Projectile Motion 1

Have a go at the following exam equations.

OCR, G481, JANUARY 2009

2 Fig. 2.1 shows the path of water from a hose pipe.

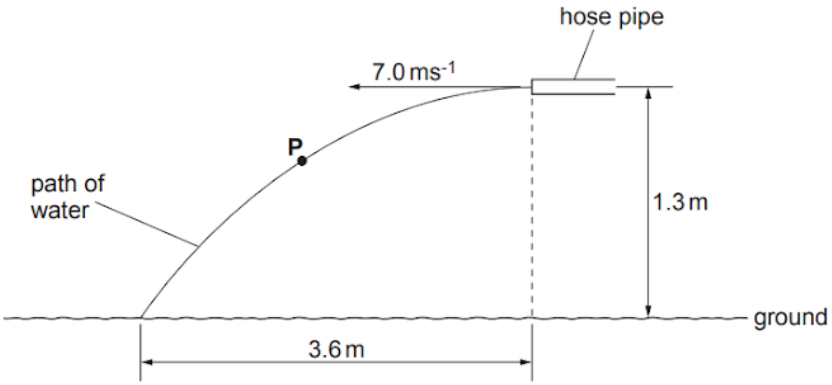

Fig. 2.1

The end of the horizontal hose pipe is at a height of 1.3 m from the ground. The initial horizontal velocity of the water is 7.0 m s^{-1}. The horizontal distance from the end of the hose pipe to the point where the water hits the ground is 3.6 m. You may assume that air resistance has negligible effect on the motion of the water jet.

(a) On Fig. 2.1, draw an arrow to show the direction of the acceleration of the water at point **P**. (Mark this arrow **A**). **[1]**

(b) Describe the energy conversion that takes place as the water travels from the end of the hose pipe to the ground.

In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[2]**

(c) Explain why the horizontal component of the velocity remains constant at 7.0 m s^{-1}.

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..... **[1]**

(d) Show that the water takes about 0.5 s to travel from the end of the pipe to the ground.

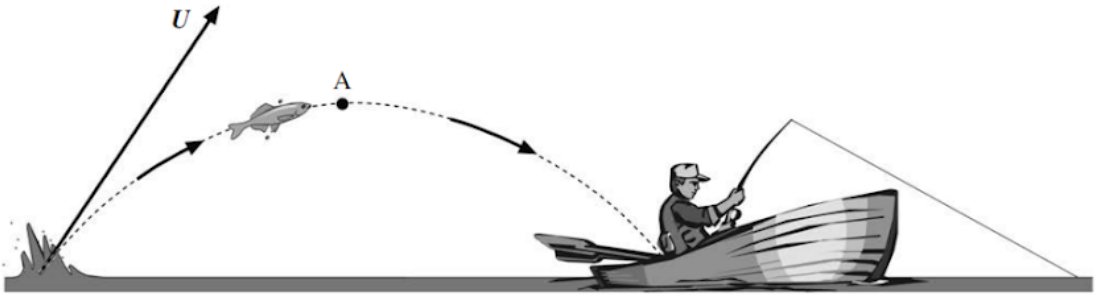
[1]

(e) Show that the speed of the water when it hits the ground is 8.6 m s^{-1}.

[3]

[Total: 8]

6. The Silver Carp is a fish which was accidentally introduced to the Mississippi river in the 1990s. It has since bred to such an extent that the river has become overpopulated with them. Many are seen to jump out of the water and they sometimes land in the boats of fishermen.
[Ignore air resistance throughout this question].



(a) The trajectory (flight path) of a Silver Carp is shown. Point **A** represents the highest point on the trajectory. Draw arrows at **A** to show

(i) the direction of motion of the Carp at this instant. (Label this arrow **D**);

(ii) the force (or forces) acting on the Carp at this instant. (Label this/these arrow(s) **F**). [2]

(b) A fisherman wishes to determine the velocity with which a Carp left the water (shown by the vector labelled ***U***). The fisherman makes the following estimations:

Horizontal distance travelled by the Carp = 4.50 m
Time of flight = 1.50 s
Maximum height = 2.75 m

Use this information to calculate:

(i) the horizontal component of the velocity of the Carp; [1]

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(ii) the initial vertical velocity of the Carp; [3]

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(iii) the magnitude of the velocity (***U***) with which the Carp left the water. [2]

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(c) Your answer to *(b)* (iii) can be checked by considering the energy changes that take place during the Carp's flight.

(i) Calculate the **total** energy possessed by the Carp at point **A**. [Assume the Carp has mass 6.0 kg] [3]

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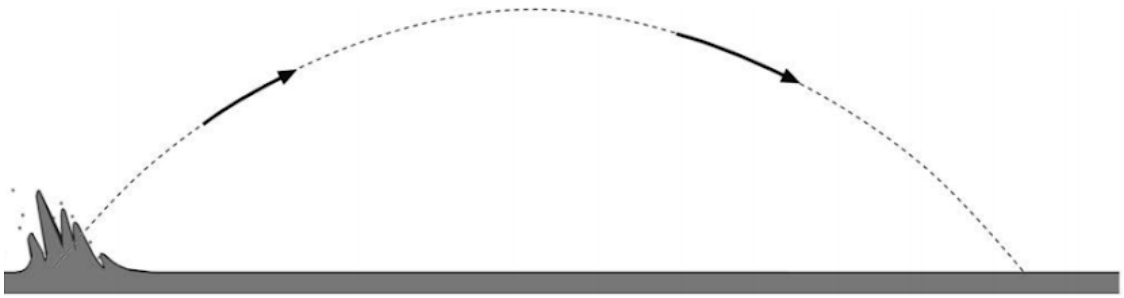
(ii) Below is a sketch of the Carp's trajectory but this time without the boat included. Mark on the diagram **two** points where the Carp will have its greatest kinetic energy. [Label both points with a letter **K**]. [1]



(iii) Use your answer to *(c)* (i) to show that the Carp's initial velocity (***U***) is the same as that calculated in *(b)* (iii). [2]

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14 The gravitational field strength on the Moon is about 1/6 of the gravitational field strength on the Earth.

(a) On the Moon, an astronaut dropped a golf ball. He later wrote "When I dropped the ball, it took about three seconds to land."

Show that the astronaut would need to be over 7 m tall for the ball to take 3 s to land.

(2)

(b) The astronaut hit the ball with a golf club. He wrote "The ball, which would have gone thirty to forty yards on the Earth, went over two hundred yards. The ball stayed up in the black sky for almost thirty seconds."

Assume an initial velocity of 18 m s^{-1} at 34° to the horizontal.

(i) Show that the astronaut's suggested time of flight of 30 s is over twice the actual value.

(3)

(ii) Show that the value given for the initial velocity leads to a value for the horizontal distance travelled by the ball in agreement with his stated value.

200 yards = 183 m

(3)

(c) A projectile would have a greater range on the Moon than the Earth because of the lower gravitational field strength and because of the lack of an atmosphere.

Explain how each of these factors would increase the range of the projectile.

(3)

(Total for Question 14 = 11 marks)