MECHANICS: MOTION AND ENERGY QUESTIONS

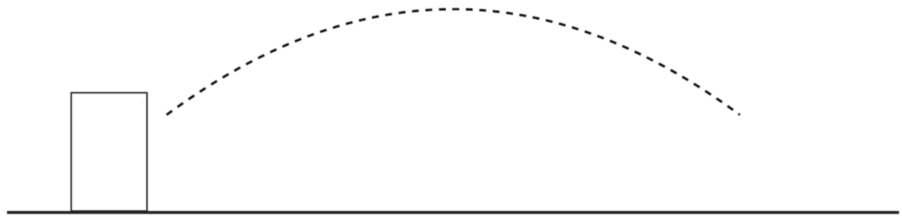
THROWING THE DISCUS - PART 2 (2010;2)

James releases the discus at an angle of 37° to the horizontal.

(a) Describe the energy changes as it **rises**, **falls,** lands and **rolls**, coming to a stop. You may ignore any forces caused by the air.

(b) State the **size and direction of the acceleration** of the discus at the highest point of its trajectory.

(c) It takes 2.4 s to return to the height at which it was released, as shown in the diagram. (James releases the discus at an angle of 37° to the horizontal.)



Calculate the speed at which he releases the discus.

(d) In fact there is a vertical force acting upward on the discus called lift. Explain how this lift force would affect the horizontal distance travelled by the discus.

CIRCULAR MOTION (2009;1)

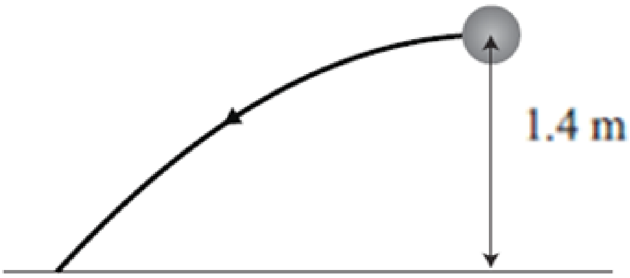
(a) Jordan drops a ball to the floor. The ball bounces up and down a few times. Explain using energy considerations, why the height of bounce of the ball, changes with time.

RELATIVE VELOCITY AND PROJECTILES (2009;2)

Jordan goes to basketball practice. Jordan throws a basketball vertically upward.

(a) Describe and explain what happens to the velocity and acceleration of the ball while it is in the air.

(b) Jordan then throws the basketball horizontally, with an initial horizontal velocity of 7.8 ms^{-1}, at a height of 1.4 m from the floor.



Calculate the velocity (magnitude and direction) of the ball just before it hits the floor.

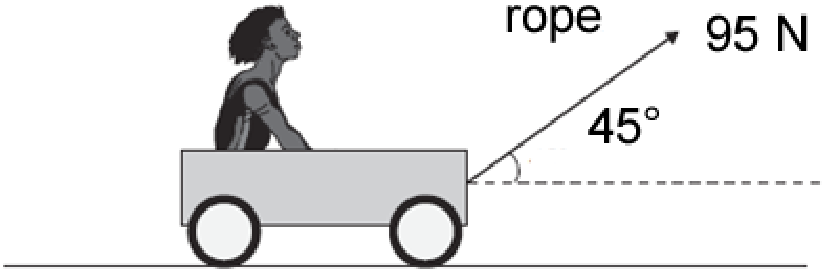
THE SOCCER MATCH (2008;1)

Louise is playing soccer for her 1st XI soccer team. Louise has a mass of 65 kg.

(a) Louise is running towards the goal at 8.0 ms^{-1}. She slows down to 6.0 ms^{-1} in 3 s. Calculate the distance she travels over the 3 s. Write your answer to the correct number of significant figures.
(b) State the main energy change when she is decelerating.
(c) Calculate her kinetic energy while she is running at 8.0 ms^{-1}

GOING TO THE PLAYGROUND (2008;2)

Rua then climbs onto a trolley and Tahi tows him with a rope, as shown in the diagram. Rua's mass is 65 kg, the mass of the trolley is 11 kg.
The tension force in the rope attached to the trolley is 95 N, and the rope is at an angle of 45° to the ground. There is a 35 N friction force on the trolley.



(a) After a while, Rua is rolling at constant speed. He throws a ball vertically upwards (relative to the trolley). Air resistance is negligible. Where will the ball land? Explain your answer.
(b) Rua throws the ball vertically at 9.8 ms^{-1}. Calculate how long it takes the ball to return to the same level.

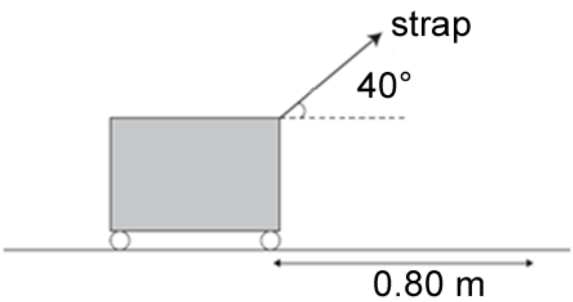
THE AIRCRAFT (2007;1)

An aircraft is flying at a height of 600 m above the ground.

(a) While landing, the speed of the aircraft reduces from 80.0 ms^{-1} to 25.0 ms^{-1} in 8.0 seconds. Calculate the size and direction of the acceleration. Express your answer to the correct number of significant figures.

THE BAGGAGE SECTION (2007;3)

(a) A suitcase is on wheels. The owner pulls it across the floor with a strap as shown in the diagram below. The force applied to pull the suitcase is 25 N and the strap is at an angle of 40° to the horizontal.



Calculate the work done pulling the suitcase 0.80 m along the floor.

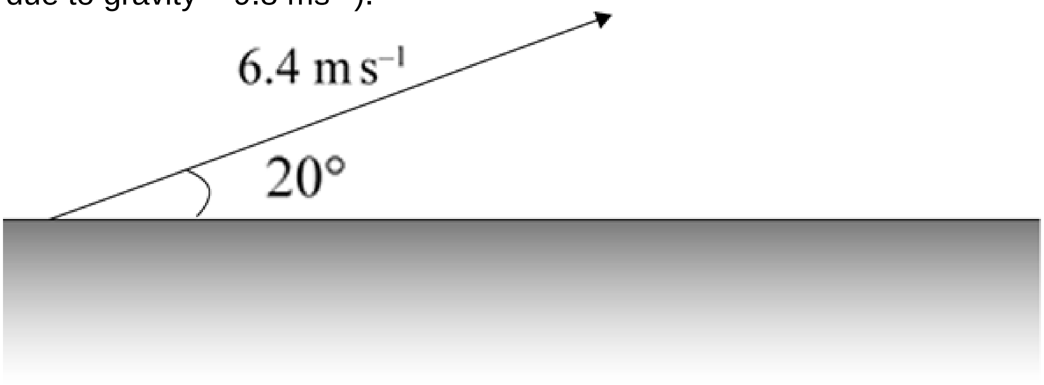
ROWING (2006;1)

Steve is in a rowing race. The total mass of Steve and his boat is 120 kg.

(a) At the beginning of the race, he is at rest. When the race starts, he accelerates to a speed of 4.5 ms^{-1} in 5.00 s. Calculate his acceleration. Write your answer to the correct number of significant figures.
(b) Calculate the distance Steve travels in the first 5.00 s.
(c) Calculate the minimum average power Steve must produce to cause this acceleration. Write your answer with the correct unit.
(d) Explain clearly why the average power Steve must actually produce will be greater than that which you calculated in (c).
(e) Later in the race, the boat is moving at constant velocity. Determine the size of the net (or total) force acting on the boat.

PROJECTILE MOTION (2006;3)

Marama is a long-jumper. She runs down a track, and jumps as far as she can horizontally. Her take-off velocity is shown in the diagram below (You can assume there is no air resistance, acceleration due to gravity = 9.8 ms^{-2}).



(a) Show that the horizontal component of her initial velocity is 6.0 ms^{-1}.
(b) Show that the vertical component of her initial velocity is 2.2 ms^{-1}.
(c) Calculate the distance she jumps horizontally.
(d) State the size and direction of her acceleration at the highest point.
(e) Explain why the horizontal component of her velocity is constant.

TRAVELLING BY CAR (2006;1)

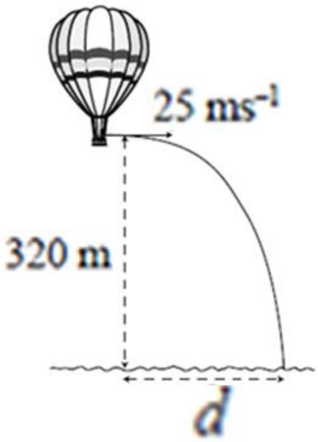
(a) A car starts from rest at traffic lights and accelerates in a straight line to a speed of 50.0 kmh^{-1} in 10 seconds. Using the approximation that 50.0 kmh^{-1} = 13.9 ms^{-1}, show that the car's acceleration is 1.4 ms^{-2}.
(b) The mass of the car and its occupants is 1357 kg. Calculate the net force acting on the car when it is accelerating.
(c) State whether the force that you calculated in your answer to (b) is equal to, less than or greater than the total driving force provided by the car's engine.
(d) Explain clearly the reason for your answer to part (c).
(e) Calculate the car's power output during the first 10 seconds of its motion. Give the correct unit for your answer.

TRAVELLING IN A HOT AIR BALLOON (2006;3)

A hot air balloon is rising vertically at a constant speed of 2.5 ms^{-1}.

(a) Compare the sizes of the total upward force acting on the hot air balloon with the total downward force acting on it, giving your reasons.

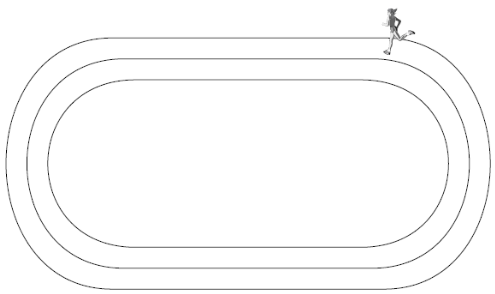
Sometime later, the hot air balloon is hovering in a stationary position, 320 m above the sea. One of the passengers throws a tennis ball with a speed of 25 ms^{-1} in a horizontal direction as shown in the diagram below.



(b) Assuming that it was a calm day with no wind, calculate the horizontal distance d from the balloon to where the ball lands in the sea.

SCHOOL SPORTS – RUNNING (2004;1)

Ana runs a 400 m race around the school track in 65 seconds.



(a) Calculate Ana's average speed for the race.

(b) At the start of the race, Ana accelerates to a speed of 6.0 ms^{-1} during the first 2.2 seconds. Calculate her acceleration, assuming it is constant.

(c) Calculate the distance that Ana travels during these first 2.2 seconds.

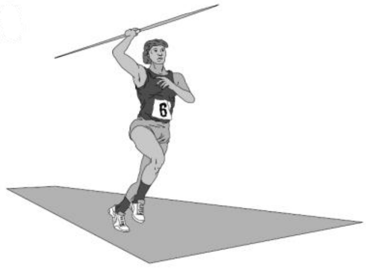
(d) During the middle part of the race, Ana, who's mass is 55 kg, is running at a steady speed of 6.5 ms^{-1}. Calculate her kinetic energy at this point in the race. State the unit for your answer.

(e) At the end of sports day, Ana drives home. During part of her journey, her car travels horizontally along a straight road for 40 m at a constant speed of 15 ms^{-1}. At this speed the car engine produces 6000 W of power. Calculate the size of the force needed to keep the car moving at this speed.

SCHOOL SPORTS – JAVELIN (2004;2)

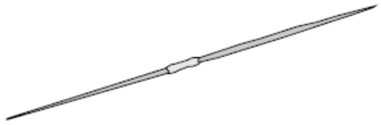
Where needed, use g = 10.0 ms^{-2}.

Joe is taking part in a javelin competition. The javelin behaves like a projectile.

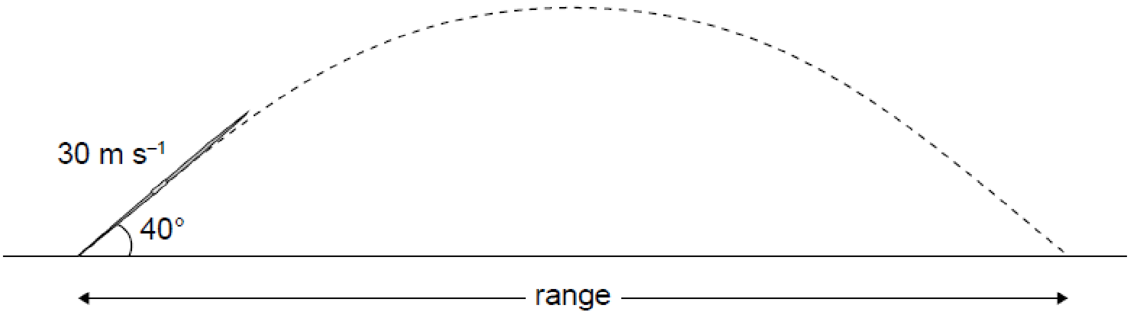


(a) Name the shape of the path of the javelin.

(b) Ignoring air resistance, draw arrow(s) on the drawing of the javelin below to show the force(s) acting on it when it is in the position shown. Name the forces.



Joe now throws the javelin into the air at an angle of 40° above the horizontal at an initial velocity of 30 ms^{-1}.



(c) Show that the horizontal component of the initial velocity of the javelin is 23 ms^{-1}.

(d) Calculate the range (horizontal distance travelled) of the javelin under these conditions.