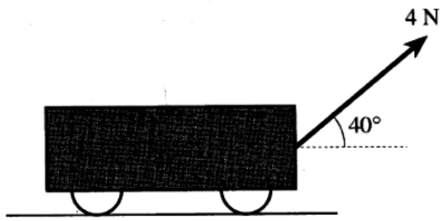
Practice examination 1

Time 1 hour 15 minutes

Answer all the questions.
The use of an electronic calculator is expected, where appropriate.

1



A toy truck is pulled along horizontal ground by means of a force of magnitude 4 N acting at 40° to the direction of motion (see diagram).

(i) Find the work done by the force in moving the truck a distance of 5 m. [3]

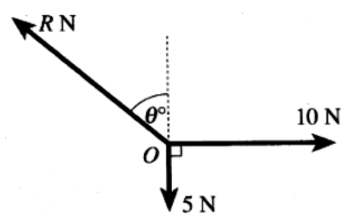
(ii) Given that the truck moves with constant speed, state the magnitude of the force resisting its motion. [1]

2 A child standing at the edge of a cliff 100 m high throws a stone vertically downwards. The stone hits the sea 4 s later. Ignoring air resistance, find

(i) the initial speed with which the stone is thrown, [2]

(ii) the speed with which the stone hits the sea. [2]

3



Three forces, with magnitudes 5 N, 10 N and R N, act at a point O in the directions shown in the diagram. Given that the three forces are in equilibrium, find the values of R and θ. [6]

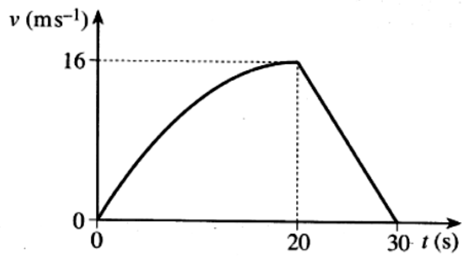
4 An athlete of mass 60 kg runs a distance of 1 km up a hill inclined at 2° to the horizontal. The athlete's speed at the bottom of the hill is 5 m s^{-1} and at the top of the hill is 4 m s^{-1}. Find, for this 1 km run,

(i) the athlete's increase in potential energy, [2]

(ii) the athlete's decrease in kinetic energy, [2]

(iii) the average power exerted by the athlete, assuming that he takes 4 minutes to cover the 1 km distance and that any resistance to motion can be neglected. [3]

5



The diagram shows the velocity–time graph for the motion of a cyclist riding along a road. The cyclist starts from rest, reaches a speed of 16 m s^{-1} after 20 s, and then decelerates uniformly to rest after a further 10 s.

(i) For the final 10 s of the motion, find the deceleration and the distance travelled. [3]

(ii) For the first 20 s of the motion, state with a reason whether the cyclist's acceleration is increasing or decreasing. [2]

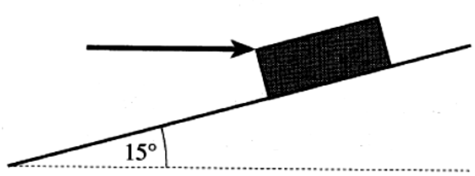
(iii) The equation connecting v and t, for $0 \leqslant t \leqslant 20$, is $v = \frac{1}{25}t(40 - t)$. Calculate the distance travelled by the cyclist during the first 20 s. [4]

6 (i) A car of mass 1200 kg travelling along a horizontal road experiences a resistance to motion of magnitude 150 N. The car is accelerating at 0.5 m s^{-2}. Find the forward driving force acting on the car. [3]

(ii) A trailer of mass 800 kg is now attached to the car. When the car and trailer are travelling along the same road the resistance to motion on the trailer has magnitude 500 N. The resistance on the car, and the forward driving force are the same as before the trailer was attached. Find the acceleration of the car and trailer, and find also the force in the towbar between the car and the trailer. [6]

7 (i) A suitcase of mass 16 kg is placed on a ramp inclined at 15° to the horizontal. The coefficient of friction between the suitcase and the ramp is 0.4. Determine whether the suitcase rests in equilibrium on the ramp, and state the magnitude of the frictional force acting on the suitcase. [4]

(ii)



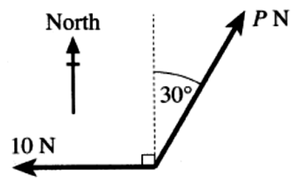
A person tries to push the suitcase up the ramp by applying a horizontal force (see diagram). Show that, for the suitcase to start moving, the magnitude of this force must be at least 120 N, to the nearest newton. [7]

Practice examination 2

Time 1 hour 15 minutes

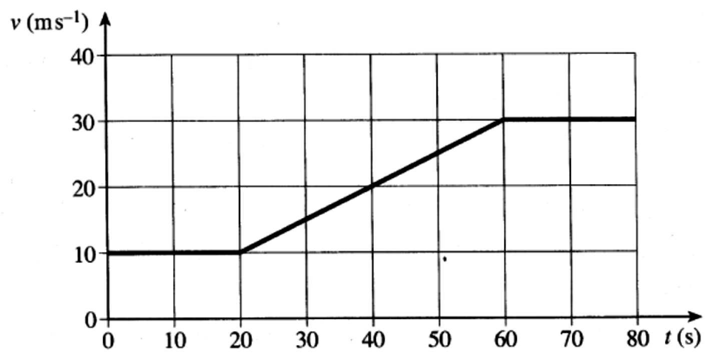
Answer all the questions.
The use of an electronic calculator is expected, where appropriate.

1



Two horizontal forces, of magnitudes 10 N and P N, act on a particle. The force of magnitude 10 N acts due west and the force of magnitude P N acts on a bearing of 030° (see diagram). The resultant of these two forces acts due north. Find the magnitude of this resultant. [4]

2

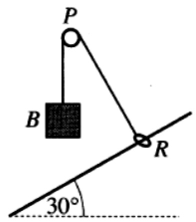


The diagram shows the velocity–time graph for a train during a part of its journey.

(i) Calculate the distance travelled by the train during the period of 80 s shown in the diagram. [3]

(ii) The train has mass 400 tonnes. Calculate the resultant forward force acting on the train while it is accelerating. [3]

3



A small ring R of mass 0.2 kg is threaded onto a fixed rod which is inclined at an angle of 30° to the horizontal. The ring is attached to a block B of mass 0.5 kg by means of a light string which passes over a smooth pulley P. The part RP of the string is perpendicular to the rod, and the part PB of the string is vertical (see diagram). The system is in equilibrium.

(i) State the tension in the string. [1]

(ii) Calculate the magnitude of the normal component of the force acting on R due to the rod. [2]

(iii) Given that the equilibrium is limiting, calculate the coefficient of friction between R and the rod. [3]

4 The sloping part of a 'slide' in a children's playground is 8 m long and slopes at 40° to the horizontal. A child of mass 20 kg slides down, starting at rest at the top and reaching a speed of 6 m s^{-1} at the bottom.

(i) Calculate the total change in energy of the child during this motion, stating whether it is an increase or a decrease. [4]

(ii) The child's motion is resisted by a force of constant magnitude F N. Find F. [2]

5 A particle moving in a straight line has velocity $v \text{ m s}^{-1}$ at time t s, where $v = t(t-6)^2$.

(i) Calculate how far the particle moves between the two times when it is instantaneously at rest. [5]

(ii) Find the set of values of t for which the acceleration is negative. [4]

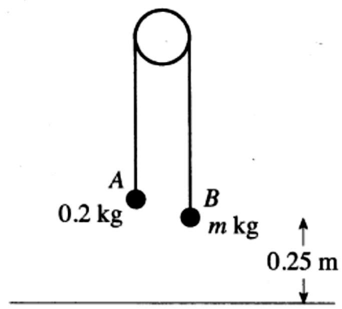
6 The total mass of a cyclist and her bicycle is 120 kg. While pedalling she generates power of 640 W. Her motion is opposed by road resistance of magnitude 16 N, and by air resistance of magnitude $8v$ N, where $v \text{ m s}^{-1}$ is her speed.

(i) Find the cyclist's acceleration when she is riding along a horizontal road at a speed of 5 m s^{-1}. [3]

(ii) Find the greatest speed that she can maintain on a horizontal road. [3]

(iii) When cycling down a hill she finds that she can maintain a speed of 10 m s^{-1}. Find the angle of inclination of the hill to the horizontal, giving your answer correct to the nearest 0.1°. [3]

7



The diagram shows particles A and B, of masses 0.2 kg and m kg respectively, connected by a light inextensible string which passes over a fixed smooth peg. The system is released from rest, with B at a height of 0.25 m above the floor. B descends, hitting the floor 0.5 s later. All resistances to motion may be ignored.

(i) Find the acceleration of B as it descends. [2]

(ii) Find the tension in the string while B is descending, and find also the value of m. [5]

(iii) When B hits the floor it comes to rest immediately, and the string becomes slack. Find the length of time for which B remains at rest on the ground before being jerked into motion again. [3]

<u>Practice 1</u>

1 (i) 15.3 J (ii) 3.06 N

2 (i) 5 m s^{-1} (ii) 45 m s^{-1}

3 $R = 11.2$, $\theta = 63.4$

4 (i) 20 900 J (ii) 270 J (iii) 86.1 W

5 (i) 1.6 m s^{-2}, 80 m
(ii) Decreasing, as the gradient of the curve is decreasing.
(iii) $213\frac{1}{3}$ m (or 213 to the nearest metre)

6 (i) 750 N (ii) 0.05 m s^{-2}, 540 N

7 (i) It does rest in equilibrium, 41.4 N.

<u>Practice 2</u>

1 17.3 N

2 (i) 1600 m (ii) 200 000 N

3 (i) 5 N (ii) 3.27 N (iii) 0.306

4 (i) Decrease of 668 J (ii) 83.6

5 (i) 108 m (ii) $2 < t < 6$

6 (i) 0.6 m s^{-2} (ii) 8 m s^{-1} (iii) 1.5°

7 (i) 2 m s^{-2} (ii) 2.4 N, 0.3 (iii) 0.2 s