Chapter 1 Physics and Physical measurement

1. C

2. D

2. B

4. D

Chapter 2

1- 21 As book

22. (a) (i) $h = \dfrac{v^2}{2g}$;
to give $h = 3.2$ m; 2

(ii) 0.80 s; 1

(b) time to go from top of cliff to the sea = 3.0 – 1.6 = 1.4 s;
recognise to use $s = ut + \frac{1}{2}at^2$ with correct substitution,
$s = 8.0 \times 1.4 + 5.0 \times (1.4)^2$;
to give $s = 21$ m; 3

Answers might find the speed with which the stone hits the sea from $v = u + at$, (42 m s^{-1}) and then use $v^2 = u^2 + 2as$.

[6]

23. (a) mass × velocity; 1

(b) (i) momentum before = 800 × 5 = 4 000 N s;
momentum after = 2 000v;
conservation of momentum gives $v = 2.0$ m s^{-1}; 3

(ii) KE before = 400 × 25 = 10 000 J KE after = 1 000 × 4 = 4 000 J;
loss in KE = 6 000 J; 2

(c) transformed/changed into;
heat (internal energy) (and sound); 2

Do not accept "deformation of trucks".

[8]

24. (a) statement that gravitational mass and inertial mass have the same numerical value;
understanding of what gravitational mass means;
e.g. "a quantity that determines the gravitational force on the object"
understanding of what inertial mass means;
e.g. "a quantity that determines the acceleration of the object" 3 max

(b) (i) the acceleration = gradient of first section of graph;
acceleration = 0.80 / 0.50 = 1.6 m s^{-2}; 2 max

Accept bald correct answer for full marks.

(ii) the total distance travelled by the lift = area under graph;
distance = (11 × 0.80) + (0.50 × 0.80) = 8.8 + 0.4 = 9.2 m; 2 max

Accept bald correct answer for full marks.

(iii) the work done = P.E. gained (= force × distance);
work done = 2500 × 9.2 = 23000 J = 23 kJ; 2 max

Accept bald correct answer for full marks.

(iv) correct substitution into power = work done / time taken

= 23000 / 12;

= 1916 W

= 1.9 kW; 2 max

(v) correct substitution into efficiency = power out / power in

= 1.9 / 5.0;

= 0.38 = 38 %; 2 max

25. (a) if the total external force acting upon a system is zero / for an isolated system;
the momentum of the system is constant; 2

Award ***[1 max]*** *if the answer is in terms of collisions.*

(b) 131 g of xenon contains 6.02×10^{23} / N_A atoms;

mass of 1 atom = $\frac{131}{6.02 \times 10^{23}}$ = 2.2×10^{-22} = 2.2×10^{-25} kg;

or

mass of nucleon 1.66×10^{-27} kg;
mass of xenon atom = $131 \times 1.66 \times 10^{-27}$ kg = 2.2×10^{-25} kg; 2

(c) time = $1.5 \times 3.2 \times 10^7 = 4.8 \times 10^7$ s;

no of atoms per second = $\frac{81}{2.2 \times 10^{-25} \times 4.8 \times 10^7}$ = 7.7×10^{18} s^{-1};

or

no of atoms in original mass = $\frac{81}{2.2 \times 10^{-25}}$ = 3.7×10^{26};

time = $\frac{3.7 \times 10^{26}}{7.7 \times 10^{18}}$ = 4.8×10^7 s = 1.5 years; 2

(d) rate of change of momentum of the xenon atoms
= $7.7 \times 10^{18} \times 2.2 \times 10^{-25} \times 3.0 \times 10^4$;
= 5.1×10^{-2} N;
= mass × acceleration;
where mass = (540 + 81) kg;

to give acceleration of spaceship = $\frac{5.1 \times 10^{-2}}{6.2 \times 10^2}$;

= (8.2×10^{-5} m s^{-2}) 5

Accept if mass of fuel omitted (= 9.4×10^{-5} *m s*$^{-2}$*).*

(e) $a = \frac{F}{m}$;

since m is <u>decreasing</u> with time, then a will be <u>increasing</u> with time; 2

(f) change in speed = area under graph;
= $(8.2 \times 4.8) \times 10^2 + \frac{1}{2}(4.8 \times 1.3) \times 10^2$;

final speed = $(8.2 \times 4.8) \times 10^2 + \frac{1}{2}(4.8 \times 1.3) \times 10^2 + 1.2 \times 10^3$;

5.4×10^3 m s^{-1};

or

use of $v = u + at$

$u = 1.2 \times 10^3$ m s^{-1};

average acceleration from the graph = $\frac{1}{2}(8.2 + 9.45) \times 10^{-5}$;

= 8.8×10^5 m s^{-2};

final speed = $4.8 \times 10^7 \times 8.8 \times 10^{-5} + 1.2 \times 10^3 = 5.4 \times 10^3$ m s^{-1}; 4

(g) $t = \frac{s}{v} = \frac{4.7 \times 10^{11}}{5.4 \times 10^3} = 8.7 \times 10^7$ s;

so total time $4.8 \times 10^7 + 8.7 \times 10^7$ s ≈ 4.2y ; 2

[19]

Chapter 3 Thermal Physics

May 2004 (2) Paper 2

1. (a) (165, 0); 1

(b) *Look for these points:*

to change phase, the separation of the molecules must increase;

Some recognition that the ice is changing phase is needed.

so all the energy input goes to increasing the PE of the molecules;

Accept something like "breaking the molecular bonds".

KE of the molecules remains constant, hence temperature remains constant; 3

If KE mentioned but not temperature then assume they know that temperature is a measure of KE.

(c) (i) time for water to go from 0 to 15° C = 30 s;

energy required = $ms\Delta\theta$ = 0.25 × 15 × 4 200 = 15 750 J;

power = $\frac{\text{energy}}{\text{time}}$ = 525 W ≈ 530 W; 3

(ii) ice takes 15 s to go from – 15 °C to 0;

energy supplied = 15 × 530 J;

sp ht = $\frac{(530 \times 15)}{(15 \times 0.25)}$ = 2100 J kg^{-1} K; 3

(iii) time to melt ice = 150 s;

$L = \frac{(150 \times 530)}{0.25}$ = 320 kJ kg^{-1}; 2

[12]

May 2005 (2) Paper 2

2. (a) more energetic molecules leave surface;

mean kinetic energy of molecules in liquid decreases;

and mean kinetic energy depends on temperature; 3

*Award **[2]** if mean not mentioned.*

(b) *e.g.* larger surface area;

increased draught;

higher temperature;

lower vapour pressure; 2 max

*Award **[1]** if candidate merely identifies two factors.*

(c) energy to be extracted = 0.35 × 4200 × 25;

+0.35 × 330 000;

+0.35 × 2100 × 5;

= 156 000 J

time = $\frac{156\,000}{86}$ = 1800 s; 4

Allow ECF if one term incorrect or missing.

[9]

November 2003 paper 2

5. (a) ***[1]** for each appropriate and valid point e.g.*
thermal energy is the K.E. of the component particles of an object;
thus measured in joules;
the temperature of an object is a measure how hot something is (it can be used to work out the direction of the natural flow of thermal energy between two objects in thermal contact) / measure of the average K.E. of molecules;
it is measured on a defined scale (Celsius, Kelvin *etc.*); 4 max

(b) (i) correct substitution: energy = power × time;
= 1200 W × (30 × 60) s;
= 2.2 × 10 J 2 max

(ii) use of $E = m c \Delta\theta$;
to get $\Delta\theta = 2.2 \times 10^6 / (4200 \times 70)$ K;
= 7.5 K; 3 max

(c) ***[1]** naming each process up to **[3 max]**.*
convection;
conduction;
radiation;

***[1]** for an appropriate (matching) piece of information / outline for each process up to **[3 max]**.*

e.g. convection is the transfer of thermal energy via bulk movement of a gas due to a change of density;
conduction is transfer of thermal energy via intermolecular collisions;
radiation is the transfer of thermal energy via electromagnetic waves (IR part of the electromagnetic spectrum in this situation) */ OWTTE*; 6 max

(d) (i) ***[1]** for each valid and relevant point e.g.*
in evaporation the faster moving molecules escape;
this means the average K.E. of the sample left has fallen;
a fall in average K.E. is the same as a fall in temperature; 3 max

(ii) energy lost by evaporation = 50 % × 2.2×10^6 J;
= 1.1×10^6 J;
correct substitution into $E = m\,l$
to give mass lost = 1.1×10^6 J / 2.26×10^6 J kg^{-1}
= 0.487 kg
= 487 g; 3 max

(iii) ***[1]** for any valid and relevant factors **[2 max]** e.g.*
area of skin exposed;
presence or absence of wind;
temperature of air;
humidity of air *etc.*;

***[1]** for appropriate and matching explanations **[2 max]** e.g.*
increased area means greater total evaporation rate;
presence of wind means greater total evaporation rate;
evaporation rate depends on temperature difference;
increased humidity decreases total evaporation rate *etc.*; 4 max

[25]

Multiple choice Questions
6. D
7. C
8. A
9. A

Chapter 4 SHM and Waves

November 2003 paper 2

1. (a) longitudinal; 1

(b) (i) wavelength = 0.5 m; 1

(ii) amplitude = 0.5 mm; 1

(iii) correct substitution into speed = frequency × wavelength;
to give $v = 660 \times 0.5 = 330$ m s^{-1}; 2 max

[5]

May 2003 paper 2

2. (a) (i) wavefront parallel to D; 1

(ii) frequency is constant;
since, $v = f\lambda$, $v \propto \lambda$
wavelength larger in medium I, **hence** higher speed in medium I; 3
Allow solution based on angles marked on the diagram or speed of wavefronts.

(b) (i) velocity / displacement / direction in (+) and (–) directions;
idea of periodicity; 2

(ii) period = 3.0 ms;
frequency = $\frac{1}{T}$ = 330 Hz; 2

(iii) *Accept any one of the following.*
at time $t = 0$ / 1.5 ms / 3.0 ms / 4.5 ms *etc.*; 1 max

(iv) area of half-loop = 140 squares ± 10 / mean $v = 4.0$ m s^{-1} ± 0.2;
$= 140 \times 0.4 \times 0.1 \times 10^{-3}$ / $4.0 \times 1.5 \times 10^{-3}$;
$= 5.6 \times 10^{-3}$ m / 6.0×10^{-3} m; 2 max
*Award **[1]** for area of the triangle.*

(v) (twice) the amplitude; 1
Allow distance moved in 1.5 m s.

May 2004 (1) Paper 2

3. (a) (i) velocity has direction; but light travels in all directions; 2

(ii) *longitudinal*: displacement along;
transverse: displacement normal to;
direction of transfer of wave energy / propagation, **not** motion; 3
*Award **[0]** for left/right and up/down for longitudinal/transverse.*

(b) (i) $\left(\frac{700}{75}\right) = 9.3$ km s^{-1}; (±0.1) 1

(ii) $\left(\frac{700}{120}\right)$ =5.8 km s^{-1}; (±0.1) 1

*Award **[1 max]** if the answers to (i) and (ii) are given in reversed order.*

(c) (i) P shown as the earlier (left hand) pulse; 1

(ii) laboratory L_3; 1

(iii) *e.g.* pulses arrive sooner;
smaller S-P interval;
larger amplitude of pulses; 3

*Allow any feasible piece of evidence, award **[1]** for each up to **[3 max]**.*

(iv) *distance from L_1* = 1060 km; (± 20)
distance from L_2 = 650 km; (± 20)
distance from L_3 = 420 km; (± 20)
Accept 3 significant digits in all three estimates.
some explanation of working; 4

(v) position marked, consistent with answers to (iv);
to the right of line L_2 L_3, closer to L_3; 1 max

Chapter 5 Electricity Answers

May 2004 paper 2

1. (c) (i) use of e.m.f. = energy / charge;

$= \dfrac{(8.1\times10^3)}{(5.8\times10^3)}$

= 1.4 V; 2

*Award **[0]** for formula $E = \dfrac{F}{Q}$ seen or implied even if answer is numerically correct.*

(ii) p.d. across internal resistance = 0.2 V; **OR** current = $\dfrac{1.2}{6}$ = 0.2A;

resistance $r = \left(\dfrac{0.2}{1.2}\right) \times 6.0$; total resistance = $\dfrac{1.4}{0.2}$ = 7.0 Ω;

= 1.0 Ω; internal resistance = 7 – 6 = 1.0 Ω; 3

Accept any other valid route.

(iii) idea of use of ratio of resistances;

energy transfer = 6/7 × 8.1 × 10^3

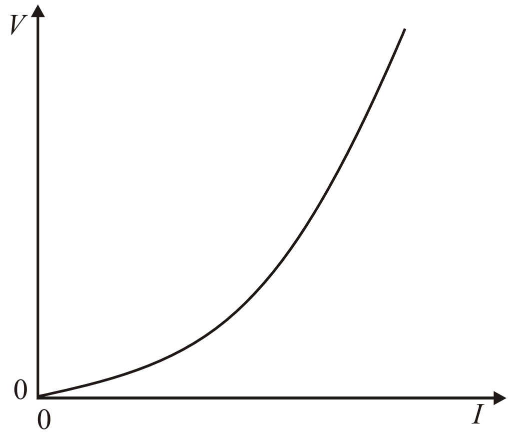
= 6.9(4) × 10 J; 2

ci *Accept any other valid route.*

(iv) charge carriers/electrons have kinetic energy / are moving;
these carriers collide with the lattice/lattice ions; *(do not allow friction)*
causing increased (amplitude of) vibrations;
this increase seen as a temperature rise;
i.e. a transfer to thermal energy; 5
Allow any other relevant and correct statements.

May 2004 (2) paper 2

2. (a)



1

Any reasonable curve in the right direction.

(b) (i) from the value of *V/I* at any point on the curve; 1
Do not accept just "from V/I".

(ii) non-ohmic because the resistance (*V/I* at each point)
is not constant / *OWTTE*; 1

(c) (i) 50 Ω; 1

(ii) recognize that the voltage must divide in the ratio 3 : 1;
to give R = 150 Ω; 2***]#***
Or answer could be solved via the current.

[6]

November 2004 paper 2

3. (a) (i) when connected to a 3 V supply, the lamp will be at normal brightness;
and energy is produced in the filament at the rate of 0.60 W;
Look for the idea that 3 V is the operating voltage and the idea of energy transformation.
or
when connected to a 3 V supply, the lamp will be at normal brightness;
and the resistance of the filament is 15 **Ω** / the current in the filament is 0.20 A; 2 max

(ii) $I = \frac{P}{V}$;
to give *I* = 0.20 A; 2

(b) (i) at maximum value, the supply voltage divides between the resistance of the variable resistor, internal resistance and the resistance of the filament;
i.e. response must show the idea of the voltage dividing between the various resistances in the circuit. Do not penalise if responses do not mention internal resistance here.
at zero resistance, the supply voltage is now divided between the filament resistance and the internal resistance of the supply; 2

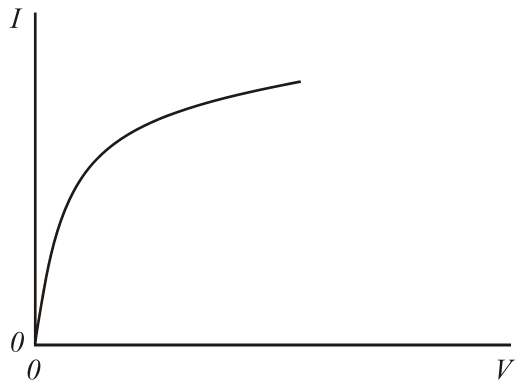
(ii) when resistance of variable resistor is zero, e.m.f. = $Ir + V_{\text{lamp}}$;
$3.0 = 0.2\,r + 2.6$;
to give $r = 2.0\ \Omega$; 3

(c) (i) 3.3 Ω; 1

(ii) 13 Ω; 1

(d) at the higher pd, greater current and therefore hotter; the resistance of a metal increases with increasing temperature; *OWTTE*; 2 max

(e)



correct approximate shape (*i.e.* showing decreasing gradient with increasing *V*); 1

(f) parallel resistance of lamp and YZ is calculated from $\frac{1}{R} = \frac{1}{4} + \frac{1}{12}$;

to give $R = 3.0\ \Omega$;
3.0 V therefore divides between 3.0 Ω and 12.0 Ω;
to give pd across the lamp = 0.60 V;

Give relevant credit if answers go via the currents i.e.
calculation of total resistance = 15.0 Ω;
total current = 0.20 A;
current in lamp = 0.15 A; 4

[18]

<u>May 2005 (1) paper 2</u>

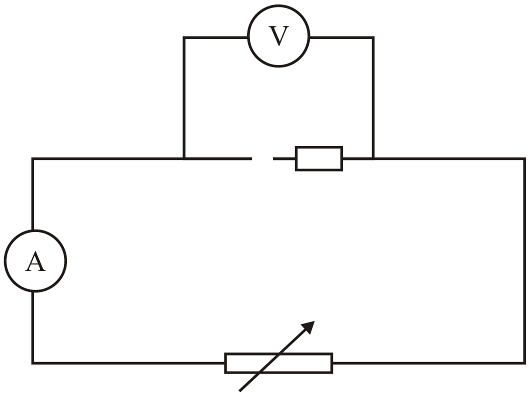
4. (a) (i) *EI*; 1

(ii) I^2r; 1

(iii) *VI*; 1

(b) (from the conservation of energy), $EI = I^2r + VI$;
therefore, $V = E - Ir$ / $E = V + Ir$; 2

(c)



correct position of voltmeter;
correct position of ammeter;
correct position of variable resistor; 3

(d) (i) $E = V$ when $I = 0$;
so $E = 1.5$ V; 2

(ii) recognize this is when $V = 0$;
intercept on the x-axis = 1.3 (±0.1) A; 2

(iii) r is the slope of the graph;
sensible choice of triangle, at least half the line as hypotenuse;
$= \frac{0.7}{0.6}$;
= 1.2 (±0.1)Ω
or
when $V = 0$ $E = Ir$;
$r = \frac{E}{I}$
$= \frac{1.5}{1.3}$;
= 1.2Ω 3

(e) $R = 1.2\Omega$;
$I = \frac{1.5}{1.2 + 1.2} = 0.63\text{A}$;
$P = I^2R = (0.63)^2 \times 1.2 = 0.48\text{W} / 0.47\text{ W}$; 3

[18]

Chapter 6 Fields

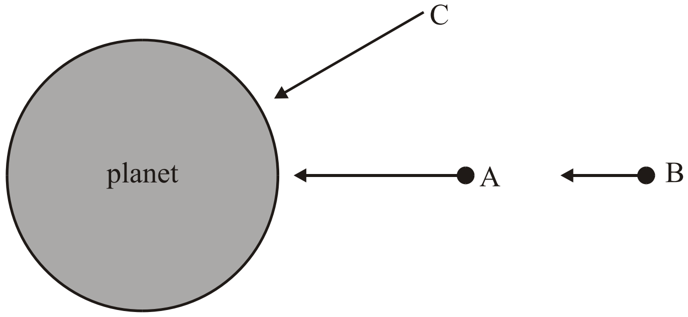
May 2004 paper 3

1. (a) $g = \frac{F}{m}$

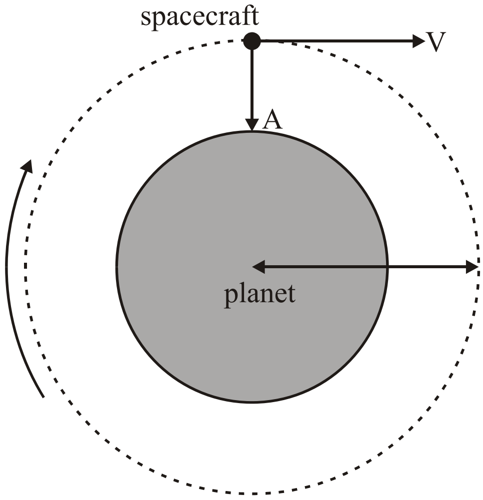
F is the gravitational force;

exerted on/experienced by a small/point/infinitesimal mass m; 2

(b) *Award* ***[1]*** *for each correct arrow. The one at B points in the same direction as that at A and is shorter. The one at C has the same length as that at A and points toward the centre of the planet.* 2



(c)



(i) velocity is tangent to path; 1

(ii) acceleration is normal to velocity toward centre; 1

(d) for realizing that $g = a$;

$a = \frac{v^2}{r} = \frac{(6.5 \times 10^3)^2}{7.5 \times 10^6}$ N kg^{-1};

$g = 5.6$ N kg^{-1}; 3

[9]

November 2004 paper 3

2. (a) attractive force is proportional to the product of the point masses;

and inversely proportional to the square of the separation; 2

Award ***[1]*** *if the response is not clear that they are point masses or if the force is attractive. Award* ***[0]*** *for quoting the formula from data booklet without any further explanation.*

(b) use of $g = \frac{GM}{r^2}$;

appropriate substitution: $g = \frac{6.67\times10^{-11}\times6.0\times10^{24}}{(6.4\times10^{6})^2}$ $= 9.77 \approx 10$ N kg^{-1}; 2

(c) (i) point marked on Earth's surface that is nearest to Moon;
since force of attraction from Moon greatest; 2
Accept other sensible comment.

(ii) same point as above; (*accept point on directly opposite side of Earth*)
explanation of why the resultant field is a minimum at this point
e.g. forces from Earth and Moon are in opposite directions; 2

(iii) each relevant point;
e.g. Earth is rotating;
Moon orbits the Earth *etc.*;
position of Sun also affects resultant field *etc.*; 2 max

[10]

<u>May 2005 paper 2</u>

3. (a) the force exerted per unit mass;
on a point / small mass; 2

(b) (i) use of $g = \frac{F}{m}$ and $F = G\frac{Mm}{R^2}$;

combine to get $g = G\frac{M}{R^2}$; 2

(ii) $M = \frac{gR_2}{G}$;

substitute to get $M = 1.9 \times 10^{27}$; 2

[6]

Chapter 7 Atomic

May 2003 paper 2

1. (a) *Deduct **[1]** for each error or omission, stop at zero* 2 max

Property	***Effect on rate of decay***		
	increase	*decrease*	*stays the same*
temperature of sample			✓
pressure on sample			✓
amount of sample	✓		

(b) (i) ${}^{4}_{2}\text{He}/{}^{4}_{2}\alpha$;
${}^{222}_{86}\text{Rn}$; 2

(ii) mass defect = 5.2×10^{-3} u;
energy = mc^2
= $5.2 \times 10^{-3} \times 1.661 \times 10^{-27} \times 9.00 \times 10^{16}$ / 1 u = 930 MeV;
= 7.77×10^{-13} J / 4.86 MeV; 3 max

(c) (i) (linear) momentum must be conserved;
momentum before reaction is zero;
so equal and opposite after (to maintain zero total); 3

(ii) $0 = m_\alpha v_\alpha + m_{\text{Rn}} v_{\text{Rn}}$;
$\frac{v_\alpha}{v_{\text{Rn}}} = -\left(\frac{m_{\text{Rn}}}{m_\alpha}\right)$
$= -\frac{222}{4} = -55.5$; 3
Ignore absence of minus sign.

(iii) kinetic energy of α-particle = $\frac{1}{2} m_\alpha v_\alpha^{2}$;
kinetic energy of radon nucleus = $\frac{1}{2}\left(\frac{222}{4}\right) m_\alpha \left(\frac{V_\alpha}{55.5}\right)^2$;
this is 1 / 55.5 of kinetic energy of the α-particle; 3 max
*Accept alternative approaches up to **[3 max]**.*

(d) *e.g.* (γ-ray) photon energy or radiation; 1

(e) (i) two (light) nuclei;
combine to form a more massive nucleus;
with the release of energy / with greater total binding energy; 3

(ii) high temperature means high kinetic energy for nuclei;
so can overcome (electrostatic) repulsion (between nuclei);
to come close together / collide;
high pressure so that there are many nuclei (per unit volume);
so that chance of two nuclei coming close together is greater; 5

[25]

May 2004 (1) paper 2

2. (a) (i) *fission*:
nucleus splits;
into two parts of similar mass;

radioactive decay:
nucleus emits;
a particle of small mass and/or a photon; 4

(ii) ${}^{235}_{92}U + {}^{1}_{0}n$;
$\rightarrow {}^{90}_{38}Sr + {}^{142}_{54}Xe + 4\,{}^{1}_{0}n$; 2
Allow ecf for RHS if LHS is incorrect.

(iii) mass number unchanged;
atomic number increases by +1; 2

(b) (i) use of $E_k = \frac{p^2}{2m}$ / equivalent;
correct conversion of MeV to joule (1.63×10^{-11} J);
correct conversion of mass to kilogram (1.50×10^{-25} kg);
momentum = 2.2×10^{-18} N s; 4

(ii) total momentum after fission must be zero;
must consider momentum of neutrons (and photons); 2

(iv) xenon not opposite to strontium but deviation < 30°);
arrow shorter / longer; 2

(c) (i) energy = $0.25 \times 198 \times 1.6 \times 10^{-13}$;
= 7.9×10^{-12} J; 2

(ii) use of $\Delta Q = mc\Delta Q$;
energy = $0.25 \times 4200 \times 80$;
= 8.4×10^{4} J; 3

(iii) number of fissions = $\frac{(8.4 \times 10^{4})}{(7.9 \times 10^{-12})}$;
mass = $1.1 \times 10^{16} \times 3.9 \times 10^{-25}$;
= 4.1×10^{-9} kg; 4

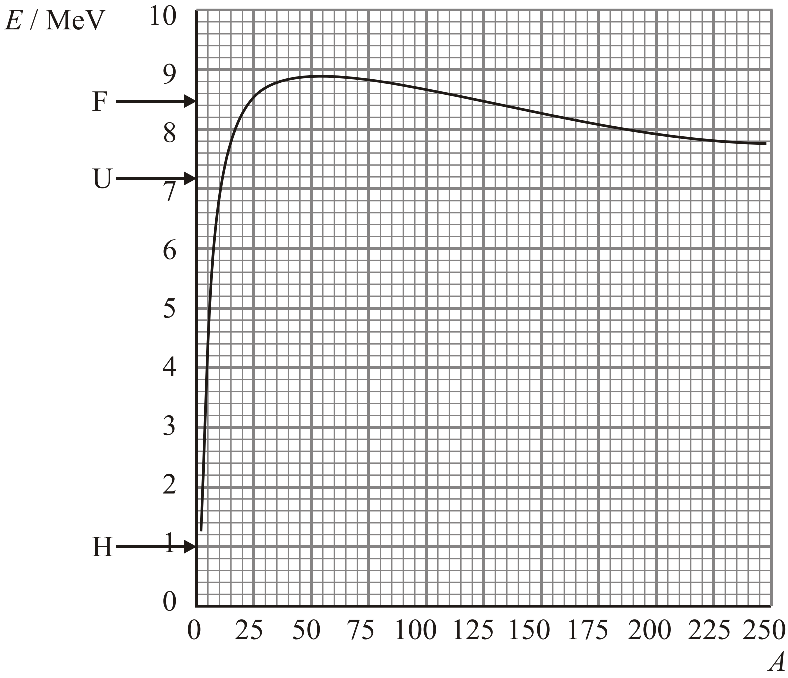
[25]

May 2004 (2) paper 2

3. (a) (i) a proton or a neutron; 1
Both needed to receive ***[1]***.

(ii) the difference between the mass of the nucleus and the sum of the masses of its individual nucleons / the energy required to separate a nucleus into its component nucleons / *OWTTE*; 1

(b)



Don't expect precision for any of these.

(i) F: between 8 and 9; 1

(ii) H: between 1 and 2; 1

(iii) U: between 7 and 8; 1

(c) general overall shape;
max at F = 56, end point U; 2

(d) mass of nucleons = (2 × 1.00728) + 1.00867 = 3.02323 u;
mass difference = 0.0072 u = 6.7 MeV;
binding energy per nucleon = 6.7/3 = 2.2 MeV; 3

(e) (i) fusion; 1

(ii) from the position on the graph, the energy required to assemble two nuclei of $^{2}_{1}H$ is greater than that to assemble one nucleus of $^{3}_{2}He$;
hence if two nuclei of $^{2}_{1}H$ combine to form one nucleus of $^{3}_{2}He$ energy must be released / *OWTTE*; 2

[13]

Chapter 8 Energy and climate Change

May 2004 (2) paper 3

1. (a) (natural process of) production takes thousands/millions of years;
fossil fuels used much faster than being produced / *OWTTE*; 2

(b) *Any two sensible suggestions e.g.*
storage of radioactive waste;
increased cost;
risk of radioactive contamination *etc*.; 2 max
To achieve full marks the differences must be distinct.

[4]

May 2004 (2) paper 3

2. (a) solar panel: solar energy → thermal energy (heat);
solar cell: solar energy → electrical energy; 2

(b) (i) input power required = 730 W (±5 W);
area $= \frac{730}{800} = 0.91\ \text{m}^2$; 2

(ii) power extracted =165 W (±20 W);
efficiency $= \frac{\text{(power out)}}{\text{power in}}$ ***or*** $\frac{165}{500}$; *(allow ecf)*
= 33 %; 3

[7]

November 2004 paper 3

3. (a) idea of thermal energy → mechanical energy/KE → electrical energy;
idea of where or how this takes place; 2
e.g. in turbines or coil rotated in a magnetic field etc.

(b) *Mark the answers for the two energy sources together.*
both non renewable;
appropriate justification for both; 2
e.g. in both cases a resource is being used and isn't being replaced / OWTTE.

(c) (i) to slow down fast moving neutrons;
so as to increase chances of neutron capture by another uranium nucleus / *OWTTE*; 2

(ii) to absorb neutrons;
so as to control rate of reaction / *OWTTE*; 2

(d) any appropriate advantage that coal fired power station does not have;
e.g. does not release CO_2 / SO_2 into atmosphere / OWTTE.
appropriate discussion relating to advantage;
e.g. so global warming / acid rain effects reduced. 2
*Allow argument that 1 kg of uranium "fuel" releases more energy w.r.t. 1 kg of coal. Award **[0]** for imprecise statements that are not clear e.g. bald "nuclear power stations pollute less".*

[10]

May 2005 (2) paper 3

4. (a) power $= \frac{\text{energy}}{\text{time}} = \frac{120 \times 10^{12}}{60 \times 60 \times 24 \times 365}$;
$= 3.8 \times 10^6\ W$;

therefore, for one turbine = 0.19 MW; 3

(b) using $p = \frac{1}{2}\rho A v^3$, $A = \frac{2p}{\rho v^3}$;

therefore, $A = \frac{2 \times 1.9 \times 10^5}{1.2 \times 9.0^3} = 4.3 \times 10^2\ m^2$;

use $A = \pi r^2$ to give $r = 12$ m; 3

(c) the wind speed varies over the year / not all the wind energy will be transferred into mechanical power / energy loss due to friction in the turbine / energy loss in converting to electrical energy / density of air varies with temperature; 1

Do not accept something like "turbines are not 100 % efficient".

(d) take up so much room;
that not possible to produce enough energy to meet a country's requirements;

noisy;
and this could have an effect on local fauna;
OWTTE; 2 max

Award **[1]** *for statement of disadvantage and* **[1]** *for some justification of statement.*

[9]

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5. (a) (i) fission 1 max

(ii) kinetic energy 1 max

(b) the two neutrons can cause fission in two more uranium nuclei producing four neutrons so producing eight *etc.*; *OWTTE*; 1 max

(c) (i) the fuel rods contain a lot more U-238 than U-235;
neutron capture is more likely in U-238 than U-235 with high energy neutrons;
but if the neutrons are slowed they are more likely to produce fission in U-235 than neutron capture in U-238; 3 max

The argument is a little tricky so be generous. The candidate needs to know about there being two isotopes present in the fuel and something about the dependence of the fission and capture in the two isotopes on neutron energy.

(ii) control the rate at which the reactions take place;
by absorbing neutrons; 2 max

(d) *Look for* **four** *of the following main points and award* **[1]** *each.*
energy lost by the slowing of the neutrons and fission elements heats the pile;
this heat extracted by the molten sodium / pressurised water / other suitable substance;
which is pumped to a heat exchanger;
water is pumped through the heat exchanger and turned to steam;
the steam drives a turbine;
which is used to rotate coils (or magnets) placed in a magnetic field (or close to coils) which produces electrical energy; 4 max

Alternatively, award 4 for a good answer, **[2]** *for a fair answer and* **[1]** *for a weak answer.*

[12]

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6. (a) (i) kinetic energy of the fission products / neutrons / photons; 1

Do not accept themal energy or heat.

(ii) if mass of uranium is too small too many neutrons escape;
without causing fission in uranium / reactions cannot be sustained; 2

(iii) the moderator (and the fuel rods); 1

(iv) mass of uranium atom = $235 \times 1.661 \times 10^{-27} = 3.90 \times 10^{-25}$ kg
or $\dfrac{0.235}{6.02 \times 10^{23}}$ kg;
mass of uranium per second = $3.90 \times 10^{-25} \times 8 \times 10^{19} = 3.12 \times 10^{-5}$ kg s^{-1};
mass of uranium per year = $3.12 \times 10^{-5} \times 365 \times 24 \times 60 \times 60$
$= 984 \approx 9.8 \times 10^{2}$ kg yr^{-1}; 3

(b) (i) 800 MW; 1

(ii) 200 MW; 1

(iii) 1600 MW; 1

(iv) the second law of thermodynamics; 1

(v) $\eta = \dfrac{800}{2400} = 33\ \%$; 1

Answer does not need to be expressed as a percentage.

(vi) $0.33 = 1 - \dfrac{300}{T_H}$;
$T_H = 450\text{K}$; 2

[14]

<u>May 2005 (1) paper 3</u>

7. (a) (i) $P \propto v^3$;
$= 15 \times 2^3 = 120$ kW; 2

(ii) the wind speed will not be reduced to zero after impact with blades;
power will be less because of frictional losses / turbulence; 2

The place where frictional losses take place must be identified.

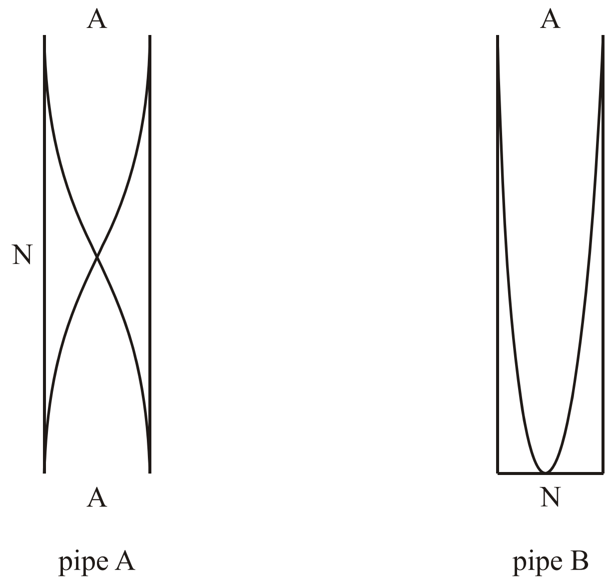
(b) wind power is renewable;
while fossil fuels are finite; 2

*Award **[0]** for statement that wind generators do not cause pollution.*

[6]

Chapter 9 Sight and waves

1. (a)



(i) correct wave shape for pipe A;
correct wave shape for pipe B; 2

(ii) correct marking of A and N for pipe A;
correct marking of A and N for Pipe B; 2

(b) (i) for pipe A, $\lambda = 2L$, where L is length of the pipe;

$c = f\lambda$ to give $L = \dfrac{c}{2f}$;

substitute to get $L = 0.317$ m; 3

(ii) for 32 Hz, the open pipe will have a length of about 5 m;
whereas the closed pipe will have half this length, so will not take up as much space as the open pipe / *OWTTE*; 2

The argument does not have to be quantitative. Award **[1]** *for recognition that low frequencies mean longer pipes and* **[1]** *for the same frequency, closed pipes will be half the length of open pipes. The fact they need less space can be implicit.*

[9]

2. (a) circular wavefronts originating from four successive source positions;
bunching of wavefronts in front, spreading out at back;
approximately, correct spacing of wavefronts in front, and behind source; 3

(b) f waves in distance $(V - v)$;

apparent wavelength = $\dfrac{(V - v)}{f}$;

apparent frequency = $\dfrac{f \times V}{(V - v)}$; 3

Allow any other valid and correct approach or statement of formula. Award **[0]** *for quote of formula with no working shown.*

(c) $\lambda' = \lambda \dfrac{(V - v)}{V}$;

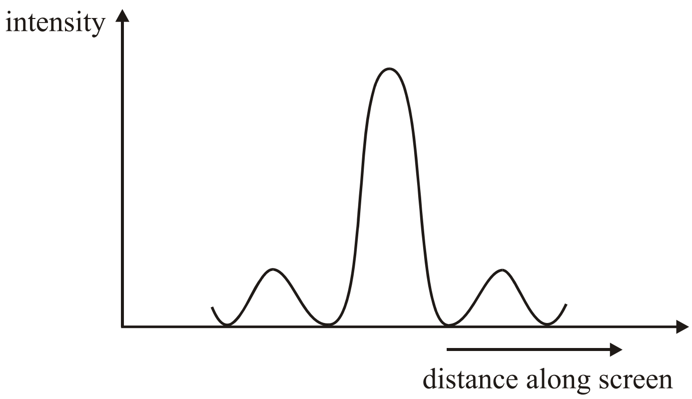
$599.996 = \dfrac{600 \times (3 \times 10^8 - v)}{(3 \times 10^8)}$;

$v = 2000\ \text{m s}^{-1}$; 3

Allow alternative version for red-shift.

[9]

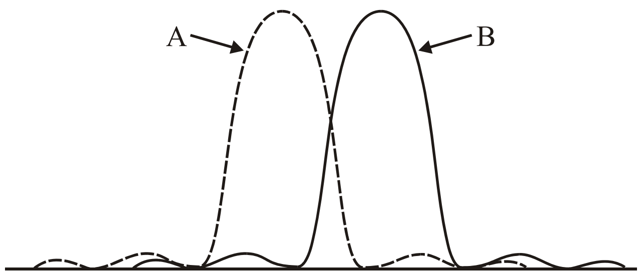
3. (a)



general shape;
relative position of secondary maxima / relative heights of secondary maxima; 2

*Award **[1 max]** if not touching x-axis.*

(b)



maximum of B coincides with first minimum of A; 1

(c) $\theta = \dfrac{1.2\lambda}{b} = \dfrac{1.2 \times 5 \times 10^{-7}}{25 \times 10^{-2}} = 2.4 \times 10^{-6}$ rad;

$= \dfrac{x}{8.1 \times 10_{16}}$;

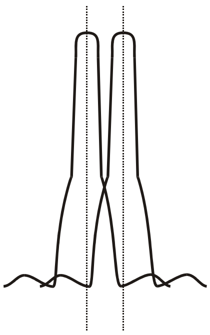
to give $x = 2.0 \times 10^{11}$ m; 3

*1.6×10^{11} m if 1.2 not used, award **[2 max]**.*

[6]

5. (a) diffraction / bending of waves (due to an aperture / obstacle); 1 max

(b) the Rayleigh Criterion is used to establish when the images of two objects are just resolved;
the minimum of one diffraction pattern falls on the maximum of the other;
relevant diagram; 3 max



Minimum of one diffraction pattern falls on the maximum of the other.

Note that a well labelled and annotated diagram could receive up to ***[2 max]***.

[4]

Chapter 10 Quantum

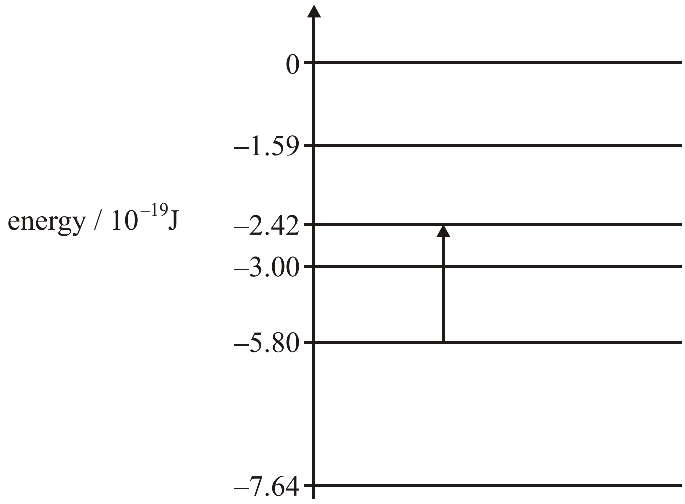
1. (a) (i) *Answer to include*:
missing frequencies / wavelengths;
in otherwise continuous spectrum; 2 max

(ii) *Answer to include*:
light from Sun is split into its component wavelengths;
using prism / grating; 2 max

(b) (i) correct substitution into $E = hf$ *and* $c = f\lambda$ to give $E = \frac{hc}{\lambda}$;
$E = 6.63 \times 10^{-34} \times 3 \times 10^{8} / 5.88 \times 10^{-7}$;
$= 3.38 \times 10^{-19}$ J 2 max

(ii) transition is an absorption so involves electron be "promoted" up between two levels;
energy of gap must be exactly $= 3.38 \times 10^{-19}$ J;
this is between (-5.80×10^{-19} J) and (-2.42×10^{-19} J) levels; 3 max

[2 max] *can be given for other relevant information concerning, for example, the existence of photons with different energies in sunlight / the immediate re-radiation in random directions. The final mark is for identifying the energy levels concerned. This can also just be shown on the diagram (see below).*



(c) *Mark (i) and (ii) together.* ***[1]*** *for each relevant point e.g.*
Bohr assumed electrons were in circular orbits around nucleus;
of fixed angular momentum that;
were stable (did not radiate) and thus the energy can be calculated;
Schrödinger considers electron "probability" waves;
only some standard waves fit the boundary conditions;
and these fix the available energies for the electron; 6 max

N.B. [4 max] *for any one of the models.*

2. (a) *aspect*:
electrons will not be emitted unless the frequency of light exceeds a certain minimum value / electrons are emitted almost instantaneously with the light falling on the surface even if light is of very low intensity / the energy of the electrons emitted is not affected by the intensity of light falling on the surface; 1

corresponding e*xplanation*:
light consists of photons whose energy is *hf* hence no electrons are emitted unless *hf* is larger than the energy needed to escape the metal / an electron is emitted as soon as it absorbs a photon. If the photon has sufficient energy no delay is required / the intensity of light plays no role in the energy of the electron only the frequency of light does; 1

(b) (i) the threshold frequency is found from the frequency axis intercept;
to be $3.8(\pm 0.2) \times 10^{14}$ Hz; 2

(ii) a value of the Planck constant is obtained from the slope;
to be $6.5(\pm 0.2) \times 10^{-34}$ J s; 2

Award ***[0]*** *for "bald" answer of* 6.63×10^{-34} *J s.*

(iii) the work function of the surface is found from the intercept with the vertical axis; to be $1.5(\pm 0.1)$ eV; 2

3. (a) the emission of an electron from the surface of a substance;
as a result of the absorption of EM (accept UV) energy / *OWTTE*; 2

(b) (i) work function of K is smaller than 4.2 eV and any reasonable justification; 1

e.g. energy of UV photon is greater than energy of visible photon
Do not award mark for "smaller" without appropriate justification.

(ii) appropriate substitution into correct formula;

e.g. $energy = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{2.1 \times 10^{-7}} = 9.47 \times 10^{-19}\ J$

appropriate division by 1.6×10^{-19} to convert joules into eV;

e.g. $9.47 \times 10^{-19}\ J = 5.92\ eV$

KE of electron = 5.92 – 4.2 eV = 1.72 eV ≈ 1.7 eV; 3 max

(c) *Award* **[1]** *for any relevant piece of information up to* **[3 max]**. *e.g.*
electron diffraction – beam of accelerated electrons fired onto a graphite target;
many electrons detected in some directions, few in others;
pattern equivalent to diffraction pattern; 3 max

[9]

4. (a) $qvB = m\frac{v^2}{r}$;

hence $r = \frac{mv}{Bq}$; 2

(b) $\frac{16.5}{15} = \frac{\frac{m_{16.5}v}{Bq}}{\frac{m_{15}v}{Bq}} = \frac{m_{16.5}}{m_{15}}$;

hence $\frac{16.5}{15} = \frac{m_{16.5}}{20} \Rightarrow m_{16.5} = 22u$; 2

(c) atoms on 15 cm path: 10 protons and 10 neutrons;
atoms on 16.5 cm path: 10 protons and 12 neutrons; 2

[6]

5. (a) the time taken for the activity of a sample to fall to half its original value / *OWTTE*; 1

Do not accept definitions that are ambiguous or wrong.

(b) appropriate substitution into $T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$;

to get 0.13 yr^{-1} (≈ $4.1 \times 10^{-9}\ s^{-1}$); 2

(c) appropriate substitution into $A = A_0 e^{-\lambda t}$;

to get $t = \frac{\ln 3}{\lambda}$ = 8.4 yr (≈ 2.6×10^{8} s); 2 max

[5]

6. (a) $^{40}_{19}\text{K} \rightarrow {}^{40}_{18}\text{Ar} + \beta^{+}(e^{+}) + v$

β^{+} / e^{+}; 2 max

(b) 8.2×10^{-6} *g*; 1

(c) (i) $\lambda = \frac{\ln 2}{T_{\frac{1}{2}}}$;

$= \frac{0.69}{1.3 \times 10^{9}} = 5.3 \times 10^{-10}\ year^{-1}$; 2

(ii) from $N = N_0 e^{-\lambda t}$ $t = \frac{1}{\lambda}\ln\left(\frac{N_0}{N}\right)$;

$= 1.9 \times 10^9 \times \ln(6.8) = 3.6 \times 10^9$ years ;

or

$\frac{1.2}{8.2} = \left(\frac{1}{2}\right)^n$

$n = 2.77$;

age $= 2.77 \times 1.3 \times 10^9 = 3.6 \times 10^9$ years; 2

[7]

Chapter 12 Relativity and Particles

1. (a) *proper time:* the time interval measured by an observer of an event that happens at the same place according to that observer;

proper length: the length of an object as measured by an observer who is at rest relative to the object; 2

Do not look for precise wording but look for the understanding of the quantities in the sense of the words.

(b) (i) no they will not appear to be simultaneous;

Look for a discussion along the following lines.
Carmen sees Miguel move away from the signal from A and since Miguel receives the two signals at the same time;
and since the speed of light is independent of the motion of the source;
Carmen will see the light from A first / light from B will reach Carmen after light
from A / *OWTTE*; 4 max

(ii) $\gamma = 2$;
to give $u = 0.87c$ (2.6×10^8 m s^{-1}); 2

(iii) both measure the correct distance;
SR states that there is no preferred reference system / laws of physics are the same for all inertial observers;
OWTTE; 2 max

[10]

2. (a) frame moving with constant velocity / frame in which Newton's first law is valid; 1

(b) $T_0 = \frac{2D}{c}$; 1

(c) (i) light reflected off mirror when midway between F and R; 1

(ii) FR = vT; 1

(iii) $(\frac{1}{2}L)^2 = D^2 + (\frac{1}{2}vT)^2$;
$L = 2\sqrt{\{D^2 + (\frac{1}{2}vT)^2\}}$; 2

(iv) $T = \frac{2\sqrt{\{D^2 + (\frac{1}{2}vT)^2\}}}{c}$;

$c^2T^2 = 4\{D^2 + (\frac{1}{2}vT)^2\}$;

use of $4D^2 = c^2T_0^2$;

hence $T = \frac{T_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$; 4

[10]

3. (a) *Award **[2]** for good understanding and **[1 max]** for some understanding.*
a means by which the position of an object can be located / *OWTTE*;
some detail *e.g.* reference to origin/axes; 2
Answers will be open-ended.

(b) $c - v$; 1

(c) c; 1 max

(d) $u' = \frac{u - v}{1 - \frac{cv}{c^2}}$;

substitute $u = c$ to get $u' = \frac{c - v}{1 - \frac{cv}{c^2}}$;

$= \frac{c - v}{1 - \frac{v}{c}} = \frac{c(c - v)}{c - v} = c$; 3

Accept answers using + instead of –.
*Award **[1]** for recognition of correct formula to use and **[1]** for correct substitution*
*and **[1]** for at least some arithmetic.*

(e) (i) time interval of an event that is observed to happen at the same place / *OWTTE*; 1

(ii) $\gamma = 2.0$;

$2.0 = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$;

arithmetic to give $v = 0.87$ c; 3

[11]

5. (a) (i) muon lepton number / electron lepton number; 1

(ii) Baryon number; 1

(iii) Baryon number / electric charge; 1

(b) there are eight gluons involved in the strong interaction; 1
Accept just the name gluons or just mesons.

[4]

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6. (a) Hadron; (*Award this mark for "bald" statement and if reason is wrong.*)
any sensible justification; 2
e.g. "contains two quarks" or "hadrons are either Baryons or mesons".

(b) any combination of three quarks;
correct answer: UUD; 2

(c) attempt (even if unsuccessful) to balance quarks left and right;

to get: $\begin{pmatrix} s \\ \bar{u} \\ \ \end{pmatrix} + \begin{pmatrix} u \\ u \\ d \end{pmatrix} \rightarrow \begin{pmatrix} d \\ \bar{s} \\ \ \end{pmatrix} + \begin{pmatrix} u \\ \bar{s} \\ \ \end{pmatrix} + \begin{pmatrix} s \\ s \\ s \end{pmatrix}$

correct discussion on how the equation balances for all quark types; 2 max
e.g. compare numbers of quarks on LHS and RHS:
u : – 1 (1 + 1) → 1
d : 1 → 1
s : 1 →–1 – 1 + (1 + 1 + 1)

[6]

Chapter 13 Astrophysics

1. (a) (i) spectral class; 1

Accept colour sequence.

(ii) absolute magnitude; 1

(b) 4

Star	***Type of star***
A	Main sequence;
B	Super Red Giant;
C	White Dwarf;
D	Main sequence;

*Award **[1]** for each correct name.*

(c) B more luminous than A;
and has lower temperature than A;
so from the Stefan-Boltzmann law;
B has greater area (radius); 3 max

(d) use of $L = 4\pi bd^2$;
from the H-R diagram $L_B = 10^6\ L_{Sun}$;
therefore $\frac{L_B}{L_{sum}} = 10^6 = \frac{7.0 \times 10^{-8} \times d_B^2}{1.4 \times 10^3}$;
to give $d_B = 1.4 \times 10^8\ AU$ (≈ 700 pc); 4

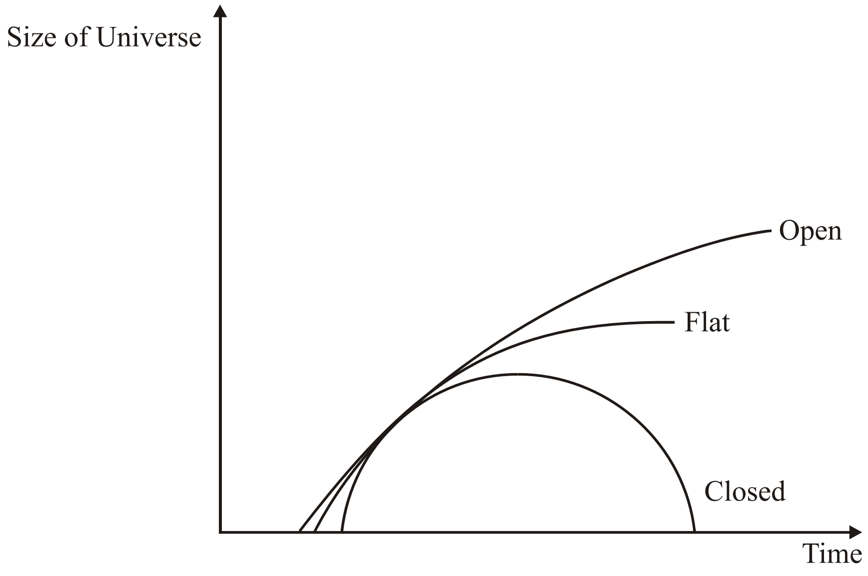
No mark is awarded for the conversion from AU to pc.

(e) at this distance the parallax angle is too small to be measured accurately;
OWTTE; 1 max

Do not accept "it's too far away"

[14]

2. (a)



3 max

Award ***[1]*** *for each correct label.*

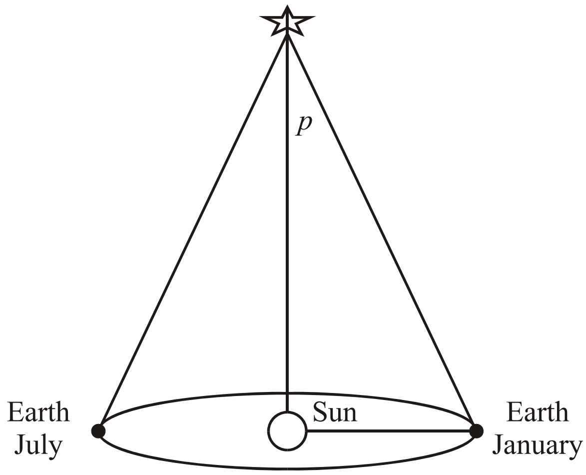
(b) 3 max

Type of Universe	*Relation between ρ and ρ_0*
Open	$\rho < \rho$
Flat	$\rho = \rho_0$
Closed	$\rho > \rho_0$

*Award **[1]** for each correct entry.*

[6]

3. (a)



Mark the definition of p and description of its measurement along with the diagram.

Essentially diagram should:
show *p*;
position of Sun;
position of Earth;
then definition of $p = \frac{\text{(distance of Earth from Sun)}}{\text{(distance of star from Sun)}}$;
diagram should show Earth positions separated by about six months;
then description should mention that angle of sight is measured at these two positions such that the difference between these two angles is equal to 2*p*; 6 max

*Award **[6 max]** for a clear description and diagram, **[3]** for an average and **[1]** for some rudimentary idea. Mark diagram and description together.*

(b) $d = \frac{1}{p} = \frac{1}{0.549} = 1.82$ pc;
$= 1.82 \times 3.26 = 5.94$ ly; 2 max

(c) (i) the radiant power from a star;
that is incident per m^2 of the Earth's surface;
Alternatively, define from $b = \frac{L}{4\pi d^2}$ *but terms must be defined to obtain the mark.*
definition of L;
definition of d; 2 max

(ii) $L = 4\pi d^2 b$;
therefore, $\frac{L_B}{L_S} = \frac{d_B{}^2 b_B}{d_s{}^2 b_s}$;
$d_S = 1\text{AU}$, $d_B = 3.8 \times 10^5$ AU;
therefore, $\frac{L_B}{L_S} = (3.8)^2 \times 10^{10} \times 2.6 \times 10^{-14} = 3.8 \times 10^{-3}$; 4 max

Allow any answer between (3.0 and 4.0) $\times 10^{-3}$.

(d) (i) temperature too low for it to be a white dwarf; 1 max

(ii) luminosity too low for it to be a red giant; 1 max

[16]

4. (a) cosmic background radiation is microwave radiation;
"filling" the universe / from all directions; 2
Award other relevant and appropriate comments e.g. "at a temperature of about 3K or left over from the Big Bang".

(b) the Big Bang predicts an expanding universe that had a very high temperature at the beginning; during the expansion the universe is cooling down and the temperature of the radiation should fall to its present low value, (which is precisely what the cosmic background radiation measures); 2
or
Big Bang producing initially very short wavelength photons/em radiation;
as the universe expands, the wavelengths become redshifted / longer (to reach current value); 2

(c) the redshift in the light observed from distant galaxies (indicating that they are moving away from each other) / the helium abundance in the universe which is about 25 % and is consistent with a hot beginning of the universe; 1
***Note**: question asks for evidence so do not accept "universe is expanding" unless the answer mentions redshift etc.*

(d) the student is wrong; space is created as the universe expands / there is no outside to the universe; 2
Award **[0]** *if no explanation or incorrect explanation.*

[7]

5. (a) (i) the distance of both stars from the Earth are approximately the same (since they are part of the binary system);
and so apparent brightness is proportional to just luminosity; 2

*Award **[1]** for use of* $b = \dfrac{L}{4\pi d^2}$ *and **[1]** for a statement that distance is the same.*

(ii) $b = \dfrac{L}{4\pi d^2}$, $L = \sigma A T^4$

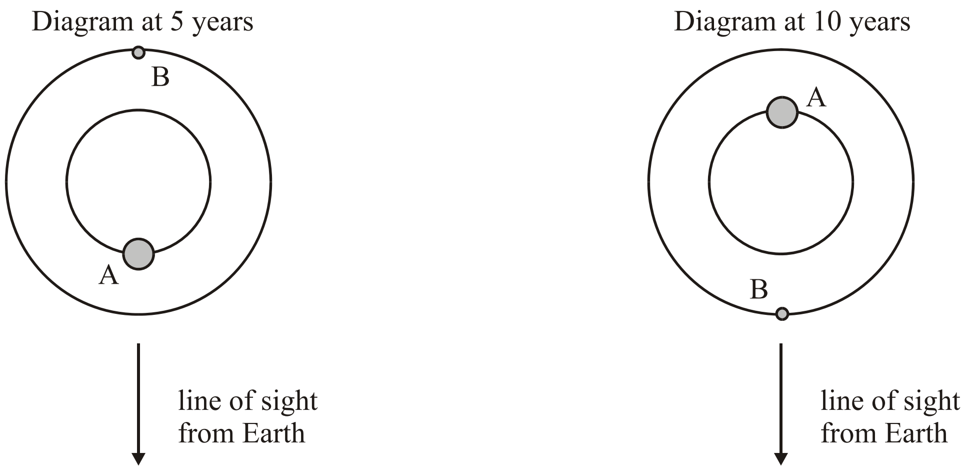
$\dfrac{b_B}{b_A} = \dfrac{\frac{L_B}{4\pi d^2}}{\frac{L_A}{4\pi d^2}} = \dfrac{A_B T_B^4}{A_A T_A^4}$;

$\dfrac{2.0 \times 10^{-14}}{8.0 \times 10^{-13}} = \dfrac{T_B^4}{10^4 T_A^4}$

$\dfrac{T_B^4}{T_A^4} = 250$;

$\dfrac{T_B}{T_A} = \sqrt[4]{250} = 3.97 \approx 4$; 4

(b) (i)



stars shown eclipsing each other;
stars in correct positions; 2 max

(ii) 10 years; 1

(iii) the <u>total</u> mass of the binary; 1

To receive the mark, it must be clear that the total mass is referred to.

[10]

6. (a) (i) light output varies periodically;
rapid brightening, gradual dimming; 2

(ii) caused by expansion / contraction of surface;
brighter as it expands; 2

(b) (i) apparent magnitude: how **bright** a star is, as measured on Earth;
absolute magnitude: apparent magnitude if star were to be 10 pc from Earth; 2

(ii) M = –6.2 (± 0.1);

$(5.2 + 6.2) = 5 \lg d - 5$;
$d = 1900$ pc; 3

*Award **[2 max]** if lg(d – 5) is used and results in d =195 pc*
***or** if (5.2 – 6.2) is used and results in d = 6.3 pc*
***or** if ln and not lg is used and results in d = 26.6 pc.*

[9]

7. (a) (isotropic) EM radiation (in the microwave region) that fills the universe / radiation left over from the Big Bang;
(characteristic of a black body) at a temperature of approximately 3 K; 2

(b) accept any curve with the same overall shape; with the peak shifted to the right since temperature is lower; 2

[4]

Chapter 14 Communications

May 2004 (1) paper 3

1. (a) light incident from glass;
emergent ray along boundary;
c marked correctly; 3

(b) $\sin c = \frac{1}{1.5}$;
for every 1.0 mm length, light travels 1.5 mm;
path length = $1.2 \times 10^8 \times 1.5$
= 1.8 km; 4

*Award **[4]** for any correct calculation that leads to 1.8 km.*

(c) (i) time = $\frac{1200}{2.0 \times 10^8} = 6.0\ \mu$s; 1

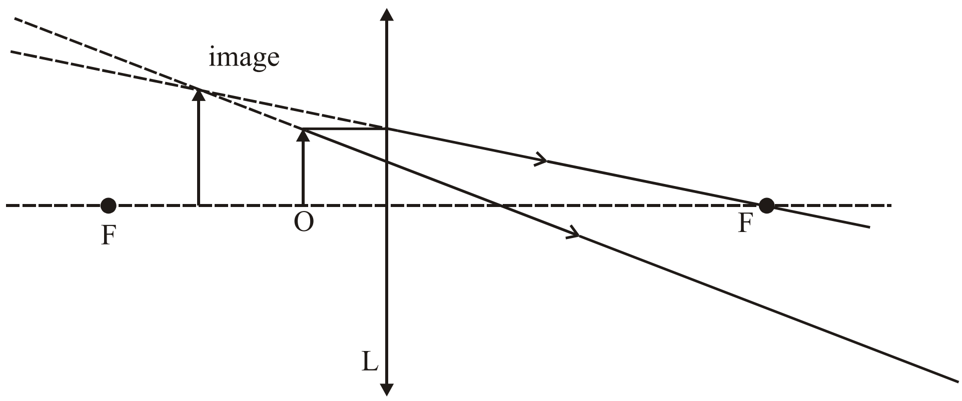
(ii) time = $9.0\ \mu$s; 1

[9]

Electromagnetic waves

May 2005 (1) paper 3

1. (a)



(i) it is the point on the principal axis;
through which a ray parallel to the principal axis passes after going through the lens; 2

*Award **[0]** if focal point is defined as a distance.*

(ii) *Award **[2]** for any **two** appropriate rays and **[1]** for correct positioning of the image (upright).* 3

(iii) it is virtual because no rays pass through the image / cannot be formed on a screen; 1

*Award **[0]** if no explanation is provided.*

(b) (i) $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

$\frac{1}{v}=\frac{1}{6.25}-\frac{1}{5.0}$;

$v=-25$ cm, so distance is 25 cm; 2

Accept negative sign in answer for distance.

(ii) $M = \frac{v}{u}$

$M = \frac{-25}{5} = -5 \left(Accept\, M = -\frac{v}{u} = 5 \right)$

$L' = 5 \times 0.8 = 4.0$ cm; 2

[10]

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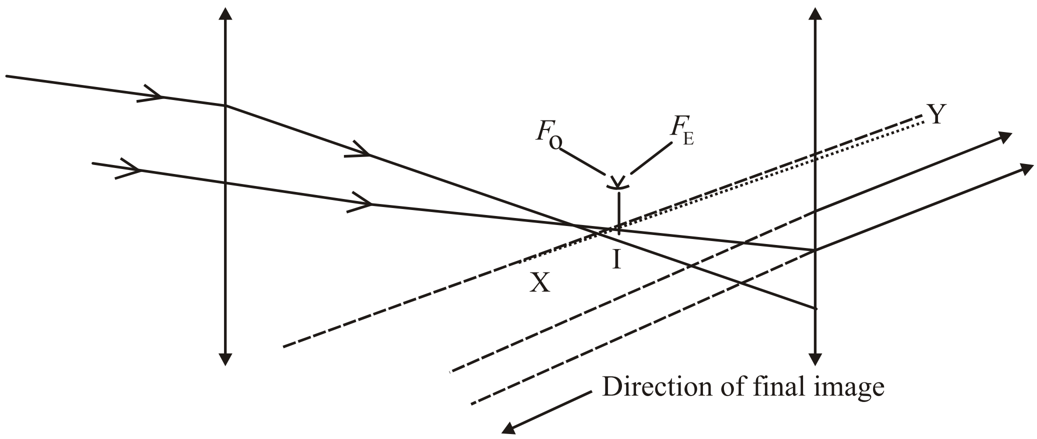
2. (a) that point (on the principal axes) to which rays parallel to the principal axis; are brought to a focus after refraction at the lens / *OWTTE*; 2

(b)



(i) at F_O / other side of eyepiece; *(judge by eye)* 1

(ii) as shown on diagram; 1

(c) at infinity; 1 max

(d) two rays parallel to XY; *(judge by eye)*
extrapolated to show direction of final image; 2

(e) object distance $u = f_O + f_e = 100$ cm;

$\frac{1}{v} + \frac{1}{100} = \frac{1}{f_e} = \frac{1}{2}$

$\frac{1}{v} = \frac{1}{2} - \frac{1}{100}$ to give $v = 2.04$ cm;

beyond eyepiece lens / between eyepiece lens and eye;

or

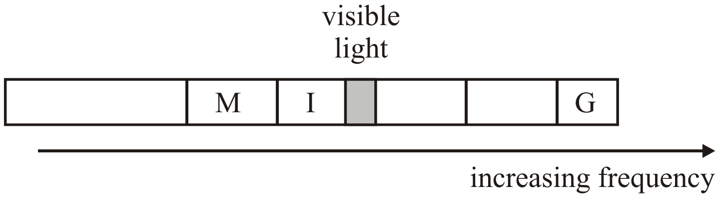
scale drawing:
suitable scale;
object distance;
rays to locate image;
image distance 2 cm beyond eyepiece lens; 4 max

[11]

<u>May 2005 (1) paper 3</u>

3. (a) light consists of oscillating magnetic and electric fields at right angles to each other;
which transfer energy at speed *c* in vacuum (in a direction at right angles to both fields); 2

(b)



(i) correct labelling of infrared waves; 1

(ii) correct labelling of microwaves; 1

(iii) correct labelling of gamma rays; 1

*Award **[1]** if all positions are incorrect but order MIG is right.*

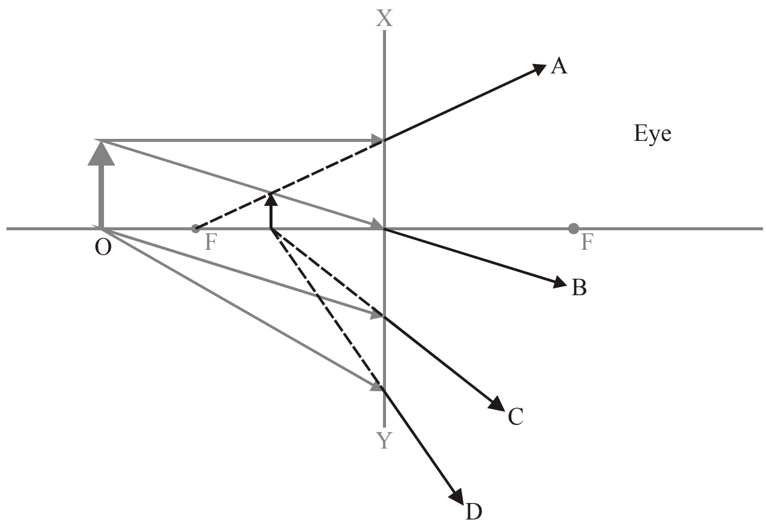
[5]

<u>May 2003 paper 3</u>

4. (a) focal point: the point on the principal axis to which rays parallel to the principal axis are brought to a focus after refraction by the lens / it is a point on the PA from which rays will be parallel to the PA after refraction by the lens; 2 max

*Look for a precise definition to gain **[2 max]** – award **[1]** for an inexact definition. Use discretion.*

(b) (i)



correct ray A;
correct ray B;
correct rays C and D;
correct location of the image; 4 max

*If a correct diagram is given for a **convex** lens award **[1]** but then use ECF for the rest of the question.*

(ii) anywhere to the right of the lens; 1

(c) virtual;
because any two rays from any one point of the object are not brought to a focus by the lens; 2 max
OWTTE;

*Virtual with incorrect explanation award **[1]** with no explanation **[0]**.*

(d)

Award marks either by calculation or drawing.

calculation:

use $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ with $f = –50$;

to give $v = –30.0$ cm;

to give $m = \frac{-30}{75} = –0.4$;

Only penalise once for incorrect sign.

drawing:

suitable scale;

correct rays;

correct measurement; 3 max

(e) no effect on linear magnification;

only effect on appearance is that image will be fainter; 2

[14]

<u>May 2005 (1) paper 3</u>

5. (a) light from a tungsten filament lamp is not coherent;

this means that the phase difference between the light from the slits will be continuously changing / some other relevant detail; 2

*The action verb is "explain" so more than just a statement is required to award **[2]**.*

(b) "fringes" of equal thickness and spacing and equal height; *(judge by eye)*

with a maximum at X; 2

*Award **[1]** only if not touching the x-axis.*

(c) $d = \frac{\lambda D}{s}$;

$= \frac{\lambda}{\vartheta}$

$= \frac{6.33 \times 10^{-7}}{4.00 \times 10^{-4}}$ = 1.58 mm;

or

accept use of $d\sin\theta = n\lambda$ with $n = 1$;

$\sin\theta = \theta$;

$d = \frac{6.33 \times 10^{-7}}{4.00 \times 10^{-4}}$ = 1.58 mm; 3