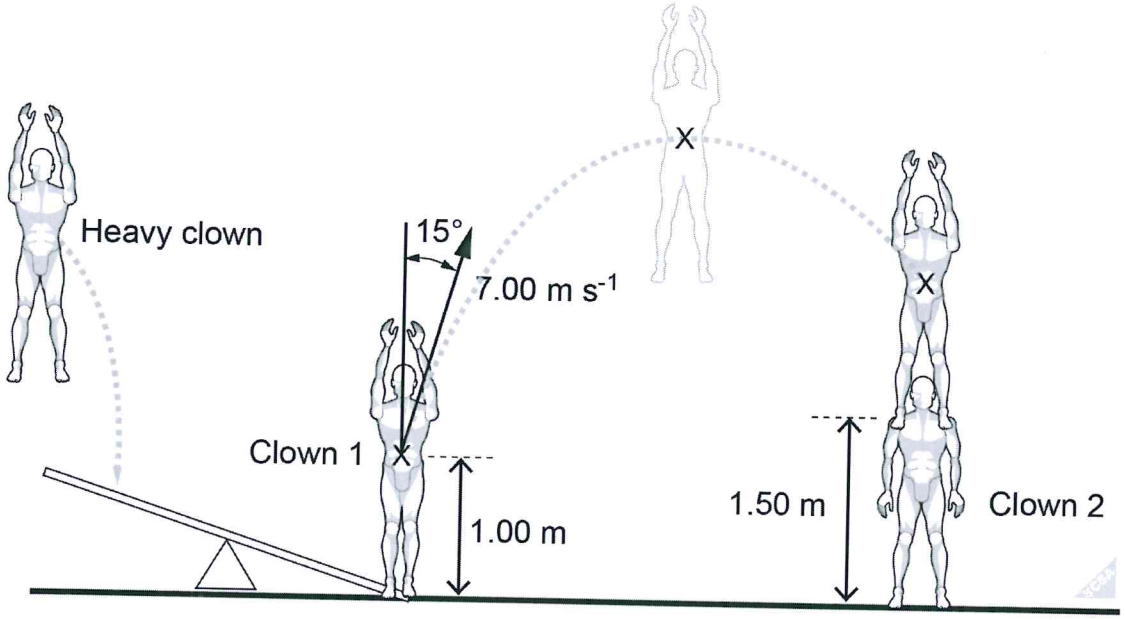
Chapter 9.3 Exam Q page 1

Question 1

(10 marks)

Clown 1 is standing on a seesaw. As part of the circus act a heavy clown will jump from a height and land on the opposite side of the seesaw to Clown 1. This will launch Clown 1 into the air with a velocity of 7.00 m s^{-1} at an angle of 15° to the vertical.

Clown 1 will travel through the air and land on the shoulders of Clown 2, following the trajectory shown with a dotted line (diagram is not drawn to scale). The centre of mass of Clown 1 is shown with an 'X'.



(a) On the diagram above, draw an arrow to show the direction of acceleration of Clown 1's centre of mass at the point of maximum height. (1 mark)

(b) Describe qualitatively **two** effects of air resistance on projectile motion in this case. (2 marks)

(c) Show by calculation that the total time Clown 1 is in the air is just over 1.1 s. Ignore air resistance. (4 marks)

(d) Determine the initial horizontal distance between Clown 1 and Clown 2. Ignore air resistance. Show **all** workings. (3 marks)

Question 2

(4 marks)

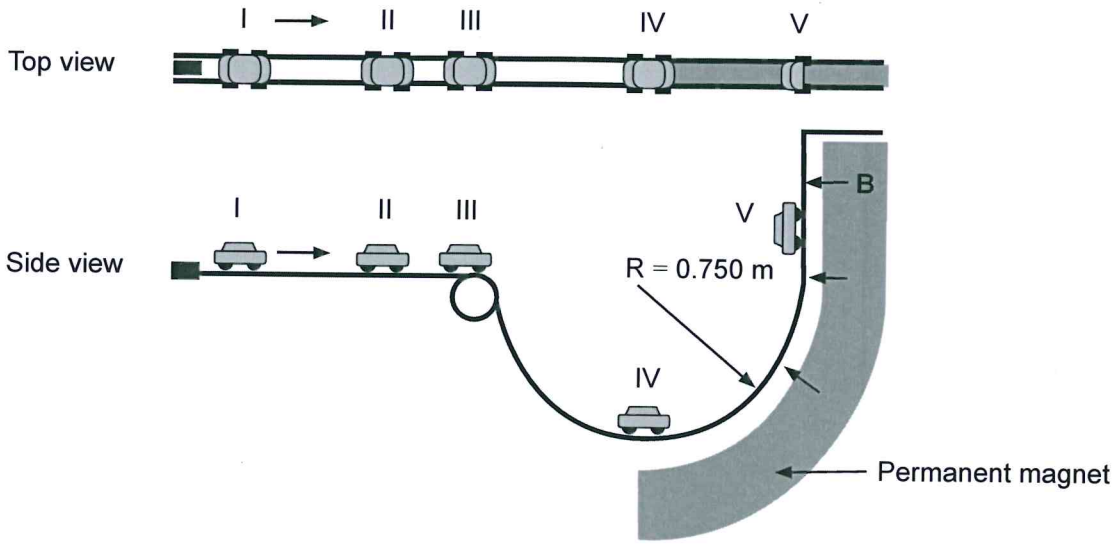
When a satellite is launched it is placed in an initial circular orbit around the Earth. Later some small jets on board the satellite will fire compressed gas for a set period of time to move it to the precise final circular orbit required. These gas jets point backward relative to the satellite's motion only and **not** toward or away from the Earth.

How can backward facing gas jets be used to raise the satellite to a higher final circular orbit?

Chapter 9.3 Exam Q Question 3

(13 marks)

Two parallel metal rails are connected by a resistor. A vehicle made of copper allows current to flow between the rails and moves from rest at Position I to Position V.



(a) The vehicle moves between Position I and Position II in 3.00 s, driven by a 3.00 V, 20.0 mA motor. The energy conversion efficiency of the vehicle is 70.0% and the mass of the vehicle is 120 g. Ignore air resistance and frictional forces.

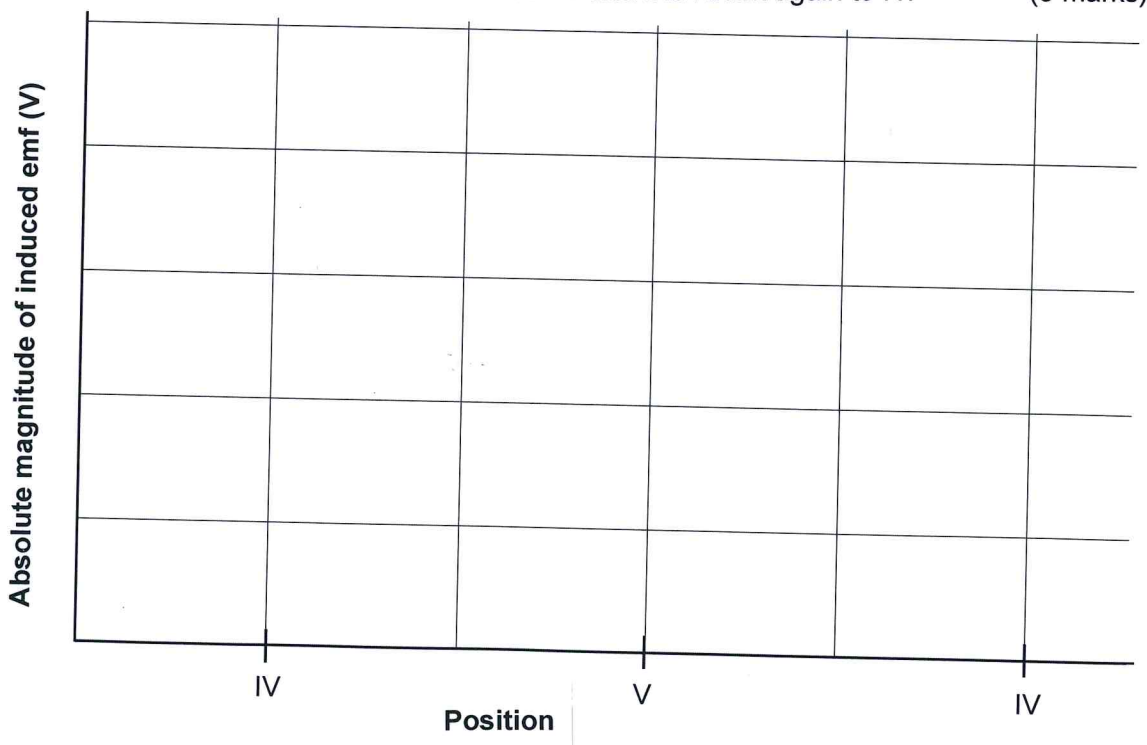
Show that the velocity of the vehicle at Position II is 1.45 m s^{-1}. (3 marks)

(b) The motor is switched off at Position II and the vehicle continues to move from Position II to Position V, and then back through Position IV. The metal rails are 0.170 m apart and have a radius of curvature of 0.750 m as shown in the diagram. A magnetic field, B, is arranged so that the field strength acting anywhere between Position IV and Position V is perpendicular to the rails, and has magnitude 0.550 T.

Calculate the magnitude of the emf induced across the vehicle as it first passes through Position IV. (4 marks)

(c) Draw a labelled free body diagram to show the forces acting on the vehicle at Position IV. (3 marks)

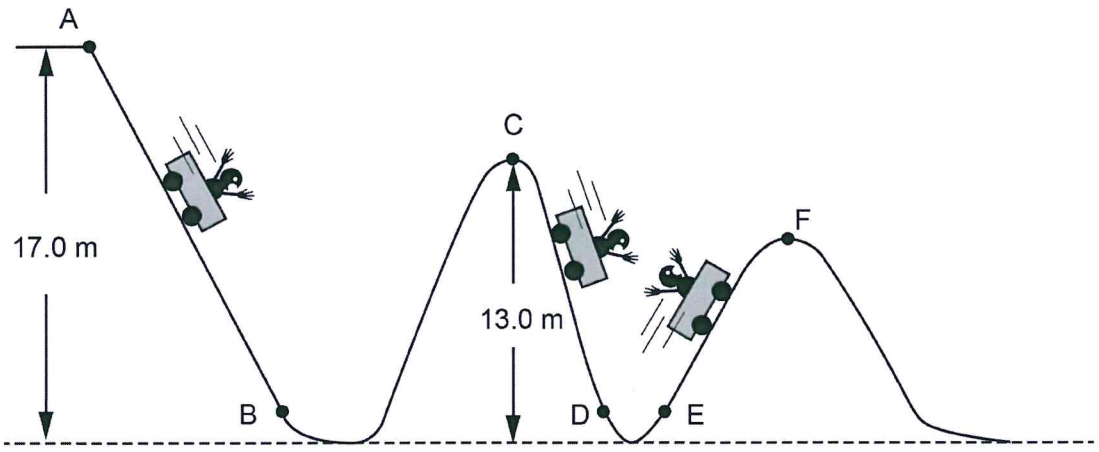
(d) Sketch a graph of the magnitude (absolute value) of induced EMF versus position as the vehicle moves from Position IV to Position V and then back again to IV. (3 marks)



Question 4

(14 marks)

A roller-coaster is 17.0 m high at its highest point, the release point A. The diagram below is a simple representation of the first part of the ride.



(a) The car is released from a stationary position at A and has no independent locomotion. Indicate the direction of the car's acceleration in each of the following regions by circling the correct answer. (3 marks)

(i)	A to B	up slope	down slope
(ii)	C to D	up slope	down slope
(iii)	E to F	up slope	down slope

(b) If the length of track between A and B is 21.0 m and the car is released from rest at A and reaches a velocity of 18.5 m s^{-1} at B, what is the magnitude of the acceleration it experiences between A and B? (4 marks)

(c) If the car **just** makes it to point C, what proportion (fraction) of the energy has been lost as heat? (3 marks)

(d) In relation to this energy lost as heat, how is it generated and where does it go? (2 marks)

(e) Will the velocity of the car be greater at point B or point D? Give a reason for your answer. (2 marks)

Question 5

(3 marks)

The engine of a toy crane lifts a small block of wood of mass 0.130 kg to a height of 0.700 m at a constant velocity. Calculate the work done in joules to achieve this.

Question 6

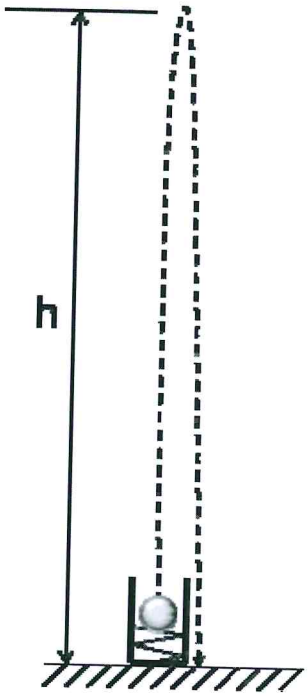
(3 marks)

On a hot day, Sam stepped off a bridge into the water below. Using the idea of conservation of energy, calculate Sam's speed, in metres per second, when he reached the water 3.40 m below. Show **all** workings.

Question 7

(16 marks)

A vertical cylinder contains a spring. A ball sits on the top of the spring, as shown in the diagram. The length of the cylinder is 0.500 m and the uncompressed length of the spring is 0.400 m. The spring is then squashed down to 0.100 m and released. The kinetic energy of the ball (m = 0.500 kg) when it leaves the spring is 100 J.



(a) Calculate the average force that the spring exerts on the ball to launch it. (3 marks)

(b) Calculate the velocity of the object when it leaves the top of the spring. (2 marks)

(c) Determine the height, h, the object reaches above the ground. (4 marks)

(d) Determine the acceleration of the object at the highest point. (1 mark)

(e) Determine the final velocity of the object, the instant before it hits the ground. (3 marks)

(f) Calculate the time needed for the object to reach the ground from the highest point. (3 marks)