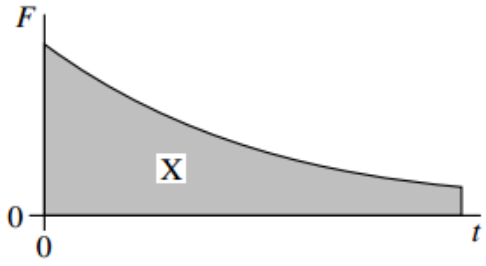
Jan 2010 Further Mechanics – Multi Choice

1 The graph shows the variation with time, t, of the force, F, acting on a body.



What physical quantity does the area X represent?

A the displacement of the body
B the acceleration of the body
C the change in momentum of the body
D the change in kinetic energy of the body

2 Water of density $1000\,\text{kg m}^{-3}$ flows out of a garden hose of cross-sectional area $7.2 \times 10^{-4}\,\text{m}^2$ at a rate of $2.0 \times 10^{-4}\,\text{m}^3$ per second. How much momentum is carried by the water leaving the hose per second?

A $5.6 \times 10^{-5}\,\text{N s}$
B $5.6 \times 10^{-2}\,\text{N s}$
C $0.20\,\text{N s}$
D $0.72\,\text{N s}$

3 Which row, **A** to **D**, in the table correctly shows the quantities conserved in an inelastic collision?

	mass	**momentum**	**kinetic energy**	**total energy**
A	conserved	not conserved	conserved	conserved
B	not conserved	conserved	conserved	not conserved
C	conserved	conserved	conserved	conserved
D	conserved	conserved	not conserved	conserved

4 What is the angular speed of a point on the Earth's equator?

A $7.3 \times 10^{-5}\,\text{rad s}^{-1}$
B $4.2 \times 10^{-3}\,\text{rad s}^{-1}$
C $2.6 \times 10^{-1}\,\text{rad s}^{-1}$
D $15\,\text{rad s}^{-1}$

5 Which one of the following does **not** involve a centripetal force?

A an electron in orbit around a nucleus
B a car going round a bend
C an α particle in a magnetic field, travelling at right angles to the field
D an α particle in a electric field, travelling at right angles to the field

6 Which one of the following gives the phase difference between the particle velocity and the particle displacement in simple harmonic motion?

A $\frac{\pi}{4}$ rad

B $\frac{\pi}{2}$ rad

C $\frac{3\pi}{4}$ rad

D 2π rad

7 A mass M hangs in equilibrium on a spring. M is made to oscillate about the equilibrium position by pulling it down 10 cm and releasing it. The time for M to travel back to the equilibrium position for the first time is 0.50 s. Which row, **A** to **D**, in the table is correct for these oscillations?

	amplitude / cm	**period / s**
A	10	1.0
B	10	2.0
C	20	2.0
D	20	1.0

8 Which one of the following statements concerning forced vibrations and resonance is correct?

A An oscillating body that is not resonating will return to its natural frequency when the forcing vibration is removed.
B At resonance, the displacement of the oscillating body is 180° out of phase with the forcing vibration.
C A pendulum with a dense bob is more heavily damped than one with a less dense bob of the same size.
D Resonance can only occur in mechanical systems.

Jan 2010 Further Mechanics – Long Answer

1 (a) Describe the energy changes that take place as the bob of a simple pendulum makes one complete oscillation, starting at its maximum displacement.

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(2 marks)

1 (b)

Figure 1

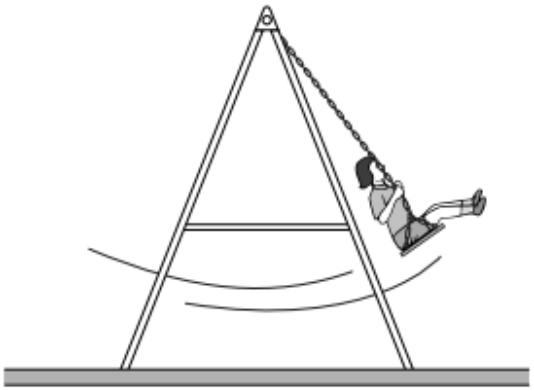


Figure 1 shows a young girl swinging on a garden swing. You may assume that the swing behaves as a simple pendulum. Ignore the mass of chains supporting the seat throughout this question, and assume that the effect of air resistance is negligible. 15 complete oscillations of the swing took 42s.

1 (b) (i) Calculate the distance from the top of the chains to the centre of mass of the girl and seat. Express your answer to an appropriate number of significant figures.

answer = ... m

(4 marks)

1 (b) (ii) To set her swinging, the girl and seat were displaced from equilibrium and released from rest. This initial displacement of the girl raised the centre of mass of the girl and seat 250 mm above its lowest position. If the mass of the girl was 18 kg, what was her kinetic energy as she first passed through this lowest point?

answer = ... J

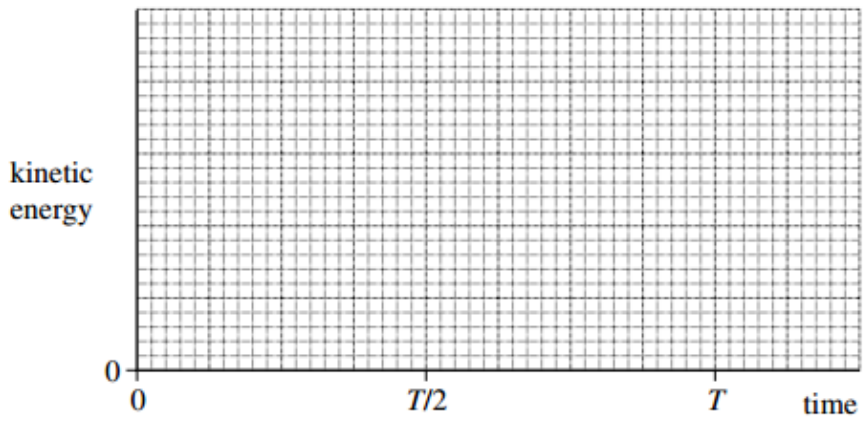
(2 marks)

1 (b) (iii) Calculate the maximum speed of the girl during the first oscillation.

answer = ... $m\,s^{-1}$

(1 mark)

1 (c) **Figure 2**



On **Figure 2** draw a graph to show how the kinetic energy of the girl varied with time during the first complete oscillation, starting at the time of her release from maximum displacement. On the horizontal axis of the graph, *T* represents the period of the swing. You do not need to show any values on the vertical axis.

(3 marks)