Date:	Name:

HFS HW Four

Total Marks 40

1. If air resistance is neglected, the horizontal velocity component of an arrow fired from a bow ..... with distance travelled

A decreases linearly from zero

B increases from zero to a maximum

C increases linearly from zero

D stays constant at a non-zero value

(Total 1 mark)

2. A shot putter launches the shot at an angle of 30o to the horizontal. The throw is repeated with the same launch speed, but this time at an angle of 40o to the horizontal. Which of the following is **not** correct?

A The horizontal range is greater

B The horizontal velocity component is increased

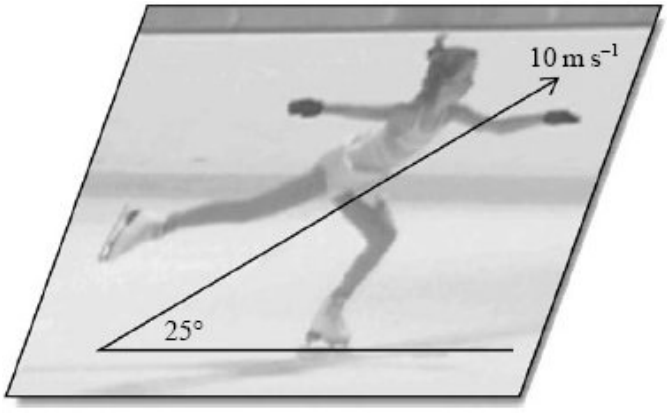
C The maximum height reached is greater

D The shot is in the air for longer

(Total 1 mark)

3. Performing complex jumps is an important aspect of a figure skater's program. Jumps with great heights and jump distances tend to leave a better impression with the judges, resulting in better marks for the skater.

A skater of mass 60 kg leaves the ice with a velocity of 10 m s–1 at an angle of 25° to the horizontal.



(a) Show that the vertical component of the skater's velocity is approximately 4 m s^{-1}.

.....

.....

(2)

(b) Calculate the time taken to reach the top of the jump.

Time taken = ...

(2)

(c) Calculate the maximum height reached.

Maximum height = ...

(2)

(Total 6 marks)

4. In 1346 the army of King Edward III of England defeated the forces of King Philip VI of France at the battle of Crecy. The following passage gives some details:

> The main reason for Edward III's success was undoubtedly the longbow. The records say that skilled longbowmen could fire as many as 12 arrows a minute – with up to 3 arrows in the air at the same time. They were said to have a lethal effect at a range of 300 m.

The time of flight was about 10 s. Assuming the path of the arrow was symmetrical show that the initial vertical component of the arrow's velocity was about 50 m s^{-1}.

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(2)

If these arrows were fired at 50° to the horizontal, calculate the velocity at which they left the longbow.

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Velocity = ...

(2)

Show that the theoretical range was about 400 m.

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(3)

The range calculated is greater than the 300 m quoted in the passage. State and explain one possible reason for the difference in the answers.

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(2)
(Total 9 marks)

5. A medieval siege engine, called a trebuchet, uses a pivoted lever arm to fire a rock projectile. Figure 1 shows a trebuchet which is ready to fire. The gravitational potential energy (E_{grav}) of the large stone counter weight is converted into E_{grav} and kinetic energy (E_k) of the small projectile and E_k of the counter weight.

Figure 1

NOT TO SCALE

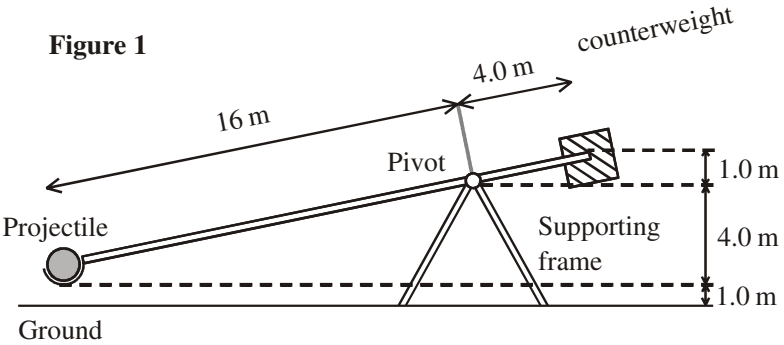
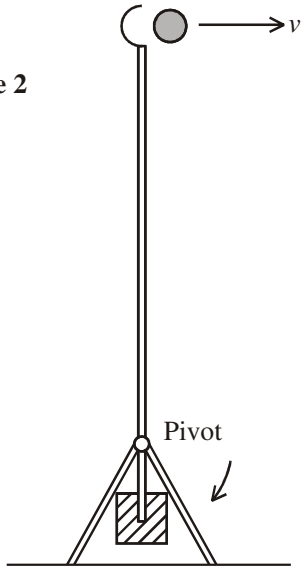


Figure 2



(a) The mass of the counter weight is 760 kg. It falls through 5 m. Show that the Eg it loses is about 37 000 J.

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(2)

(b) (i) The mass of the projectile is 55 kg. Its height increases by 20 m as the lever arm rotates. Show that the total E_k of the projectile and the counterweight is about 26 000 J.

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(2)

(ii) State one assumption you have made in your calculation of the E_k.

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(1)

(iii) The equation below can be used to find the speed *v*.

$$26\,000\ \text{J} = \frac{1}{2} \times 760\ \text{kg} \times \left(\frac{v}{4}\right)^2 + \frac{1}{2} \times 55\ \text{kg} \times v^2$$

Explain the term $\frac{1}{2} \times 760\ \text{kg} \times \left(\frac{v}{4}\right)^2$ in this equation.

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(2)

(c) Solving this equation gives a speed *v* of 22.5 m s^{-1}.

(i) Assuming the trebuchet launches its projectile horizontally over level ground, calculate the time of flight of the projectile.

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Time = ...

(2)

(ii) Calculate the distance the projectile travels before it hits the ground.

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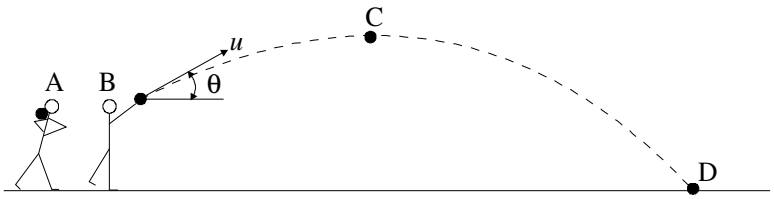
Distance = ...

(2)

(Total 11 marks)

6. A shot putter asks an A level physics student to help improve his performance. The student sketches the diagram shown below and makes some measurements.



The shot is stationary at position A.
The shot leaves the putter's hand at point B.
θ (angle from horizontal at which shot leaves hand) = 34.5°
u (speed at which shot leaves hand) = 12.9 m s^{-1}

Show that the initial vertical component of u is about 7 m s^{-1}.

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(1)

Calculate the time between the athlete releasing the shot at B and it reaching C, the highest point in its path.

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Time = ……

(2)

The total time of flight of the shot, from it leaving B to landing at D, is 1.71 s. Comment on this time in relation to your previous answer.

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(2)

Calculate the *horizontal* distance travelled by the shot between B and D.

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Horizontal distance = ……

(2)

The shot has mass 5.00 kg. Show that the shot's kinetic energy as it leaves his hand at B is about 420J.

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(1)

The acceleration of the shot from A to B takes 0.229 s. The student suggests that the average power the shotputter is developing during the putt might be calculated as follows:

Power = energy transferred/time taken
= 420 J/0.229 s
= 1830 W

Suggest *two* reasons why this figure is lower than the actual power developed.

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(2)

Suggest briefly how the student might have made the measurements of *u*.

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(2)
(Total 12 marks)