M1. (a)   any **two** from:

- travel (at same speed) through a vacuum / space
    *do **not** accept air for vacuum*

- transverse

- transfer energy

- can be reflected

- can be refracted

- can be diffracted

- can be absorbed

- travel in straight lines

2

(b)   can pass through the ionosphere
                    accept atmosphere for ionosphere
                    *do **not** accept air for ionosphere*
                    accept travel in straight lines
                    accept not refracted / reflected / absorbed by the ionosphere

1

(c) $v = f\ \lambda$

1.2×10^6 / 1200 000
                    *allow **1** mark for correct substitution*
                    ie $3.0 \times 10^8 = f \times 2.5 \times 10^2$

2

hertz / Hz
                    *do **not** accept hz **or** HZ*
                    *accept kHz **or** MHz*
                    *answers 1.2 MHz **or** 1200 kHz gain all **3** marks*
                    for full credit the unit and numerical value must be consistent

1

[6]

M2.   (a)   (i)   gamma

accept correct symbol

1

(ii)   any **one** from:

• (ultraviolet has a) higher frequency
ultraviolet cannot be seen is insufficient

• (ultraviolet has a) greater energy

• (ultraviolet has a) shorter wavelength
ignore ultraviolet causes cancer etc

1

(b) 1.2×10^7 / 12 000 000

*allow **1** mark for correct substitution, ie $3 \times 10^8 = f \times 25$*

2

hertz / Hz / kHz / MHz
*do **not** accept hz **or** HZ*
*answers 12 000 kHz **or** 12 MHz gain **3** marks*
for full credit the numerical answer and unit must be consistent

1

(c)   (i)   away (from each other)
accept away (from the Earth)
accept receding

1

(ii)   distance (from the Earth)
*accept how far away (it is)*

1

speed galaxy is moving

1

(iii)   (Universe is) expanding

1
[9]

M3. (a) (i) **two** correct rays drawn
1 mark for each correct ray

• ray parallel to axis from top of object **and** refracted through focus **and** traced back beyond object

• ray through centre of lens **and** traced back beyond object

• ray joining top of object to focus on left of lens taken to the lens refracted parallel to axis **and** traced back parallel to axis beyond object
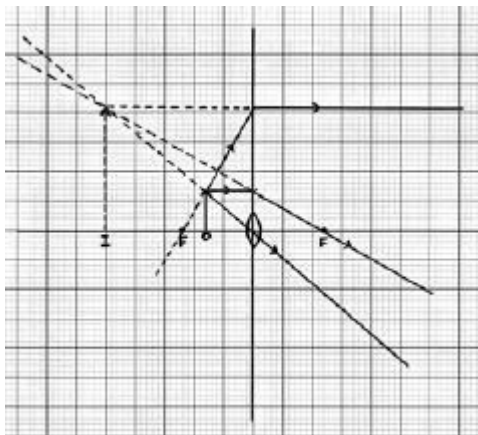
2

an arrow showing the position **and** correct orientation of the image for their rays
*to gain this mark, the arrow must go from the intersection of the traced-back rays to the axis **and** the image must be on the same side of the lens as the object and above the axis*

1

(ii) (x) 3.0
accept 3.0 to 3.5 inclusive
or

$$\frac{\text{their image height}}{\text{object height}}$$

correctly calculated
allow 1 mark for correct substitution into equation using their figures
ignore any units

2

(b)   any **two** from:

in a camera the image is:

- real not virtual

- inverted and not upright
    accept upside down for inverted

- diminished and not magnified
    accept smaller and bigger
    accept converse answers but it must be clear the direction of the comparison
    both parts of each marking point are required

2

[7]

M4. (a) (i) to check rise in temperature (of other thermometers) was due to the (different wavelengths of) light

accept as a control / comparison

to measure room temperature is insufficient

1

(ii) any **two** from three:

- different colours produce different heating effects / (rises in) temperatures

- red light produces the greatest heating effect / (rise in) temperature

or

- violet produces the least heating effect / (rise in) temperature

- all colours produce a greater heating effect than outside the spectrum

an answer

the longer the <u>wavelength</u> the greater the (rise in) temperature

or

the lower the <u>frequency</u> the greater the (rise in) temperature gains both marks

2

(b) move a thermometer into the infrared region / just beyond the red light

allow use an infrared camera / infrared sensor

1

the temperature increases beyond 24(°C)

accept temperature higher than for the red light

1

(c) $v = f \times \lambda$

9.4×10^{-6}

accept 9.375×10^{-6} or 9.38×10^{-6}

or

0.0000094

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accept 0.000009375
or 0.00000938
*allow **1** mark for correct substitution*
ie 3 × 10⁸ = 3.2 × 10¹³ × λ

2

(d)   at night the surroundings are cooler
accept at night the air is colder
there is no heat from the Sun is insufficient

or

at night there is a greater temperature difference between people and surroundings

1

(so surroundings) emit less infrared (than in daytime)
accept camera detects a greater contrast

or

gives larger difference in infrared emitted (between people and surroundings)

1

[9]

M5.(a) (i) frequency

1

wavelength

1

(ii) 10^{-15} to 10^{4}

1

(b) 2.0×10^{5}

correct substitution of
*3.0×10^{8} / 1500 gains **1** mark*

2

Hz

1

(c) (i) (skin) burns

1

(ii) skin cancer / blindness

1

(d) (i) any **one** from:

- (detecting) bone fractures
- (detecting) dental problems
- treating cancer

1

(ii) any **one** from:

- affect photographic film
- absorbed by bone
- transmitted by soft tissue

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- kill (cancer) cells

  answer must link to answer given in (d)(i)

1

(iii) 9 / 36 = 0.25
0.5 / 2 = 0.25
4 / 16 = 0.25

   accept:
   36 / 9 = 4
   2 / 0.5 = 4
   16 / 4 = 4

2

conclusion based on calculation

   *two calculations correct with a valid conclusion scores **2** marks*
   *one correct calculation of k scores **1** mark*

1

[13]

M6.   (a)   C or 0.18 mm

1

        (b)   0.6 (m)

                *allow **1** mark for correct substitution and/or transformation **or***
                1 mark for changing frequency to Hz
                *answer 600 gains **1** mark*

2

        (c)   creates an alternating current

                accept 'ac' for alternating currentaccept alternating voltage

1

            with the same frequency as the radio wave

                accept signal for radio wave

                *accept it gets hotter for **1** mark provided no other marks*
                scored

1

        (d)   X-rays cannot penetrate the atmosphere

                accept atmosphere stops X-rays

                *do **not** accept atmosphere in the way*

        or

        X-rays are absorbed (by the atmosphere) before reaching Earth

                <u>*ignore*</u> *explanations*

1

[6]

M7.(for both fibres) increasing the <u>wavelength</u> of light decreases and then increases the
      percentage / amount of light transmitted

                *accept for **1** mark:*
                (for both fibres) increasing the <u>*wavelength*</u> *(of light) to 5 (x*
                10^{-7} metres), decreases the (percentage) transmission

1

            (for both fibres) the minimum transmission happens at 5 (x 10^{-7} metres)
            or
            maximum transmission occurs at 6.5 (x 10^{-7} metres)

                *accept for a further **1** mark:*

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(for both fibres) increasing the <u>wavelength</u> of the light from 5 (x 10⁷ metres) increases the amount of light transmitted

increasing <u>wavelength</u> (of light), decreases the percentage transmitted is insufficient on its own

1

the shorter fibre transmits a greater percentage of light (at the same wavelength)

*accept for **1** mark:*
Any statement that correctly processes data to compare the fibres

1

[3]

M8. (a) 10^{-15} metres to 10^4 metres

1

(b) (i) any **one** from:

- (TV / video / DVD) remote controls
  mobile phones is insufficient

- (short range) data transmission
  accept specific example, eg linking computer peripherals

- optical fibre (signals)
  *do **not** accept Bluetooth*

1

(ii) 0.17

*an answer 17 cm gains **3** marks*

an answer given to more than 2 significant figures that rounds to

*0.17 gains **2** marks*

*allow **1** mark for correct substitution, ie $3 \times 10^8 = 1.8 \times 10^9 \times \lambda$*

3

(c) (maybe) other factors involved

accept a named 'sensible' factor, eg higher stress / sedentary lifestyle / overweight / smoking more / diet / hot office / age

not testing enough people is insufficient

unreliable data is insufficient

1

[6]