 kJ and the work done against the resistance to motion is 800 kJ. Find the speed of the lorry at the bottom of the hill. [4]

16 A lorry of mass 15 000 kg climbs a hill of length 500 m at a constant speed. The hill is inclined at 2.5° to the horizontal. The resistance to the lorry's motion is constant and equal to 800 N.

N-12-41-6

(i) Find the work done by the lorry's driving force. [4]

On its return journey the lorry reaches the top of the hill with speed 20 m s^{-1} and continues down the hill with a constant driving force of 2000 N. The resistance to the lorry's motion is again constant and equal to 800 N.

(ii) Find the speed of the lorry when it reaches the bottom of the hill. [5]

17 A crane is used to raise a block of mass 50 kg vertically upwards at constant speed through a height of 3.5 m. There is a constant resistance to motion of 25 N. N+H-43-1

(i) Find the work done by the crane. [3]

(ii) Given that the time taken to raise the block is 2 s, find the power of the crane. [2]

18 A small block is pulled along a rough horizontal floor at a constant speed of $1.5\,\text{m s}^{-1}$ by a constant force of magnitude 30 N acting at an angle of $\theta°$ upwards from the horizontal. Given that the work done by the force in 20 s is 720 J, calculate the value of θ. [3]

(J-5)

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19 A particle of mass 0.8 kg slides down a rough inclined plane along a line of greatest slope AB. The distance AB is 8 m. The particle starts at A with speed $3\,\text{m s}^{-1}$ and moves with constant acceleration $2.5\,\text{m s}^{-2}$.

4/-N-10

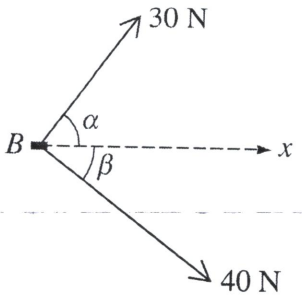
(i) Find the speed of the particle at the instant it reaches B. [2]

(ii) Given that the work done against the frictional force as the particle moves from A to B is 7 J, find the angle of inclination of the plane. [4]

When the particle is at the point X its speed is the same as the average speed for the motion from A to B.

(iii) Find the work done by the frictional force for the particle's motion from A to X. [3]

20



A block **B** lies on a rough horizontal plane. Horizontal forces of magnitudes 30 N and 40 N, making angles of α and β respectively with the **x**-direction, act on **B** as shown in the diagram, and **B** is moving in the **x**-direction with constant speed. It is given that $\cos\alpha = 0.6$ and $\cos\beta = 0.8$.

(i) Find the total work done by the forces shown in the diagram when **B** has moved a distance of 20 m. [2]

(ii) Given that the coefficient of friction between the block and the plane is $\frac{5}{8}$, find the weight of the block. [3]

21 A box of mass 25 kg is pulled in a straight line along a horizontal floor. The box starts from rest at a point A and has a speed of $3\ \text{m s}^{-1}$ when it reaches a point B. The distance AB is 15 m. The pulling force has magnitude 220 N and acts at an angle of $\alpha°$ above the horizontal. The work done against the resistance to motion acting on the box, as the box moves from A to B, is 3000 J. Find the value of α. N-13-42-2 [5]

22 A car of mass 1250 kg travels from the bottom to the top of a straight hill of length 600 m, which is inclined at an angle of 2.5° to the horizontal. The resistance to motion of the car is constant and equal to 400 N. The work done by the driving force is 450 kJ. The speed of the car at the bottom of the hill is 30 m s^{-1}. Find the speed of the car at the top of the hill. [5]

23 An object of mass 8 kg slides down a line of greatest slope of an inclined plane. Its initial speed at the top of the plane is $3\,\text{m s}^{-1}$ and its speed at the bottom of the plane is $8\,\text{m s}^{-1}$. The work done against the resistance to motion of the object is 120 J. Find the height of the top of the plane above the level of the bottom. M2–J–11 [4]

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24 A lorry of mass 16 000 kg climbs from the bottom to the top of a straight hill of length 1000 m at a constant speed of $10\,\text{m s}^{-1}$. The top of the hill is 20 m above the level of the bottom of the hill. The driving force of the lorry is constant and equal to 5000 N. Find

(i) the gain in gravitational potential energy of the lorry, [1]

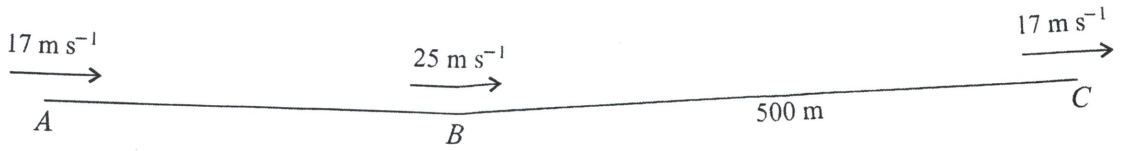
(ii) the work done by the driving force, [1]

(iii) the work done against the force resisting the motion of the lorry. [1]

On reaching the top of the hill the lorry continues along a straight horizontal road against a constant resistance of 1500 N. The driving force of the lorry is not now constant, and the speed of the lorry increases from $10\,\text{m s}^{-1}$ at the top of the hill to $25\,\text{m s}^{-1}$ at the point P. The distance of P from the top of the hill is 2000 m.

(iv) Find the work done by the driving force of the lorry while the lorry travels from the top of the hill to P. [5]

25



7-7-15

A lorry of mass 12 500 kg travels along a road that has a straight horizontal section AB and a straight inclined section BC. The length of BC is 500 m. The speeds of the lorry at A, B and C are 17 m s^{-1}, 25 m s^{-1} and 17 m s^{-1} respectively (see diagram).

(i) The work done against the resistance to motion of the lorry, as it travels from A to B, is 5000 kJ. Find the work done by the driving force as the lorry travels from A to B. [4]

(ii) As the lorry travels from B to C, the resistance to motion is 4800 N and the work done by the driving force is 3300 kJ. Find the height of C above the level of AB. [4]

26 A load is pulled along horizontal ground for a distance of 76 m, using a rope. The rope is inclined at 5° above the horizontal and the tension in the rope is 65 N. 42-J-11

(i) Find the work done by the tension. [2]

At an instant during the motion the velocity of the load is $1.5\ \text{m s}^{-1}$.

(ii) Find the rate of working of the tension at this instant. [2]

Energy, Work & Power-WORK DONE

27 One end of a light inextensible string is attached to a block. The string makes an angle of $\theta°$ with the horizontal. The tension in the string is 20 N. The string pulls the block along a horizontal surface at a constant speed of $1.5\ \text{m s}^{-1}$ for 12 s. The work done by the tension in the string is 50 J. Find θ. [3]

42-J-17

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28 A block is pulled for a distance of 50 m along a horizontal floor, by a rope that is inclined at an angle of $\alpha°$ to the floor. The tension in the rope is 180 N and the work done by the tension is 8200 J. Find the value of α. [3]

29 A block is pulled in a straight line along horizontal ground by a force of constant magnitude acting at an angle of 60° above the horizontal. The work done by the force in moving the block a distance of 5 m is 75 J. Find the magnitude of the force. J-12-42-1 [3]

3 0 A man pushes a wheelbarrow of mass 25 kg along a horizontal road with a constant force of magnitude 35 N at an angle of 20° below the horizontal. There is a constant resistance to motion of 15 N. The wheelbarrow moves a distance of 12 m from rest.

(i) Find the work done by the man. [2]

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(ii) Find the speed attained by the wheelbarrow after 12 m. [3]

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31 A particle of mass 0.6 kg is dropped from a height of 8 m above the ground. The speed of the particle at the instant before hitting the ground is $10\,\text{m}\,\text{s}^{-1}$. Find the work done against air resistance. [3]