

M1. ideas that

- direct solar radiation will provide enough energy to heat the (specially designed) buildings during the period Oct-Mar / summer
- solar cells will produce plenty of electricity in Oct-Mar / summer (when wind generators produce little)
- a couple of wind generators will produce all electricity needed (for all but heating) Apr-Oct / winter

- number required makes wind generators unsuitable for heating / buildings
- no solar energy in June and July / little in winter
- solar / wind have little effect on environment
- **or** cause no air pollution
- solar and wind complement each other

- **or** together provide energy all year
- fuel / gas / diesel can provide energy all the time / at any time
- fuel / gas / diesel needed for transport
- fuel / gas / diesel needed for heating in winter
- diesel has to be imported

- diesel likely to freeze
- gas wouldn't have to be imported
- drilling for gas difficult / harms environment
- but atmospheric pollution a global rather than local matter so any produced in Antarctic doesn't matter much

(deduct 1 mark (to min. zero) for incorrect claims about destroying ozone layer)

- gas produces less carbon dioxide (for the same energy released) than diesel*
- gas produces less sulphur dioxide (for the same energy released than diesel*

(* these ideas met by candidates in Q.16 so must be allowed, though not required)
any ten for 1 mark each

[10]

##

(NB. Answers referring to planets to gain zero marks
 Answers in terms of stars – deduct 1 mark)

- A light from (most) other galaxies shows a red-shift
- B this means that these galaxies and our own galaxy are moving apart / Universe expanding
- C the red-shift of more distant galaxies is greater
- D this means that the further apart galaxies are the faster they are moving away from each other
- E the relationship is proportional so this means that in the past they all set out from the same point

*each properly related point
 for 1 mark*

[5]

M3.

- Q is louder
- Q is higher (pitch/note but not frequency)
*[if loudness and pitch both mentioned but direction wrong /
 absent credit 1 mark]*
- louder because bigger amplitude/height
- higher pitch because higher frequency/shorter wavelength/waves closer together
- factor of 2 mentioned w.r.t either
*(NB converse answer for P)
 each • for 1 mark*

[5]

M4. (a) *answer includes items:*
B D G
each for 1 mark 3

(b) *answer includes items:*
A E F [allow H here for a further mark]
each for 1 mark 3

(c) *answer includes items:*
C H* I J
*each for 1 mark [*unless already credited in (b)]* 4

(d) *ideas that:*

- lucky in the sense that they weren't initially looking for the background radiation [others were!!!]
- more than just lucky in that they investigated it and didn't just ignore it
each for 1 mark

[NB Reference to letters only, not a prose answer, gain only ½ mark each.
Total rounded down] 2

[12]

M5. *ideas that:* galaxies show a red-shift
gains 1 mark

but more distant galaxies show bigger red-shift

gains 2 marks

galaxies moving away/Universe expanding

gains 1 mark

but more distant galaxies moving away faster

gains 2 marks

so all Universe once in one place

for 1 further mark

(only if the previous 2 marks are also gained)

[5]

M6. (i) (wave) speed = frequency \times wavelength

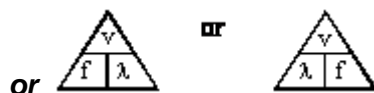
or any correctly transposed version

accept $v = f \times \lambda$

or transposed version

accept $m/s = 1/s \times m$

or transposed version



but only if subsequently used correctly

1

(i) 325

1

metres per second

or m/s or 0.325 km/s for 2 marks

1

[3]

M7. (a) (i) the outlet mark

hot water rises **or** floats up
do not accept heat rises

the inlet mark

1

cold water replacing any drawn off comes in at the bottom and does not mix with hot **or** cool the hot water

do not accept descriptions of a convection current

1

(ii) only heats top (of tank) **or** a small volume

credit heats less water

1

no mixing occurs with cold because hot water is less dense **or** water is a poor conductor

no mixing because cold water is more dense

1

(b) radiation (losses from tank)

do not accept reflection of heat

1

lower from light **or** white **or** shiny surfaces

credit they are poor radiators for both marks

1

[6]

M8. (a) (i) more turns **or** waves per second

*accept spinning **or** turning **or** faster*

1

(ii) less time spent cutting field lines

*accept shorter time in field **or** when the frequency increases
(the wavelength decreases)*

1

(iii) more energy given

*accept more KE put in
accept a higher voltage produced
do not credit more power*

1

(b) more coils

1

more powerful magnets

accept put in better bearings

do not credit reduce friction or add soft iron core

1

[5]

M9. any **four** related points

- * the Universe (as we know it) started (about) 14 000/15 000 million years ago or (about) 15 billion years ago or between (about) 10 to 20 billion years ago
- * from one point **or** from a singularity

or at the beginning of time

- * in an enormous outpouring of matter (and energy)

- * (and) has been expanding ever since
- * (evidence is that) the galaxies are all moving away from one another
- * (evidence is that) the more distant a galaxy is the faster it is moving away (from all the other galaxies)
- * evidence is microwave background

or cosmic background radiation

- * ... relic of an earlier **or** hot phase resulting from (shortly) after the start **or** Big Bang
- * evidence is red shift
- * ... of light **or** radiation from (distant) stars **or** galaxies **or** quasars **or** due to Doppler (-Fizeau) effect

accept bya for billion years ago or

mya for million years ago

do not credit vague responses such as it all started with a big explosion

[4]

M10. (a) changes the sound wave(s)
 to a varying **or** changing (electric) potential difference **or** p.d. **or** voltage
or current **or** to an irregular alternating current or a.c. **or** transfers
 sound energy to electrical energy (1) mark is vibrations **or** pulses **or** of
 sound **or** in air become electrical waves
do not credit just 'to electricity' or 'to a.c' 2

(b) (i) decrease **or** reduce the amplitude
accept less amplitude nothing else added 1

(ii) increase the frequency **or** decrease
 wavelength
accept higher frequency nothing else added 1

[4]

M11. (a) 12.7 1

(b) the further away, the faster it is moving away 1

(c) all galaxies have been moving away from us for approximately the same length of
 time 1

therefore they were all probably produced at the same time 1

[4]

- M12.** (a) any **two** from
- reliable
accept it is not always windy
 - can be used as storage for surplus electricity
 - generates more electricity
accept would need hundreds of wind turbines to generate this electricity
takes less space is neutral
 - no noise pollution
*do **not** accept can be started up quickly*
- 2
- (b) advantage :
- does not produce greenhouse gases / carbon dioxide / water
or acid rain / sulphur dioxide
- 1
- disadvantage :
- danger from radioactive materials if accidents **or** waste radioactive materials
accept slower start-up time
- 1
- (c) any **one** situation with a suitable explanation
- satellite
 - weigh less **or** work for many years **or** remote
 - remote places on Earth pump water **or** operate phones **or** road signs / lights **or** weather stations **or** too expensive / impractical
 - calculators / watches small amount of electricity needed
- 2

[6]

- M13.** (a) any **two** from
- Universe started in one place
 - (huge) explosion
 - Universe is expanding
do not accept big bang
- 2

- (b) Quality of written communication:
Links needed between :
galaxies, red shift, and distance / expansion
- 1

- any **two** from
- light from (galaxies) shifted towards red end of spectrum
 - the further away the galaxy, the greater the red shift
 - this shows that galaxies are moving away from us
 - this suggests that Universe is expanding
do not accept light from planets
- 2

[5]

- M14.** (a) **(oil / natural gas / coal)**
no marks are given for choosing the correct non-renewable energy source
- burning releases carbon dioxide (1) greenhouse effect (1)
- OR**
allow 2 effects for 2 marks
- burning (releases sulphur dioxide (1) acid rain (1))
- OR**
(nuclear power)
no marks given for choosing the correct non-renewable energy source
- accidents can release very dangerous radioactive material (1)

produces waste that stays dangerously radioactive for thousands of years **or**
radioactive waste has to be stored safely for thousands of years (1)
accept the cost of installation and decommissioning is high

2

(b) any four from:

(wind power)

no marks are given for choosing the correct non-renewable energy source

- considered unsightly / visual pollution (1) very large areas of land (1)
- noisy for people living nearby / noise pollution (1)

(tidal power)

no marks are given for choosing the correct non-renewable energy source

- barrages / visual pollution (1)
- destroys the habitat of many living organisms (1)

(hydroelectricity)

no marks are given for choosing the correct non-renewable energy source

- damming / visual pollution (1)
- very large areas of land (1) flooding (1)

4

[6]

M15. (a) loft insulation

1

energy saved in 10 years £600

1

net saving (600 – 110) £490

1

OR

hot water jacket

1

energy saved in 10 years £140

1

This is the highest percentage saving on cost

1

(b) transferred to environment / surroundings

1

as heat / thermal energy

1

[5]

M16. do **not** give any credit for renewable **or** non-renewable **or** installation **or** decommissioning costs

fossil fuel advantage

1

a reliable source of energy

fossil fuel disadvantage

pollution by carbon dioxide /

accept causes acid rain

accept highest costs / more expensive than nuclear / more expensive than renewable

1

nuclear advantage

do not produce gases that increase the greenhouse effect **or** cause acid rain

accept nuclear is cheaper than fossil

1

nuclear disadvantage

accidents / waste can release very dangerous radioactive material radiation

*accept it produces waste that stays dangerously radioactive for thousands of years **or** radioactive waste has to be stored safely for thousands of years*

1

renewable advantage

there are no fuel costs

*almost pollution free (apart from noise and visual)
accept cheaper than fossil*

1

renewable disadvantage

not a reliable source of energy except for hydroelectric

*accept (most) require large areas of land
accept visual / noise pollution*

1

[6]

M17. light from distant galaxies red shifted

accept longer wavelength for red shifted

1

further galaxies display greater red shift

1

the further away galaxies are the faster they are moving away from us (our galaxy)

1

[3]

M18. (a) convection

air is heated by the burner / particles gain energy

air expands / particles move about more / particles move faster

air becomes less dense / particles are more spread out

air rises / particles rise - *not* heat rises

air from C moves into the heater / particles from C move into the heater to replace it / them

any four for 1 mark each

4

- (b) (i) radiation
for one mark
- 1
- (ii) black surface radiates / emits well
(allow absorbs and emits well) (allow comparison with shiny / white surfaces)
- large surface area needed
high temperature (of the lumps)
any one for 1 mark
- 1

[6]

M19. (a) must give one advantage and one disadvantage of each to get 4 marks and 2 further scoring points

Advantages and disadvantages relevant to:

(1) health risk

(5) cost

(6) environmental factors

(7) transport/ storage

e.g. common coal / nuclear – high cost of building both

anti-nuclear examples

nuclear fuel transported on roads/rail in region

possible effects on public health in surrounding area

high cost of de-commissioning

long life very active waste materials produced

how waste materials stored safely for a long time

anti-coal examples

unsightly

pollution

supplies of fuel limited

acid rain

non-renewable

pro-nuclear examples
fuel cheap
no foreseeable fuel shortage

pro-coal examples
safe
reliable
large coal reserves
disposal of solid waste is easier
to max 6

6

(b) choice 0 marks

any three valid reasons each with explanation, which may or may not be comparisons with other fuel

But

at least two of which must be relevant to this site

3

[9]

M20. (i) the Universe might have started with an explosion/"Big Bang"

1

(ii) light from galaxies is shifted to red end of spectrum
the further away the greater the red shift all galaxies receding furthest fastest
microwave background echo of big bang

for 1 mark each

2

[3]

M21. (i) currents of moving liquids/gases/fluids carrying/transferring energy
(can name fluid) 1

(ii) liquids/gases **expand** when their temperature rises/when they are heated

the **density** of the heated liquid/gas is then **less** than that of the colder liquid/gas which has not been heated

the warmer/less dense liquid/gas **then rises** through the colder/denser liquid/gas

the **colder/denser liquid/gas falls** to replace the liquid/gas which has risen, and in turn becomes heated

for 1 mark each

4

[5]

M22. (a) radio – 1500
ultra violet 3×10^{-8}
visible – 5×10^{-7}
X-rays – 1×10^{-11} 4

(b) 1×10^{10} Hz 10^{10} HzOK
for 4 marks

else 1×10^{10}
for 3 marks

else $3 \times 10^8/0.03$
for 2 marks

else $v = \text{frequency} \times \text{wavelength}$ or $3 \times 10^8 = 0.03f$
any answer with unit Hz scores 1, 2 or 3
for 1 mark

4

[8]

- M23.** (a) (i) £150
gets 2
- Else $1000 - (250 + 350 + 100 + 150)$ or $1000 - 850$
gets 1 2
- (ii) (Named) floor covering
OR Insulation under floor
for 1 mark 1
- (b) (i) Draught proof doors or fibre glass in loft or in cavity
For draught proofing
gains 1 mark
- Very low cost/easy to install
Repays for itself quickly/cost recuperated quickly
Reasonable energy saving
any 2 for 1 mark each
- For loft insulation
- Second lowest installation cost/easy to install
Reasonable large energy savings for this cost
Reasonable payback time
gains 1 mark
- For foam filled cavity**
Biggest energy/cash saving
Cost effective
any 2 for 1 mark each 3
- (ii) **Double glazing**

gains 1 mark

Costs most
Saves least energy
Least cost effective

any 2 for 1 mark each

3

[9]

M24. light from (distant) galaxies shows shift to red end of spectrum
wavelength increased explained by galaxies moving away from us
more distant galaxies have greater recession speed seen in all directions
suggests universe is **expanding** any sensible reference to similar effect on Earth

any 6 for 1 mark each

[6]

M25. (a) (i) much ash produced
acid rain
global warming/greenhouse effect
any 2 for 1 mark each

2

(ii) landscaping/road building*
removal of exhaust gases*
use alternative source not producing
CO₂* (*sequential (i))
for 1 mark each

2

(b) (i) $E = 5 \times 10^8 \times 3600 \times 24 \text{ J/day}$
 $\times 4 \text{ (for 4 generators) (sequential on } P \times t) = 1.73 \times 10^{14} \text{ (J/day)}$
for 1 mark each

3

(ii) $2.66 \times 10^{10} \times 18\,829 = 4.86 \times 10^{14}$
for 1 mark each

2

(iii) Eff = output/input
Eff = $1.73/4.86$
Eff = 0.36 or worked to a percentage
for 1 mark each

3

- (c) (i) boiler – heat to surroundings
turbine – not all steam energy used/heat/sound lost to surroundings
generator – heat in wires/coils/heat to surroundings
transformer – heat in wires/coils/heat to surroundings
any 1 for 1 mark

1

- (ii) energy spread out/diluted
as surroundings become warmer/energy lost as heat
difficult to use for further useful energy/transfers
any 2 for 1 mark each

2

[15]

M26. the higher the voltage the smaller the current
small current gives small energy loss
in the form of heat
(or efficiency greater, or energy/heat losses low – gets 1)
for 1 mark each

[3]

M27. coal has chemical energy
 when burnt heat/energy produced longest
 used to boil water/make steam sequence
 used to turn turbine(s)
 which now have ke
 turbine(s) turn generator(s)
 (where (ke) transferred electrical energy)
 (or electrical energy produced)
any 5 for 1 mark each

[5]

M28. (i) Speed = wavelength × frequency
 $3.108 = 1.5 \cdot 10^6 \times \text{wavelength}$
 Wavelength = 200m
for 1 mark each

3

(ii) 8

1

[4]

M29. (a) 90% of 2.1011
 2.16.1011

2

(b) (i) Can be located anywhere
 Continuous output
 Sustain coal industry
any 2 for 1 mark each

(ii) Low running cost
 No atmospheric pollution

Gives calm coastal waters
any 2 for 1 mark each

- (iii) High installation costs – built in sea
 Coast environmental damage – wildlife disturbance
 Time dependence – need dropping tide
any 2 for 1 mark each
(1 for a valid disadvantage, 1 for reason)

6

[8]

M30. To gain marks the candidate must

- | | | | |
|----|---|---------------------------------|---|
| 1. | Select one option | Advantages) | Max 4 |
| 2. | State 8 valid advantages/disadvantages/relevant comparisons with either of the alternatives | Disadvantages)
Comparisons) | Min 1
If no A or D or C then Max 4
No option then Max 4 |

Look for As, Ds for chosen scheme.
 Then for Cs compared with A/D for chosen scheme.

Below are listed some of the relevant mark scoring points.

	Advantages	Disadvantages
Wind	Land available to North No pollution Close/low transmission costs No fuel costs Renewable energy resource	Initial cost Many windmills/much land Calm day problem Few long term jobs
Coal	Waste land to North Prevailing wind to East Good road/rail transport Close/low transmission costs Save coal industry	Pollution Initial costs Fuel costs Non-renewable energy Resource

Overall labour intensive

Hydroelectric environment	No pollution Mountains/lake/river nearby No fuel costs Renewable energy source	Possible drought Distant/transmission costs Few jobs created Possible expensive underground transmission cable Construction of dam affects
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[8]

M31. (i) 0.5

1

(ii) wave speed = frequency \times wavelength

accept $v = f \times \lambda$

accept s for v

accept $m/s = Hz \times m$

accept



providing subsequent method correct

1

(iii) 15.2 km

both numerical answer and unit are required for both marks

numerical answer and unit must be consistent

allow 1 mark for 15.2 with incorrect or no unit

allow 2 marks for an answer of 1.52 km if the answer to (b)(i) was given as 5

r 1 mark for correct transformation

or 1 mark for correct use of speed = distance/time



unit on its own gains no credit

2

[4]

- M32.** (i) an innumerable collection of galaxies
accept any word meaning a large number for innumerable
accept all the galaxies
*do **not** accept everything* 1
- (ii) all matter concentrated at a (single) point
accept all matter part of a single 'superatom' 1
- single (massive) explosion (sending matter outwards) 1
- (iii) increasing or expanding 1

[4]

- M33.** (i) wave speed = frequency x wavelength
accept correct transformation
accept $v = f \times \lambda$
accept s for speed
accept $m/s = Hz \times m$
- accept  if subsequent use of  is correct* 1
- (ii) 500 000 000
*credit for 1 mark correct transformation in words **or** numbers*
***or** correct substitution* 2
- Hertz
3 marks for 500 000k Hz **or 500 MHz**

numerical answer and unit must be consistent for full credit

1

[4]

M34. (i) an enormous explosion causing matter to spread from one point

1

(ii) it is increasing **or** expanding

1

[2]

M35. (i) an enormous explosion causing matter to spread from one point

1

(ii) it is increasing **or** expanding

1

[2]