Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

WJEC CBAC

1321/01

PHYSICS
PH1: Motion Energy and Charge

A.M. TUESDAY, 24 May 2011

$1\frac{1}{2}$ hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	12	
2.	10	
3.	9	
4.	21	
5.	17	
6.	11	
Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 80.

The number of marks is given in brackets at the end of each question or part question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

1. A heavy sledge is pulled across a level snowfield by a force F as shown. To keep the sledge moving at constant velocity a **horizontal** force component of 200 N is required.
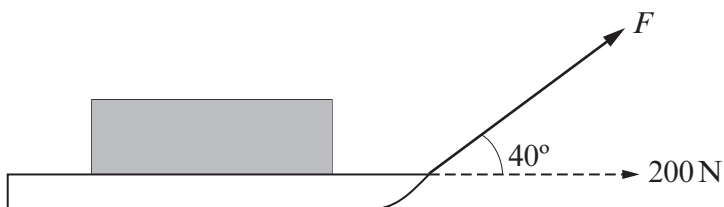
(a) Calculate the force F needed to produce a horizontal component of 200 N on the sledge. [2]

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(b) (i) Define *work done* and use this definition to explain why no work is done in the vertical direction. [3]

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(ii) It takes 30 minutes to pull the sledge a distance of 2.0 km across level ground. Calculate

(I) the work done; [2]

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(II) the mean power needed. [2]

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(c) Assume the force *F* calculated in *(a)* is now applied horizontally as shown. Calculate the initial acceleration of the sledge given that its mass is 40.0 kg and assuming that the frictional force stays the same. [3]

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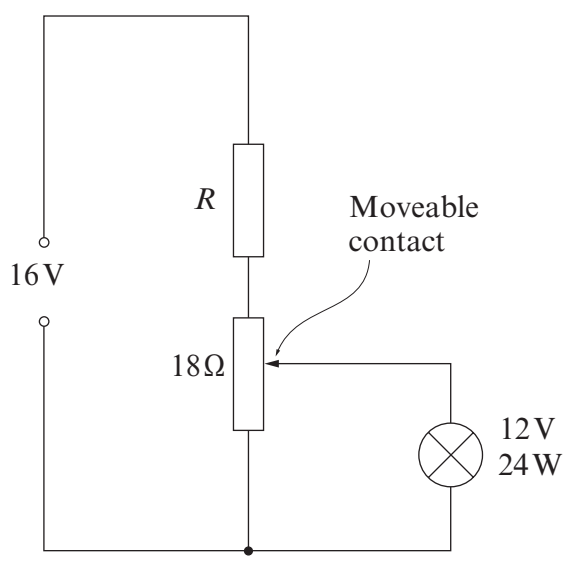
Turn over.
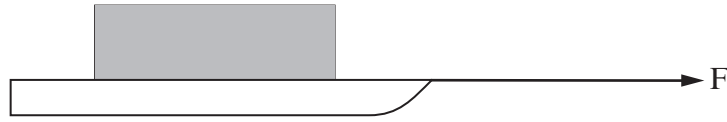
2. A student uses the circuit below to produce a current-voltage graph for a 12 V, 24 W filament lamp.

R

Moveable
contact

16 V

18 Ω

12 V
24 W

(a) Show clearly on the diagram the correct positions for the voltmeter and ammeter. [2]

(b) When the lamp is working normally, calculate

   (i)   the current flowing through it; [1]

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   (ii)   its resistance. [1]

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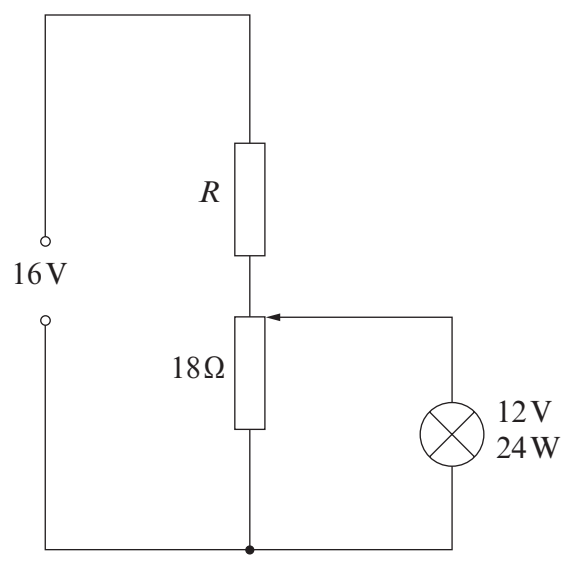..

(c) The value of *R* is chosen so that the voltage across the lamp can be varied between 0 V and 12 V. The circuit below shows the position of the moveable contact when the lamp is operating normally (i.e. at 12 V).

Calculate the required value of *R*. [4]

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R

16 V

18 Ω

12 V
24 W

(d)   Sketch on the axes below the current-voltage graph expected for the filament lamp.   [2]

Current

Voltage

6
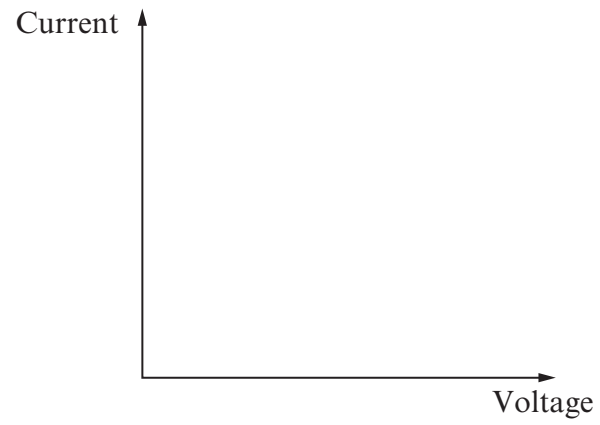
3. *(a)* What name is given to the turning effect of a force? [1]

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(b) (i) A simple toy mobile, consisting of a star and a triangle is shown hanging freely. Assume the rod AB is weightless. Calculate the weight of the triangle. [2]
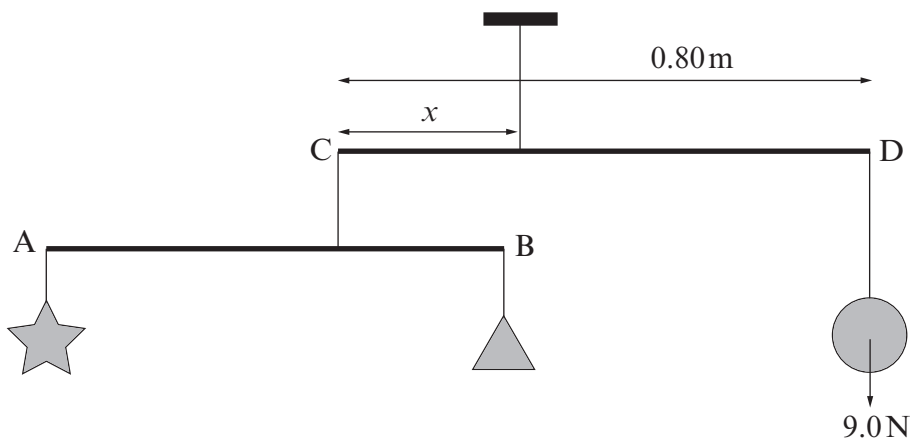
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Thread attached
to ceiling

A 0.40 m   0.20 m   B

4.0 N
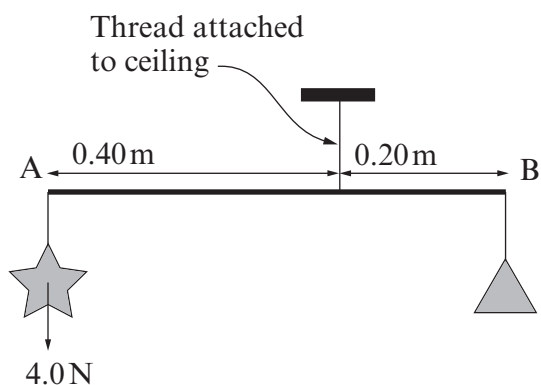
(ii) Hence calculate the tension in the thread attached to the ceiling. [1]

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(c) The mobile is now attached to another weightless rod CD of length 0.80 m, making a more complex mobile as shown. A sphere of weight 9.0 N is attached to D and the mobile is hung freely from the ceiling.

0.80 m

x

C   D

A   B

9.0 N

(i) The distance x can be adjusted to allow the rod CD to hang horizontally. Calculate x. [3]

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(ii) The original star and triangle mobile is now replaced with a single 'crescent moon' of weight 12.0 N as shown. Explain whether x will now have to increase, decrease or stay the same to keep CD horizontal. [2]
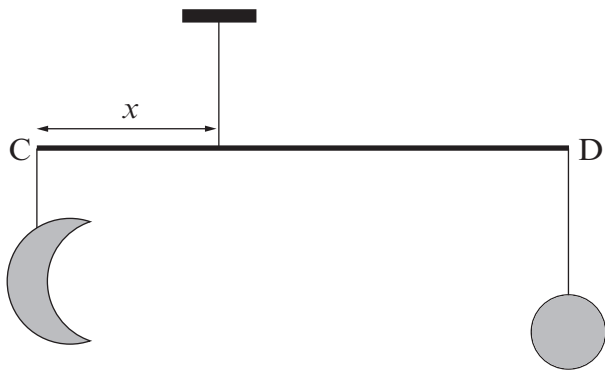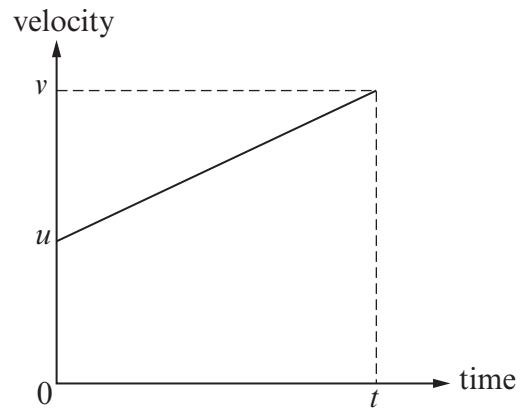
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Turn over.

4. *(a)* A velocity-time graph is given for a body which is accelerating in a straight line.

(i) Using the symbols given on the graph, write down an expression for the gradient and state what it represents. [2]

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(ii) Using the symbols given on the graph, write down an expression for the area under the graph and state what it represents. [2]

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(iii) Hence or otherwise show clearly that, using the usual symbols,

$$x = ut + \tfrac{1}{2}at^2$$ [2]

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(b) A cyclist accelerates **from rest** with a constant acceleration of $0.50 \, \text{m s}^{-2}$ for $12.0 \, \text{s}$. Calculate

(i) the distance travelled in this time; [2]

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(ii) the maximum velocity attained. [2]

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(c) After $12.0 \, \text{s}$, the cyclist stops pedalling and 'freewheels' to a standstill with constant deceleration over a distance of $120 \, \text{m}$.

(i) Calculate the time taken for the cyclist to decelerate to a stand-still. [2]

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(ii) Calculate the magnitude of the cyclist's deceleration. [2]

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Turn over.

(d) Draw an acceleration-time graph on the grid below for the **whole of the cyclist's journey**. [4]
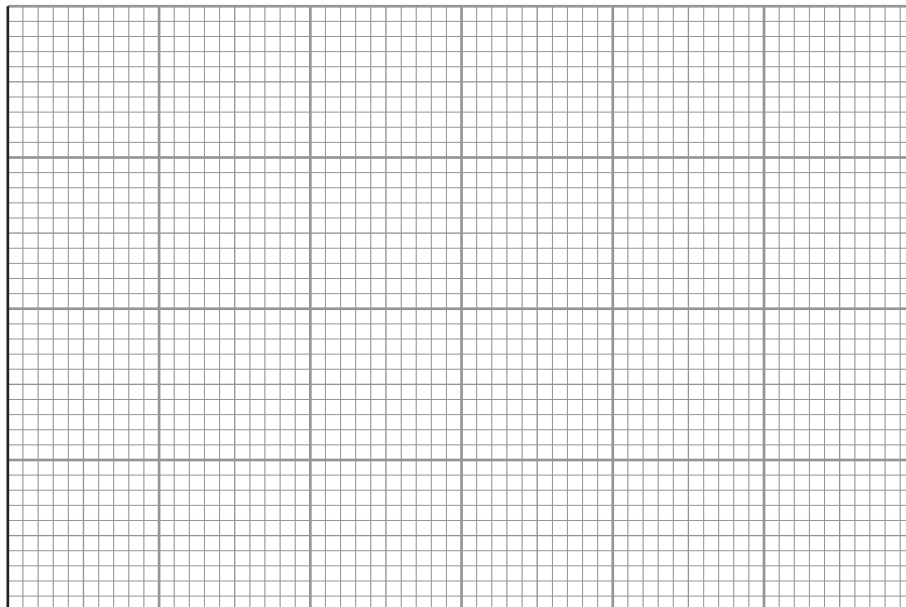
(e) In reality the cyclist would not slow down with constant deceleration. This is because the total resistive force acting on the cyclist consists of a constant frictional force of 8.0 N **and** an air resistance force which is proportional to the square of the cyclist's velocity.

(i) When the cyclist was travelling with maximum velocity, the total resistive force acting was 165 N. Calculate the force of air resistance at this velocity. [1]

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(ii) Hence calculate the total resistive force acting when the cyclist is moving at half the maximum velocity. [2]

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5. *(a)* Starting from a relevant equation, show that the unit of resistivity is Ω m. [2]

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(b) A cable consists of 14 strands of copper wire, each of **diameter** 1.3 mm.

Strand of copper wire
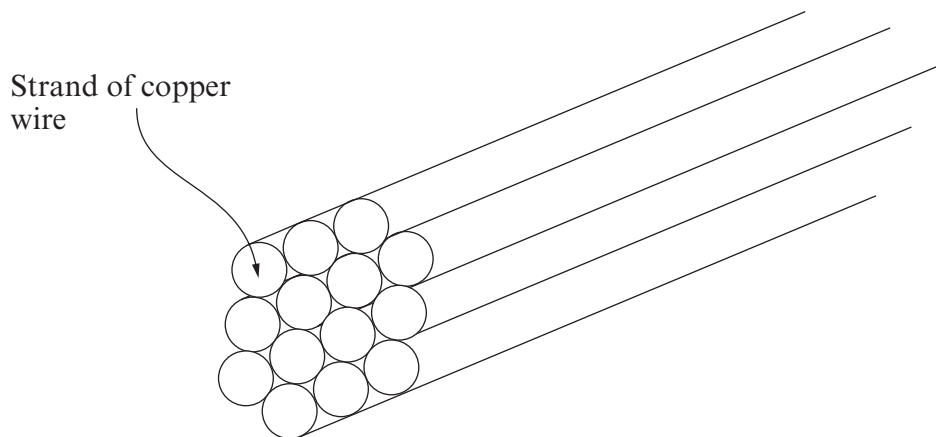
(i) Show that the cross-sectional area of **one** strand of the copper wire is approximately 1.3×10^{-6} m^2. [1]

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(ii) Hence calculate the resistance of one strand of length 20.0 m. [1]
[Resistivity of copper = 1.7×10^{-8} Ω m].

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(iii) Determine the combined resistance of the 14 strand cable. [2]

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Turn over.

12

(iv) Showing your working clearly, calculate the ratio:

$$\frac{\text{Energy dissipated in one second in a } \textbf{single strand} \text{ carrying a current of } 3.0\,\text{A}}{\text{Energy dissipated in one second in the } \textbf{whole cable} \text{ carrying a current of } 3.0\,\text{A}}$$ [3]

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(v) Give an advantage of the 14 strand copper cable over

   (I) a single strand copper cable of 1.3 mm diameter,   [1]

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   (II) a solid core cable of the same total cross-sectional area.   [1]

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(c) Consider **one** strand of length 20.0 m as shown. The strand contains 2.0×10^{24} free electrons.

20.0 m
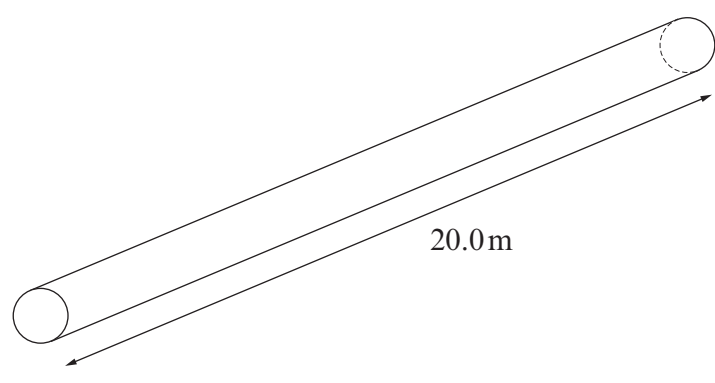
(i) Calculate the number of free electrons per unit volume in this wire. [1]

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(ii) Hence calculate the mean drift velocity of electrons in the strand when there is a current of 3.0 A in it. [2]

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(iii) Determine the mean drift velocity in the whole (14 strand) cable when there is a current of 3.0 A in it. [3]

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Turn over.

6. *(a)* An equation which can be applied to a cell of emf *E* and internal resistance *r* is

$$V = E - Ir$$

(i) What does *V* represent? [1]

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(ii) What does *Ir* represent? [1]

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(b) A voltmeter connected across the terminals of a cell reads 2.4 V. An ammeter (whose resistance is zero) reads 6.0 A when connected briefly across the cell.
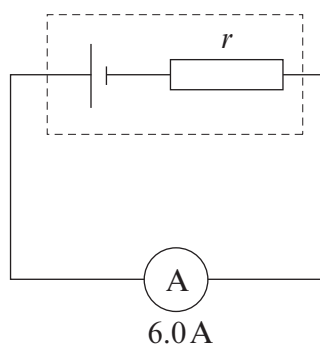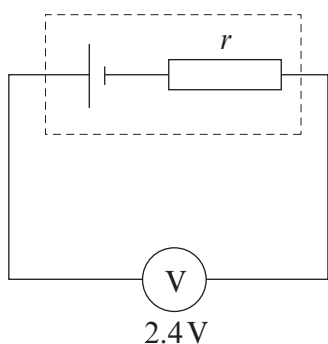
(i) Write down the emf of the cell. [1]

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(ii) Calculate the internal resistance of the cell. [1]

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(iii) Give one reason for not leaving the ammeter connected to the cell. [1]

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only

(c)   Calculate the current through a 2.0 Ω resistor when it is connected across the cell.   [2]

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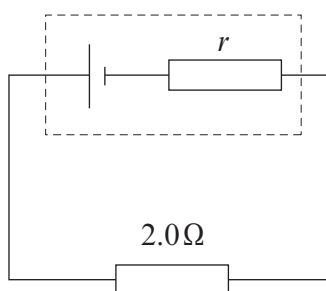
(d)   Determine the number of cells of this type which, when connected in series with the 2.0 Ω resistor, will produce a current of 3.0 A.   [4]

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Turn over.

GCE PHYSICS
TAG FFISEG
Advanced Level / Safon Uwch

Data Booklet

A clean copy of this booklet should be issued to candidates for their use during each GCE Physics examination.

Centres are asked to issue this booklet to candidates at the start of the GCE Physics course to enable them to become familiar with its contents and layout.

Values and Conversions

Avogadro constant	N_A =	$6 \cdot 02 \times 10^{23}$ mol^{-1}
Fundamental electronic charge	e =	$1 \cdot 60 \times 10^{-19}$ C
Mass of an electron	m_e =	$9 \cdot 11 \times 10^{-31}$ kg
Molar gas constant	R =	$8 \cdot 31$ J mol^{-1} K^{-1}
Acceleration due to gravity at sea level	g =	$9 \cdot 81$ m s^{-2}
Gravitational field strength at sea level	g =	$9 \cdot 81$ N kg^{-1}
Universal constant of gravitation	G =	$6 \cdot 67 \times 10^{-11}$ N m^2 kg^{-2}
Planck constant	h =	$6 \cdot 63 \times 10^{-34}$ J s
Boltzmann constant	k =	$1 \cdot 38 \times 10^{-23}$ J K^{-1}
Speed of light *in vacuo*	c =	$3 \cdot 00 \times 10^{8}$ m s^{-1}
Permittivity of free space	ε_o =	$8 \cdot 85 \times 10^{-12}$ F m^{-1}
Permeability of free space	μ_o =	$4\pi \times 10^{-7}$ H m^{-1}
Stefan constant	σ =	$5 \cdot 67 \times 10^{-8}$ W m^{-2} K^{-4}
Wien constant	W =	$2 \cdot 90 \times 10^{-3}$ m K

$T/\text{K} = \theta/°\text{C} + 273 \cdot 15$

$1 \text{ u} = 1 \cdot 66 \times 10^{-27}$ kg

AS

$$\rho = \frac{m}{V}$$

$$v = u + at$$

$$x = \tfrac{1}{2}(u + v)t$$

$$x = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

$$\Sigma F = ma$$

$$W = Fx\cos\theta$$

$$\Delta E = mg\Delta h$$

$$E = \tfrac{1}{2}kx^2$$

$$E = \tfrac{1}{2}mv^2$$

$$Fx = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mu^2$$

$$\text{Efficiency} = \frac{\text{Useful energy transfer}}{\text{total energy input}} \times 100\%$$

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

$$I = \frac{\Delta Q}{\Delta t}$$

$$I = nAve$$

$$R = \frac{\rho l}{A}$$

$$R = \frac{V}{I}$$

$$P = IV$$

$$V = E - Ir$$

$$\frac{V}{V_{total}}\left(\text{or } \frac{V_{OUT}}{V_{IN}}\right) = \frac{R}{R_{total}}$$

$$c = f\lambda$$

$$T = \frac{1}{f}$$

$$\lambda = \frac{ay}{D}$$

$$d\sin\theta = n\lambda$$

$$n_1 v_1 = n_2 v_2$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$E_{k\,max} = hf - \phi$$

$$\lambda_{max} = W\,T^{-1}$$

$$P = A\sigma T^4$$

Particle Physics

particle (symbol)	Leptons			Quarks	
	electron (e^-)	electron neutrino (v_e)		up (u)	down (d)
charge (e)	-1	0		$+\frac{2}{3}$	$-\frac{1}{3}$
Lepton number	1	1		0	0

A2

$$\omega = \frac{\theta}{t}$$

$$v = \omega r$$

$$a = \omega^2 r$$

$$a = -\omega^2 x$$

$$x = A\sin(\omega t + \varepsilon)$$

$$v = A\omega\cos(\omega t + \varepsilon)$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$p = mv$$

$$Q = mc\Delta\theta$$

$$p = \frac{h}{\lambda}$$

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

$$M/\text{kg} = \frac{M_r}{1000}$$

$$pV = nRT$$

$$p = \tfrac{1}{3}\rho\overline{c^2}$$

$$U = \tfrac{3}{2}nRT$$

$$k = \frac{R}{N_A}$$

$$W = p\Delta V$$

$$\Delta U = Q - W$$

$$C = \frac{Q}{V}$$

$$C = \frac{\varepsilon_o A}{d}$$

$$U = \tfrac{1}{2}QV$$

$$Q = Q_0 e^{-t/RC}$$

$$F = BIl\sin\theta \text{ and } F = Bqv\sin\theta$$

$$B = \frac{\mu_o I}{2\pi a}$$

$$B = \mu_o nI$$

$$\Phi = AB\cos\theta$$

$$V_{\text{r.m.s.}} = \frac{V_0}{\sqrt{2}}$$

$$A = \lambda N$$

$$N = N_o e^{-\lambda t} \text{ or } N = \frac{N_o}{2^x}$$

$$A = A_o e^{-\lambda t} \text{ or } A = \frac{A_o}{2^x}$$

$$\lambda = \frac{\log_e 2}{T_{1/2}}$$

$$E = mc^2$$

Fields

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

$$V_E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

$$W = q\Delta V_E,$$

$$F = G\frac{M_1 M_2}{r^2}$$

$$g = \frac{GM}{r^2}$$

$$V_g = \frac{-GM}{r}$$

$$W = m\Delta V_g$$

Orbiting Bodies

Centre of mass: $r_1 = \dfrac{M_2}{M_1 + M_2}d$;

Period of Mutual Orbit: $T = 2\pi\sqrt{\dfrac{d^3}{G(M_1 + M_2)}}$

Options

A: $\dfrac{V_1}{N_1} = \dfrac{V_2}{N_2}$; $\quad E = -L\dfrac{\Delta I}{\Delta t}$; $\quad X_L = \omega L$; $\quad X_C = \dfrac{1}{\omega C}$; $\quad Z = \sqrt{X^2 + R^2}$; $\quad Q = \dfrac{\omega_0 L}{R}$

B: $c = \dfrac{1}{\sqrt{\mu_0\varepsilon_0}}$; $\quad \Delta t = \dfrac{\Delta\tau}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

C: $\varepsilon = \dfrac{\Delta l}{l}$; $\quad Y = \dfrac{\sigma}{\varepsilon}$; $\quad \sigma = \dfrac{F}{A}$; $\quad U = \tfrac{1}{2}\sigma\varepsilon V$

D: $I = I_0\exp(-\mu x)$; $\quad Z = c\rho$

E: $\dfrac{\Delta Q}{\Delta t} = -AK\dfrac{\Delta\theta}{\Delta x}$; $\quad U = \dfrac{K}{\Delta x}$ $\quad \dfrac{Q_2}{Q_1} = \dfrac{T_2}{T_1}$ $\quad$ Carnot efficiency $= \dfrac{(Q_1 - Q_2)}{Q_1}$

Turn over.

PMT

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Mathematical Information

SI multipliers

Multiple	Prefix	Symbol
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c

Multiple	Prefix	Symbol
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E
10^{21}	zetta	Z

Areas and Volumes

Area of a circle $= \pi r^2 = \dfrac{\pi d^2}{4}$ Area of a triangle $= \dfrac{1}{2}$ base $\times$ height

Solid	Surface area	Volume
rectangular block	$2\,(\,lh + hb + lb\,)$	lbh
cylinder	$2\,\pi r\,(\,r + h\,)$	$\pi r^2 h$
sphere	$4\,\pi r^2$	$\frac{4}{3}\,\pi r^3$

Trigonometry
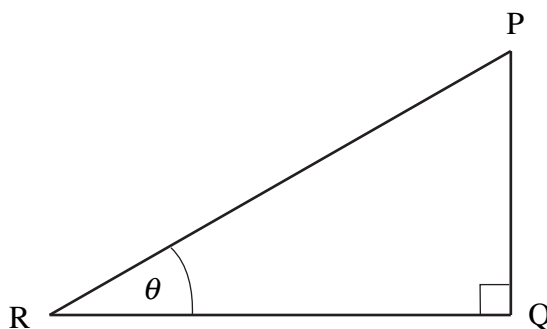
$$\sin\theta = \frac{PQ}{PR}, \quad \cos\theta = \frac{QR}{PR}, \quad \tan\theta = \frac{PQ}{QR}, \quad \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$PR^2 = PQ^2 + QR^2$$

Logarithms (A2 only)
[Unless otherwise specified 'log' can be $\log_e$ (i.e. ln) or $\log_{10}$.]

$\log(ab) = \log a + \log b$ $\log\left(\dfrac{a}{b}\right) = \log a - \log b$

$\log x^n = n\log x$ $\log_e e^{kx} = \ln e^{kx} = kx$

$\log_e 2 = \ln 2 = 0{\cdot}693$

(1321-01A)