Higher Physics - October Holiday Homework

1. A helicopter is flying at a constant height above the ground. The helicopter is carrying a crate suspended from a cable as shown.

(*a*) The helicopter flies 20 km on a bearing of 180 (due South). It then turns on to a bearing of 140 (50° South of East) and travels a further 30 km.

The helicopter takes 15 minutes to travel the 50 km.

(i) By scale drawing (or otherwise) find the resultant displacement of the helicopter. 3

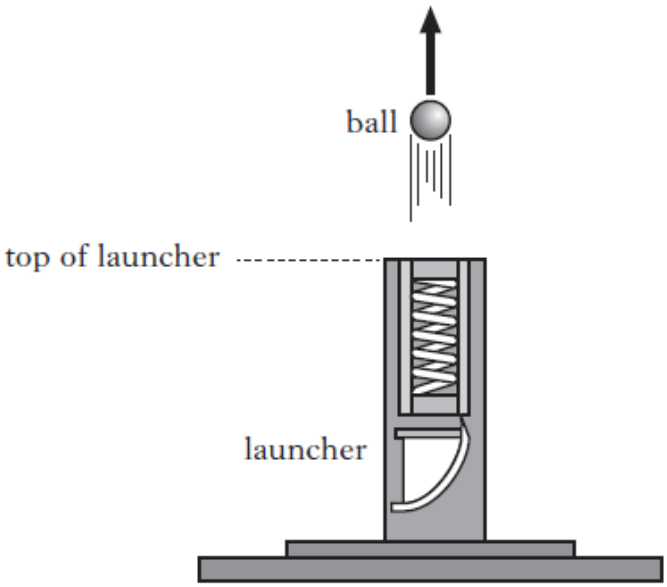
(ii) Calculate the average velocity of the helicopter during the 15 minutes. 3

2. A student investigates the motion of a ball projected from a launcher.

The launcher is placed on the ground and a ball is fired vertically upwards.

The vertical speed of the ball as it leaves the top of the launcher is $7{\cdot}0\,\text{m s}^{-1}$.

The effects of air resistance can be ignored.



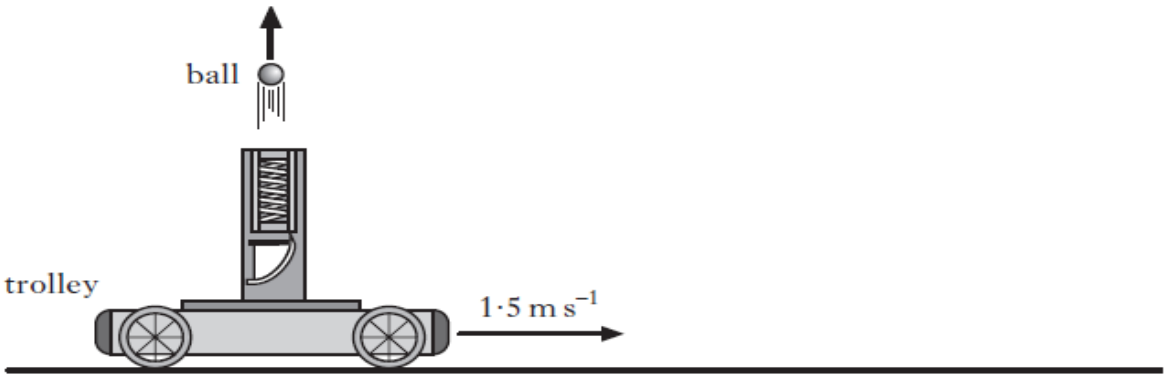
(*a*) (i) Calculate the maximum height above the top of the launcher reached by the ball. 3

(ii) Show that the time taken for the ball to reach its maximum height is 0·71 s. 2

2. continued

(*b*) The student now fixes the launcher to a trolley. The trolley travels horizontally at a constant speed of $1{\cdot}5\,\text{m s}^{-1}$ to the right.

The launcher again fires the ball vertically upwards with a speed of $7{\cdot}0\,\text{m s}^{-1}$.



(i) Determine the velocity of the ball after 0·71 s. 2

(ii) The student asks some friends to predict where the ball will land relative to the moving launcher. They make the following statements.

Statement X: *The ball will land behind the launcher.*

Statement Y: *The ball will land in front of the launcher.*

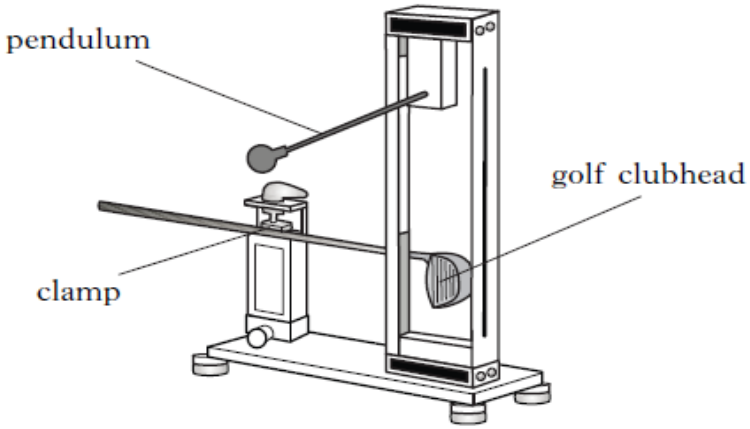
Statement Z: *The ball will land on top of the launcher.*

Which of the statements is correct?

You must justify your answer. 2

3. Golf clubs are tested to ensure they meet certain standards.

(*a*) In one test, a securely held clubhead is hit by a small steel pendulum. The time of contact between the clubhead and the pendulum is recorded.



The experiment is repeated several times.

The results are shown.

248 µs 259 µs 251 µs 263 µs 254 µs

(i) Calculate:

(A) the mean contact time between the clubhead and the pendulum; **1**

(B) the approximate absolute random uncertainty in this value. **2**

(ii) In this test, the standard required is that the maximum value of the mean contact time must not be greater than 257 µs.

Does the club meet this standard?

You must justify your answer. **2**

(*b*) In another test, a machine uses a club to hit a stationary golf ball.

The mass of the ball is $4{\cdot}5 \times 10^{-2}$ kg. The ball leaves the club with a speed of $50{\cdot}0\ \text{m s}^{-1}$. The time of contact between the club and ball is 450 µs.

(i) Calculate the average force exerted on the ball by the club. **3**

(ii) The test is repeated using a different club and an identical ball. The machine applies the same average force on the ball but with a longer contact time.

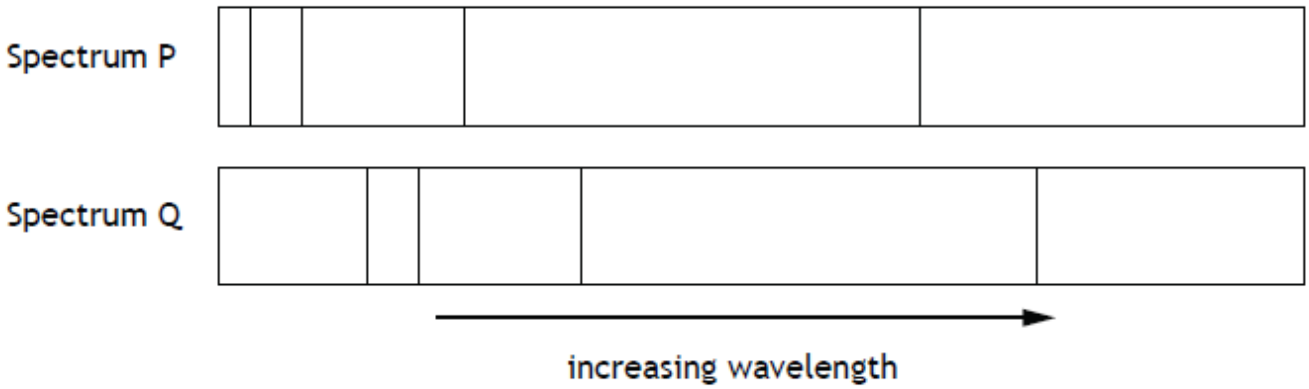
What effect, if any, does this have on the speed of the ball as it leaves the club?

Justify your answer. **2**

4. Estimate the gravitational force of attraction between two students sitting beside each other.

Clearly show your working for the calculation and any estimates you have made. **(3)**

5. (a) The diagram below represents part of the emission spectra for the element hydrogen.



Spectrum P is from a laboratory source.

Spectrum Q shows the equivalent lines from a distant star as observed on the Earth.

(i) Explain why spectrum Q is redshifted. **2**

(ii) One of the lines in spectrum P has a wavelength of 656 nm. The equivalent line in spectrum Q is measured to have a wavelength of 676 nm.

Calculate the recessional velocity of the star. **5**

(b) The recessional velocity of a distant galaxy is $1{\cdot}2 \times 10^{7}\,\text{m s}^{-1}$.

Show that the approximate distance to this galaxy is $5{\cdot}2 \times 10^{24}\,\text{m}$. **2**

[Total of 38 Marks]