1 **(a)** Fig. 12.1 shows a bicycle with a front lamp **A** and a rear lamp **B** powered by the same battery.

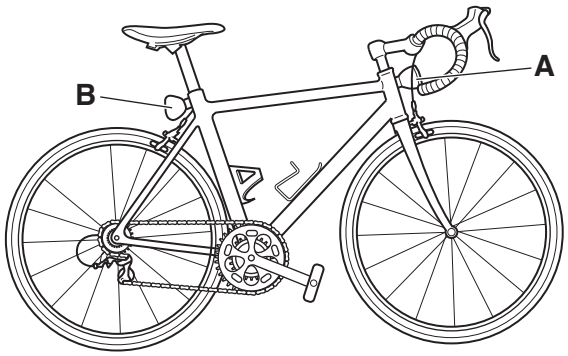

Fig. 12.1

Fig. 12.2 is a circuit diagram to show how the lamps are connected.

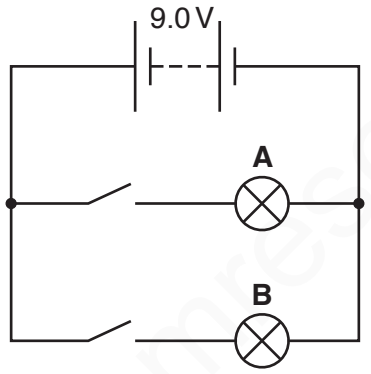

Fig. 12.2

(i) Lamp **A** has a resistance of 16.0 Ω and lamp **B** has a resistance of 8.0 Ω.

Calculate the combined resistance of the two lamps in this circuit when both switches are closed.

Show your working.

resistance = ... Ω [2]

(ii) Calculate the power of lamp **B**.

State any formula you use, show your working and give the unit of your answer.

formula

working

power = ... unit ..... [4]

(b) One of the lamps is shown in Fig. 12.3.

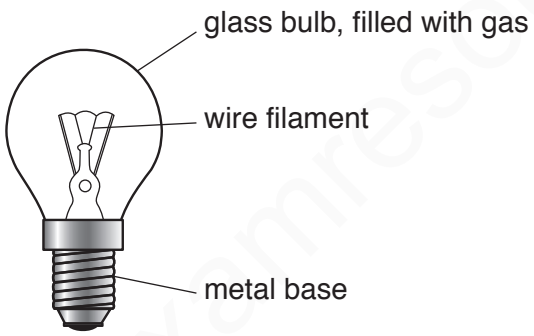

Fig. 12.3

The hot lamp transfers thermal energy.

(i) Name the process that transfers thermal energy through the metal base.

.....[1]

(ii) Name the **two** processes that transfer thermal energy between the hot wire filament and the glass bulb.

1 .....

2 .....
[1]

(c) The cyclist has a flat tyre. She pumps up the flat tyre with a volume of 3168 cm^3 of air at atmospheric pressure.

When the tyre is inflated, the volume of air in the tyre is 1441 cm^3. Assume that there was no air in the flat tyre.

The pressure of the air in the inflated tyre is 2.22×10^5 N/m^2.

The temperature of the air does not change.

(i) Write down the value of the inflated tyre pressure in pascals (Pa).

..... Pa [1]

(ii) Calculate the atmospheric pressure in N/m^2.

State the formula you use and show your working.

formula

working

atmospheric pressure = ...N/m^2 [2]

MARKING SCHEME:

(a)(i)	$R = R_1 \times R_2 / R_1 + R_2$ or $16 \times 8 / 16 + 8$; 5.3(3) (Ω) ;	**2**
(a)(ii)	current = voltage / resistance or 9 / 8 OR 1.1(25) (A) ; power = voltage × current or 9×1.125 ; = 10(.125) ; Watts / W ;	**4**
(b)(i)	conduction ;	**1**
(b)(ii)	convection **AND** radiation ;	**1**
(c)(i)	2.22×10^5 (Pa) ;	**1**
(c)(ii)	P1 = (P2 × V2) / V1 or $(2.22 \times 10^5 \times 1441) / 3168$; $= 1.01 \times 10^5$ (N / m^2) ;	**2**

2 **(a)** An iron magnet picks up two iron nails as shown in Fig. 6.1.

Fig. 6.1

Explain why the nails do not hang vertically.

.....

.....

..... [2]

(b) An isotope of iron has a nuclide notation $^{60}_{26}Fe$ and decays by beta particle emission to an isotope of cobalt.

(i) State what is meant by the term *isotope*.

.....

..... [1]

(ii) Use nuclide notation to complete the symbol equation for this β-decay process.

$$^{60}_{26}Fe \rightarrow \text{.....} + \text{.....}$$ [2]

(c) An iron wire of length 0.50 m has a cross sectional area of $4.0 \times 10^{-5}\,m^2$ and a resistance of $1.21 \times 10^{-3}\,\Omega$.

Calculate the resistance of an iron wire of length 0.25 m that has a cross sectional area of $8.0 \times 10^{-5}\,m^2$.

resistance = ... Ω [3]

(d) A block of iron is on a bench.

The surface of the block of iron in contact with the bench has an area of 144 cm^2.

The mass of the block of iron is 13.6 kg.

Calculate the pressure exerted by the block of iron on the bench in N/cm^2.

gravitational field strength = 10 N/kg

pressure = ... N/cm^2 [3]

[Total: 11]

MARKING SCHEME:

(a)	ref. to induced magnetism (in) nails ; two nail heads / north poles / like poles, will repel each other ;	**2**
(b)(i)	atoms having same atomic number / proton number and different mass number / neutron number ;	**1**
(b)(ii)	$^{60}_{27}Co$; $^{0}_{-1}e$;	**2**
(c)	evidence that resistance is halved by cross sectional area change ; evidence that resistance is halved by length change ; new resistance = $3.0 \times 10^{-4}\ \Omega$;	**3**
(d)	136 N ; pressure = force / area **OR** 136 / 144 ; 0.94 (N / cm^2) ;	**3**

3 **(a)** A farmer drives his tractor at a constant speed.

Fig. 6.1 shows four forces **P**, **Q**, **R** and **S** acting on the tractor.

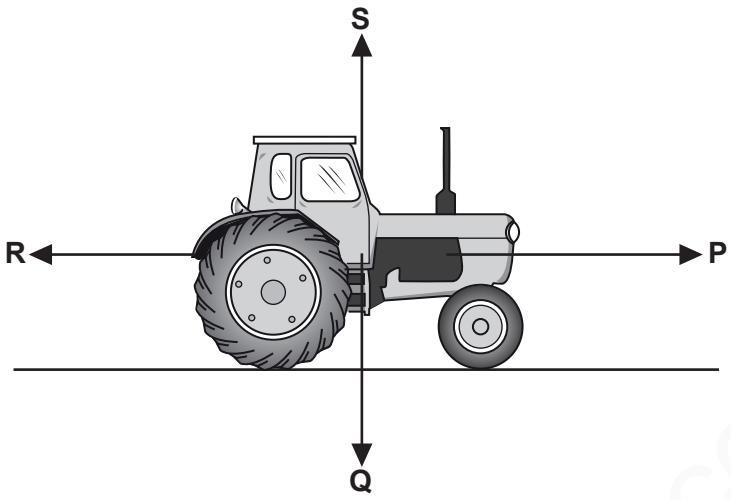

Fig. 6.1

(i) State the letter corresponding to the gravitational force acting on the tractor.

..... [1]

(ii) Force **P** is 1500 N.

State the value of force **R**.

Explain your answer.

force **R** = ... N

explanation .....

..... [2]

(b) The tractor accelerates.

The force causing this acceleration is 4200 N.

The weight of the tractor is 35 000 N.

The gravitational field strength *g* is 10 N / kg.

Calculate the acceleration of the tractor.

acceleration = ... m/s^2 [3]

(c) The tractor has very wide tyres as shown in Fig. 6.2.

Fig. 6.2

The tractor sinks into the soil if the pressure acting on the ground is too large.

Explain why having wider tyres reduces the pressure of the tractor on the ground.

.....

.....

..... [2]

(d) The farmer lifts a bucket of water from a well.

The bucket of water has a weight of 120 N and is lifted through a vertical distance of 18 m.

Calculate the work done.

work done = ... J [2]

[Total: 10]

MARKING SCHEME

(a)(i)	**Q** ;	**1**
(a)(ii)	1500 (N) ; constant speed / forces are balanced / resultant is zero ;	**2**
(b)	mass = 3500 kg ; force / mass or 4200 / 3500 ; acceleration = 1.2 (m / s^2) ;	**3**
(c)	larger (surface) area ; (so pressure is less as) P = F / A ;	**2**
(d)	(work done =) force × distance or 120 × 18 ; = 2160 (J) ;	**2**

4 **(a)** A horse of mass 450 kg accelerates constantly from rest and reaches a maximum speed of 9 m/s after 3 seconds. In this time, the horse has travelled 13.5 m.

(i) Show that the force that causes the acceleration of the horse is 1350 N.

[3]

(ii) Calculate the work done by the horse in travelling 13.5 m.

work done = ... J [2]

(b) The horse stands with all four hooves in contact with the ground.
The horse exerts a force of 4500 N on the ground.

Each hoof of the horse has an area of 90 cm^2.

Calculate the pressure, in N/m^2, exerted by the horse on the ground.

pressure = ... N/m^2 [3]

(c) Horseshoes are usually made from either iron or steel.

Describe **one** difference between the magnetic properties of iron and steel.

.....

..... [1]

(d) The audible frequency range for horses is from 14 Hz to 25 000 Hz.

Compare this range to that of a human.

.....

..... [1]

(e) A horse is treated for cancer using the isotope iridium-192. The iridium-192 is injected into the cancer.

Iridium-192 decays by β-emission to produce an isotope of platinum.

Use nuclide notation to complete the symbol equation for the β-decay process.

$$^{192}_{77}\text{Ir} \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}\text{Pt} + {}^{\cdots\cdots}_{\cdots\cdots}\beta$$

[2]

[Total: 12]

MARKING SCHEME

(a)(i)	acceleration = 9/3 = 3 m/s^2 ; force = mass × acceleration ; working or 3 × 450 (= 1350 N) ;	3
(a)(ii)	work done = force × distance / 1350 × 13.5 ; = 18 200 (J) ;	2
(b)	90 × 4 = 360 (cm^2) = 0.036 m^2 ; pressure = force / area or 4500 / 0.036 ; pressure = 125 000 (N/m^2) ;	3
(c)	iron, magnetises / loses magnetism, quicker ; steel, magnetises / loses magnetism, slower ; **max 1**	1
(d)	humans have smaller audible range ;	1
(e)	$^{192}_{77}Ir \rightarrow {}^{192}_{78}Pt + {}^{0}_{-1}\beta$;;	2