Topic 1 Mechanics
1B Energy

1B.1 Gravitational potential and kinetic energies

1 If we assume that the coconut falls 5.0 m, then the speed would be 9.9 m s^{-1}.

2 17.2 m s^{-1}

3 29.7 m s^{-1}

4 1.90 m

5 Air resistance and friction are negligible; energy is only transferred between kinetic and gravitational potential stores.

1B.2 Work and power

1 (a) Work done by lioness is 126 J.

(b) Work done by eagle is 113 J, so lioness does more work by 13 J.

2 4160 J

3 (a) 0.20 W

(b) 0.33 or 33%

4 0.29 or 29%

1B Exam practice

1 A

2 A

3 D

4 B

5 (a) Wind exerts a force / push on the blades, blades move (through a distance in the direction of the force) OR energy is transferred from kinetic energy of wind to (KE of) the blades

(b) (i) Volume per second = 6000 m^2 × 9 m = 54 000 m^3

Total volume in 5 seconds = 54 000 m^3 × 5 s = 270 000 (m^3)

(ii) Mass = 1.2 kg m^{-3} × 270 000 m^3 = 324 000 kg

(iii) E_k = ½ × 324 000 kg × (9 m s^{-1})^2 = 13 122 000 J

(iv) Energy from the wind in 5 seconds = 0.59 × 13 100 000 J = 7 741 980 J

Power = $\frac{\text{energy}}{\text{time}} = \frac{7\,741\,980\text{ J}}{5\text{ s}}$ = 1.548 MW

(c) Any one from:

Would need to stop wind entirely

Wind or air still moving

Wind or air still has KE

Not all the air hits the blades

(d) Any two from:

Wind does not always blow / if there is no wind they do not work / wind speeds are variable / need minimum amount of wind to generate the electricity / need a large amount of wind / cannot be used in very high winds

Only 59% max efficiency

Low power output / need a lot of turbines / need a lot of space

6 (a) $x = 2 \times \pi \times 3.7\text{ m} = 23.2\text{ m}$

$W = F\Delta x$

$W = 800\text{ N} \times 23.2\text{ m}$

$W = 18\,600\text{ J}$

(b) $\text{Power} = \frac{\text{work done}}{\text{time}}$

$= \frac{144 \times 18\,600\text{ J}}{60 \times 60\text{ s}}$

= 744 W (accept any dimensionally correct unit – ignore later units if W used as well)

(use of 20 000 J gives 800 W)

7 QWC (quality of written communication) – spelling of technical terms must be correct and the answer must be organised in a logical sequence. Any six of the following:

It will not strike the student's face / at most will just touch / returns to starting point

The total energy of the pendulum is constant / energy is conserved

It cannot move higher than its starting point because that would require extra gpe

Mention specific energy transfer: gpe → ke / ke → gpe

Energy dissipated against air resistance so will stop it quite reaching its starting point (consequent on attempt at describing energy loss mechanism)

Pushing does work on the ball / pushing provides extra energy if pushed, it can move higher (accept further) and will hit the student

If the face moves (forward) the ball may reach it (before it is at its maximum height)

OR if the face moves (back) the ball will not reach it

8 (a) (i) Horizontal component = 650 N × cos 42º

= 483 (N)

(ii) Work = 483 N × 15 × 7 m

= 50 715 J

(b) Force in the direction of motion

OR force is parallel to the direction of motion

OR force is applied in a horizontal direction

OR there is no vertical component of force

so less applied force

9 $W = mg$

$W = 0.98\text{ N}$ OR $W = 0.1\text{ (kg)} \times 9.81\text{ (N kg}^{-1}\text{)} = 1\text{ N}$

$W = Fs$ OR $gpe = mgh$

$gpe = 0.98\text{ J}$

$P = \frac{W}{t}$

$P = 0.98\text{ W}$