Question 1

John is walking along at a constant speed of 2.0 m s^{-1}. He drops a tennis ball. Assume air resistance is negligible. Which of the paths **A – E** in **Figure 1** below best represents how John sees the ball fall?

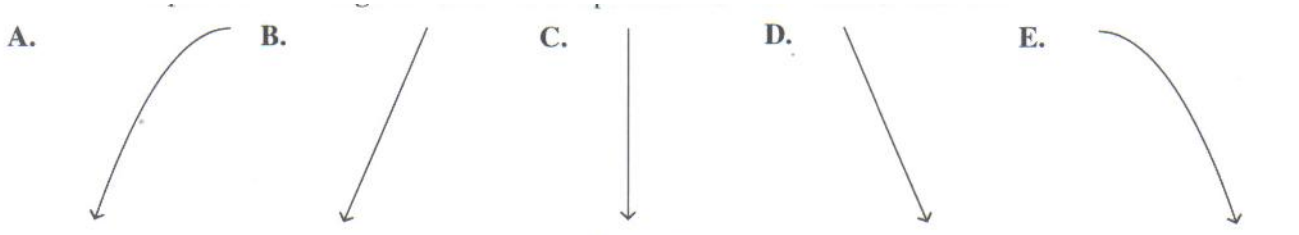


Figure 1

Question 2

A truck driver talking on his mobile phone runs straight into the back of a car which is topped at the traffic lights. The truck and the car move forward, locked together, at a speed of 8.0 m s^{-1} after the collision. The mass of the car is 1000 kg and the mass of the truck is 5000 kg.

(a) Calculate the speed of the truck before the collision.

(b) Calculate the amount of energy that is 'lost in the collision.

(c) Explain where the energy that is 'lost' in this collision goes.

A car of mass 1400 kg is pulling a flat-pack style caravan of mass 1000 kg as shown in Figure 2. The frictional force acting on the car is 750 N and on the caravan 250 N.

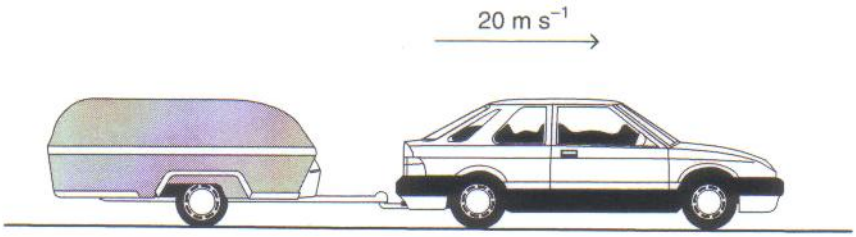


Figure 2

The car is travelling at a constant velocity of 20 m s^{-1}.

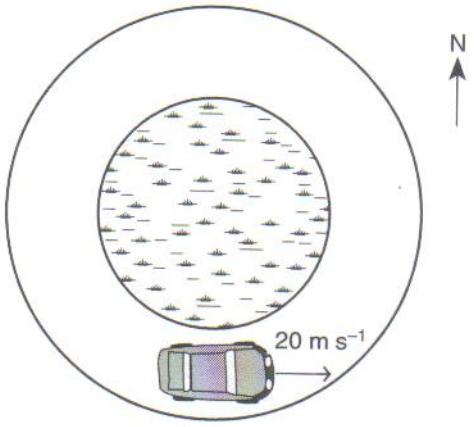
Question 3

(a) Calculate the size of the engine force required to enable the car to travel at a constant velocity of 20 m s^{-1}.

The car now accelerates at a rate of 3.0 m s^{-1}. The friction on the car and caravan is unchanged.

(b) Calculate the magnitude of the tension in the tow bar joining the car to the caravan.

The figure below shows a car travelling at a constant speed of 20 m s^{-1} in a circle around a large roundabout of radius 60 m. The direction of north is indicated by N.



Question 4

(a) Which of the answers below best indicates the direction of the velocity of the car at the instant shown in **the above figure**?

A. north
B. south
C. east
D. west
E. Cannot be determined from the information given.

(b) Which of the answers below best indicates the direction of the acceleration acting on the car at the instant shown in **the above figure**?

A. north
B. south
C. east west
D. Cannot be determined from the information given.

The mass of the car is 1200 kg.

(c) Calculate the size of the centripetal force acting on the car.

(d) Explain what specifically causes this centripetal force.

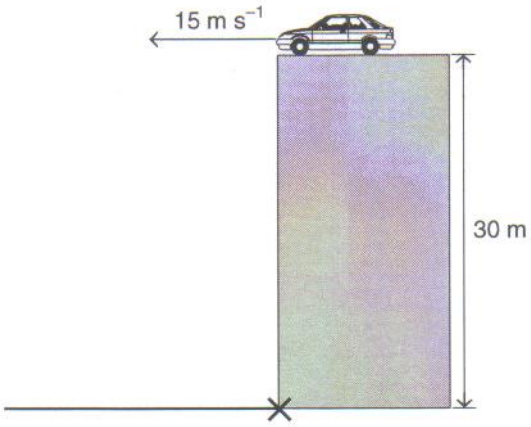
……..

……..

……..

……..

The figure below shows a car being driven at a speed of 15 m s^{-1}.off the top of a 30 m high building as part of an advertisement for a car safety. Ignore friction and air resistance.



Question 5

(a) Which one of the following best describes the nature of the path that the car follows as it is driven off the top of the building?

A. Part of an ellipse.
B. An arc of a circle.
C. A parabola.
D. A hyperbola.
E. Cannot be determined from the information given.

(b) Calculate the time it takes for the car to go from the top of th building to the street level.

(c) Calculate how far the car lands from the point x.

(d) Calculate the velocity at which the car hits the street.

The mass of the Earth is 8.0 X 10^{24} kg and the mass of the moon is 7.4 X 10^{22} kg. The radius of the Earth is 6.4 X 10^{6} m and the radius of the moon is 1.7 x 10^{6} m. The orbital radius of the moon around the Earth taken from the centre of the moon to the centre of the Earth is 3.8 x 10^{8+} m. Use G = 6.67 x 10^{-11} N m^2 kg^{-2}.

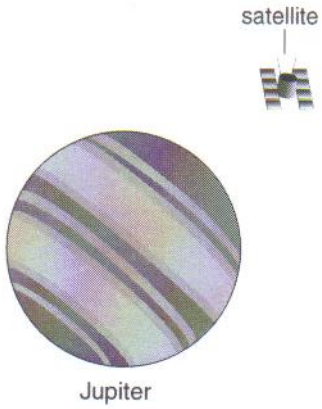
Question 6

(a) Calculate the size of the gravitational force acting between the Earth and the moon.

(b) Calculate the period of the moon around the Earth.

(c) Calculate the orbital speed of the moon around the Earth.

The figure below shows a satellite in orbit above the planet Jupiter at an altitude of 200 km.



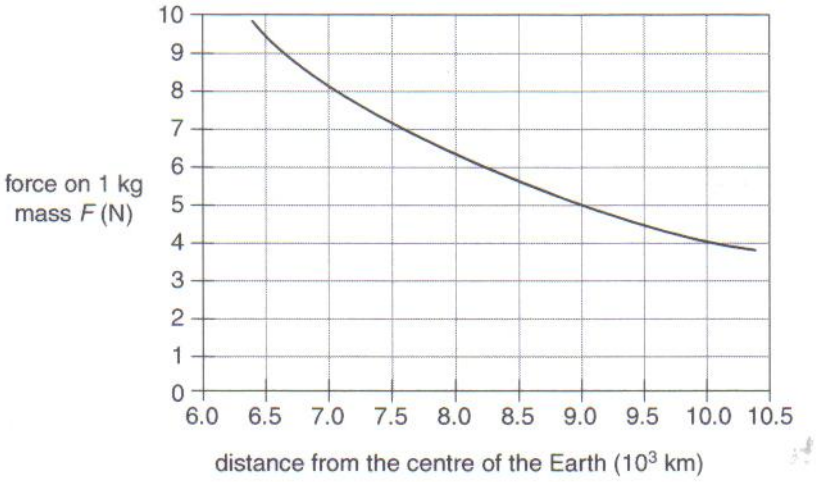
The radius of Jupiter is 7.2 x 10^4 km, the mass of Jupiter is 1.9 x 10^{27} kg and the value of G = 6.67 x 10^{-11} N m^2 kg^{-2}.

Question 7

(a) Calculate the magnitude of the acceleration due to gravity at this orbital height.

(b) Draw on **the above figure** using labelled arrows, all of the forces acting on the satellite.

The figure below shos a graph of the force acting on a 1 kg mass as a function of distance from the Earth's centre. The radius of the Earth is 6400 km.



Question 8

(a) Use **the graph** to estimate the value of the gravitational acceleration at the Earth's surface.

A space-lab of mass 1.2 tonnes is placed at a altitude 600 km above the Earth's surface.

(b) Estimate the size of the force acting on the space-lab at this height.

The space-lab is now moved from its 600 km position to 1600 km above the Earth's surface.

(**c)** Use the graph to estimate the amount of energy required to move the space-lab to this new orbit height.