Q1. A ballbearing $\mathbf{X}$ of mass $2m$ is projected vertically upwards with speed u. A ballbearing $\mathbf{Y}$ of mass m is projected at 30° to the horizontal with speed $2u$ at the same time. Air resistance is negligible. Which of the following statements is correct?

A The horizontal component of $\mathbf{Y}$'s velocity is u. ⬭

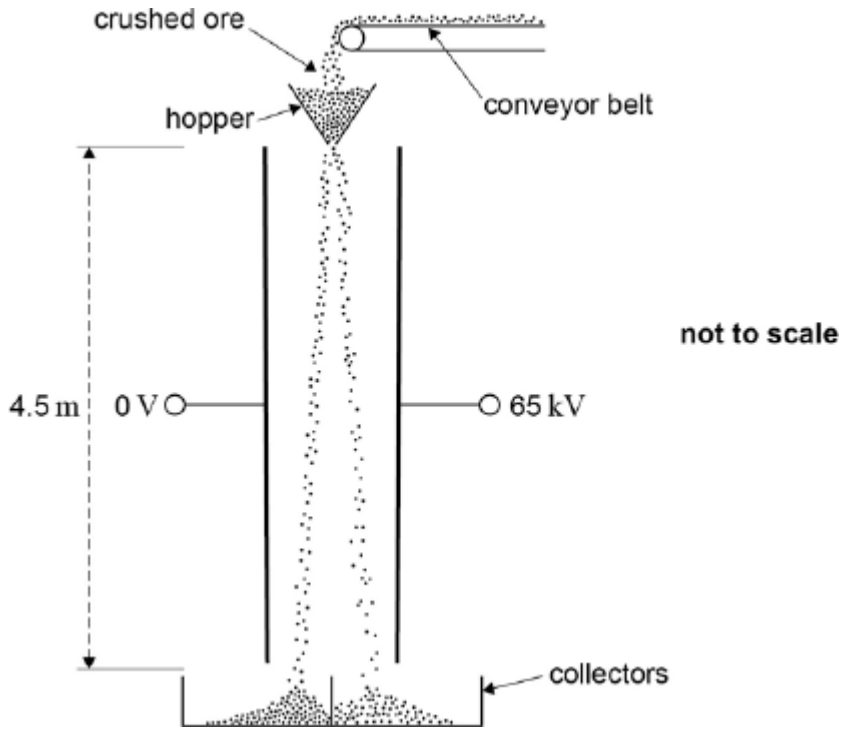
B The maximum height reached by $\mathbf{Y}$ is half that reached by $\mathbf{X}$ ⬭

C $\mathbf{X}$ and $\mathbf{Y}$ reach the ground at the same time. ⬭

D $\mathbf{X}$ reaches the ground first. ⬭

(Total 1 mark)

Q2. The figure below shows a system that separates two minerals from the ore containing them using an electric field.



The crushed particles of the two different minerals gain opposite charges due to friction as they travel along the conveyor belt and through the hopper. When they leave the hopper they fall 4.5 metres between two parallel plates that are separated by 0.35 m.

(a) Assume that a particle has zero velocity when it leaves the hopper and enters the region between the plates.

Calculate the time taken for this particle to fall between the plates.

time taken = _____s

(2)

(b) A potential difference (pd) of 65 kV is applied between the plates.

Show that when a particle of specific charge 1.2×10^{-6} C kg^{-1} is between the plates its horizontal acceleration is about 0.2 m s^{-2}.

(3)

(c) Calculate the total horizontal deflection of the particle that occurs when falling between the plates.

horizontal deflection = _____m

(1)

(d) Explain why the time to fall vertically between the plates is independent of the mass of a particle.

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(2)

(e) State and explain **two** reasons, why the horizontal acceleration of a particle is

different for each particle.

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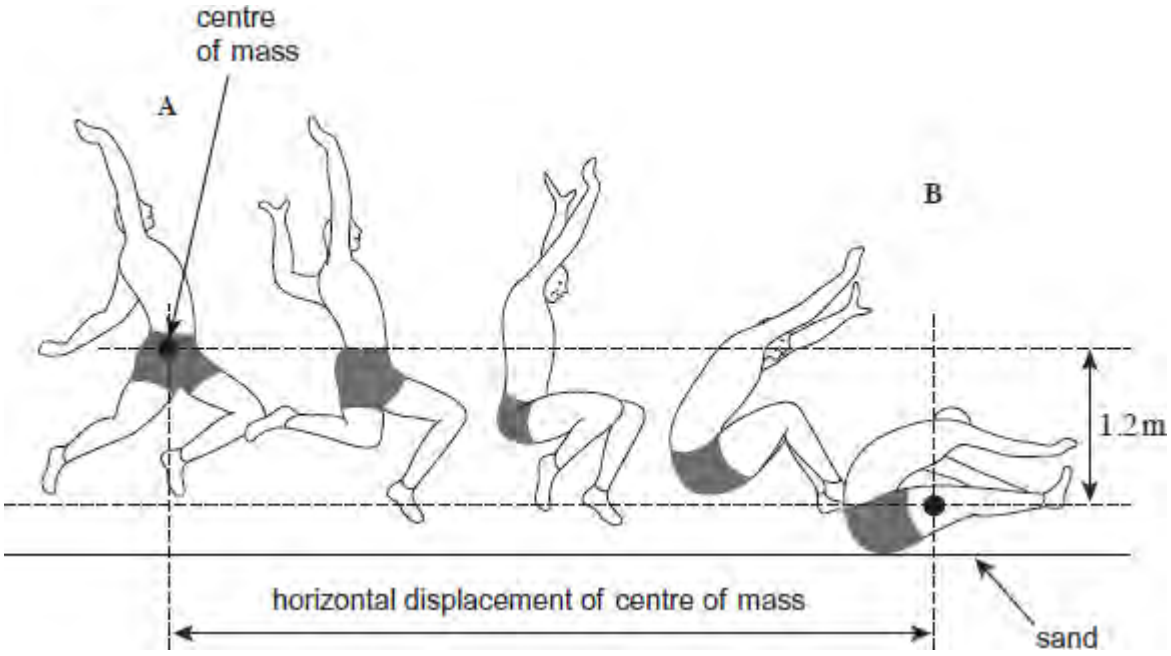
(4)
(Total 12 marks)

Q3. The motion of a long jumper during a jump is similar to that of a projectile moving under gravity. The figure below shows the path of an athlete above the ground during a long jump from half-way through the jump at position **A**, to position **B** at which contact is made with sand on the ground. The athlete is travelling horizontally at **A**.



(a) During this part of the jump, the centre of mass of the athlete falls 1.2 m.

(i) Calculate the time between positions **A** and **B**.

time ..... s

(3)

(ii) The athlete is moving horizontally at **A** with a velocity of 8.5 m s^{-1}. Assume there is noair resistance. Calculate the horizontal displacement of the centre of mass from **A** to **B**.

horizontal displacement ..... m

(2)

(b) (i) The athlete in the image above slides horizontally through the sand a distance of 0.35 m before stopping.

Calculate the time taken for the athlete to stop. Assume the horizontal component of the resistive force from the sand is constant.

time ..... s

(2)

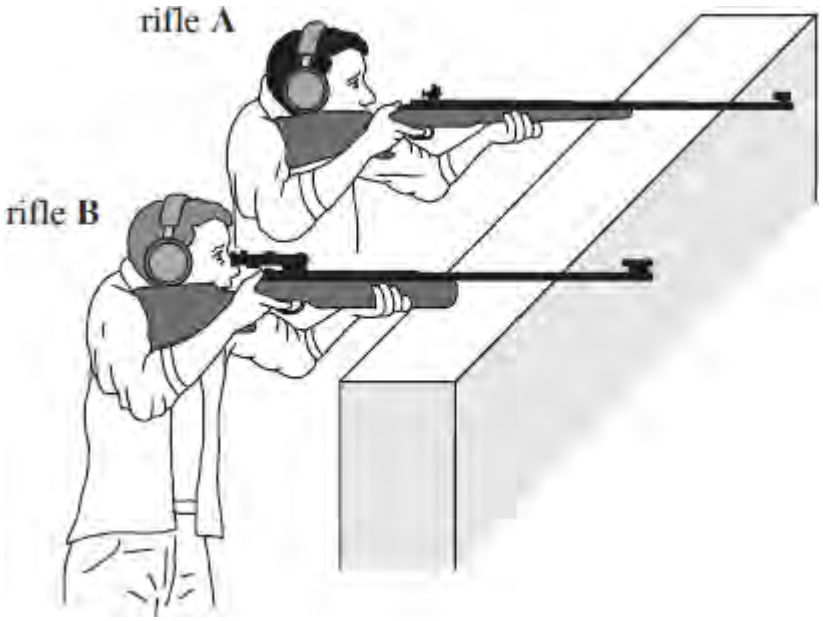
(ii) The athlete has a mass of 75 kg. Calculate the horizontal component of the resistive force from the sand.

horizontal component of resistive force ..... N

(3)

(Total 10 marks)

Q4. The diagram below shows two different rifles being fired horizontally from a height of 1.5 m above ground level.
Assume the air resistance experienced by the bullets is negligible.



(a) When rifle **A** is fired, the bullet has a horizontal velocity of 430 m s^{-1} as it leaves the rifle. Assume the ground is level.

(i) Calculate the time that the bullet is in the air before it hits the ground.

time ..... s

(2)

(ii) Calculate the horizontal distance travelled by the bullet before it hits the ground.

horizontal distance ..... m

(1)

(b) Rifle **B** is fired and the bullet emerges with a smaller horizontal velocity than the bullet from rifle **A**.

Explain why the horizontal distance travelled by bullet **B** will be less than bullet **A**.

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(3)
(Total 6 marks)

Q5.(a) Describe how a beam of fast moving electrons is produced in the cathode ray tube of an oscilloscope.

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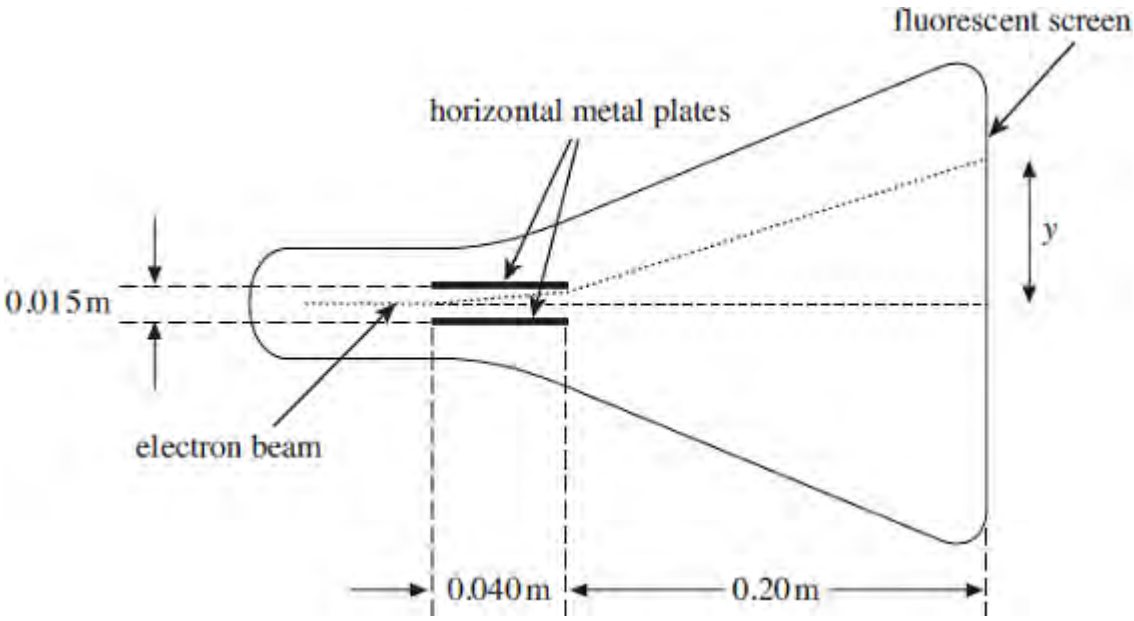
(3)

(b) The figure below shows the cathode ray tube of an oscilloscope. The details of how the beam of electrons is produced are not shown.



The electron beam passes between two horizontal metal plates and goes on to strike a fluorescent screen at the end of the tube. The plates are 0.040 m long and are separated by a gap of 0.015 m. A potential difference of 270 V is maintained between the plates.An individual electron takes 1.5×10^{-9} s to pass between the plates.The distance between the right-hand edge of the plates and the fluorescent screen is 0.20 m.

(i) Show that the vertical acceleration of an electron as it passes between the horizontal metal plates is approximately 3.2×10^{15} ms^{-2}.

(3)

(ii) Show that the vertical distance travelled by an electron as it passes between the horizontal metal plates is approximately 3.6 mm.

(2)

(iii) Show that the vertical component of velocity achieved by an electron in the beam by the time it reaches the end of the plates is approximately 4.7×10^6 m s^{-1}.

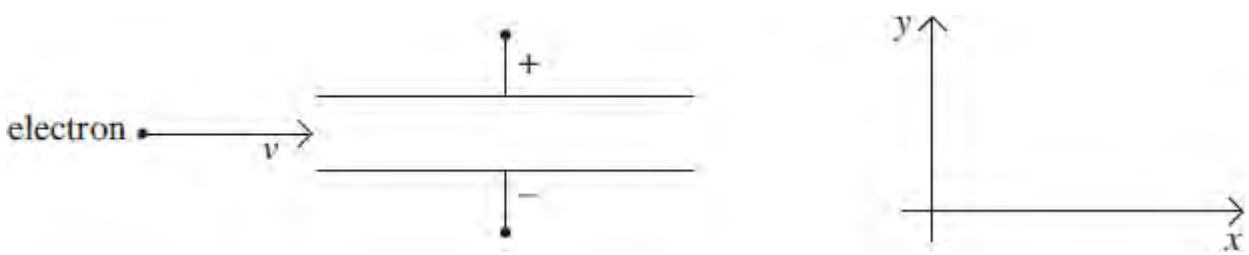
(2)

(iv) Calculate the vertical displacement, *y*, of the electron beam from the centre of the screen. Give your answer in m.

vertical displacement ..... m

(3)
(Total 13 marks)

Q6. A beam of electrons, moving with a constant velocity *v* in a vacuum, enters a uniform electric field between two metal plates.



Which line, **A** to **D**, in the table describes the components of the acceleration of the electrons in the *x* and *y* directions as they move through the field?

	acceleration in x direction	acceleration in y direction
A	zero	zero
B	zero	constant
C	constant	zero
D	constant	constant

(Total 1 mark)

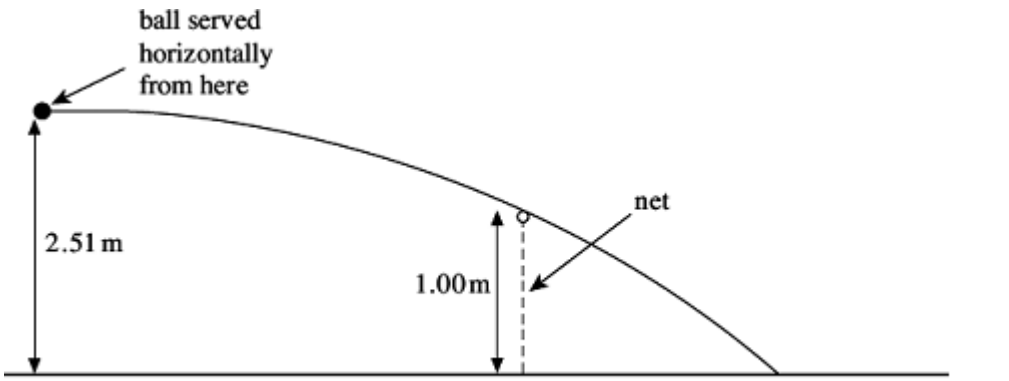
Q7. Which line, **A** to **D**, in the table correctly describes the trajectory of charged particles which enter separately, at right angles, a uniform electric field, and a uniform magnetic field?

	uniform electric field	uniform magnetic field
A	parabolic	circular
B	circular	parabolic
C	circular	circular
D	parabolic	parabolic

(Total 1 mark)

Q8. A tennis player serves a ball from a height of 2.51 m at 18.0 ms^{-1} in a horizontal direction. The ball just clears the net which is 1.00 m high. In this question assume that air resistance is negligible.

The figure below shows the ball and its resulting trajectory across the court.



not to scale

(a) Show that the ball takes approximately 0.6 s to reach the net after being served.

(3)

(b) (i) Calculate the vertical component of the velocity of the ball as it passes over the net.

vertical component of velocity ..... ms^{-1}

(2)

(ii) Calculate the overall velocity of the ball as it passes over the net.

magnitude of velocity ..... ms^{-1}

angle to horizontal ..... degree

(3)

(Total 8 marks)