Pages 178–182 Exam practice questions

1 B

2 B

3 C

4 C

5 D

6 A

7 B

8 A

9 B

10 B

11 a) Potential energy is transferred into heat energy as work is done to drive it into the wood.

$mgh = Fs$ (1)

$F = \frac{mgh}{s}$ (1)

$= \frac{0.31\ \text{kg} \times 9.8\ \text{N kg}^{-1} \times 0.25}{6 \times 10^{-3}\ \text{m}}$ (1)

= 130 N (2 s.f.)

b) Once the nail is knocked into the wood, there is a longer length of it in contact with the wood; so the frictional force, *F*, on it is larger. Since the pile driver falls with the same energy, *s* becomes less as $F \times s$ is constant. (1,1,1)

12 a) $\Delta E_p/s = \frac{9600\ \text{kg}}{60\ \text{s}} \times 9.8\ \text{N kg}^{-1} \times 36\ \text{m}$ (1,1)

$= 56\ \text{kJ s}^{-1}$ (2 s.f.)

b) efficiency $= \frac{\text{useful power}}{\text{power input}}$

$= \frac{56\ \text{kW}}{80\ \text{kW}}$ (1)

= 0.71 (2 s.f.)

13 a) There are balanced forces in a horizontal direction: 92 kN drag balanced by 4×23 kN = 92 kN of thrust (1)

b) Weight = *mg*

$= 110\,000\ \text{kg} \times 9.8\ \text{N kg}^{-1}$

= 1.1 MN

So lift = 1.1 MN

c) $P = Fv$

(1)

= 23 kN × 240 m s^{-1}

= 5.5 MW (to 2 s.f.)

14 a) Energy cannot be created or destroyed, but it can be (1) transferred from one form of energy to another. (1)

b) $\Delta h = 12 \sin 30 = 6$ m (1)

$\Delta PE = mg\Delta h$

= 32 kg × 9.8 N kg^{-1} × 6 m (1)

= 1.9 kJ (2 s.f.) (1)

c) $\Delta KE = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 32$ kg × 9.3^2 (m $s^{-1})^2$ (1)

= 1.4 kJ (2 s.f.) (1)

d) Work is done against frictional forces; potential energy is transferred to heat energy. (1,1)

e) Energy transferred to heat = 1.9 kJ – 1.4 kJ

= 0.5 kJ (1)

Work = force × distance

Force = $\frac{\text{work done}}{\text{distance}}$ (1)

$= \frac{500 \text{ J}}{12 \text{ m}}$

= 42 N (1)

15 a) i) $a = \frac{v-u}{t}$

$= \frac{41 \text{ m s}^{-1}}{0.49 \times 10^{-3} \text{ s}}$ (1)

= 84 000 m s^{-2} (1)

i) $F = ma$

= 0.046 kg × 84 000 m s^{-2}

= 3.8 kN

b) $KE = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0.046$ kg × 41^2 (m $s^{-1})^2$

= 39 J

c) $\frac{1}{2}mv^2 = F \times s$

39 J = 3.8 kN × s

s = 0.01 m (1 cm)

d) During the contact between the club and ball some energy will be dissipated as sound and heat. Work is done by the club to transfer the energy, so the contact distance is a little greater.

16 a) $\Delta E_p = mg\Delta h$

= 1300 kg × 9.8 N kg^{-1} × 17 m

= 220 kJ (2 s.f.)

b) i) $\frac{1}{2}mv^2$ = 220 kJ

$\frac{1}{2}$ × 1300 kg × v^2 = 220 kJ

$v^2 = \frac{440\,000\text{ J}}{1300\text{ kg}}$

v = 18 m s^{-1}

ii) Drag on the boat will slow it down. So some potential energy is transferred to heat energy on the way down.

c) i) Either $mgh = \frac{1}{2}mv^2$

$\Longrightarrow v^2 = 2gh$ (2)

so the speed is unaffected.

OR since drag acts on the boat, a greater mass might mean that there is less effect on the speed. So speed might be a little more than before. (2)

ii) $\frac{1}{2}mv^2 = F \times d$

Assuming the same drag force, then a larger mass will require a larger stopping distance. (2)

17 a) When you drive a car work is done against resistive (or drag) forces. (1)

$W = Fs$

You have to travel a distance s. If the drag force is bigger, more work is done, so more energy used from petrol. (1,1)

b) $P = Fv$

= 540 N × 30 m s^{-1}

= 16.2 kW (2)

c) i) efficiency = $\frac{\text{useful power}}{\text{power input}}$

power input = $\frac{16.2\text{ kW}}{0.27}$

= 60 kW (2)

ii) Energy is transferred to heat in the engine and some noise. (1)

d) Energy used = $P \times t$ (1)

= 60 kW × 3600 s

= 216 MJ (1)

Petrol used = $\frac{216\text{ MJ}}{32\text{ MJ l}^{-1}}$

= 6.8 J (1)

18 a) Mass = 350 million $m^3 \times 3000$ kg m^{-3}

(1)

= 1.05×10^{12} kg

b) $\Delta PE = 1.05 \times 10^{12}$ kg $\times 9.8$ N $kg^{-1} \times 5000$ m (1)

= 5.0×10^{16} J

c) The minimum KE of the meteor must have been 5.0×10^{16} J

$\Rightarrow 5 \times 10^{16} = \frac{1}{2} mv^2$

(1)

$\Rightarrow m = \frac{10 \times 10^{16}}{(1.4 \times 10^4)^2}$

= 5×10^8 kg

d) The meteor is likely to have been much larger as the rock was probably vaporised on impact.

Shock waves will have travelled around the Earth.

19 a) work done = area under the graph

(1)

= ½ × 2800 N × 0.3 m = 420 J

(1)

b) $420 = ½ \times 86 \times v^2$

(2)

$v^2 = 9.8$

$v = 3.1\ \text{m s}^{-1}$

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20 $\text{KE} = \frac{1}{2}mv^2$

So if *v* is double, the KE is four times as much.

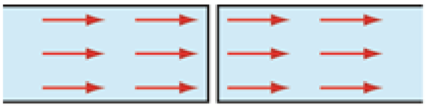
$E = Pt$

So if the power is constant, it will take four times the time to reach a kinetic energy four times greater.

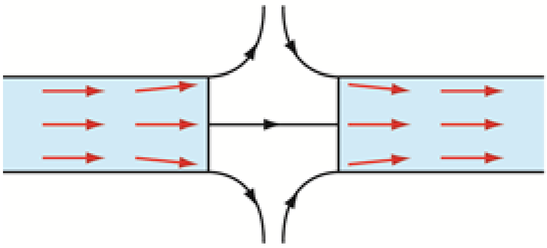
21 a) Work done = area under the graph

The area is about 10 squares = 10 × 1 N × 0.01 m = 0.1 J

b) The magnetic potential energy of the magnets has been increased. When the magnets are in contact, the magnetic domains are in greater alignment. When they are pulled apart, then the directions of some domains are tilted to the side. (Think of the diagrams of magnetic fields you drew during KS3 work.)



Magnets in contact: low magnetic potential energy



Magnets separated: high magnetic potential energy

c) Newton's third Law tells us that each magnet experiences equal and opposite magnetic forces, so they travel to the same distance.

Each magnet has 0.05 J of magnetic potential energy (MPE) transferred to it; each magnet moves 0.025 m.

So $\frac{1}{2}mv^2$ = MPE – work done against frictional forces

$\frac{1}{2} \times 0.05 \times v^2 = 0.05 - 0.4 \times 0.025$

$v^2 = 2 - 0.4 = 1.6$

$v = 1.3\ \text{m s}^{-1}$

d) This is a little estimation work. The total area (to ∞) under the graph is about 0.12 J.

So each magnet has 0.06 J of MPE transferred to it.

0.12 J = Fs

$\Rightarrow$ 0.12 J = 0.4 N × s

s = 0.3 m or each magnet moves 0.15 m.

d) The closest distance is when the magnetic attraction is balanced by the frictional force of 0.4 N. This is about 6 cm.

22 a) N m^{-2} = N m × m^{-3} = J m^{-3}

b) Pressure × volume = $mg\Delta h$

$$P = \frac{mg\Delta h}{V}$$

$$= \frac{0.015\ \text{kg} \times 9.8\ \text{N kg}^{-1} \times 10\ \text{m}}{75 \times 10^{-2} \times 10^{-3}\ \text{m}^3}$$

= 2000 J m^{-3} or 2000 N m^{-2}

This is about 0.02 of an atmosphere pressure.